LA SALLE COUNTY NUCLEAR STATION - UNIT 1&2
COMMONWEALTH EDISON COMPANY

IMPEDANCE TEST REPORT

SAFETY-RELATED EQUIPMENT QUALIFICATION

POST NRC AUDIT DOCUMENTATION - VOL. 7

BY

ENGINEERING MECHANICS DIVISION

SARGENT & LUNDY ENGINEERS

6-1-81

EMD FILE #030469

SARGENT & LUNDY
ENGINEERS
CHICAGO

SUMMARY

This summary report contains comparison between results of final qualification reports (either analysis or test) and in-plant mechanical impedence measurements on seventeen representative LaSalle County-1 Nuclear Power Plant equipment. The objectives of this evaluation are:

To assess the similarity and differences between the impedence test results and the existing qualification reports; and

To re-assess the adequacy of the equipment for the additional hydrodynamic loadings, particularly in regard to the high frequency resonances reported as a result of impedence testing.

Based on the findings, as detailed in sections 1 thru 17 of this report, it can be concluded that, in general, a good agreement exists between the existing qualification reports and the results of the in-plant impedence tests. Moreover, there is adequate margin of safety to account for higher frequency resonances found in the impedence test measurements.

LASALLE COUNTY NUCLEAR STATION UNIT - 1 & 2

IMPEDANCE TEST REPORT

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Client Commonwealth Edison Company		Prepared by Ismail Kisisel	Date
Project LaSalle County, Units I & II		Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No. E21-C001	Approved by	Date

I. OBJECTIVE

The objectives of this study can be summarized as follows:

a) To assess the comparison between the impedance test results and the existing qualification report,

b) To re-assess the adequacy of the equipment for the additional hydrodynamic loadings, particularly in regard to the high frequency resonances reported as a result of impedance tests conducted in-situ.

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORT

Qualification report presented the results of analytical assessment and design qualification for this LPCS pump. (Ref. 1)

In order to assure the functional reliability and operability as well as the structural integrity, the following analytical efforts and considerations were undertaken:

a) A detailed dynamic/static analysis was performed on a three dimensional finite element model, which represented the mass, stiffness and boundary conditions of the pump-motor assembly.

b) The seismic and hydrodynamic load combinations (T-Quencher) as stipulated in the design environment were met.

c) Compliance was assured with the design requirements of the ASME B&PV., Section III Code (NB-3200) per service levels B & C and with other conservative methods of mechanics and stress analysis.

d) Operability was verified by checking relative displacements at critical locations.

Based on the results of analysis as presented in Ref. 1, this LPCS Pump was qualified as a reliable and functional pump for the RHR system in the ECCS.

The schematic representation of the finite element model is given in Figure 1. Essentially, the model is a three dimensional lumped mass beam element model, capable of accepting loads from the vertical and two horizontal directions simultaneously. Model has a total number of 105 nodes, 97 beam elements and 16 boundary elements. S&L SAPIV computer program was used for both dynamic and static analysis of the model.

A modal analysis was performed using the subspace iteration technique and all eigenvectors were saved on a permanent file for subsequent analysis with various dynamic loading conditions. Twenty-five modes were considered in the analysis, with the highest frequency of 140.5 cps. This frequency is high enough to cover the ZPA of all applicable response spectra. Table 1 on page gives the frequencies of the structure. As can be seen from this table, the fundamental frequency of the equipment is 7.82 cps.

III. SUMMARY OF PERTINENT RESULTS FROM IMPEDANCE TEST REPORT

SQRT in-plant impedance testing on the LPCS pump was done on July 24, 1980. At that time, all hydraulic and electrical connections to the

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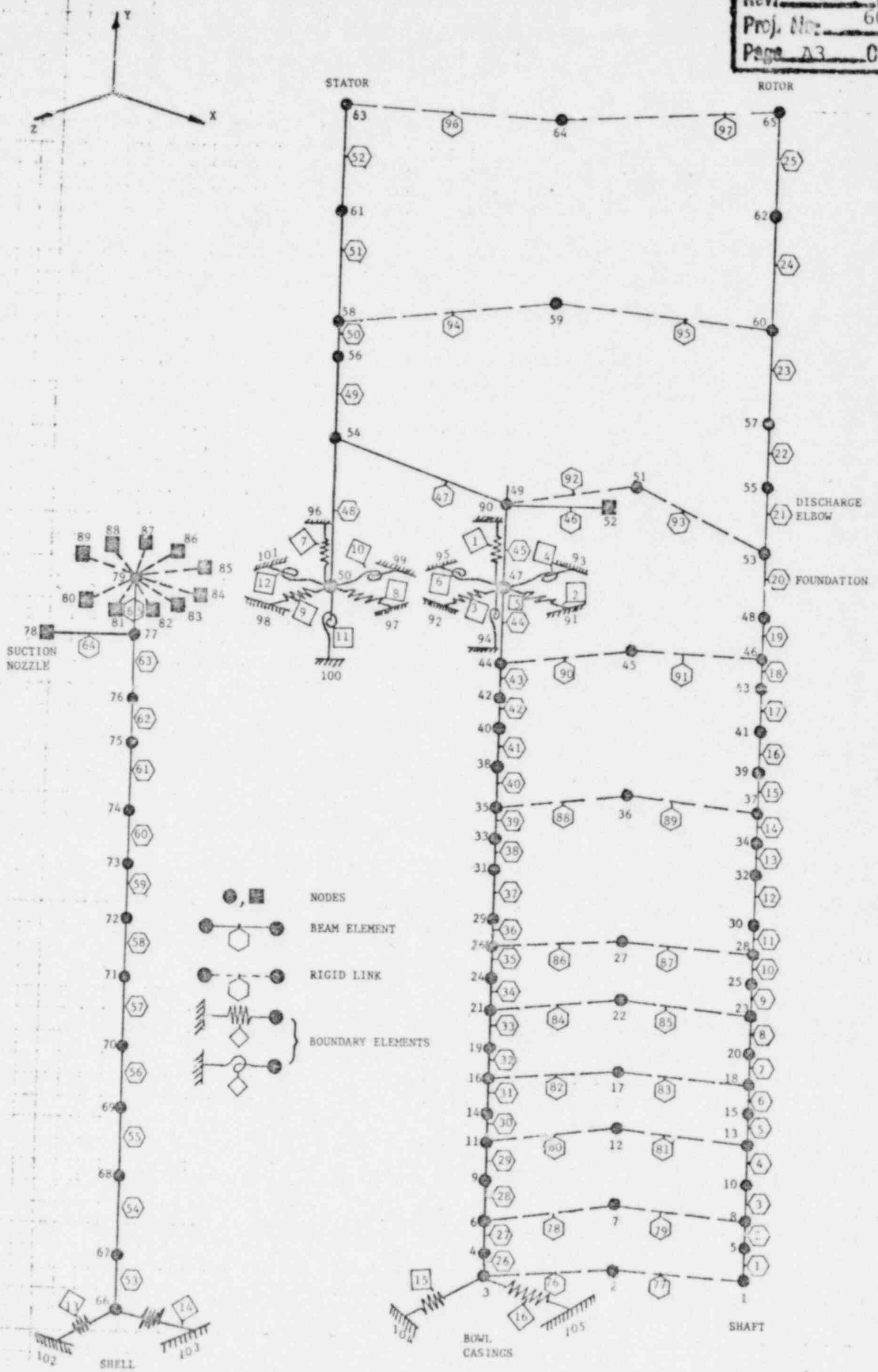

FIGURE 1. FINITE ELEMENT MODEL

TABLE 1 - EIGENFREQUENCIES

PRINT OF FREQUENCIES

MODE NUMBER	CIRCULAR FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)	TOLERANCE
1	.4912+02	.7818+01	.1279+00	.6705-08
2	.5352+02	.8518+01	.1174+00	.2559-08
3	.7308+02	.1163+02	.8598-01	.3421-07
4	.7606+02	.1211+02	.8260-01	.2253-07
5	.2167+03	.3450+02	.2899-01	.1594-07
6	.2173+03	.3458+02	.2892-01	.1240-07
7	.2335+03	.3717+02	.2691-01	.1848-07
8	.2590+03	.4122+02	.2426-01	.2935-07
9	.3729+03	.5935+02	.1685-01	.4124-07
10	.4034+03	.6421+02	.1558-01	.8730-08
11	.4605+03	.7330+02	.1364-01	.8963-08
12	.4825+03	.7679+02	.1302-01	.2232-07
13	.4923+03	.7835+02	.1276-01	.1750-07
14	.5284+03	.8409+02	.1189-01	.1954-07
15	.5818+03	.9259+02	.1080-01	.3988-07
16	.5910+03	.9406+02	.1063-01	.3304-07
17	.5957+03	.9481+02	.1055-01	.1984-08
18	.5962+03	.9489+02	.1054-01	.2878-07
19	.6201+03	.9869+02	.1013-01	.1167-08
20	.6219+03	.9898+02	.1010-01	.3537-08
21	.6266+03	.9973+02	.1003-01	.2506-07
22	.6269+03	.9978+02	.1002-01	.1471-07
23	.6430+03	.1023+03	.9772-02	.3082-07
24	.6845+03	.1089+03	.9179-02	.4870-05
25	.8828+03	.1405+03	.7117-02	.1305-07

pump and motor were completed. The wire frame model of the test A5 geometry is shown in Figure 2.

The TRANSITEK hydraulic shaker with the small weight (122 lb. mass) was attached to the top of the motor in the horizontal directions at points 27 and 31. The acceleration amplitudes at that point were limited to the range of 0.1 to 0.3g at the request of the contractor responsible for the pump installation. Further details pertaining geometry, method of testing and evaluation are given in References 2 and 3.

The modal parameters as identified by the tester (Ref. 2, Table 4.2.1) are given in Table 2, page A7.

IV. COMPARISON OF RESULTS

An inspection of the wire frame model of the impedance test geometry as given in Figure 2 indicates that the measurements were essentially conducted on the portion of the pump/motor assembly that is visible above the foundation plate; namely the motor stand, outside elements of the motor and the discharge elbow. Therefore, before attempting any comparison of the results, the frequencies that are pertinent to these parts are to be identified from the analysis results. This task is carried on, and by carefull inspection of the node displacements and rotations at the nodes of finite element model, describing the above mentioned portions of the equipment assembly, the important frequencies are identified and tabulated in Table 3, page A8.

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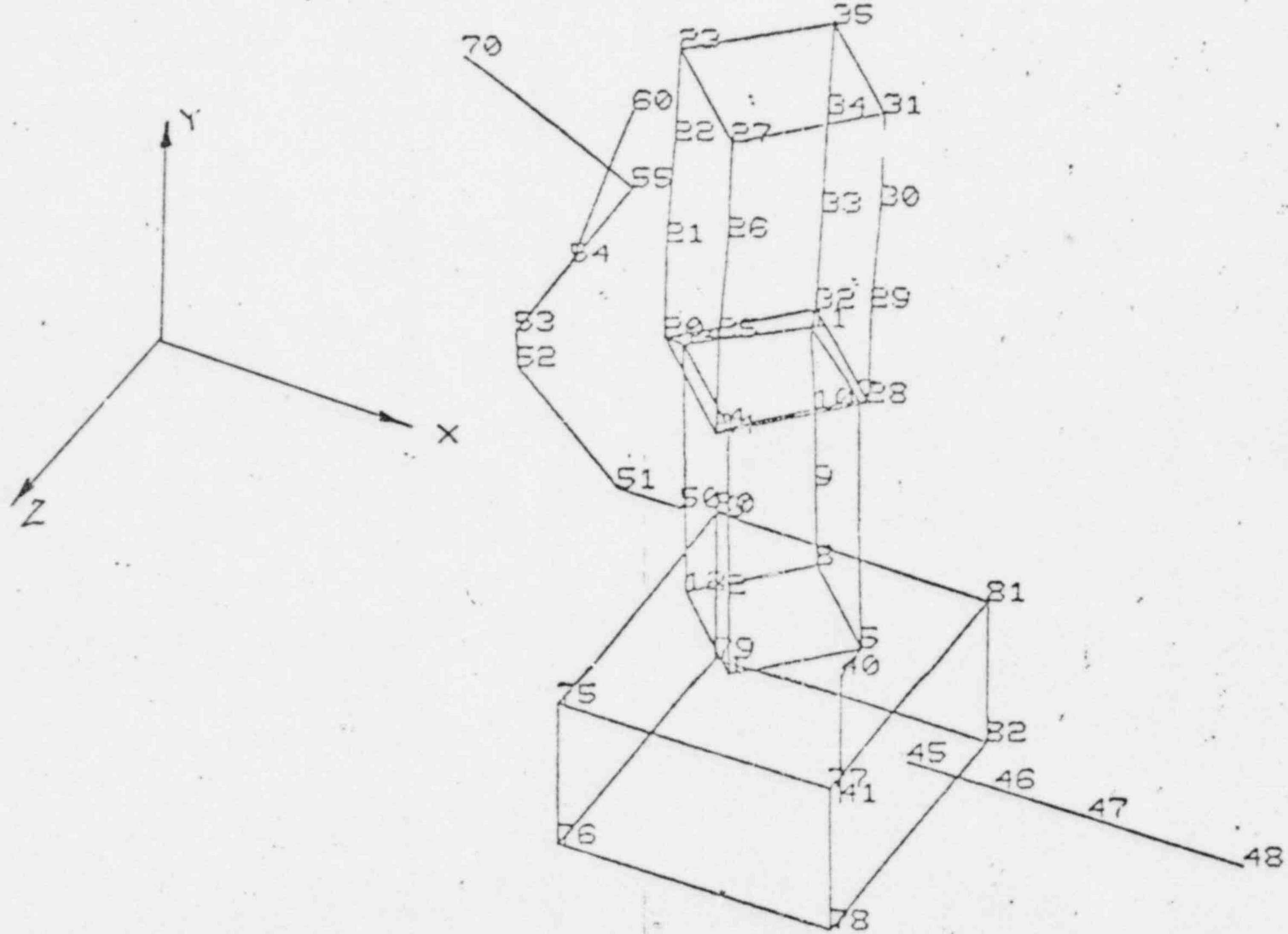

Figure 2

Revised Drawing
of the LPCS Pump

TABLE 2

MODAL PARAMETERS OF THE LPCS PUMP

(IMPEDANCE TEST)

Mode	Frequency	Damping	Ref.	Res.
1	11.722	0.047359	27Z+	27Z+
2	53.341	0.041495	27Z+	27Z+
3	63.485	0.041254	27Z+	27Z+
4	10.355	0.012157	31X+	31X+
5	83.151	0.043828	31X+	31X+
6	12.150	0.016476	31X+	31X+

The Z-direction input force spectrum and four representative transfer functions in various directions are presented on pages A10 - A14.

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Project LaSalle County, Units I & II	Reviewed by	Date
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TABLE 3

ANALYTICAL FREQUENCIES FOR THE PORTIONS OF THE EQUIPMENT CORRESPONDING TO THE TESTED REGION

MODE	FREQUENCY
1	7.82
2	8.52
3	11.63
4	12.11
9	59.35
10	64.21
11	73.30
12	76.79
13	78.35
14	84.09
15	92.59

By comparing Tables 2 and 3 following can be said:

a) frequency range covered by analysis is inclusive of the frequency range presented as test results.

b) and of six experimental frequencies presented, four resonant frequencies can be matched very closely with frequencies given in Table 3, namely, 11.722 and 11.63, 12.150 and 12.11, 63.485 and 64.21, 83.151 and 84.09.

c) by investigating transfer functions given in pages A11 - A14, it can be concluded that there are a number of resonant frequencies between 53. and 65. cps., which is an inclusive range for modes 9 and 10 reported in Table 3,

d) by investigating the input force spectrum given on page A10, it is concluded that frequencies below 10 cps. were not adequately excited during the experiements, resulting a difficulty in positive identification of resonant frequencies below 10 cps. Yet, investigation of transfer functions in Z direction that are presented on pages A12 and A13 indicate that there is an identifiable frequency in the vicinity of 8.5 cps, however, not well defined due to insufficient excitation.

e) In general there is good agreement between analytical and test results. Small differences may be attributed to the conservative approach that is followed in the finite element modelling.

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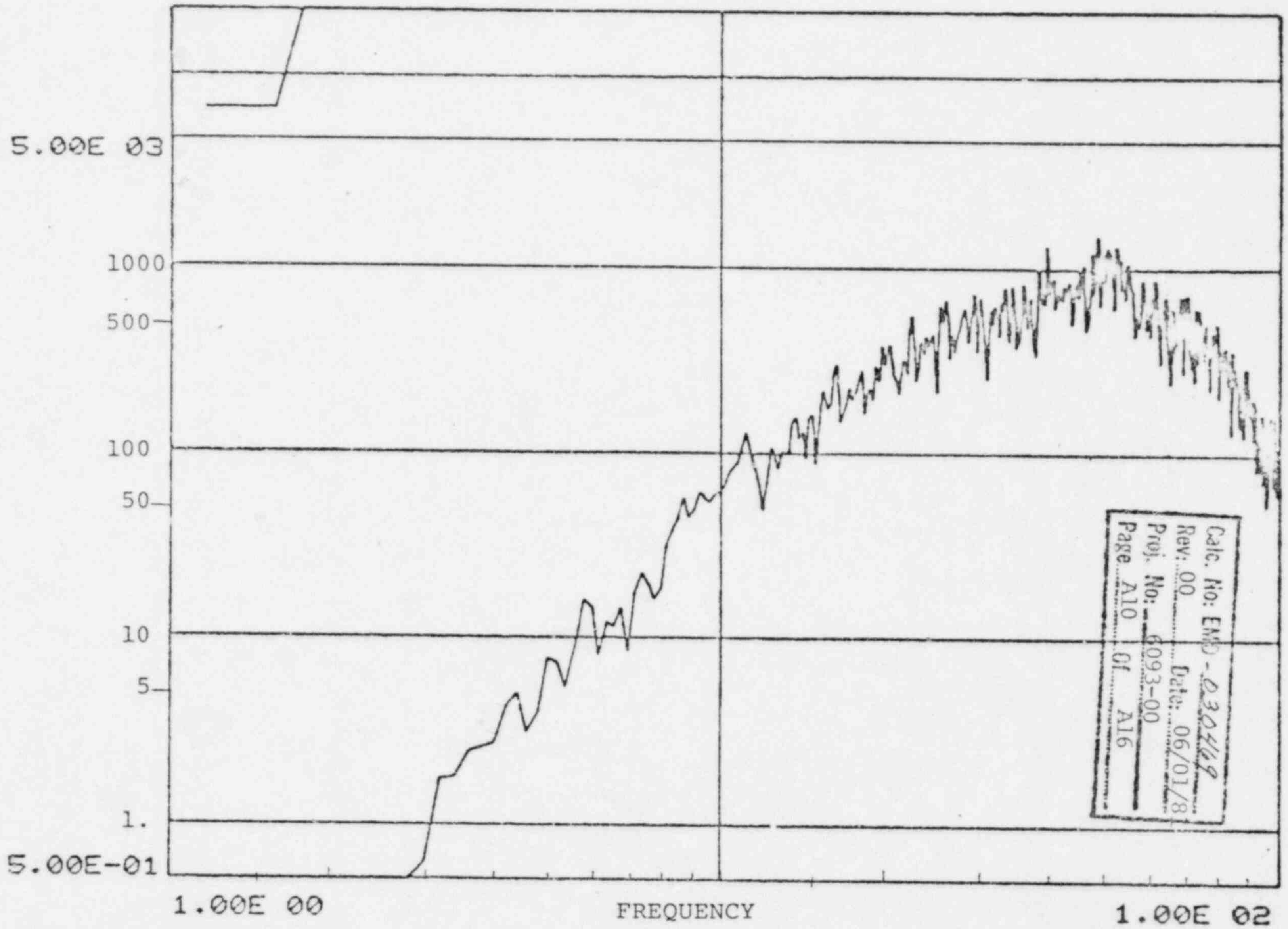

A1:LO PR CORE SPRA PUMPS

072480-000000 SPECTRUM-BODE
022681-000000 27Z+ 27Y+ #1:

Z-DIRECTION INPUT FORCE SPECTRUM

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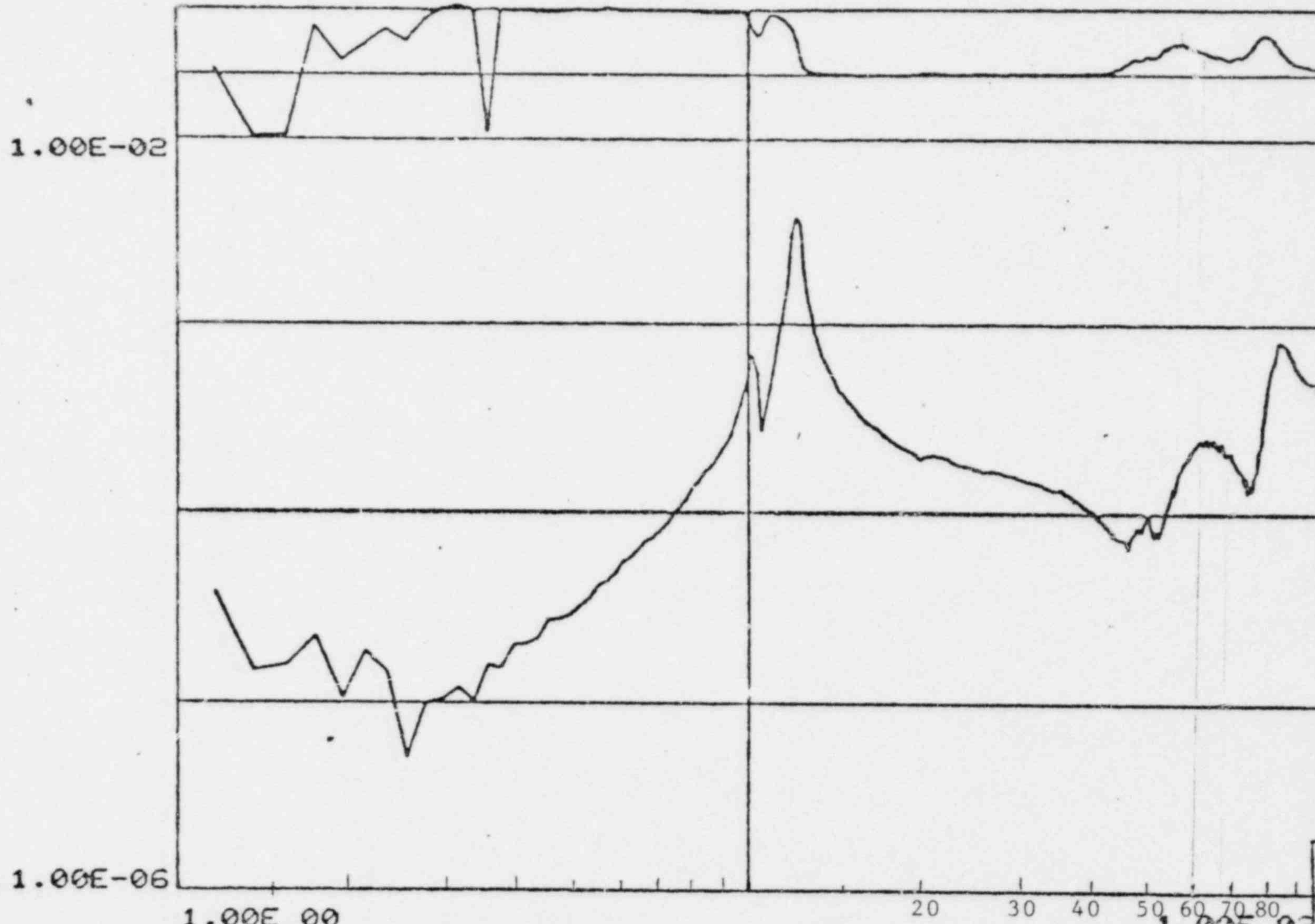

A1:LO PR CORE SPRA PUMPS

072480-000000 FREQRESP-BODE
020981-000000 31X+ 31X+ 80:

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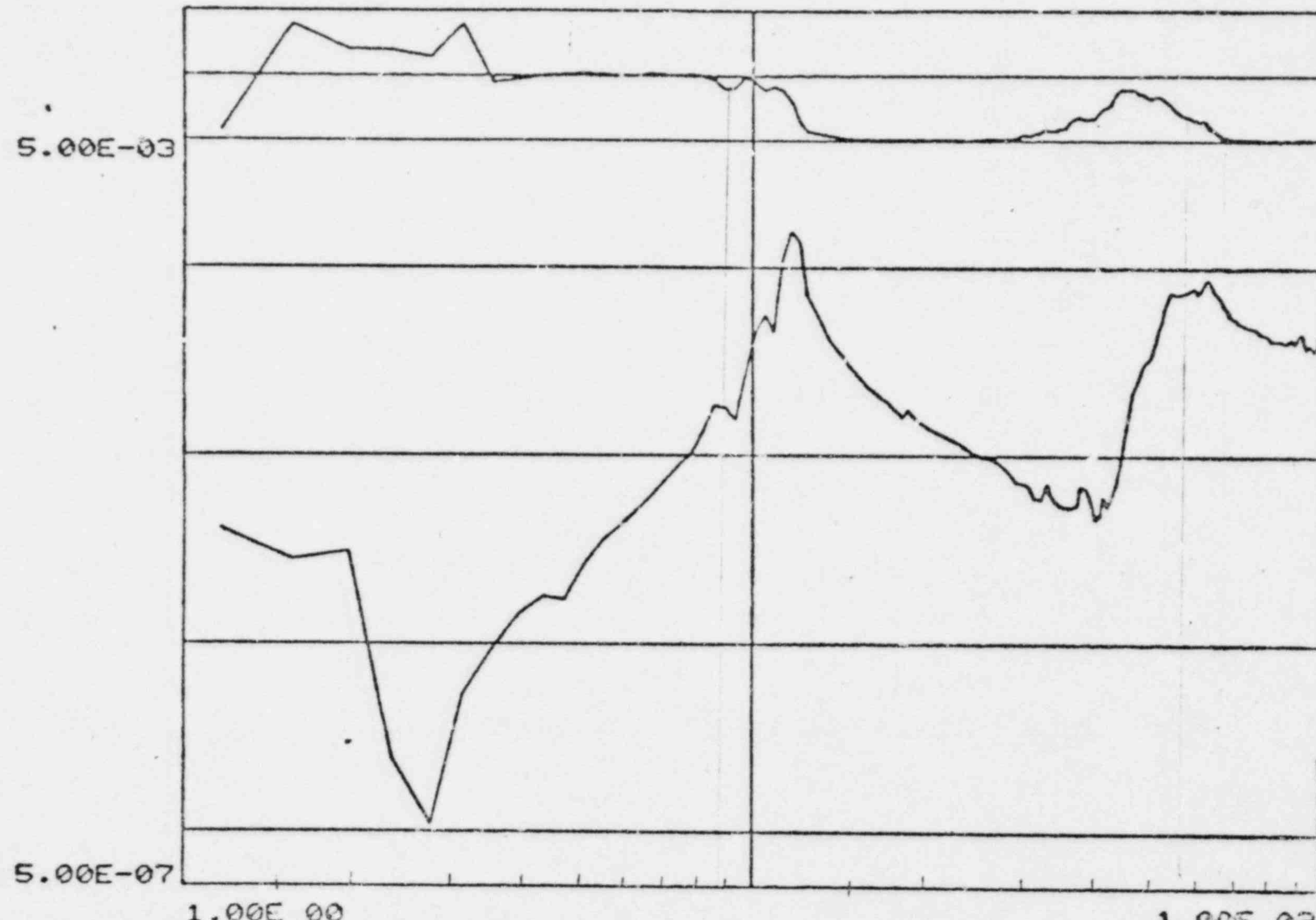
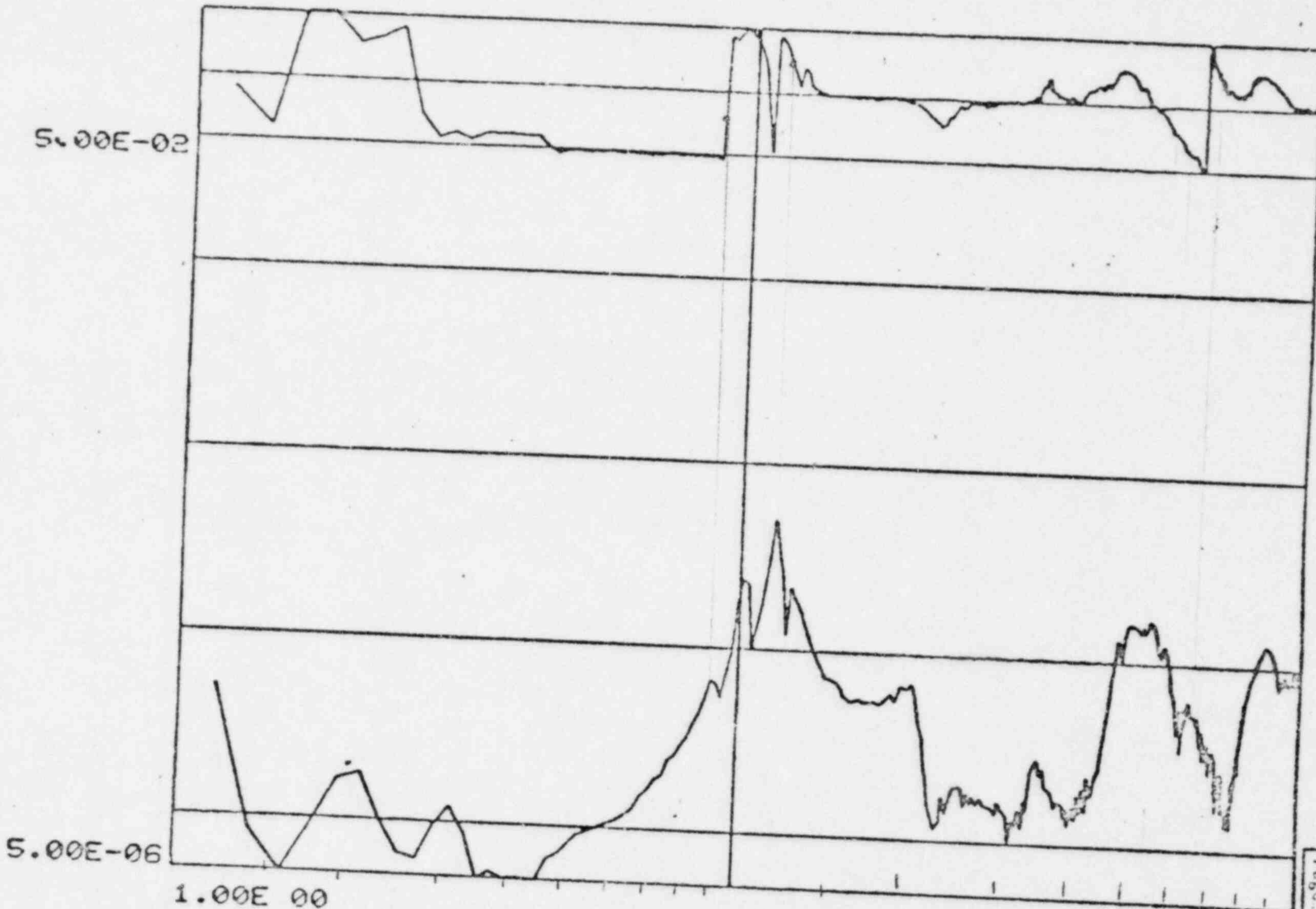


A1:LO PR CORE SPRA PUMPS

072480-000000 FREQRESP-BODE
020981-000000 272+ 35Z- 801



A1:LO PR CORE SPRA PUMPS

072480-000000
020981-000000

FREQRESP-BODE
31X+ 27Z+ 80:

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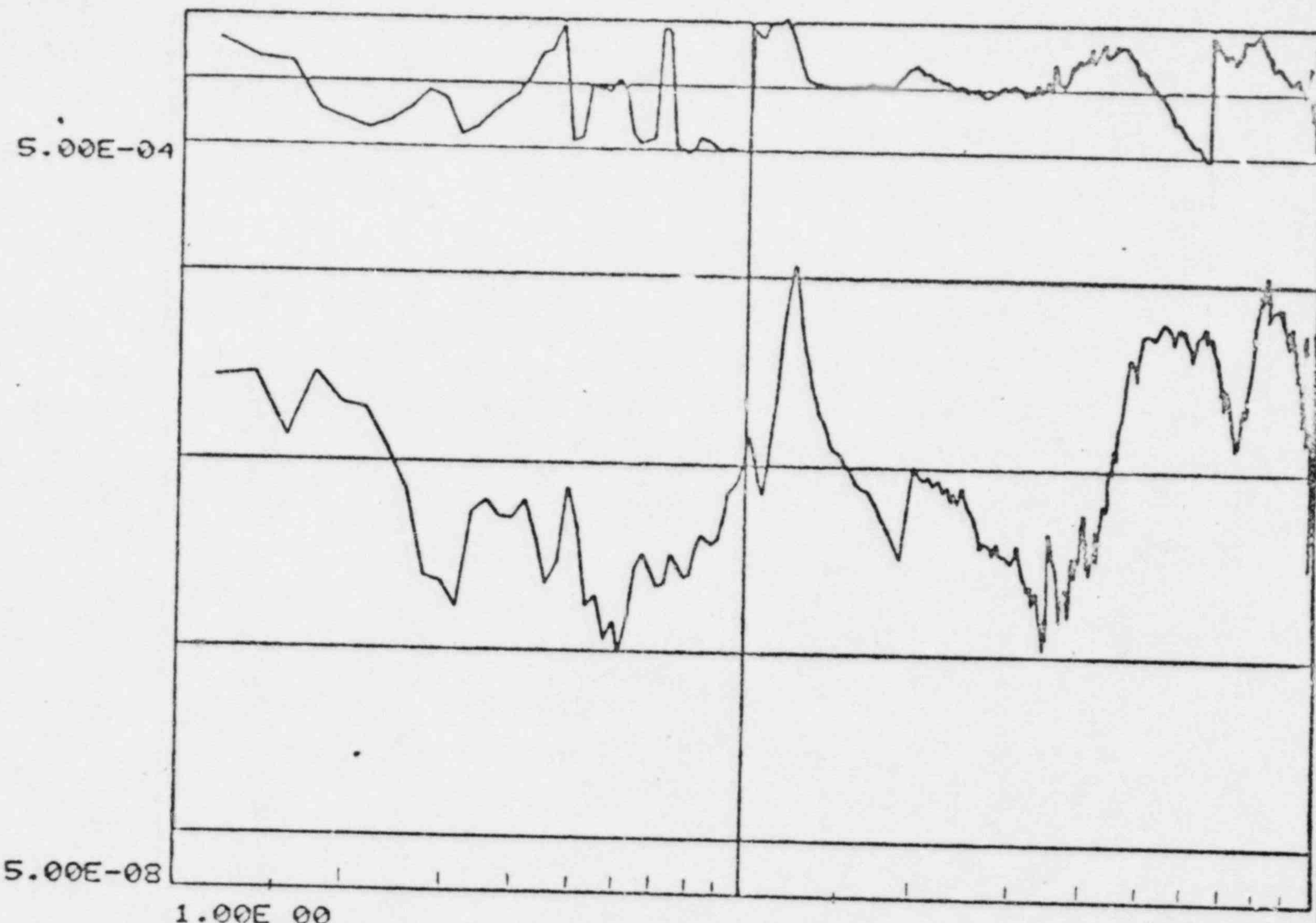


A1:LO PR CORE SPRA PUMPS

072480-000000 FREQRESP-BODE
020981-000000 31X+ 35Y+ 30:

V. CONSIDERATION OF HIGH FREQUENCY RESONANCES

In the case of this equipment, there is no special evaluation required for the high frequency resonances at this stage, simply because the analysis considered both the seismic and hydrodynamic (T-quencher) response spectra load combinations, and the frequency range was wide enough (7.82 - 140.5 cps), and equipment was qualified for this frequency range.

VI. CONCLUSION

Comparison and discussion of results indicate that the frequencies identified by analysis and by impedance testing are practically the same, confirming that the method of analysis, and the modelling technique using finite element methodology was correct and adequate.

VII. REFERENCES

1. "Equipment Qualification of Low Pressure Core Spray Pump - LaSalle County 1", Sargent & Lundy, EMD File No. 028197, Rev. 00, March 1981.

2. "Final Test Report - SQRT In-Plant Impedance Testing, LaSalle County 1", Transitek, Inc. Job No. 80042, EMD File No. 029601, Rev. 00, March 1981.

3. "Impedance Test Results for LPCS Pump" (Add. to Ref. 2 above).

I. OBJECTIVES

The objectives of this study are:

(i) To compare and draw conclusions on equipment adequacy based on the impedance test result and the existing qualification report.

(ii) To determine equipment adequacy for the additional hydrodynamic loads. This is of additional concern in view of the high frequency resonances reported in the impedance test.

(iii) To assess the importance of pipe vibration on pipe mounted equipment particularly with regard to the transmissability of high frequency vibration through the piping system.

ANALYTICAL MODEL (3)

A conservative estimate of the minimum natural frequency has been obtained (3) by considering a single degree of freedom-limped mass cantilever model. By inspection it is clear that the yoke section is the weakest section in the valve assembly. Thus a consideration of this section would yield the lowest natural frequency for the system.

The single-degree of freedom model is

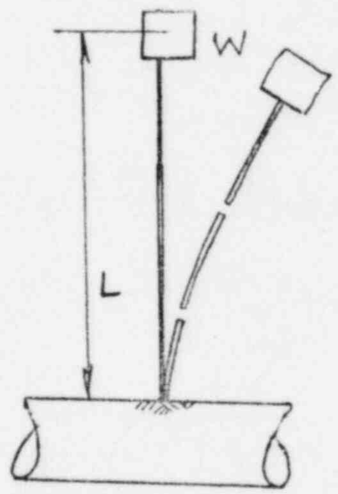


Figure 1

The natural frequency, f_n is completed using

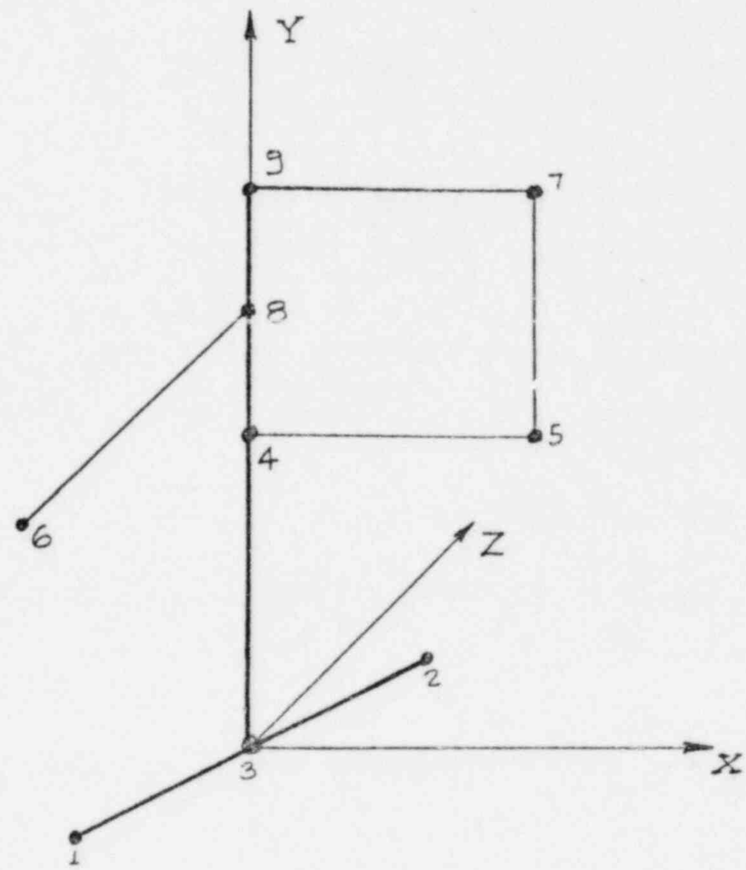
$$f_n = \frac{1}{2\pi} \left\{ \frac{3EI}{(W/g)L^3} \right\}^{1/2} \quad ---(i)$$

The computed frequency using (i) above is 62 Hz. (3)

TEST MODEL

1. Geometry. (2)

   The geometry of the 2" pipe mounted valve described by the location of the accelerometers is shown below.



Nodes 1 thru 9 represent location of accelerometers.

Discussion of Experimentally Obtained Frequencies & Mode Shapes

In the experimental analysis by Transitek (2) node 7 has been excited along the three coordinate exes. The following natural frequencies have been identified.

(i) Seven frequencies based on excitation along the X axis at node 7.

(ii) Nine frequencies based on excitation along the Y axis at Node 7.

(iii) Five frequencies based on excitation along the Z axis at node 7.

Based on the above frequencies the structure-mode shapes have been plotted. Cross coupling coefficients have not been included due to the lack of a definite orthogonal structure frame of reference.

Excitation Along X Axis

Seven equipment natural frequencies have been identified for structure excitation along the X axis at node 7. From the mode shapes it is seen that six of these modes are associated with pipe movement. Hence a realistic assessment of the actual equipment frequency can be made only if quantitative data of the transmitted vibration is studied. These modes correspond to shapes 1 thru 5 and 7 on pages 28 thru 32 and 33 respectively of the Transitek Report (2).

Shape 6 on page 33 of the Transitek Report corresponding to a frequency of 60.07 Hz deserves further investigation. Pipe motion at this frequency is minimal in contrast to the rest of the modes. Node seven, which is further away than node 5 from the point of support, displaces more than node 5. These observations suggest a cantilever type valve motion.

A 1 d-o-f vibration analysis of the gate-valve indicates a flexural frequency equal to 60.07 Hz. Thus showing close agreement between the experimental and the 1 d-o-f analytical model. Equipment shape corresponding to this frequency as represented by the wire model is shown on page B3 .

A typical system frequency corresponding to pipe motion is shown on page B11.

Excitation Along Y Axis

Equipment excitation at node 7 along the Y direction is characterized by movement of the pipe along the Y axis. Some local transmitted vibration is present, however the importance of this vibration can only be assessed by quantitative values for each of the nodes. Pipe vibration can be characterized by the following dominant pipe vibratory modes.

(i) Rocking Mode

Typically shapes 1, 2 and 3 pages 36 thru 38 of (2). In this mode both the ends of the pipe diverge after a common meeting point.

(ii) Parallel Mode

Shape 4 page 39 of (2) corresponds closely to this mode. The pipe is seen to exhibit a nearly parallel up and down motion.

(iii) Convergent/Divergent Mode

In this mode the pipe vibratory motion is such that the pipe axis tends to either diverge or converge from some point either on or off the pipe. These modes are shown on p. 40 thru 44 of (2).

It is clear that none of the above modes constitute a global mode. Local modes associated with pipe transmitted frequencies may be present. The extent, and severity of these local modes can be gauged using quantitative nodal displacement data. An example of each of the modes (i) thru (iii) is shown on pages B11thru B14.

Excitation Along Z Axis

Five mode shapes corresponding to five natural frequencies identified are shown on pages 46 thru 50 of (2). All of the modes shown correspond to pipe motion. A typical system frequency corresponding to pipe motion is shown on page B15. Pipe motion is clearly identifiable in this plot.

Comparison of Experimental & Analytical Equipment Frequencies

Experimentally Obtained Valve Frequencies (2)

Equipment Frequency Hz	Axis	Remarks - (Based on Mode Shape)
11.45	X	Pipe motion observed - valve stem moves with pipe
13.66	X	" " " " " " " "
18.82	X	" " " " " " " "
21.30	X	" " " " " " " "
31.89	X	" " " " " " " "
60.07	X	Cantilever mode observed
69.57	X	Pipe motion observed - valve stem moves with pipe
7.339	Y	Pipe motion observed - valve stem moves with pipe
10.7	Y	" " " " " " " "
13.16	Y	" " " " " " " "
21.46	Y	" " " " " " " "
37.67	Y	" " " " " " " "
70.61	Y	" " " " " " " "
73.02	Y	" " " " " " " "
90.75	Y	" " " " " " " "
94.12	Y	" " " " " " " "
7.216	Z	Pipe motion observed - valve stem moves with pipe
6.691	Z	Pipe torsional frequency.
21.49	Z	Pipe motion observed - valve stem moves with pipe
31.32	Z	" " " " " " " "
37.52	Z	" " " " " " " "

Analytical Equipment Frequency

A cantilever frequency of 62 Hz is computed for the valve assembly. The valve is modeled as indicated in Figure 1 of page B2. The computed frequency compares well with the experimentally observed frequency of 60.07 Hz.

Qualification For Hydrodynamic Loads

The valve is qualified for 6g (3). The response spectra shown on pages B16 thru B19 indicate that the acceleration obtained by summing the horizontal slab, vertical wall and slab acceleration values is 1.86g. This value is below the value for which the valve is qualified. Hence the valve is qualified.

Brief Evaluation of Piping Vibration Tests (4)

The following three piping subsystems were tested:

2" line	RI-65C Subsystem
4" line	HP-06 Subsystem
14" line	HP-02 Subsystem

The original qualification analysis for the 4" & 14" pipe mounted equipment indicated that the valves were unacceptably flexible.
The required design changes were then made and subsequently implemented in the field. *

The impedance test was performed on the 4" & 14" lines before the required design changes were implemented in the field. Thus no basis for comparison exists between the final qualification report incorporating the required design changes and the Impedance Test performed prior to the incorporation of the neccessary design changes.

For the case of the 2" pipe line the original qualification report was adequate and the equipment tested corresponded to the equipment qualified analytically. Hence an excellent basis of comparison between the pipe frequencies and the equipment frequencies exists.

The frequencies at the valve location given in (4) and reproduced on pages B11 & B12 are identical to the valve frequencies (pages B7 &B8) given earlier. The average damping ratios expressed in terms of the % of critical damping are 2.48%, 3.2% and 2.7% along each of the three orthogonal axes X,Y &Z respectively. The tests (4) further indicate that the high frequency vibrations are attenuated no faster than the low frequency vibrations in the piping system.

* The data on these design changes were transmitted to NRC thru our transmittal dated 3-10-81 (EMD File # 028847).

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For 2" Motor Operated Gate Valve			Calc. No. EMD 030469	
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				Page B10	of B 22

Client Commonwealth Edison Company		Prepared by Nasir Munir	Date
Project LaSalle County, Units I & II		Reviewed by	Date
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Concluding Remarks

The 2" motor operated gate valve is qualified for the additional hydrodynamic loads. The response spectra indicate a maximum acceleration of 1.86g. The valve however can withstand an acceleration of 6 g. Good correlation exists between the analytically computed frequency (62 Hz) and the experimentally obtained frequency. (60.07 Hz).

References

1. Final Test Report - SQRT In Plant Impedance Testing
   LaSalle Co. 1, Transitek, Inc. EMD File No 029461. 3-17-81.

2. Impedance Test Results for 2" Motor Operated Gate Valve
   (Add. to Ref. 1) 3-17-81.

3. Equipment Qualification of 2" Motor Operated Gate Valve
   LaSalle Co. - 1, Sargent & Lundy EMD File No. 024218.

4. Final Test Report Phase I Piping Vibration Tests
   LaSalle Co. - 1, Transitek, Inc. EMD File No 029605
   3-26-81.

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TABLE 4.3.3.1

MODAL PARAMETERS MEASURED IN THE X DIRECTION

MODE	FREQUENCY (HZ)	DAMPING (Fraction of Critical)
1	11.45	.065
2	13.66	.034
3	18.82	.018
4	21.30	.022
5	31.89	.012
6	60.10	.009
7	69.57	.014

TABLE 4.3.3.2

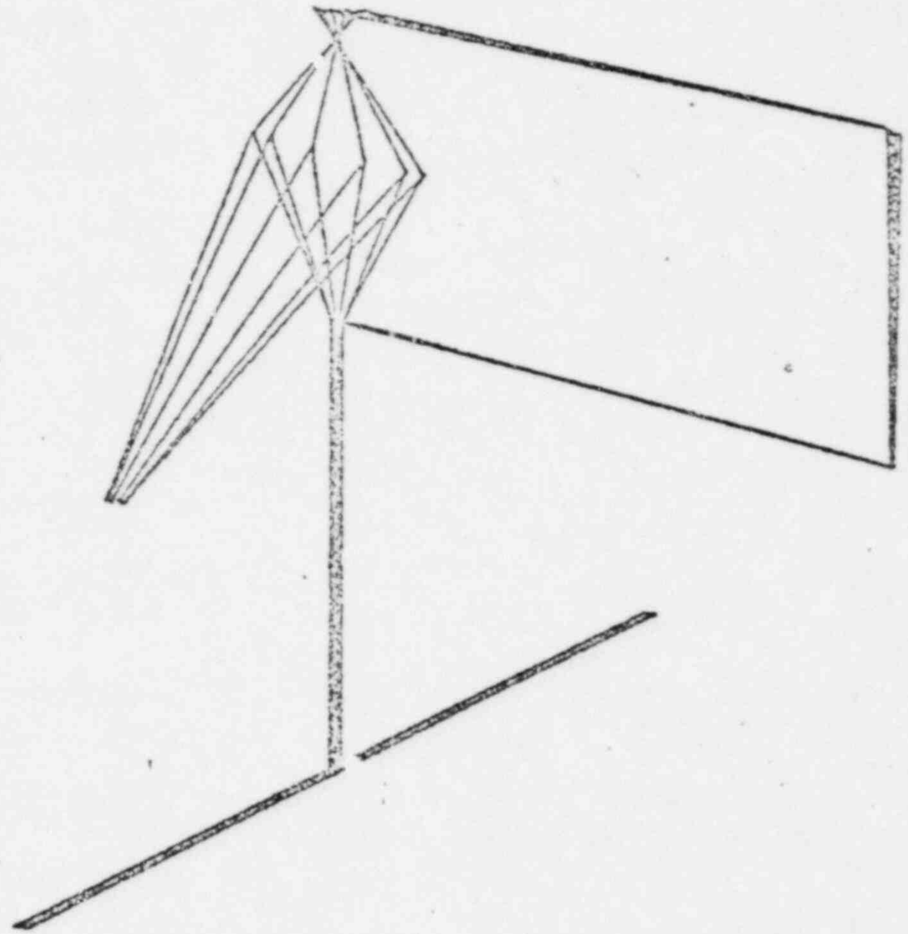
MODAL PARAMETERS MEASURED IN THE Y DIRECTION

MODE	FREQUENCY (HZ)	DAMPING (Fraction of Critical)
1	7.34	.016
2	10.77	.063
3	13.16	.036
4	21.46	.026
5	37.67	.019
6	70.61	.017
7	73.02	.066
8	90.75	.025
9	94.12	.020

TABLE 4.3.3.3

MODAL PARAMETERS MEASURED IN THE Z DI'ECTION

MODE	FREQUENCY (HZ)	DAMPING (Fraction of Critical)
1	7.22	.029
2	9.69	.039
3	21.50	.023
4	31.32	.029
5	37.52	.015



CANTILEVER MODE: PIPE MOTION MINIMAL, GRADUALLY TAPERED DEFORMATION AT EXTREMITIES OF MOTOR

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X-AXIS SHAPE 6

15: 7X+ COMP,F= 60.070 HZ (0.4, 1.0, 1.0, 0.0)=VIEW

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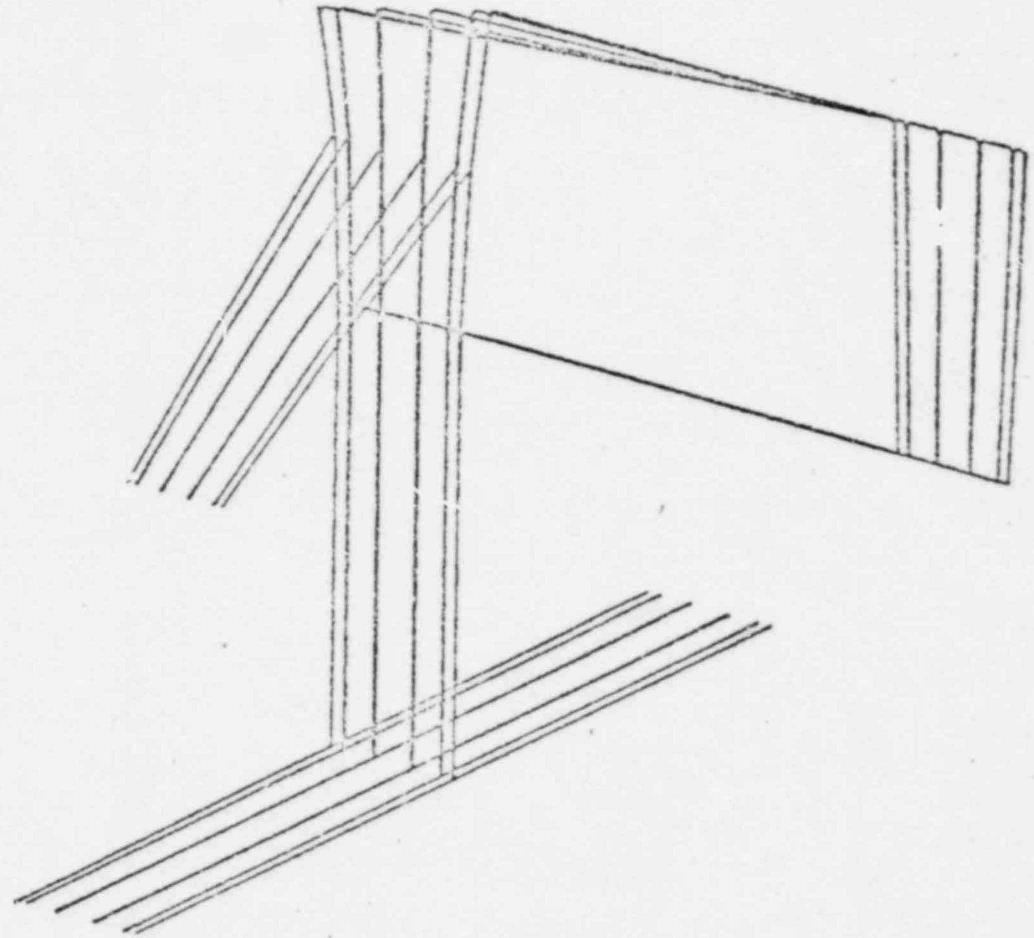
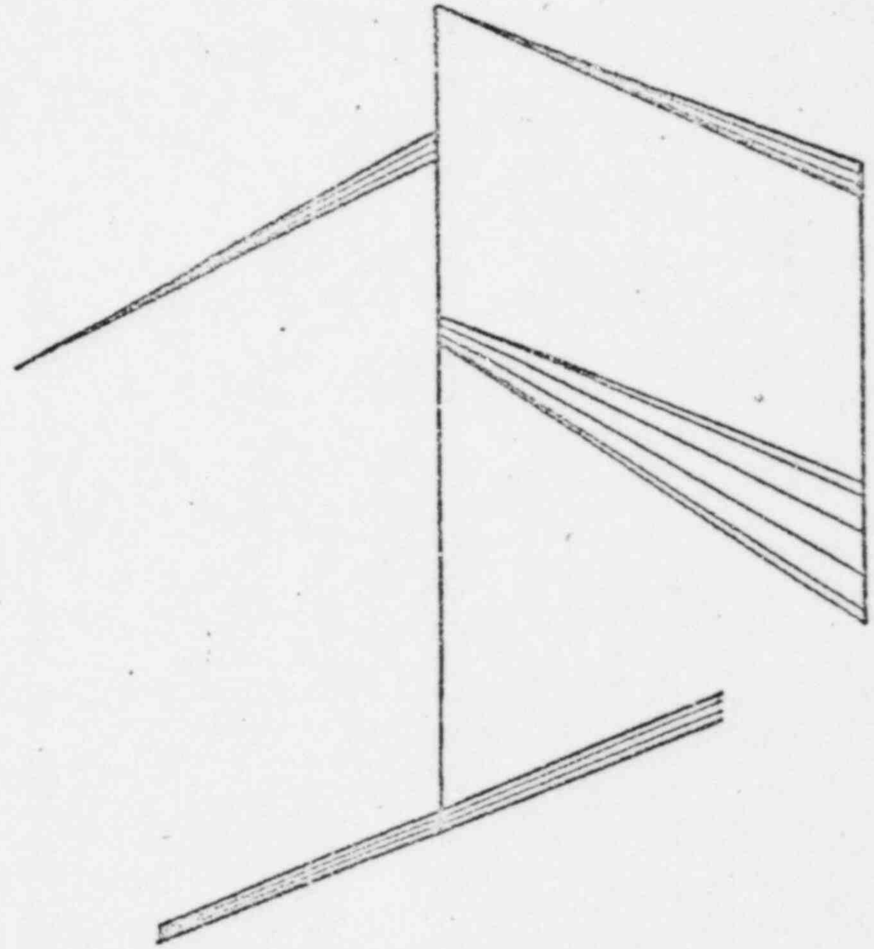


MOVEMENT OF PIPE & STEM SEEN

X-AXIS SHAPE 1
10: 7X+ COMP,F= 11.450 HZ (0.4, 1.0, 1.0, 0.0)=VIEW



PARALLEL MODE

Y-AXIS SHAPE 4

4: 7Y+ COMP,F= 21.460 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

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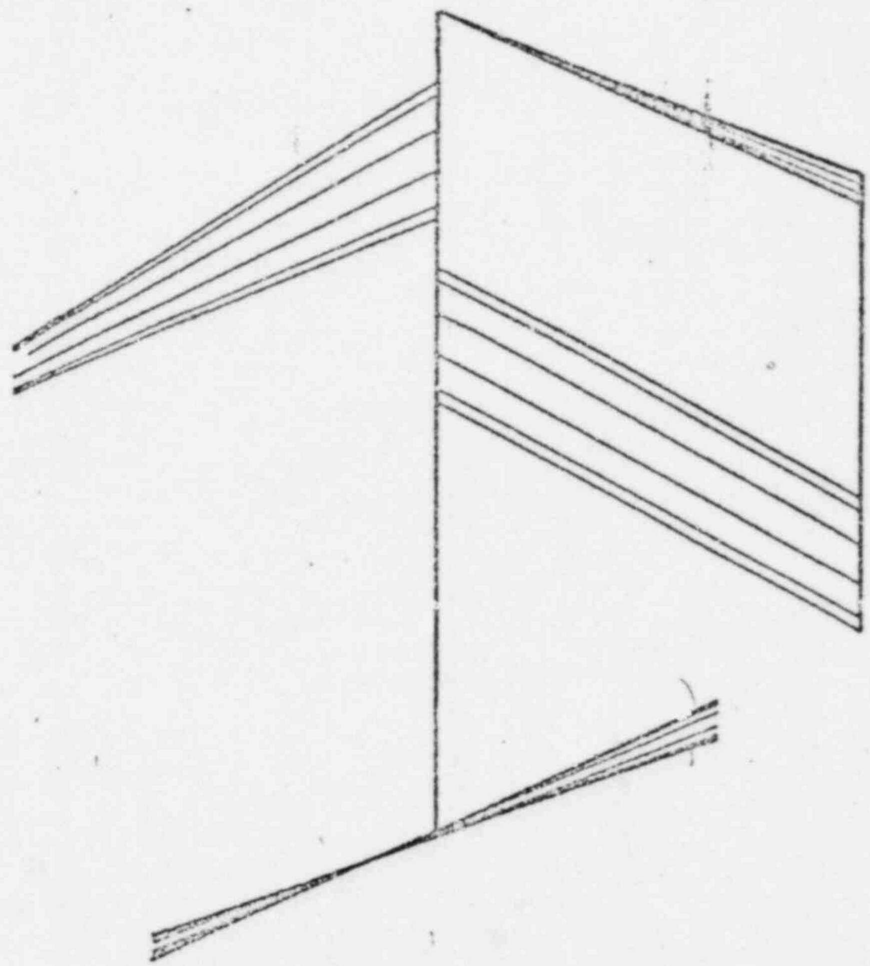

ROCKING MODE

Y-AXIS SHAPE 1

1: 7Y+ COMP,F= 7.339 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

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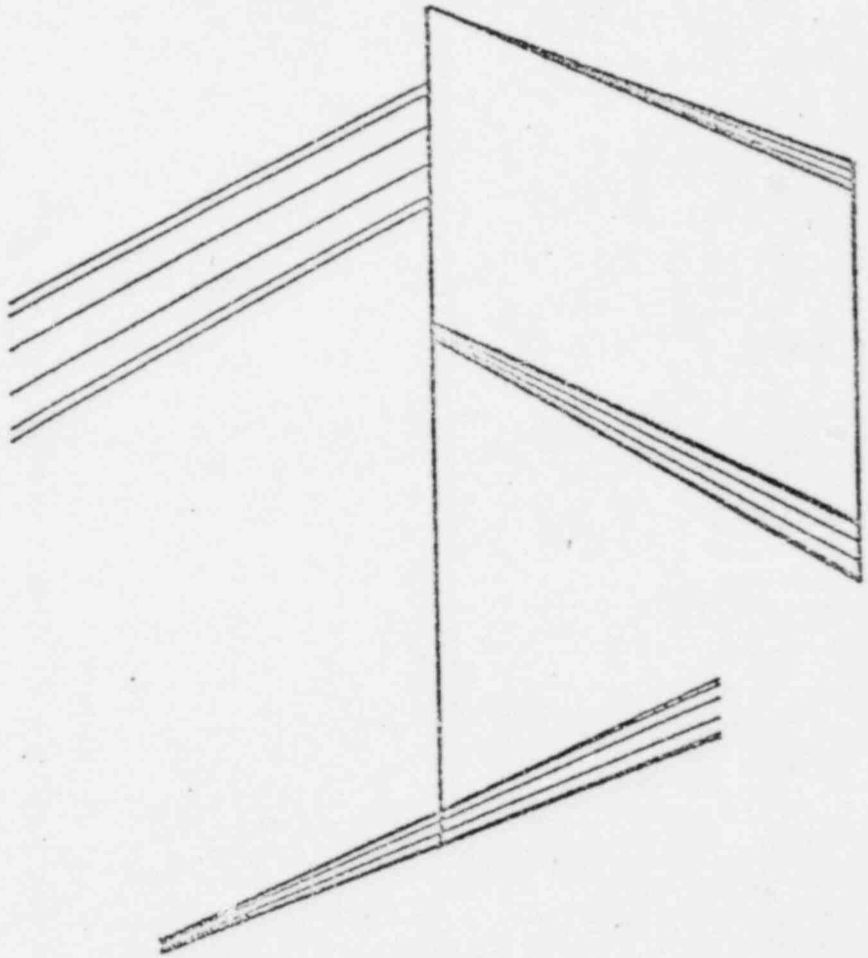

CONVERGENT MODE

Y-AXIS SHAPE 5

5: 7Y+ COMP,F= 37.670 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD-030147
Rev: 00 Date: 06/04/86
Proj. No: 4266-00
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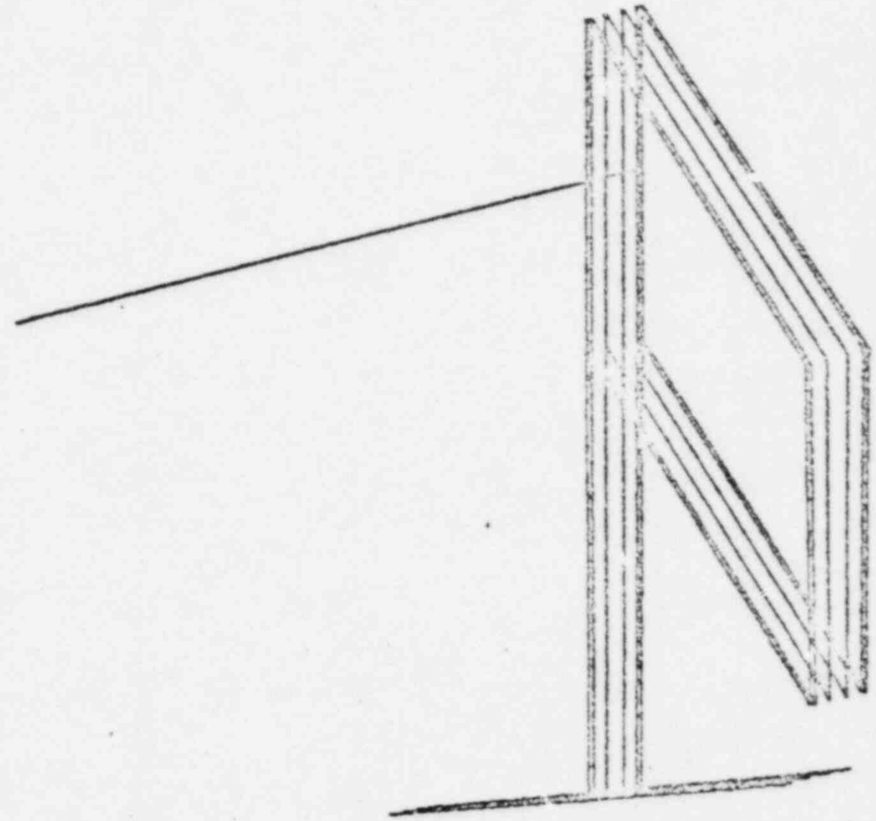

SHOWS TRANSVERSE MOVEMENT OF PIPE ACCOMPANIED BY STEM MOVEMENT

SHAPE 1 MODIFIED

S: 7Z+ COMP,F= 7.216 HZ (1.0, 1.0, 0.4, 0.0)=VIEW

Calc. No: EMD - 030467
Rev: 00 Date: 06/01/90
Proj. No: 4266-00
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SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For		Calc. No. 030469	
			Rev. 00	Date 06/01/81
	Safety–Related	Non–Safety–Related	Page B19	of B.22

Client Commonwealth Edison Company		Prepared by	Date
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Proj. No. 4266/4267/6093-00	Equip. No.	Approved by	Date

REQUIRED RESPONSE SPECTRUM CURVE

(EMERGENCY CONDITION)

FOR

1 E51 - F019

2" VALVE PLUS PIPING

LOCATED IN

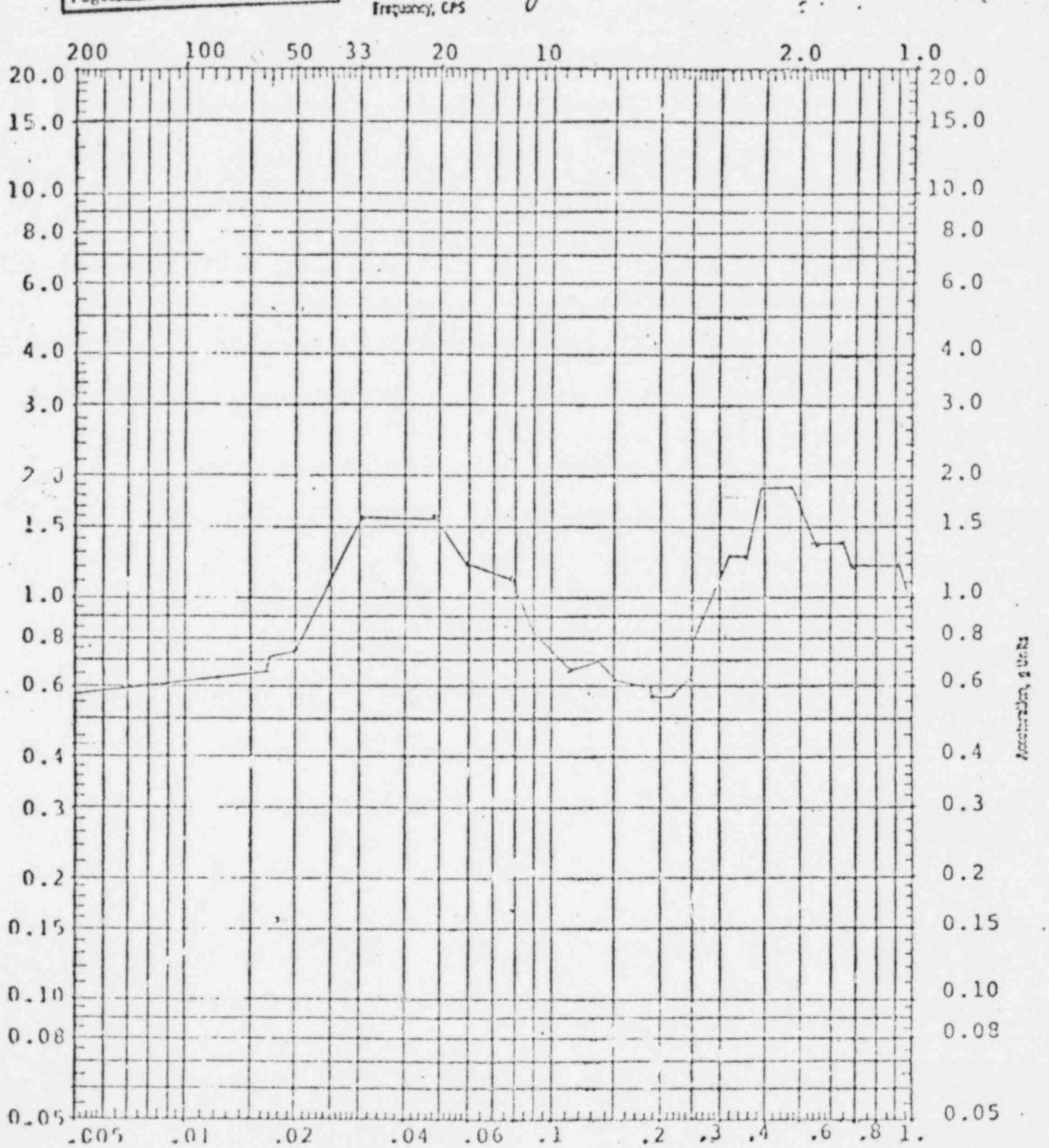
REACTOR BUILDING El. 687'0"

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 3289-18
DESIGN BY [illegible] DATE 1-22-80
CHECKED BY [illegible] DATE 1-22-80 SHEET 4 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/31/81
Proj. No: 4266-00
Page B.?? of B.22

REV. NO.	0						
DATE	1-22-80						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 694'6" 2% Damping Horizontal Slab NS-EW

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-18
DESIGN BY Saldana DATE 1/22/80
CHECKED BY DATE 1-22-80 SHEET 6 OF 27

SARGENT & LUNDY ENGINEERS

Calc. No: EMD- 030469
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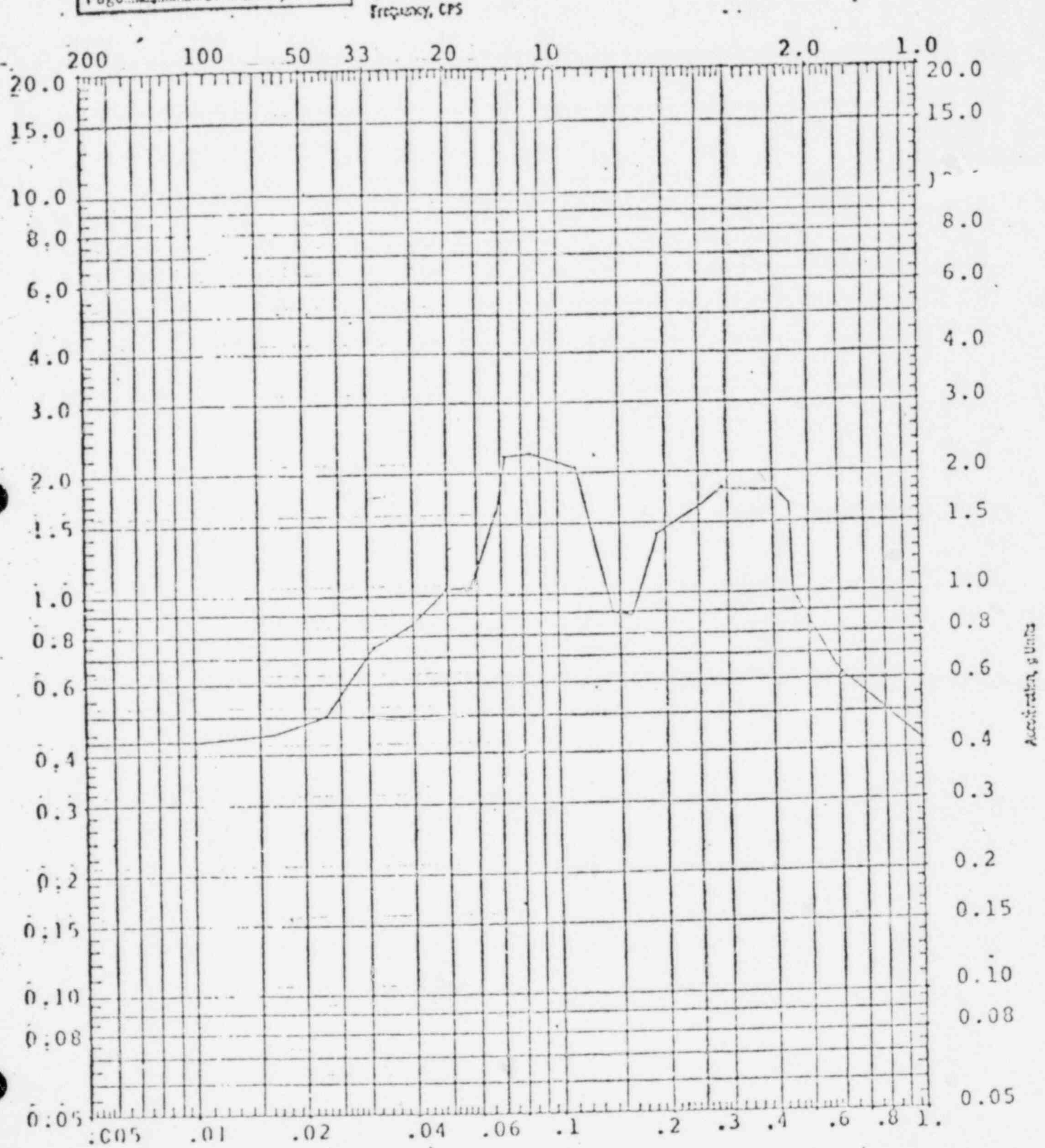
REV. NO.	0						
DATE	1-22-80						
INITIALS							



REACTOR BUILDING-ELEVATION: 694'6" 2% Damping Vertical Wall
Envelop of a) SSE + CO_{LEVY-1}
b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

CLIENT COMMONWEALTH EDISON COMPANY

SARGENT & LUNDY ENGINEERS

PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4389-18

DESIGN BY S. Vaupa DATE 1-22-80

CHECKED BY [illegible] DATE 1-22-80 SHEET 5 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
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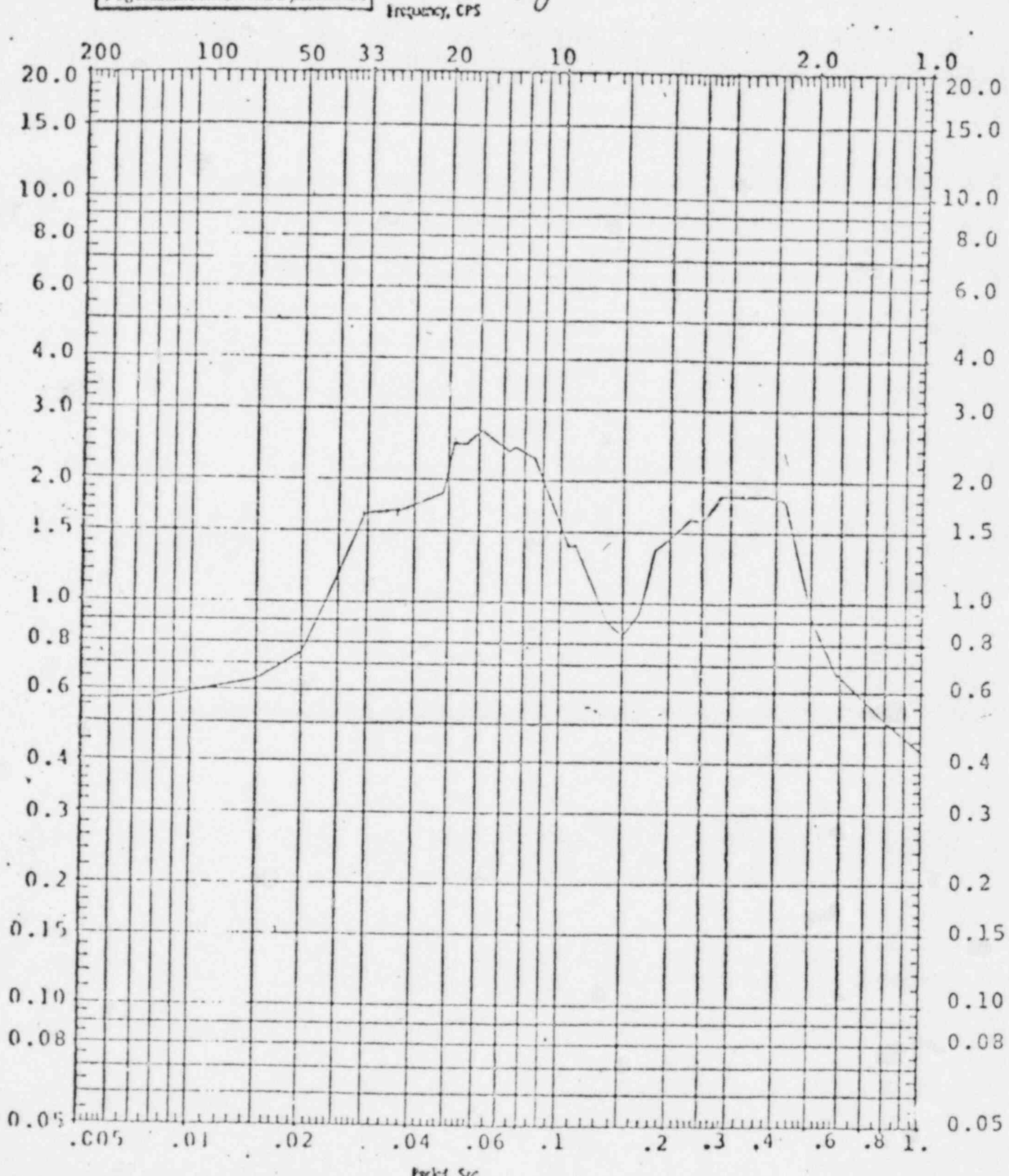
REV. NO.	0							
DATE	1-22-80							
INITIALS	[illegible]							



REACTOR BUILDING-ELEVATION: 694'6" 2% Damping Vertical Slab

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG + Envelop of (SRV + SRV)

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
		Page C1 of C18

Client Commonwealth Edison Company	Prepared by S. Yassin Date
Project LaSalle County, Units I & II	Reviewed by Date
Proj. No. 4266/4267/6093-00 Equip. No. C41-C001A,B	Approved by Date

I. OBJECTIVE

The objectives of this study are as follows:

a) Comparison between the impedence test results and the existing qualification reports which were done by analysis and tests.

b) To re-assess the adequacy of SLLC Pump for the present pool dynamic loads especially in the high frequency zones reported by the impedence tests conducted in-situ.

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORTS

In order to assure the functional reliability and operability as well as the structural integrity of the pump and the motor of the Standby Liquid Level Control, the following reports were issued:

1) Hand Calculations for Seismic Qualification of the pump fluid end aligning pins, pump hold-down bolts and foundation bolts. In the same report SRV requalification was completed using 'g' values at 50 Hz for the new response spectra load combinations and PIPSYS loads for the Ramshead combinations. Fluid end aligning pin and pump hold-down bolts were analyzed. (Reference 1)

2) Tests were conducted to qualify the motor. The qualification method used is described in detail in Reference 2.

The motor insulation resistance was measured along with the

thermal Aging of the stator at 347°F - 365°F for 40 hrs. Also the stator and all non-metallic parts were subjected to gamma radiation dosage during a 23-hr period.

A seismic test was conducted including resonance search in three axes, OBE Simulation (1.4 g peak), SSE Simulation (2 g peak). The motor was then operated for 125 minutes while loaded to 40 HP.

As for testing the pump, the performance data, as stated by the vendor, may be found in vendor print files.

Based on the results of the previous two reports (Ref. 1 & 2), the Standby Liquid Level Control Pump-Motor Unit was qualified. See Tables 1 & 2.

III. SUMMARY OF PERTINENT RESULTS FROM IMPEDENCE TEST REPORT

SQRT in-plant impedence test on the SLLC Pump-Motor Unit was conducted on July 14, 1980. The wire frame model of the test geometry is shown in Figure 1.

The hydraulic shaker was attached to three places:

a) The top of the motor (Nodes 10 and 11).

b) The corner of the hydraulic cylinder (Node 18).

Further details pertaining method of testing and evaluation are given in References 3 and 4.

The modal parameters as identified by Transitek test are given in Table 3.

IV. COMPARISON OF RESULTS

1) The first mode on Ge Test (31 Hz) did not appear in Transitek modes. This can be explained by the fact that after coupling the motor with the pump the assembly became stiff enough to eliminate this resonant frequency.

2) The Transitek frequencies were inclusive of the frequency range of the motor tests (GE) excluding the frequency mentioned in 1).

3) From the four frequencies presented by Transitek two frequencies, namely 46.05 and 79.5 Hz were matching very closely to the GE tests (48 and 79, 80 Hz).

4) The GE tests did not show any frequency beyond 80 Hz on the motor alone. Apparently due to the fact that Transitek tested the Pump-motor assembly, the pump contributed to the appearance of higher frequencies (86.25 and 94.997 Hz).

5) Both tests agree that there is no resonant frequency below 30 Hz.

6) Even if we assume that the system does have a global mode of 31 Hz in the horizontal direction (a very conservative assumption), then from the corresponding response spectra (Figure 8) we find that the g-value at this Frequency is 0.55g. From Calc. #EMD-021193 the pump was qualified for 1.2g vertical and .83 g horiz. loads. Also from GE Tests the motor was qualified at this (31 Hz) frequency therefore it is acceptable.

7) From the response spectra at El. 820'6" in the vertical direction and horizontal direction the ZPA frequency is about 45 Hz, therefore, the only range of interest in frequencies might be up to 45 Hz. Both tests show that all frequencies (except 31 Hz for motor only) are above 45 Hz.

IV. CONSIDERATION OF HIGH FREQUENCY RESONANCE

For this equipment there is no special evaluation required for the high frequency resonances because the analysis (EMD-021193) has considered both the seismic and hydro-dynamic response spectra load combinations with RAMSHEAD which is more conservative than the ones with T-quencher loads. Also the ZPA frequency in the response spectra curves is about 45 Hz.

V. CONCLUSION

Comparison and discussion of the results indicate that the frequencies identified by both the analysis, GE tests and Transitek tests are compatible.

The stresses calculated in the analysis are conservative based on the response spectra curves used. Thus the equipment is qualified as a class I active equipment.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For		Calc. No. EMD-030469	
			Rev. 00	Date 06/01/81
	Safety-Related	Non-Safety-Related	Page C5	of C18

Client Commonwealth Edison Company	Prepared by / Date
Project LaSalle County, Units I & II	Reviewed by / Date
Proj. No. 4266/4267/6093-00 Equip. No. H22-P030-33	Approved by / Date

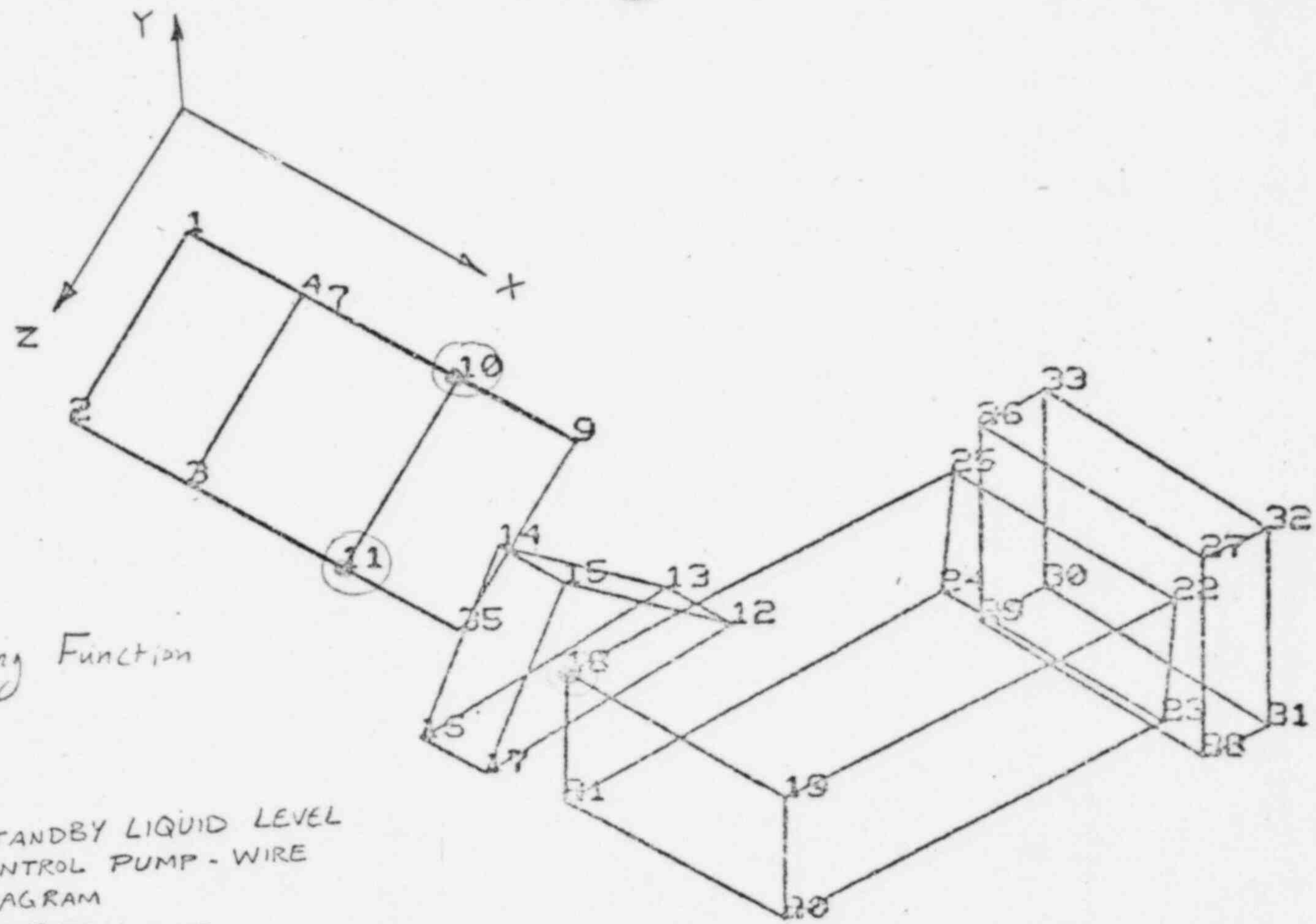
REFERENCES

1) "Standby Liquid Control Pump", Stress report Calculation No. EMD-030493.

2) G.E. Report No. 5430-6958 Dated 1/28/77, EMD File No: 030494.

3) Results of Impedence Test for Standby Liquid Control Pump Transitek Inc. Report, EMD File No. 029471.

4) Preliminary Report Sections 1, 2, 3, 5, 6 SQRT IN-PLANT Impedence Tests LaSalle County Station Unit 1, Transitek, Inc. Report 1/7/81.



(•) Source of Forcing Function in test

FIGURE 1: STANDBY LIQUID LEVEL CONTROL PUMP - WIRE DIAGRAM TRANSITEK TEST

5: 18Y+ COMP,F= 79.500 HZ (1.0, 1.0, 1.0, 0.0)

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For Standby Liquid Level Control Pump-Motor Unit

Safety-Related | Non-Safety-Related

Calc. No. EMD-030469
Rev. 00 Date 06/01/81
Page C6 of C18

Client Commonwealth Edison Company
Project LaSalle County, Units I & II
Proj. No. 4266/4267/6093-00 Equip. No. C41-C001A,B

Prepared by S. Yassin Date
Reviewed by Date
Approved by Date

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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Client	Commonwealth Edison Company	Prepared by S. Yassin	Date
Project	LaSalle County, Units I & II	Reviewed by	Date
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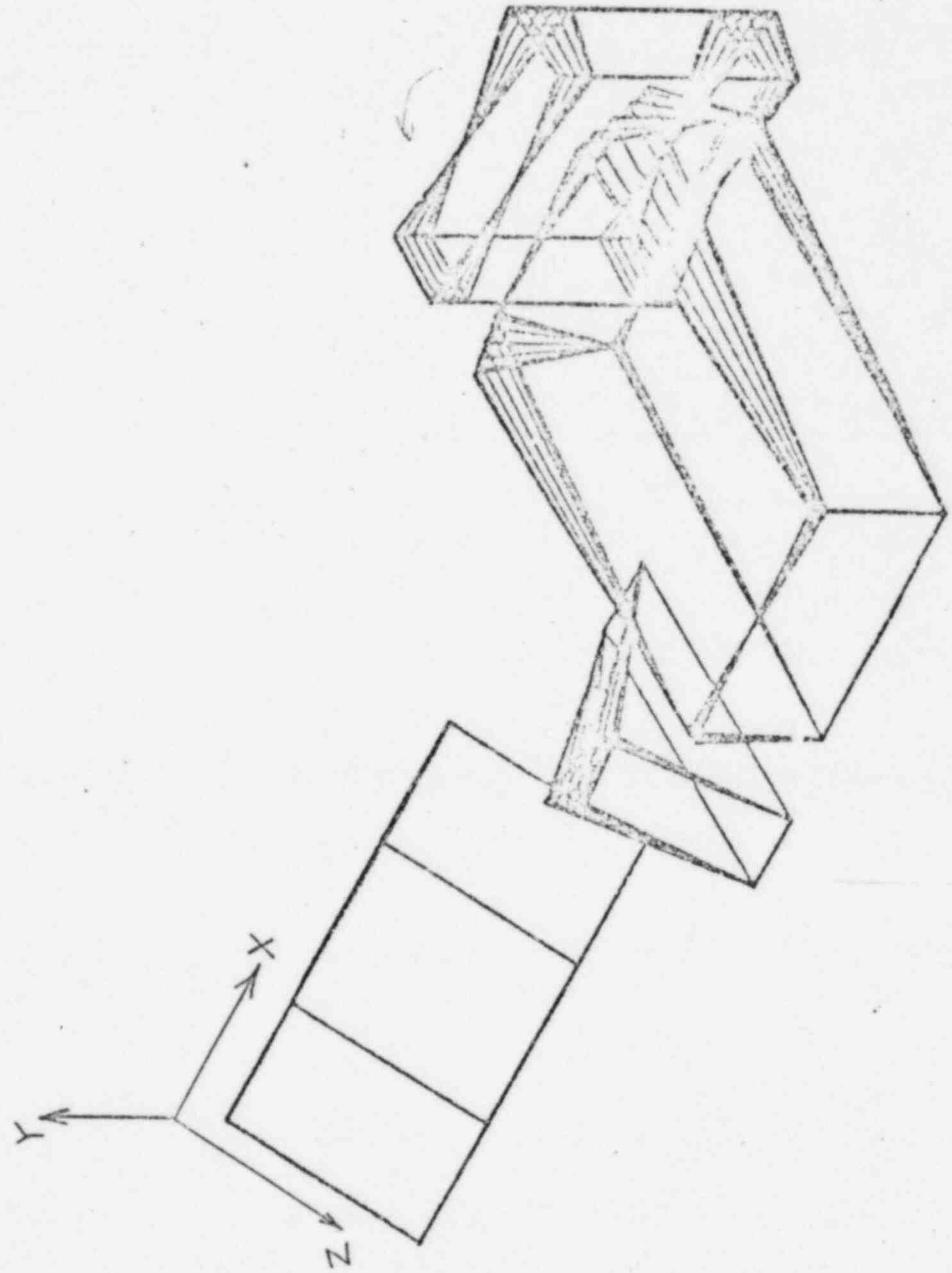

FIGURE 2
TRANSITEK TEST
MODE SHAPE AT 79.5 HZ

5: 13Y+ COMP,F= 79.500 HZ (1.0, 1.0, 1.0, 0.0)-VIEW

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. FMD-030469
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Project LaSalle County, Units I & II	Reviewed by Date
Proj. No. 4266/4267/6093-00 Equip. No. C41-C001A,B	Approved by Date

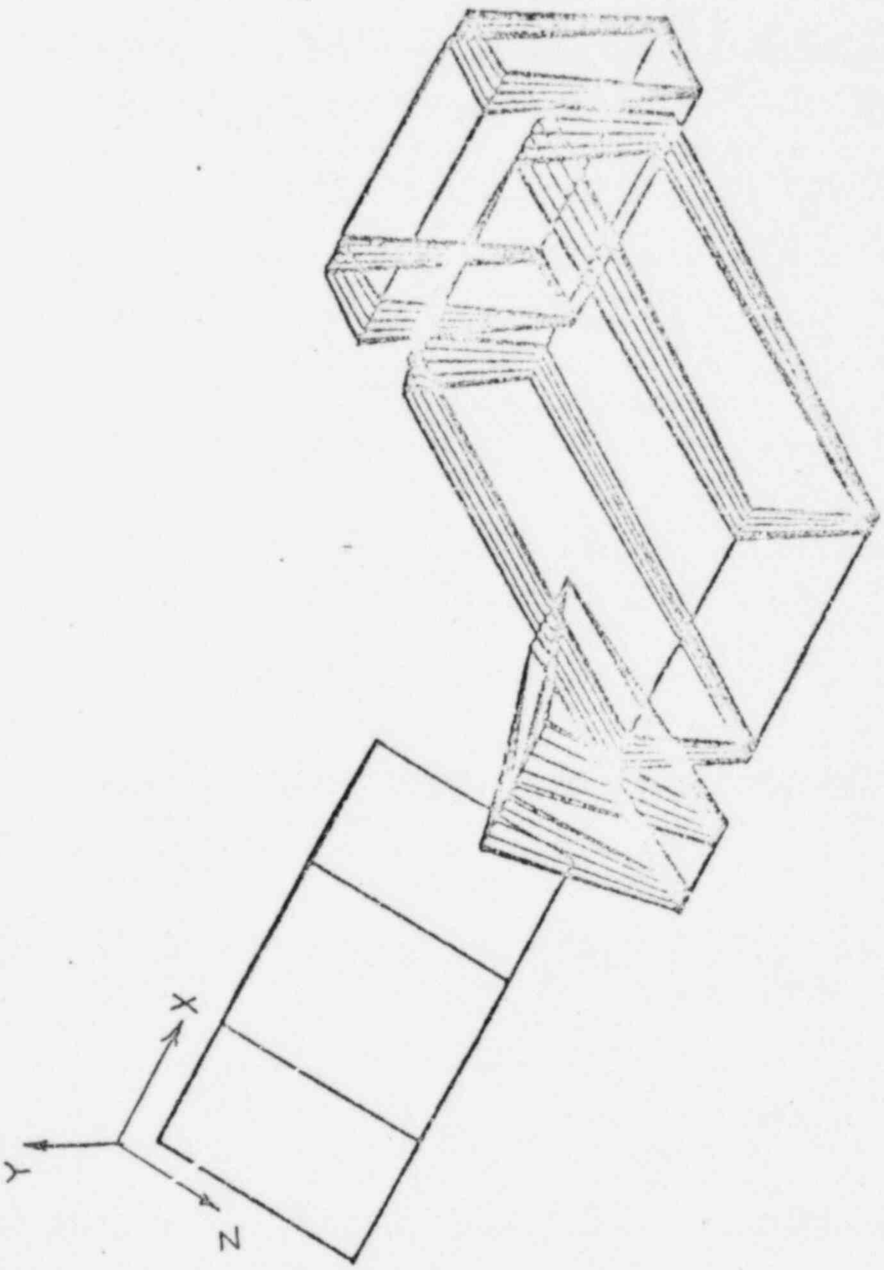

FIGURE 4
TRANSITEK TEST
MODE SHAPE AT 79.5 HZ

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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Project	LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No. C41-C001A,B	Approved by	Date

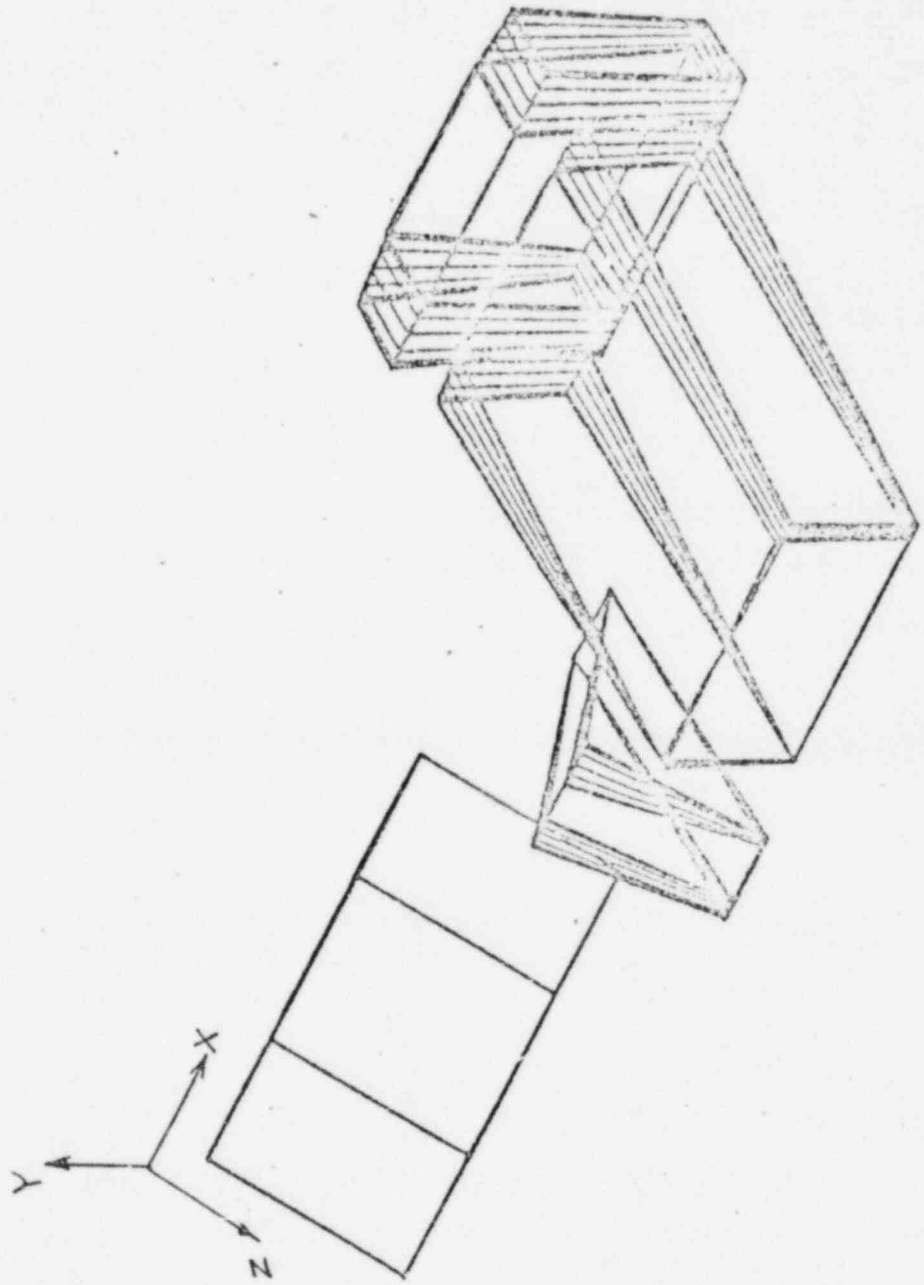

FIGURE 5
TRANSITEK TEST
MODE SHAPE AT 86.25HZ

3: 25X- COMP,F= 86.250 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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Client	Commonwealth Edison Company	Prepared by S. Yassin	Date
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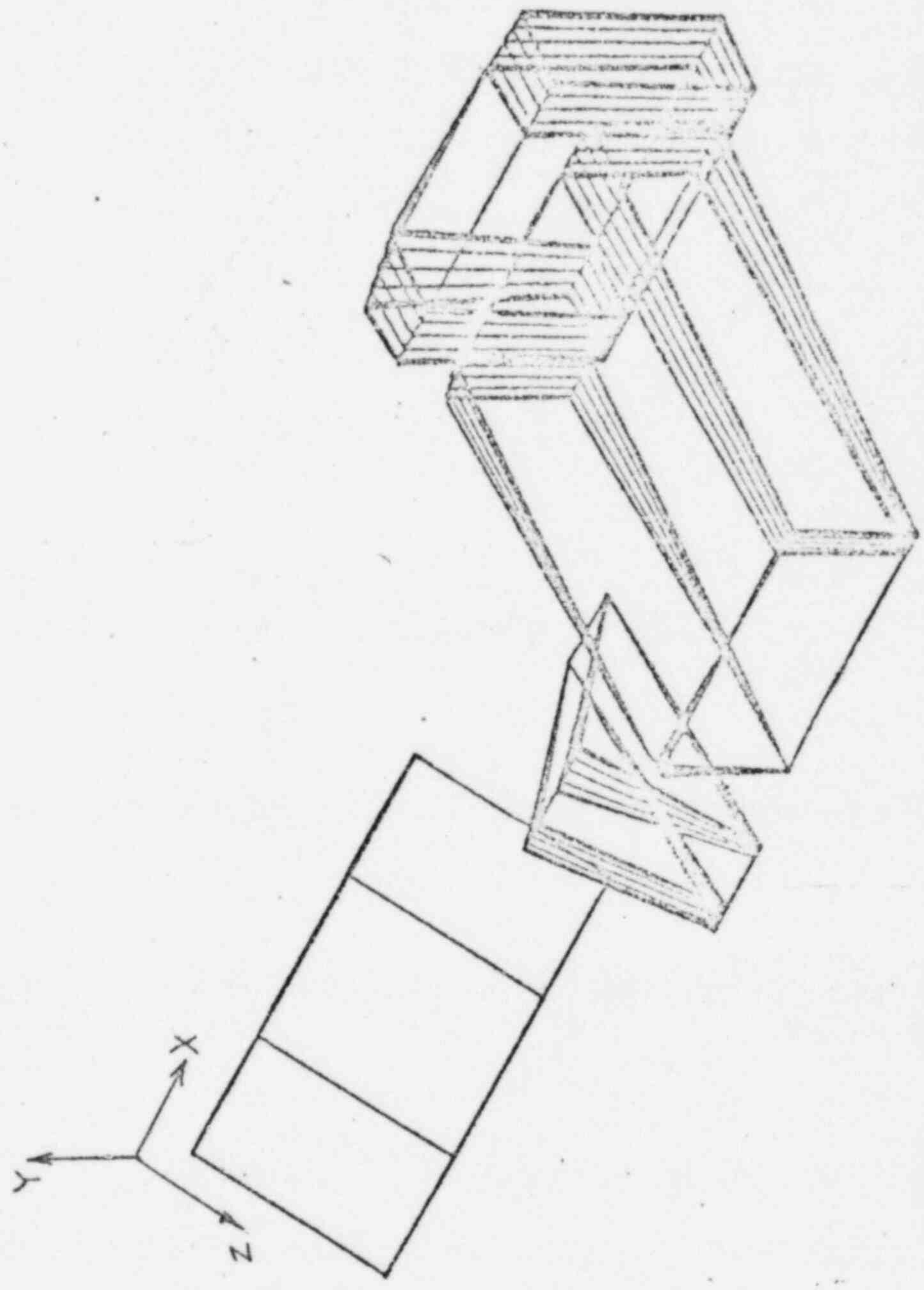
FIGURE 6
TRANSITEK TEST
MODE SHAPE AT 94.997 HZ



4: 25X- COMP,F= 94.997 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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Client: Commonwealth Edison Company		Prepared by: S. Yassin	Date
Project: LaSalle County, Units I & II		Reviewed by	Date
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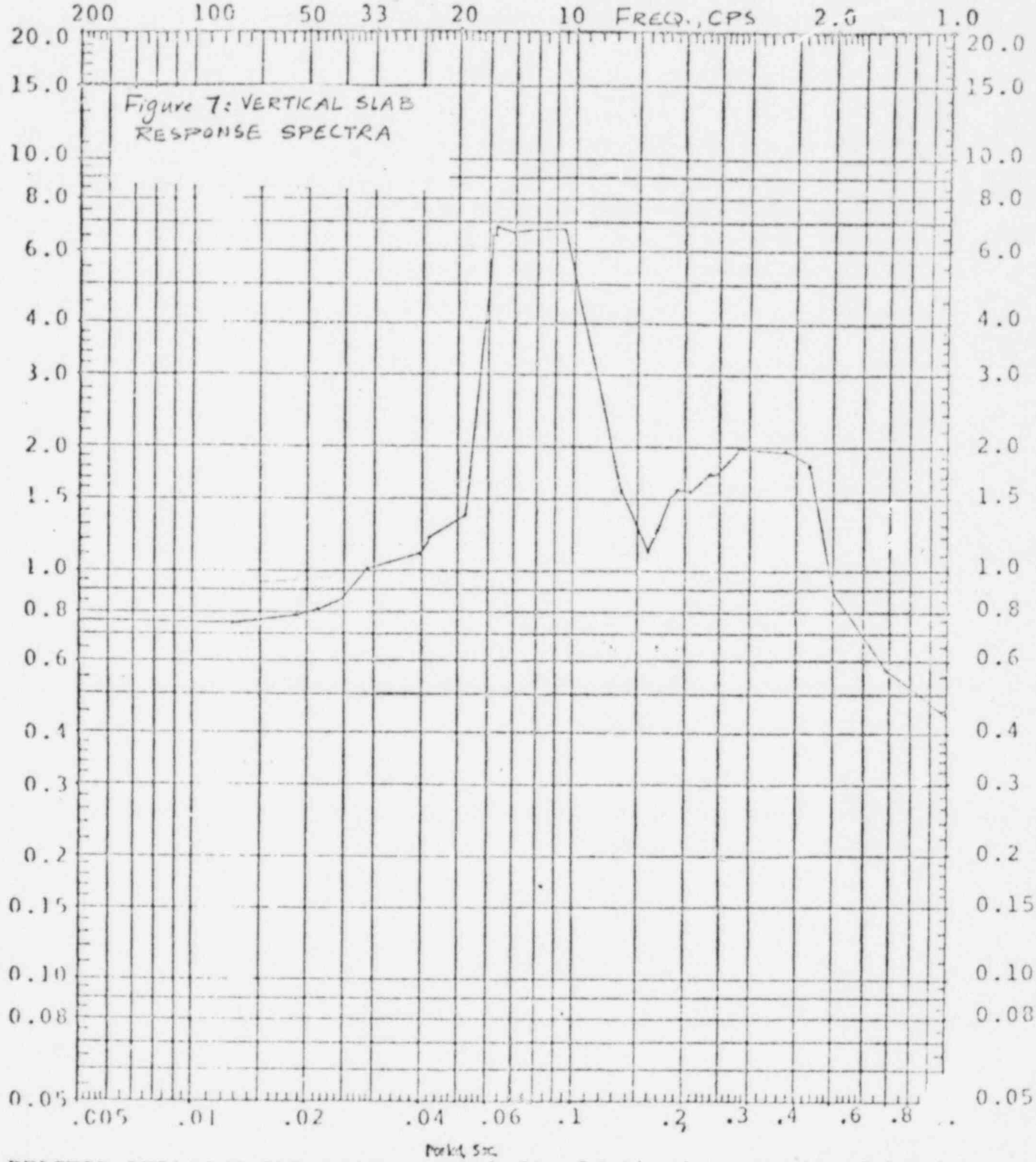

REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Slab

Envelope of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV[illegible] + SRV[illegible])

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit Safety-Related / Non-Safety-Related	Calc. No. EMD-030469 Rev. 00 Date 06/01/81 Page C12 of C18

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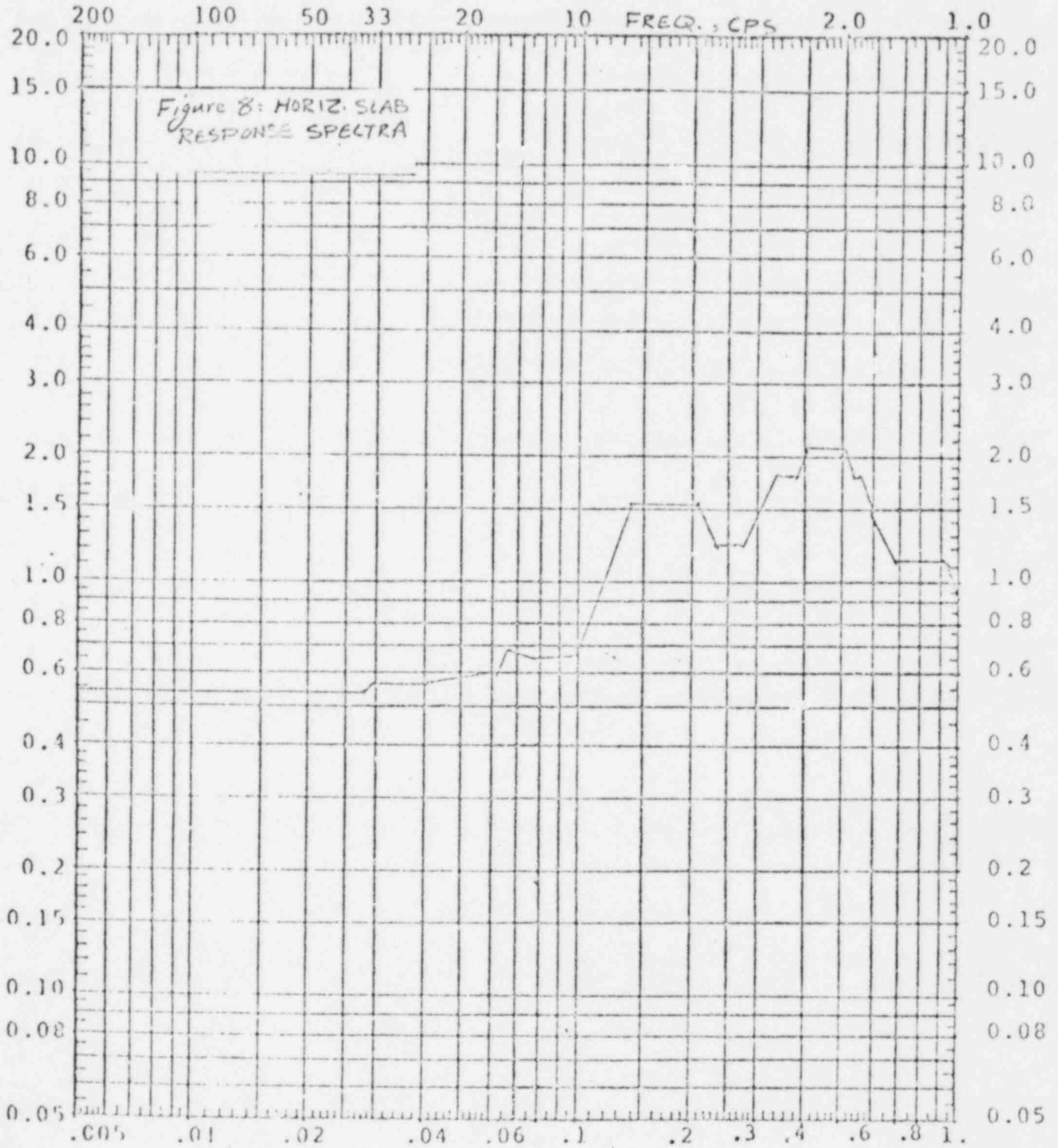

REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Horizontal Slab NS-EW

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit		Calc. No. EMD-030469
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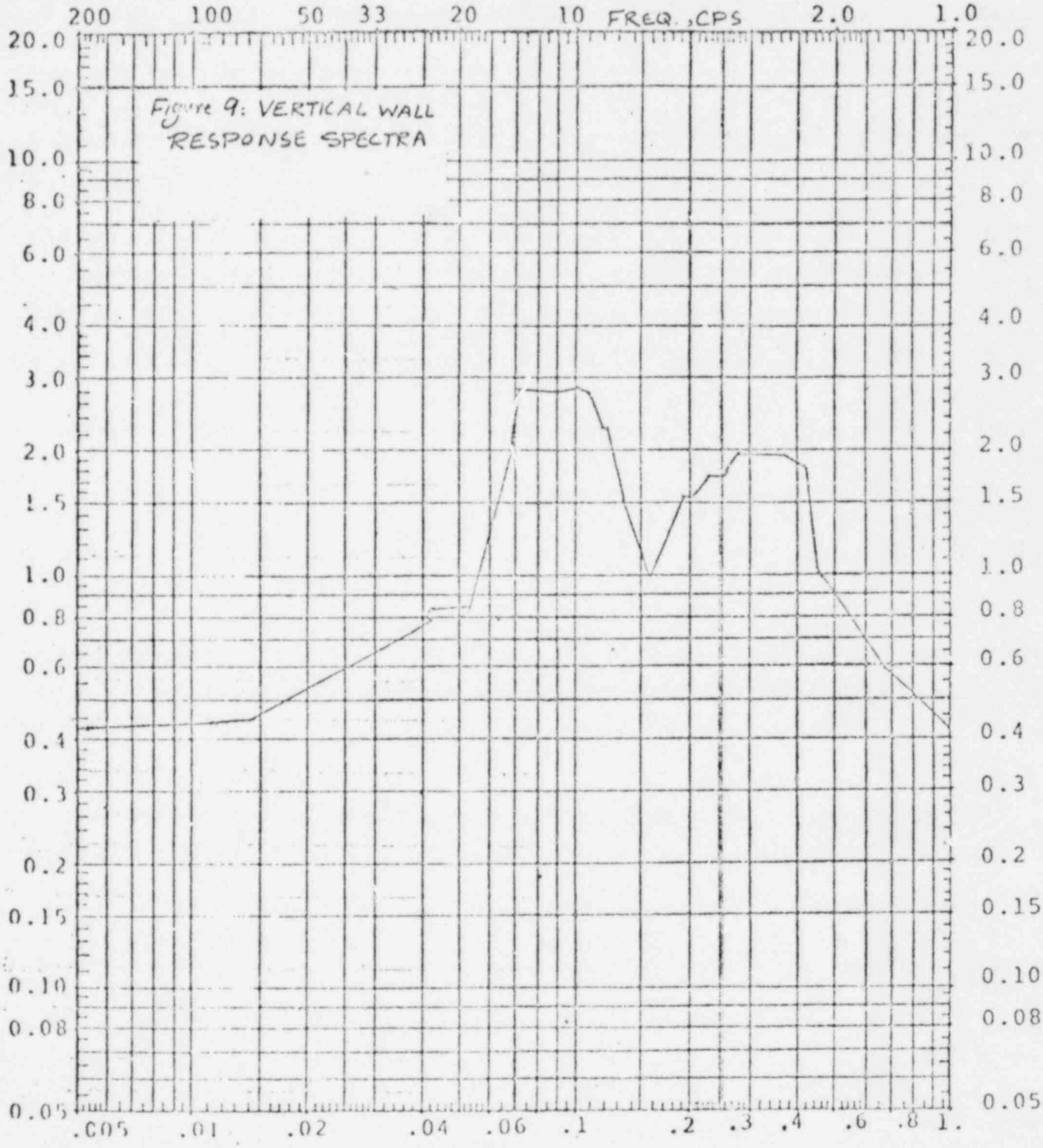

REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Wall

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE & CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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NTS APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.

Report No. 5430-6958

Date: 28 January 1977

TABLE 1

1.) Axis Definitions

X Parrallel to Motor Shaft
Z Perpendicular to Motor Shaft and Mounting Base
Y Lateral to Motor Shaft; Parallel to Mounting Base

2.) Resonance Frequencies, X Axis. Resonance Search

Response Accelerometer	Response Axis	Location
A	X	Top of Housing, Shaft end
B	Z	Top of end bell
C	X	End bell, near vent

		Response Accelerometer			
Frequency	Control	A X	B Z	C X	Condition
54	0.2	-	0.4	-	Motor On
54	0.2	-	0.5	-	Motor Off

3.) Response Frequencies, Z Axis Resonance Search

Response Accelerometer	Response Axis	Location
A	Z	Top of Housing, Shaft end
B	Z	Top of end bell
C	X	End of bell, near vent

		Response Accelerometer			
Frequency	Control	A Z	B Z	C X	Condition
48	0.2	-	-	1.1	Motor On
79	0.2	-	-	0.7	Motor On
31	0.2	-	-	0.7	Motor Off
51	0.2	-	0.5	1.5	Motor Off
55	0.2	-	0.5	-	Motor Off
60	0.2	-	-	0.5	Motor Off

AETL APPROVED ENGINEERING TEST LABORATORIES
A NATIONAL TECHNICAL SERVICES CO.

Report No. 5430-6958
Date: 28 January 1977

TABLE 2

4.) Response Frequency, Y Axis Resonance Search

Response Accelerometer	Response Axis	Location
A	Y	Center of Motor, above vent
B	Z	Top of housing, shaft end
C	Z	Top of end bell

Frequency	Control	Response Accelerometer A Y	B Z	C Z	Condition
54	0.2	-	1.0	0.8	Motor On
71	0.2	-	1.0	0.6	Motor On
54	0.2	-	1.1	0.9	Motor Off
60	0.2	-	1.1	1.0	Motor Off
80	0.2	-	0.7	0.5	Motor Off

Table 3

MODE PARAMETERS

LABEL	FREQ	DAMPING	AMPLITUDE	PHASE	REF	RES	MODE	FLAGS				
1	46.045	0.032566	1.7611E-03	-1.0497	25X-	14X+	1	0	0	0	1	1
2	79.500	0.013705	1.6496E-02	-1.2226	25X-	25X+	2	0	0	0	1	1
3	86.247	0.014311	1.3808E-02	-0.9038	25X-	25X+	3	0	0	0	1	1
4	94.997	0.012544	6.0095E-02	-2.1593	25X-	25X+	4	0	0	0	1	1
5	80.554	0.011182	2.9008E-03	-1.6523	18Y+	18Y-	5	0	0	0	1	1

$

SARGENT & LUNDY
ENGINEERS
CHICAGO

Calcs For Standby Liquid Level Control Pump-Motor Unit

Safety-Related | Non-Safety-Related

Calc. No. EMD-030469

Rev. 00 Date 06/01/81

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Client Commonwealth Edison Company

Project LaSalle County, Units I & II

Proj. No. 4266/4267/6093-00 Equip. No. C41-C001A,B

Prepared by S. Yassin Date

Reviewed by Date

Approved by Date

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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TABLE 4: Comparison Between GE and Impedence Tests

ITEM	GE Test ON MOTOR			Transitek Test ON MOTOR-PUMP Assymbly
Unit Tested	Motor Only			Motor-Pump Assembly
Location of Shaker	Under the Motor (Table Shaker)			Mounted on top of Motor and corner of pump's hydraulic cylinder
Direction of Forcing Function	• Paraller and ⊥er to motor shaft • Vertical Direction			Same
Conditions	Motor on and off			Motor off
Resonant Frequencies		Motor on	Motor off	
	31		✓	
	48	✓		46.05
	51		✓	
	54		✓	
	55		✓	
	60		✓	
	71	✓		
	79	✓		79.5
	80		✓	
				86.25
				94.997

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Standby Liquid Level Control Pump-Motor Unit	Calc. No. EMD-030469
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		Page FINAL of C18

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Proj. No. 4266/4267/6093-00 Equip. No. C41-C001A,B	Approved by — Date

TABLE 4 : Comparison Between G.E. and Impedence Tests (Cont'd)

AGREEMENT	DISAGREEMENT	REMARKS
	First Mode of GE Test (31 Hz) did not show in TransiteK Test	GE Test on motor Only. Coupling Pump w/ motor in TransiteK Tests raised 1st Mode to 46 Hz
TransiteK Freq are inclusive of Freq. range of GE motor test Frequencies		
Two out of Four Freq. by transiteK (46 & 80 Hz) are closely matching GE motor Freq.		
	GE Test on Motor did not show Resonance for f > 80 Hz	Resonant Freq For Unit (TransiteK) would give higher Frequencies than motor alone.
No resonance below 30 Hz		

I. OBJECTIVE

The objectives of this study can be summarized as follows:

a) To assess the comparison between the impedance test results and the existing qualification report.

b) To re-assess the adequacy of the equipment for the additional hydrodynamic loadings, particularly in regard to the high frequency resonances reported as a result of impedance tests conducted in-situ.

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORT

The Standby Gas Treatment Equipment Train shown on CVI drawing B453-0001 Rev. B in Ref. 1, was designed and analyzed for seismic and operating loads and was qualified to the effect that it did not suffer any deformations and stresses that would interfere with the functioning of the units.

The housing framework is treated as a planar frame and one average bay is investigated each for various parts of the structure, disregarding the benefit of interior stiffeners.

Frequencies that are hand calculated as a result of plate theory within elastic stability range are prescribed in Table 1 on page D2. It can be conservatively stated that minimum frequencies for the entire unit are 21., 25. and 26.6 cps as a result of this analysis.

TABLE 1

CALCULATED FREQUENCIES FOR VARIOUS PARTS OF THE

1VG01S SGTS EQUIPMENT TRAIN

	Frequency (cps) *		
Part	X	Y	Z
Base (Front)	1765.3	29.6	127.2
Base (Rear)	1483.9	24.6	>127.2
Roof	>33	25	> 33
Side Panels	>33	>33	21
End Panels	26.6	>33	> 33
Transition	70.9		
Inlet Cone:	Top =>	27.2	
	Bottom =>	>33	
	Sides =>	32.5	

* Directions are indicated on the wire diagram on page D4.

III. SUMMARY OF PERTINENT RESULTS FROM IMPEDANCE TEST REPORT

SGTS equipment train was shaken in four different orientations at points 58, 86 and 151 as shown on Figure 1 on page D4. At the time of testing, the equipment train was completely installed and properly secured to the floor. All electrical and pneumatic connections were complete. The unit was tested without the charcoal filters because preservation of these units required that they remain in sealed storage.

The large hydraulic shaker was used to excite the equipment train. The level of force used in the test ranged from 800 pound force peak to 2500 pound force peak. The acceleration response levels were 0.1g to 0.5g., depending on the location. Details of testing are given in R . 2 and Ref. 3. The modal parameters as identified by the tester (Ref. 2, Tables 4.8.1, 4.8.2, 4.8.3) are given on Table 2, page D5.

IV. COMPARISON OF RESULTS

A. End Panel:

The end panel boundaries are indicated by nodes 1,2,3,4,51,52, 53,54 on the wire diagram (Fig. 1, p.D4). A minimum frequency of 26.6 cps was identified for this portion of the equipment, by way of analysis. Tester identified nine frequencies for the same portion. These frequencies are listed in Table 2, under

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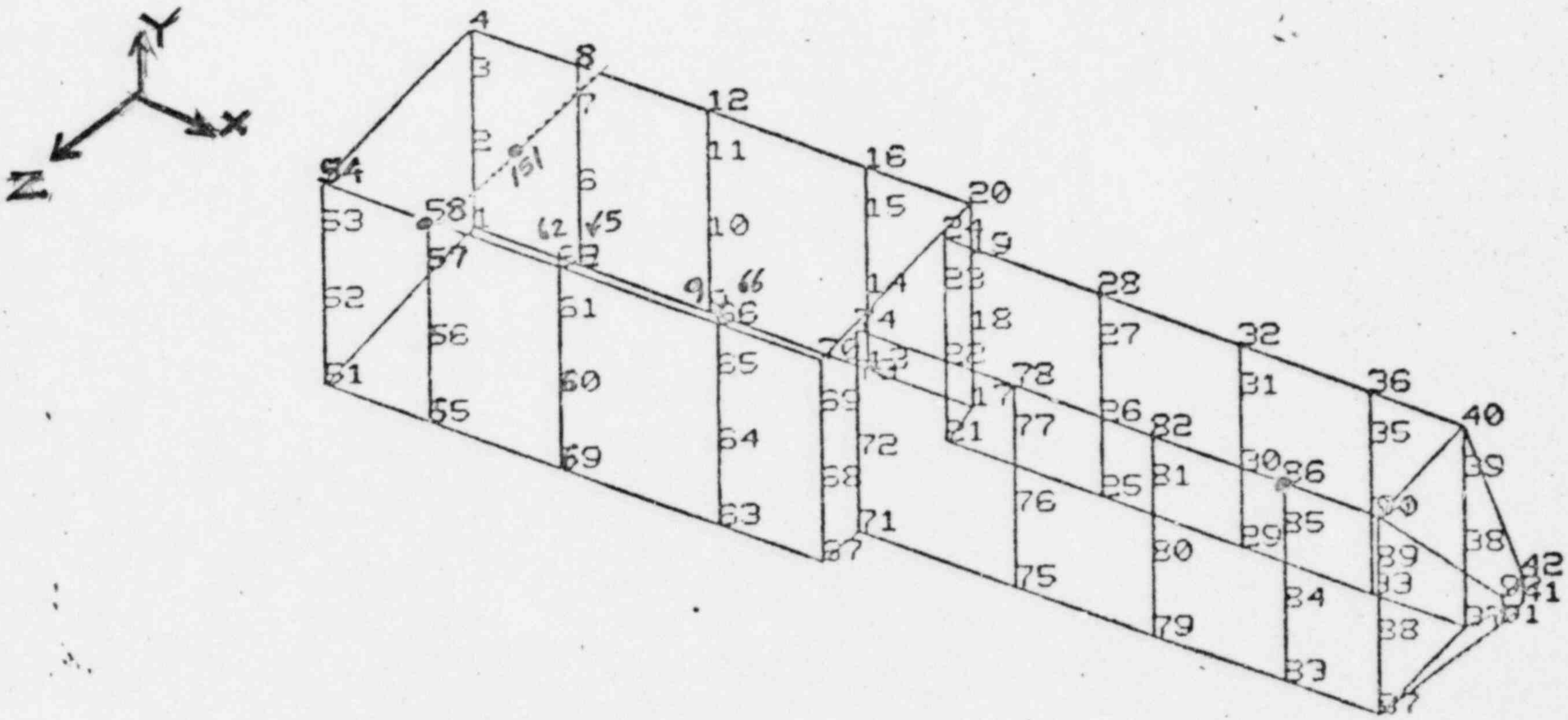

0: 0 UND.,F= UNDEFINED (0.6, 1.0, 1.0, 0.0)=VIEW

FIGURE 1.

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TABLE - 2

MEASURED FREQUENCIES FOR SGTS EQUIPMENT TRAIN

Excitation Point	Frequency (cps)	Damping
151 X +	19.08	0.041
	21.01	0.021
	26.91	0.028
	28.70	0.019
	36.09	0.010
	40.14	0.016
	65.57	0.010
	73.40	0.023
	81.20	0.007
58 Y +	24.20	0.021
	27.40	0.045
	29.90	0.009
	36.60	0.005
	40.96	0.008
	45.70	0.003
	51.00	0.002
	64.90	0.006
	78.70	0.030
	86.60	0.002
	13.60	0.015
86 Z +	28.60	0.050
	29.60	0.005
	34.60	0.008
	39.20	0.005
	59.70	0.018
	63.40	0.011
	83.60	0.023
	92.10	0.006
	95.50	0.001
58 Z +	38.40	0.091
	53.80	0.041
	57.00	0.031
	64.50	0.001
	97.90	0.034

excitation point 151 X+ . The range is from 19.08 to 81.20 cps. As seen, analytically identified 26.6 cps frequency is also observed in this list. Yet, two frequencies smaller than 26.6, namely 19.08 and 21.01 cps., also exist. However, inspection of horizontal response spectrum curve indicates that all nine frequencies are in the ZPA range.

B. Side Panels and Inlet Cone:

Minimum frequency for side panels is identified as 21. cps., by analysis in Z direction and the test results indicate fourteen frequencies affecting various parts of the panels in a range from 28.6 to 97.7 cps. Again, all these frequencies are in the ZPA range of the horizontal spectrum curve.

C. Roof:

Minimum frequency identified by analysis is 25 cps., in vertical direction. The test results indicate eleven frequencies affecting the roof panels in a range from 13.6 to 86.6 cps. The mode shape for 13.6 cps., frequency is given on Figure 2, page D7. The maximum deflection is seen to occur at node 58. This particular node (58) is the location where the large shaker was attached on top of the equipment train to excite the structure during the test. The weight of the shaker is 500 lbs. The inspection of the structure in as built condition indicates no special conditions for the occurance of this frequency strictly in this region. It appears that this frequency is a localized frequency, excited by

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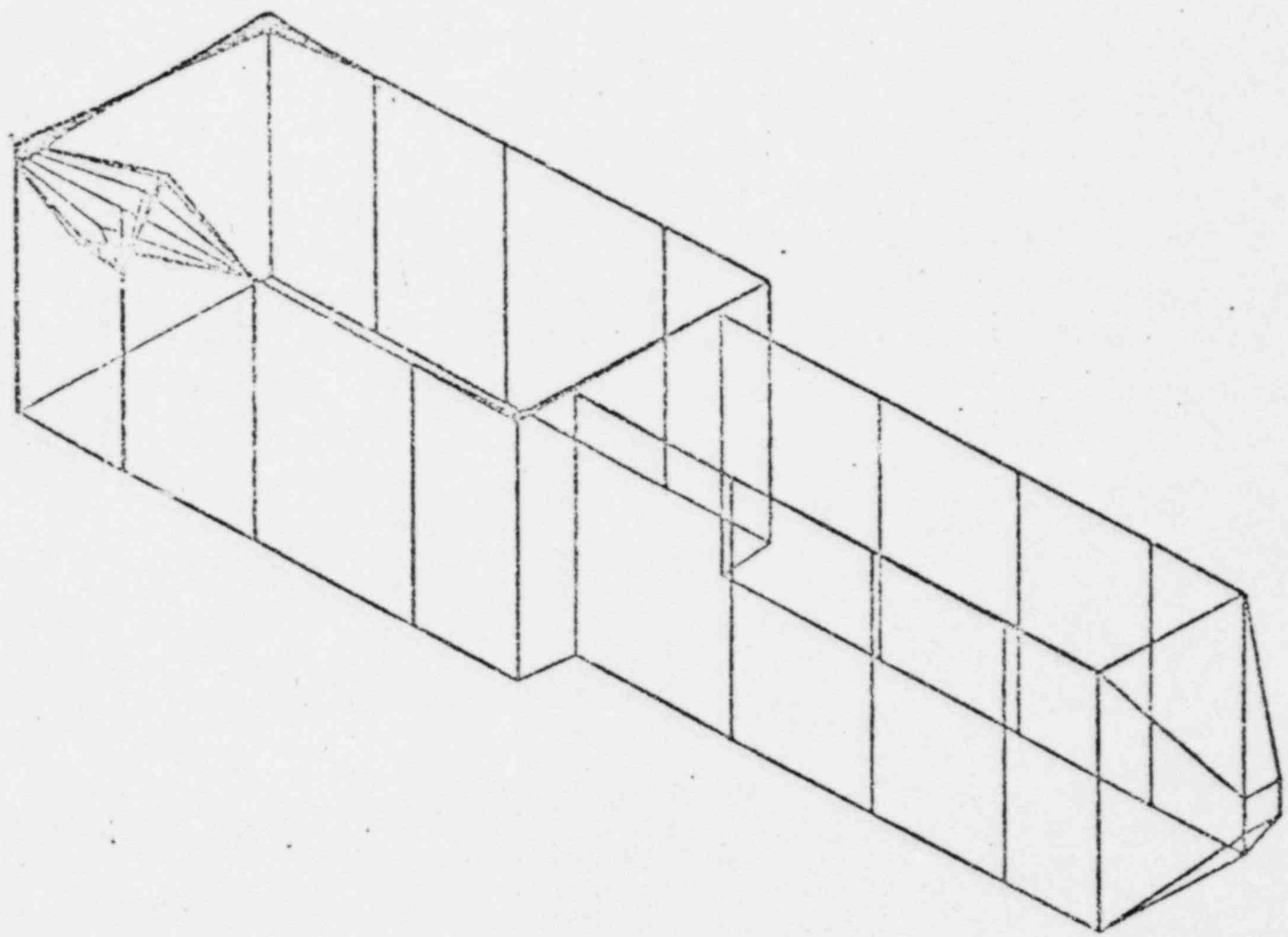
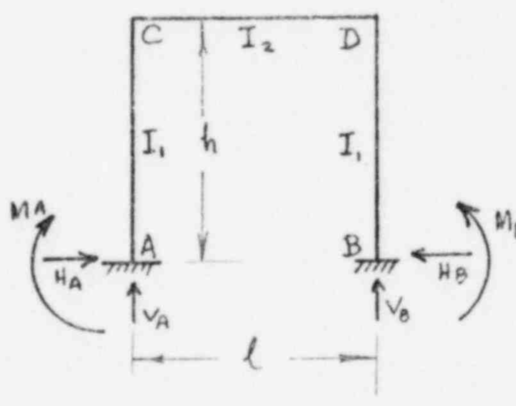


SBGT REF 58Y
11: 58Y+ COMP,F= 13.600 HZ (1.0, 1.0, 1.0, 0.0)-VIEW

FIGURE 2

the own mass of the shaker itself. However, since it is lengthy to prove this argument analytically, 13.6 cps. is considered as a natural frequency of the structure and an equivalent static analysis is carried on for this portion of the structure to assure the structural integrity. A simplified and conservative frame model is considered without the benefit of internal stiffeners. There are two 3 x 2 x 1/4" L angle stiffeners welded to the 1/4" plate forming the casing of the equipment train in this region. The representative frame, cross-section and properties are shown below. Pertinent computations are given on following pages.



$I_1 = I_2 = I$

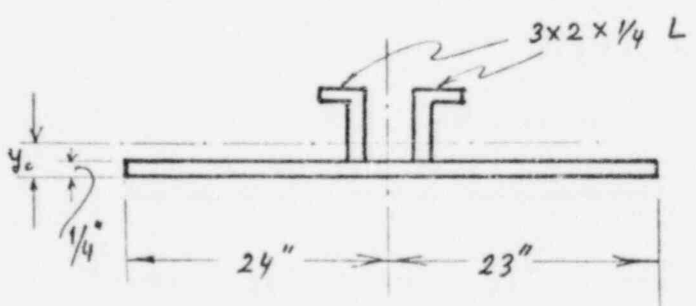
$h = \ell = 97''$

$k = \frac{I_2}{I_1} \frac{h}{\ell} = 1$

Accelerations for 13.6 cps :

horizontal = 0.6 g

vertical = 6.4 g



$A = 14.13 \ in^2$

$I = 11.24 \ in^4$

$y_c = 0.448 \ in$

$C = 3.[illegible] - y_c = 2.766 \ in$

Load cases :

a) Distributed load on CD

Acceleration from wertical response spectrum curve

$a_v = 6.4\ g$

Equivalent vertical distributed load

$\omega_v = 14.13 \times 0.283 \times 6.4 = 25.59$ lb/in

∴ Using frame formulas, following can be calculated:

$$H_A = H_B = \frac{\omega_v \ell^2}{4h(k+2)} \quad ; \quad V_A = V_B = \frac{\omega_v \cdot \ell}{2}$$

$$M_A = M_B = \frac{\omega_v \ell^2}{12(k+2)}$$

$$M_C = M_D = \frac{\omega_v \ell^2}{6(k+2)}$$

or :

$$H = 25.59 \times (97)^2 / 4 \times 97\,(1+2) = 206.8 \text{ lb}$$

$$V = 25.59 \times 97 / 2 = 1241.1 \text{ lb}$$

$$M_A = M_B = 25.59 \times (97)^2 / 12 \times (1+2) = 6688.2 \text{ in-lb}$$

$$M_C = M_D = 25.59 \times (97)^2 / 6 \times (1+2) = 13376.5 \text{ in-lb}$$

b) Distributed load on BD

Acceleration from horizontal response spectra curve

$a_H = 0.6\,g$

Equivalent distributed load

$\omega_H = 14.13 \times 0.283 \times 0.6 = 2.4$ lb/in

$H_A = \frac{\omega_H \cdot h}{8} \frac{2k+3}{k+2} = 48.5$ lb

$H_B = H_A - \omega_H \cdot h = -184.3$ lb

$V_A = -V_B = \frac{\omega_H h^2 k}{\ell(6k+1)} = 33.2$ lb

$M_A = \frac{\omega_H h^2}{24}\left(\frac{5k+9}{k+2} - \frac{12k}{6k+1}\right) = 2781.0$ in-lb

$M_C = M_A - H_A h = -1923.5$ in-lb

$M_B = -\frac{\omega_H h^2}{24}\left(12 - \frac{5k+9}{k+2} - \frac{12k}{6k+1}\right) = -5287.0$ in-lb

$M_D = M_B - H_B h + \frac{\omega_H h^2}{2} = 1299.3$ in-lb

c) Distributed load on AC (same direction as BD)

$H_A = 184.3$ lb ; $M_A = 5287.0$ in-lb

$H_B = -48.5$ lb ; $M_B = -2781.0$ in-lb

$V_A = 33.2$ lb ; $M_C = -1299.3$ in-lb

$V_B = -33.2$ lb ; $M_D = 1923.5$ in-lb

d) Concentrated load on D

$W = 97 \times 14.13 \times 0.283 \times 0.6 = 232.7$ lb.

$H_A = -H_B = W/2 = 116.3$ lb

$V_A = -V_B = 3Whk/(6k+1)l = 99.7$ lb

$M_A = -M_B = (Wh/2)(3k+1)/(6k+1) = 6450.2$ in-lb

$M_C = -M_D = -(Wh/2)(3k)/(6k+1) = -4837.7$ in-lb

Combined moments

	A	B	C	D
Dist. load on CD	± 6688.2	± 6688.2	∓ 13376.5	∓ 13376.5
" " BD	2781.0	-5287.0	-1923.5	1299.3
" " AC	5287.0	-2781.0	-1299.3	1923.5
Const " at D	6450.2	-6450.7	-4837.7	4837.7

Largest moment at A or B $\Rightarrow |\Sigma M_i| = 21206.4$ in-lb.

Corresponding: $V = 1473.7$ lb, $H = 633.5$ lb.

Bending stress: $\sigma_b = Mc/I = (21206.4 \times 2.766)/11.24$

$\sigma_b = 5218$ psi.

Max. Operating pressure: 14" W.G $\Rightarrow$ 0.505 psi

Moment due to pressure: $M_p = \frac{0.505 \times 47}{12} \times \frac{97^3 + 97^3}{97+97} = 18631$ in-lb.

Bending due to pressure:

$\sigma_p = (18631 \times 2.766)/11.24 = 4584$ psi

$\sigma_{TOT} = 9802$ psi $< \sigma_{All}$

Therefore, the final bending and pressure load stress (shear and membrane stresses are negligible) is 9802. psi. for combined seismic, hydrodynamic and operating loads.

There are five other frequencies, namely 24.2, 27.4, 29.9, 36.6 and 40.96 cps., that have acceleration values slightly higher then the ZPA value. Their combined effect is:

$$a_c = \sqrt{(1.25 + 1.05 + 1.03)^2 + 1^2 + 0.86^2} \quad g$$

$$a_c = 3.58 \text{ g}$$

If 13.6 cps. frequency is also considered to exist and all six frequencies are excited simultaneously, the acceleration value will be:

$$a_c = 7.33 \text{ g.}$$

Comparing both these values and, values and results described on pages D8-D11, it can be concluded that an acceleration of 7.33g does not present any problems; the section considered has considerable margin up to allowable stress. Elsewhere on the structure, the typical section will have one 3 x 2 x 1/4 angle stiffener, instead of two, reducing the area and moment of inertia to slightly lesser values, yet by inspection of figure 2, it is obvious that 13.6 cps., does not participate at these sections, making sure a_c = 3.58g.

This value of acceleration, in spite of lesser stiffness, still does not create an overstress problem.

D. Instruments:

There are various instruments mounted on the side panels of the SGTS Equipment Train, mostly on the east side. Differential pressure transmitters and numerous thermometers and switches are basically mounted on the 1/4 inch plate of the housing unit. Special measurements were done at the locations where these instruments are mounted and no new resonances were identified beyond those which existed as global resonances on the SGTS Equipment Train. Since all the instruments are mounted on side panels, the frequencies identified before correspond to the ZPA range on the horizontal response spectra curve for all modes. Consequently, it can be concluded that, the mounted instruments will experience acceleration values of the ZPA, namely 0.6g in case of the combined seismic-hydrodynamic events.

V. CONSIDERATION OF HIGH FREQUENCY RESONANCES

Inspection of Table 1, page D2 indicates that existence of high frequency modes were predicted by analysis, but were not identified in most cases. The test results that are summarized on Table 2, page D5 shows that there are a number of high frequency modes existing for various parts of the equipment. In all cases, for the horizontal direction, frequencies that are above 16. cps., and for the vertical

direction frequencies above 40 cps have corresponding response acceleration values in their ZPA range. Therefore, these frequencies have no significance as far as the structural integrity and operability are concerned. (The response spectra curves are included at the end of this report.)

VI. CONDLUSIONS

Comparison and discussion of results indicate that the frequencies identified by analysis and by testing generally agree; except three modes, two of which identified for the rear panel and one for the roof. Yet, all the frequencies considered both in lower and higher ranges indicate no serious effects on the structural integrity and operability of the SGTS Equipment Train, verifying the adequacy of this equipment for seismic, hydrodynamic and operating loads.

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Client Commonwealth Edison Company	Prepared by	Date
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Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

VII. REFERENCES

1. "Filter Housing Seismic Analysis For 1R2VG01S" EMD File No. 007725.

2. "Qualification Documents For SGTS Equipment Train 1,2VG01S", J2583, 11/10/80.

3. "Final Test Report - SQRT In-Plant Impedance Testing, LaSalle Co. 1", Transitek Inc. Job No. 80042, EMD File No. 029601-00, March 1981.

4. "Impedance Test Results For SGTS Equipment Train," (Add. to Ref. 3 above).

5. Response Spectrum Curves, Reactor Building, El. 820'-0". (pp D16-D18 of this report)

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DESIGN BY Z. Cromer DATE 1-22-80
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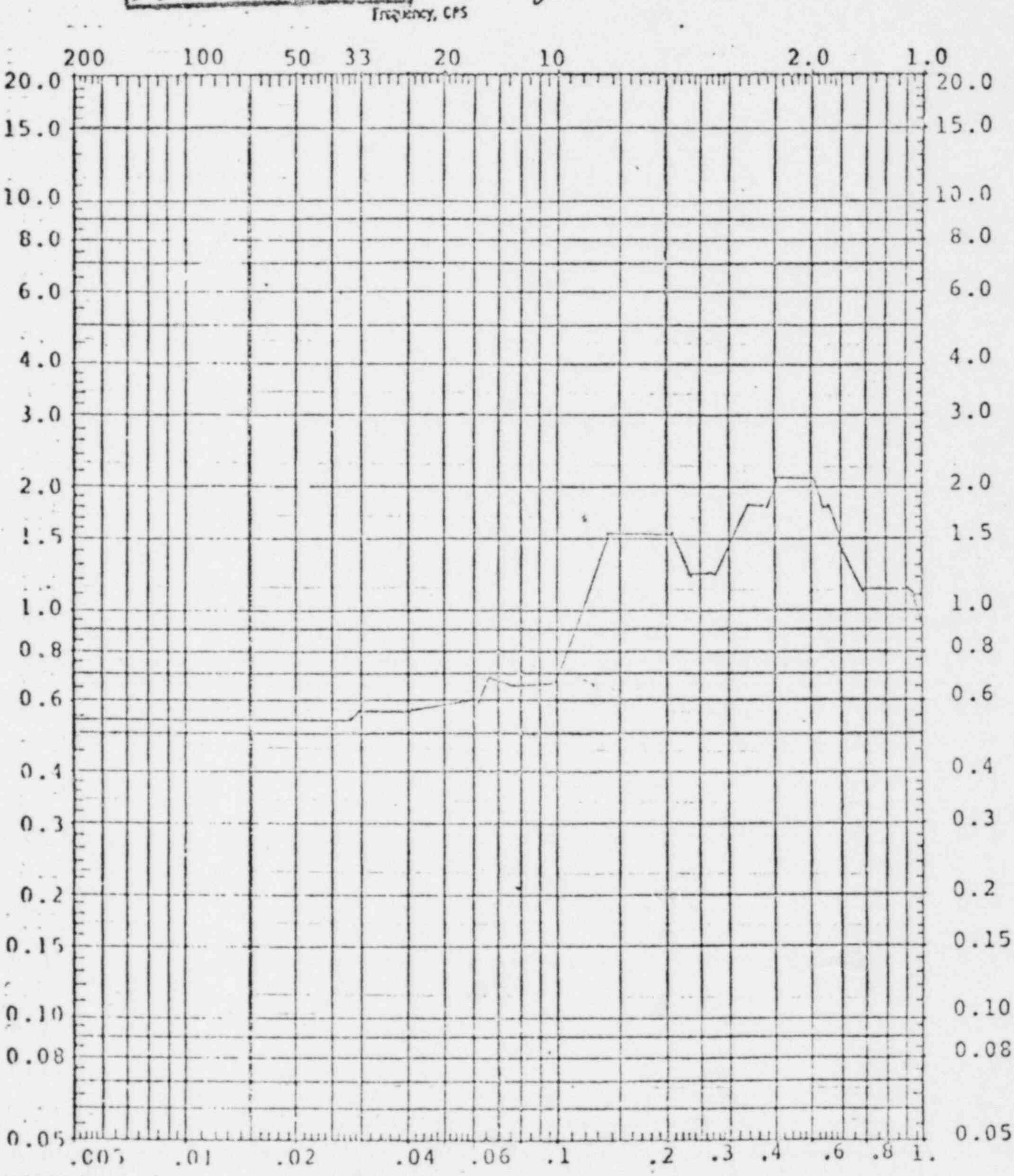

REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Horizontal Slab NS-EW

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

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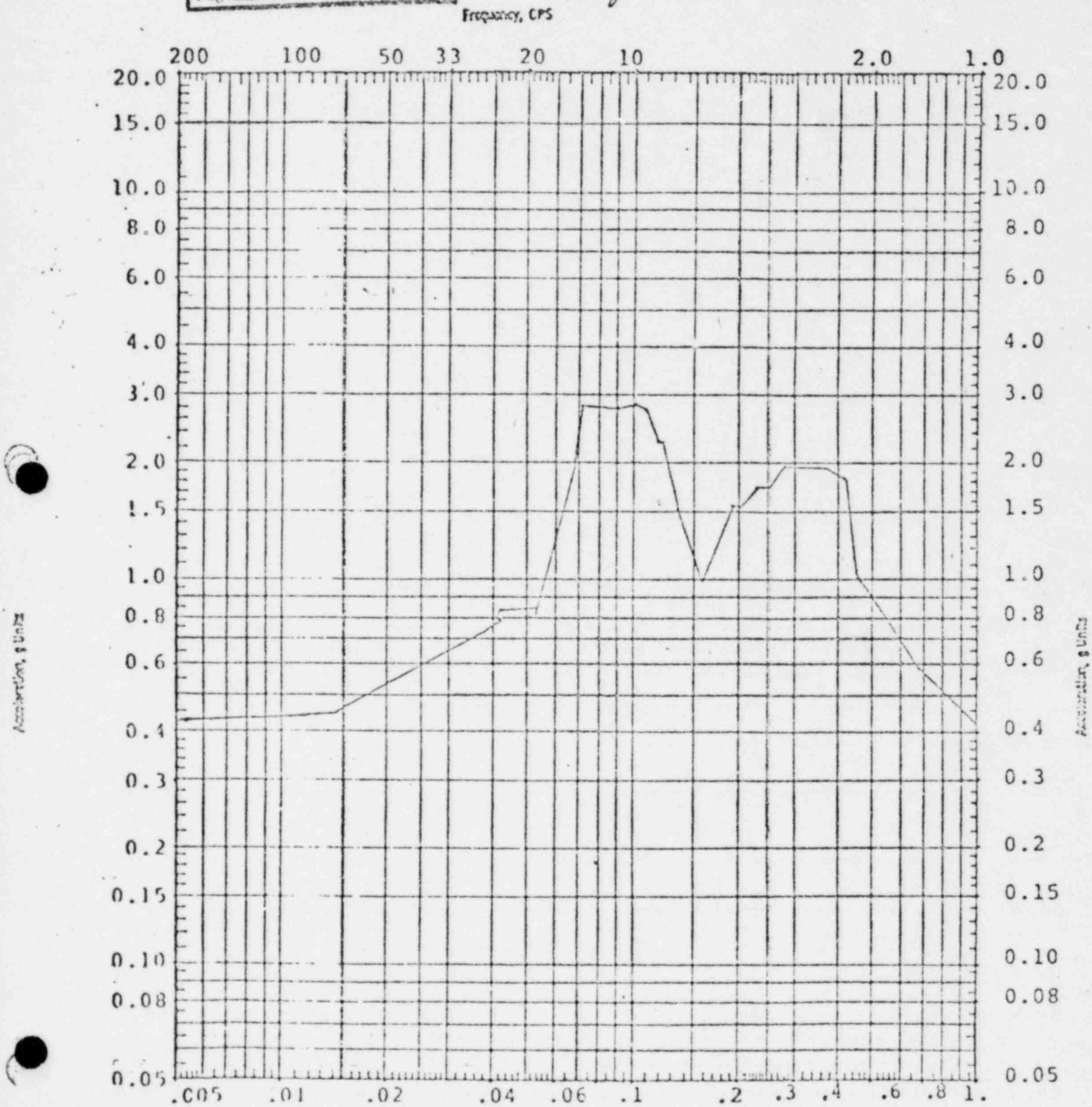

REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Wall

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

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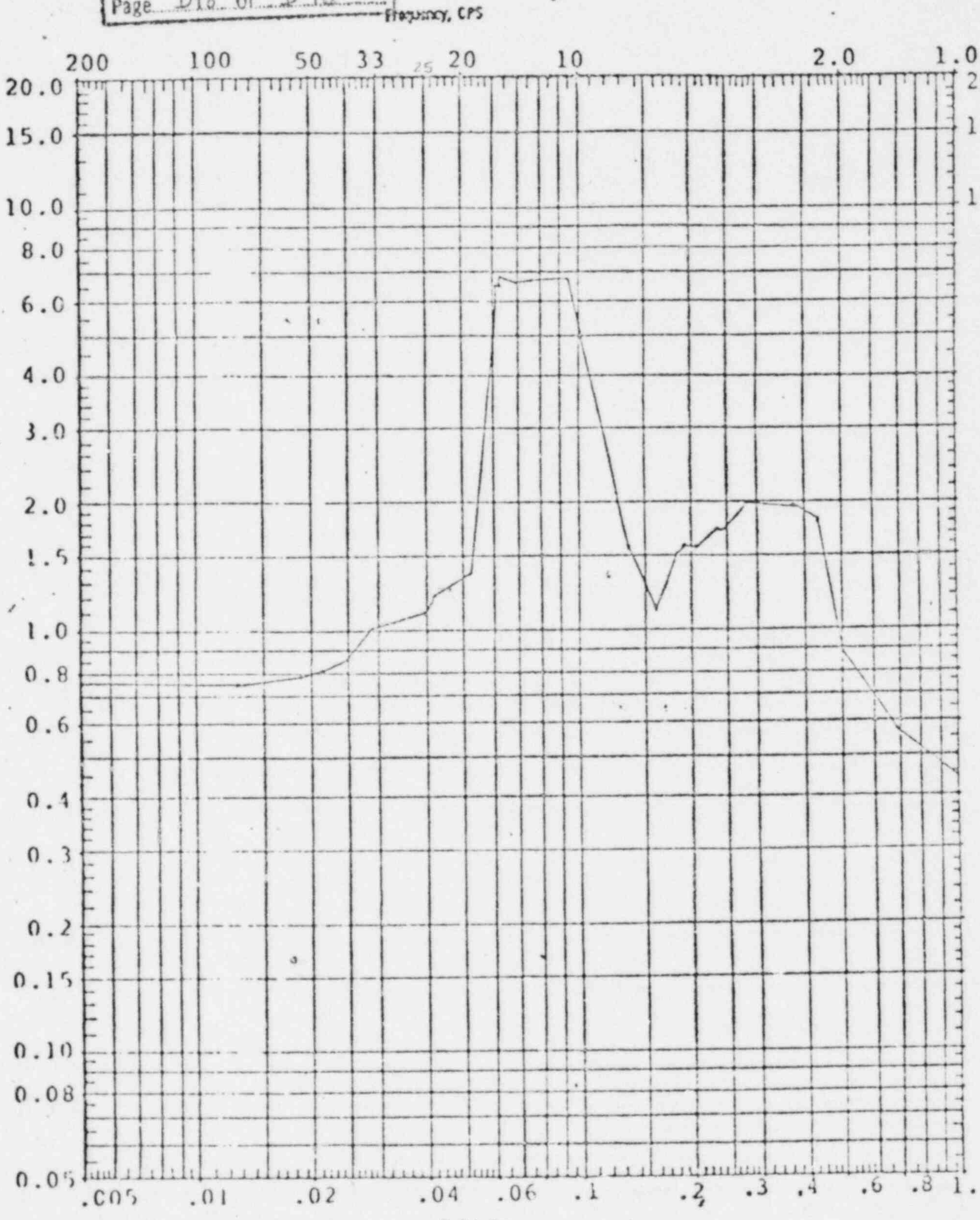

REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Slab

Envelope of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of ($SRV_{...}$ + $SRV_{...}$)

I. OBJECTIVE

The objective of this study can be summarized as follows:

a) To assess the comparison between the impedence test results for SRM & IRM Preamplifier Enclosure and the existing qualification report.

b) To re-assess the adequacy of SRM & IRM Preamplifier Enclosure for the additional pool dynamic loads particularly in the region of high frequency resonances.

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORT

Qualification report presented the results of a dynamic analysis (Ref. 1) using S&L SAP-IV computer program with seismic loading in X, Y & Z directions for SRM & IRM Preamplifiers Enclosures which were welded on the Floor (P030 & P033) by two legs. Stress in P030 & P033 Panels were considered more critical than P031 & P032 which are bolted to the vertical wall.

The mathematical model consisted of 74 nodes, 62 beam elements and 66 plate elements (See Figures 1 & 2). The response spectra method was used to calculate the forces in the model's elements.

The response spectra curves used in the analysis were obtained by enveloping SSE (2% Damping) and OBE (1% Damping) seismic loadings at EL 740'-0" of the reactor building.

Figures 3 & 4 represent the enveloped response spectra for horizontal and vertical directions.

In this model all devices and attachments including the weight of the preamplifiers were considered for their masses which were distributed on the nearest nodes.

The weight of each amplifier was conservatively assumed to be 50 lb. which tended to give smaller values for resonant frequencies.

Based on the results of analysis as presented in Reference 1 the SRM & IRM Preamplifier Enclosures were qualified as a reliable and functional structure.

Table 1 shows the resonant frequencies for the enclosure in the analysis. As can be seen from this table, the fundamental frequency of the enclosure is 7.35 Hz.

III. SUMMARY OF PERTINENT RESULTS FROM IMPEDENCE TEST REPORT

SQRT in-plant impedence testing on the equipment was done on July 27, 1980. The three preamplifiers were installed and were operational at the time of testing. The panel (1H22-P030) with L=30", W=17", H=36" was mounted by molly bolts secured to the concrete wall. For unknown reasons, the wall had high (0.5g)

ambient vibrations. The panel was excited by both electromagnetic shaker and the hammer blows. Excitation by electromagnetic shaker and the large hammer was done in three directions while response was measured in the Z direction. The wire diagram of the tested panel is shown in Figures 5 & 6. The preamplifiers were excited separately by the use of the small (3 oz.) hammers while the response was measured at the points pictured in Fig. 7.

Figure 8 is a representative transfer function using the large hammer with the response in the Z direction. Figures 9, 10 and 11 are representative transfer functions as excited by the electromagnetic shaker in the Y, X and Z directions, respectively. Note that for the two Z direction tests, resonances are equivalent.

Table 2 lists the resonant frequencies and dampings determined from analytical fits to the test data. The cross coupling coefficients for each resonance are listed in Table 3.

Figures 12 through 17 are composite mode shapes associated with the resonant frequencies in the Z direction. Figure 18 through 20 are the mode shapes associated with the resonant frequencies in the Y direction while Figures 21 through 25 are associated with the X-direction.

According to the Impedence Test report, the results show many resonances in the 30-100 Hz range.

IV. COMPARISON OF THE RESULTS

a. Wire Frame model in Impedence Test Vs. Finite Element Model: By inspection of the wire frame model (Figures 26, 27) it is indicated that the measurements were taken at three or four points of each corner of the enclosure plus the CG of the side of each plate. For the preamplifiers, measurements were taken at each corner and the midpoints (Pts. 32, 37 & 42). Essentially, the wire frame model is very similar to the finite element model. The global axes for each model are as follows:

$$X_T = -X_A, \quad Y_T = Z_A, \quad Z_T = Y_A$$

Where T = Impedence Test, A = Analysis as shown in Figure 27.

Table 4 shows the nodal points in the wire frame and the corresponding nodal point(s) in the analysis for comparison.

b. Frequency range covered by analysis is inclusive of the frequency range presented by tests up to about 63 Hz which is the cut off frequency in the analysis.

c. Due to the fact that the preamplifiers' masses were lumped at the nearest nodes on the panel's sides the first mode in the analysis was lower (7.25 Hz) vs. the first mode in the tests (10.4 Hz). Also in the analysis the weight of each preamplifier was assumed to be 50 lbs. which is very

conservative since the average weight of each is 21 lbs. As a result of this assumption the first mode in the analysis tended to be lower than the tested panel.

Another factor which contributed to this high first mode is the fact that in the test the shaker did not have enough energy to excite the panel at a frequency below 10 Hz.

d. By comparing the second mode in both the test and the analysis 20.8 Hz in test vs. 17.92 Hz in the analysis it can be noticed that they are comparable because of the excess weight of the preamplifiers assumed in the analysis and the nature of the finite element model in assuming lumped mass versus distributed mass actually present and reflected in the test results.

e. A major difference in the two models is that the model analyzed was mounted on the floor by two legs while the panel tests was one which was mounted on the wall. That tended to give higher resonant frequencies in the test rhan in the analysis due to the flexibility of the leg supports.

f. The impedence tests showed two frequencies 29.5 and 30.7 Hz which were not shown in the analysis results. From the mode shape composite associated with 29.5 Hz (Figure 12) it can be shown that it is a local mode for <u>the door</u> at node No. 25 of the wire diagram where there is <u>no</u> instrument located hence it has no effect on its performance.

g. As a conservative approach by inspecting the maximum stresses which might result due to the frequencies 29.5 and 30.7 Hz in the panel the following calculations were made:

From Reference 1 the maximum stresses in the beam element $\cong$ 16100 psi. By multiplying this steess by a factor K where

$$K = \frac{2g_{max} + \bar{g}}{2g_{max}}$$

$\bar{g}$ = g value corresponding to the given frequency

g_{max} = maximum g value in the Response Spectra Curve

$$K = \frac{2(1.9)+.7}{2(1.9)} = 1.184 \quad (f = 29.5 \text{ to } 30.7 \text{ Hz})$$

Therefore

$\therefore S_{max}$ = 19062 psi $<$ 25,500 psi allowable ($.7\ S_y$)

Hence it is safe. Table 5 shows the values of k for every mode.

h. As mentioned before due to the fact that the cut-off frequency in the analysis was about 60 Hz, any frequency above this number did not show in the results. However, since the ZPA frequency for this equipment is 50 Hz, frequencies higher than this value are not important from the qualification point of view.

i. In general there is a good agreement between the analytical and the test results.

V. CONSIDERATION OF HIGH FREQUENCY RESONANCES

In the case of SRM & IRM Preamplifier Enclosures there is no special evaluation required for the high frequency resonances at this stage. The reason for this is the fact that the ZPA frequency at the EL 740'-0" is about 50 Hz., (considering all seismic and hydrodynamic loads Figures 28, 29 & 30), while in the existing qualification analysis frequencies up to 65 Hz are already accounted for.

VI. CONCLUSION

Comparison between the impedence test results and the analysis done by S&L indicates that the frequencies identified are practically the same. Some of the frequencies were not identified in the analysis due to modeling techniques but by conservatively estimating the stresses the maximum stress in any beam is still less than the allowables hence acceptable. As a conclusion the method of analysis and modeling techniques were correct and adequate.

VII. REFERENCES

1. "Qualification Report for SRM & IRM Preamplifier Enclosure" EMD Calc. # EMD-030188, Dated 5/26/81.

2. Impedence Test For SRM & IRM Preamplifier Enclosure, Transitek Inc, EMD File No. 029474, dated 3/10/81.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469	
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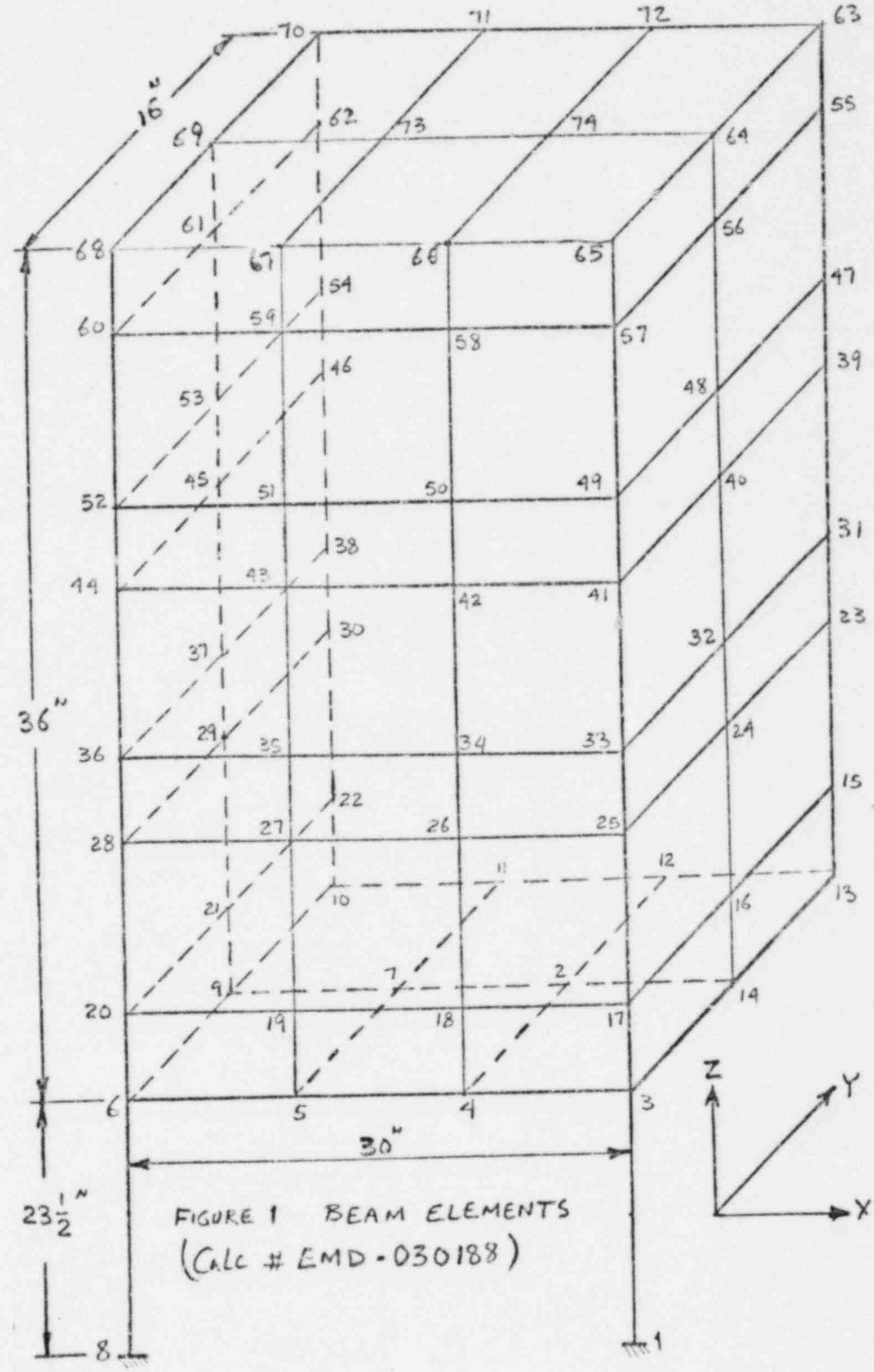

FIGURE 1 BEAM ELEMENTS
(Calc # EMD-030188)

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CHICAGO

Calcs. For SRM & IRM Preamplifier Enclosure

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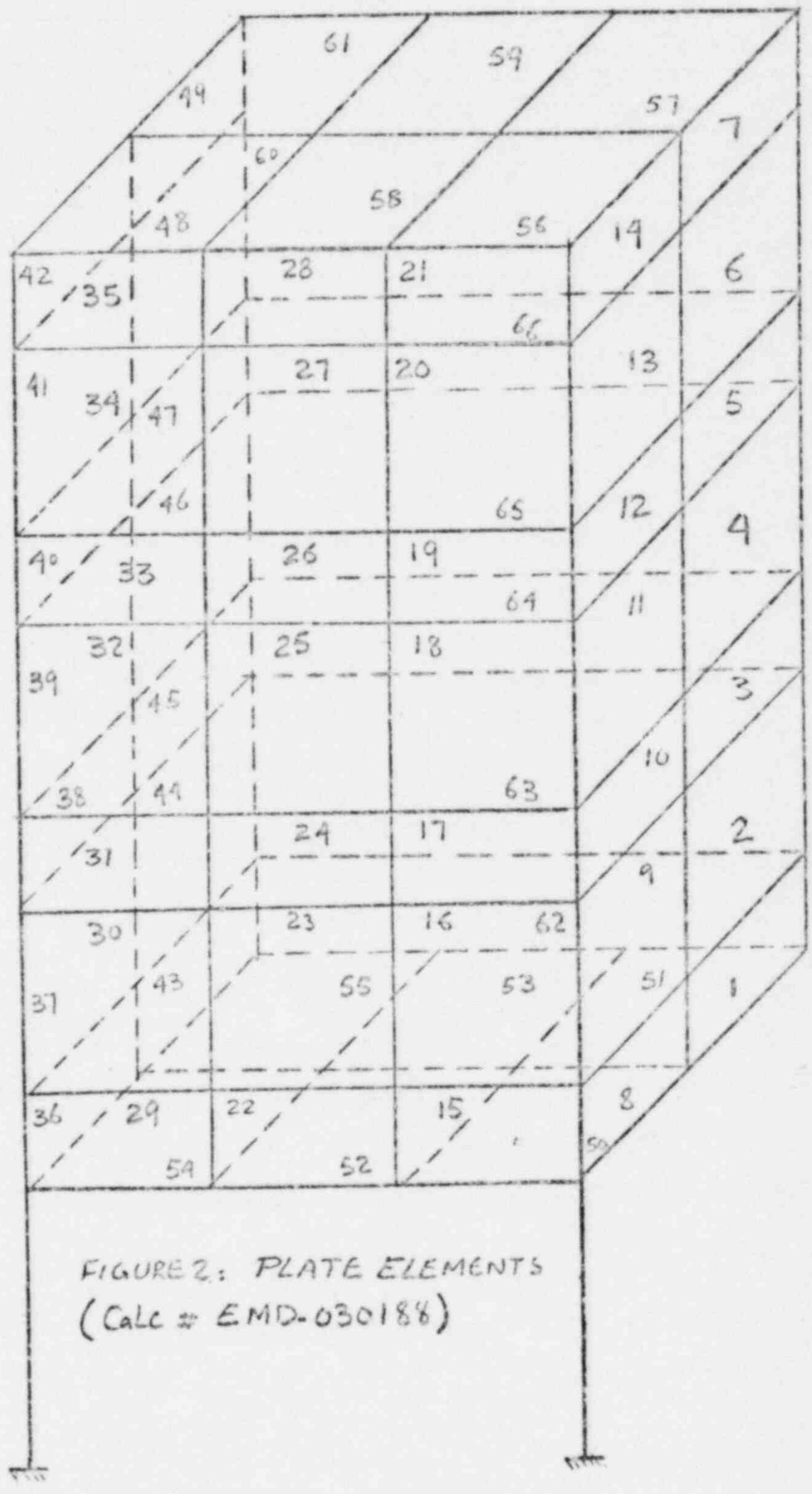

FIGURE 2: PLATE ELEMENTS
(Calc # EMD-030188)

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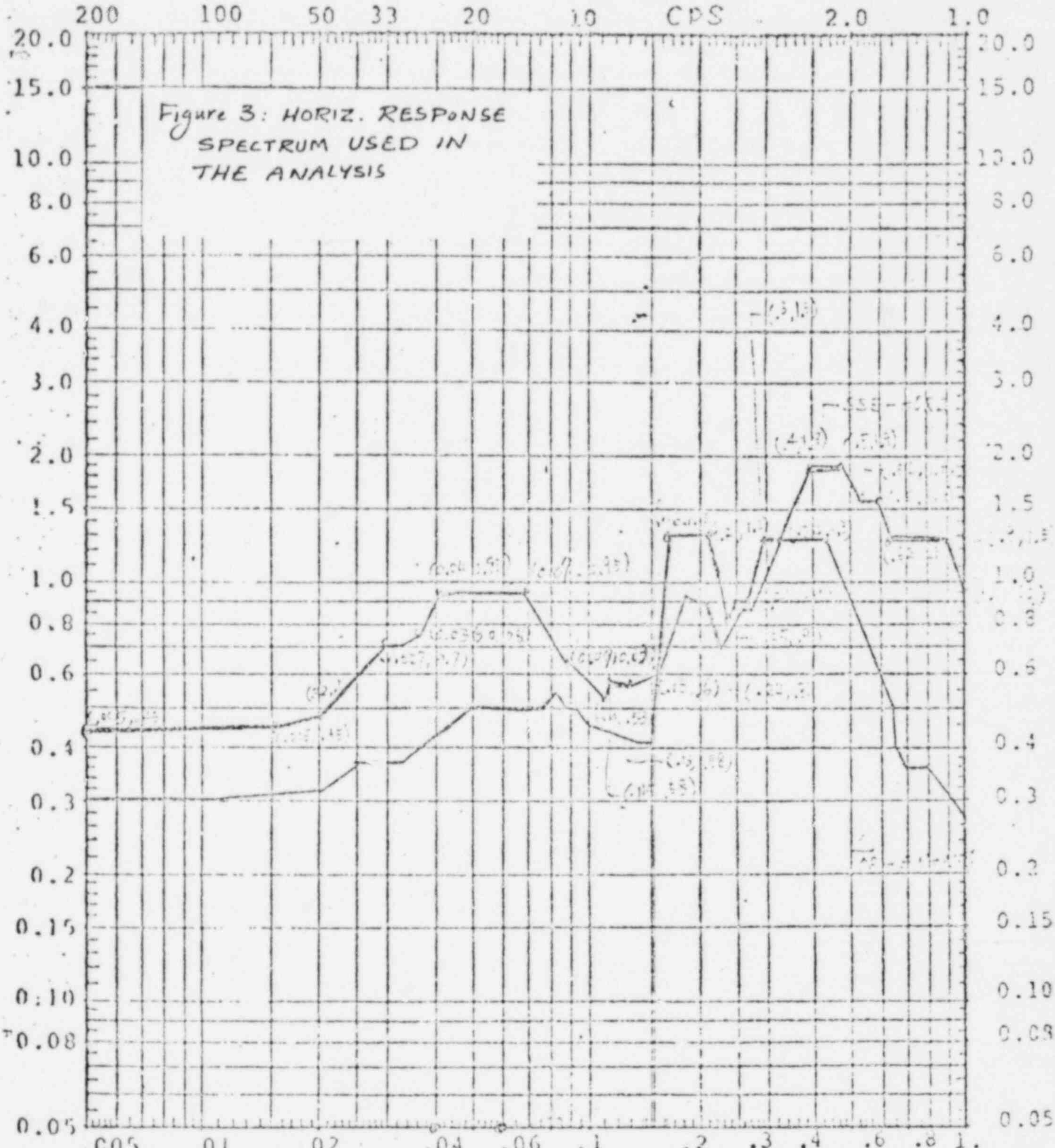

REACTOR BUILDING-ELEVATION : 740' 2% Damping Horizontal

1% Damping

ENV OF {[(OBE-EW) and (OBE-NS)] and (SSE-HORZ)}

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	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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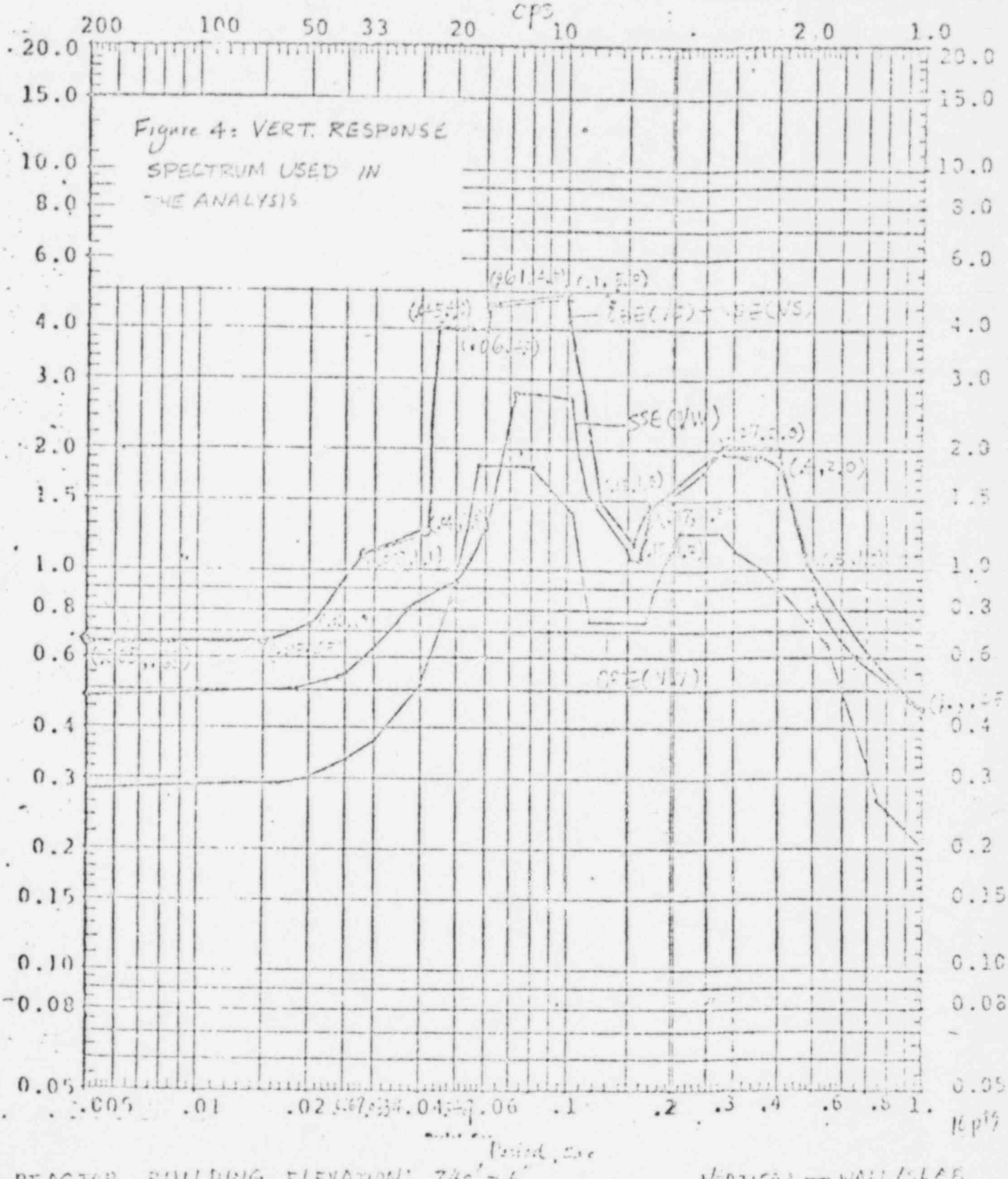
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date



REACTOR BUILDING ELEVATION: 786' - 6"   VERTICAL — WALL/SLAB

1% DAMPING — Upset   2% DAMPING — Emergency

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030187	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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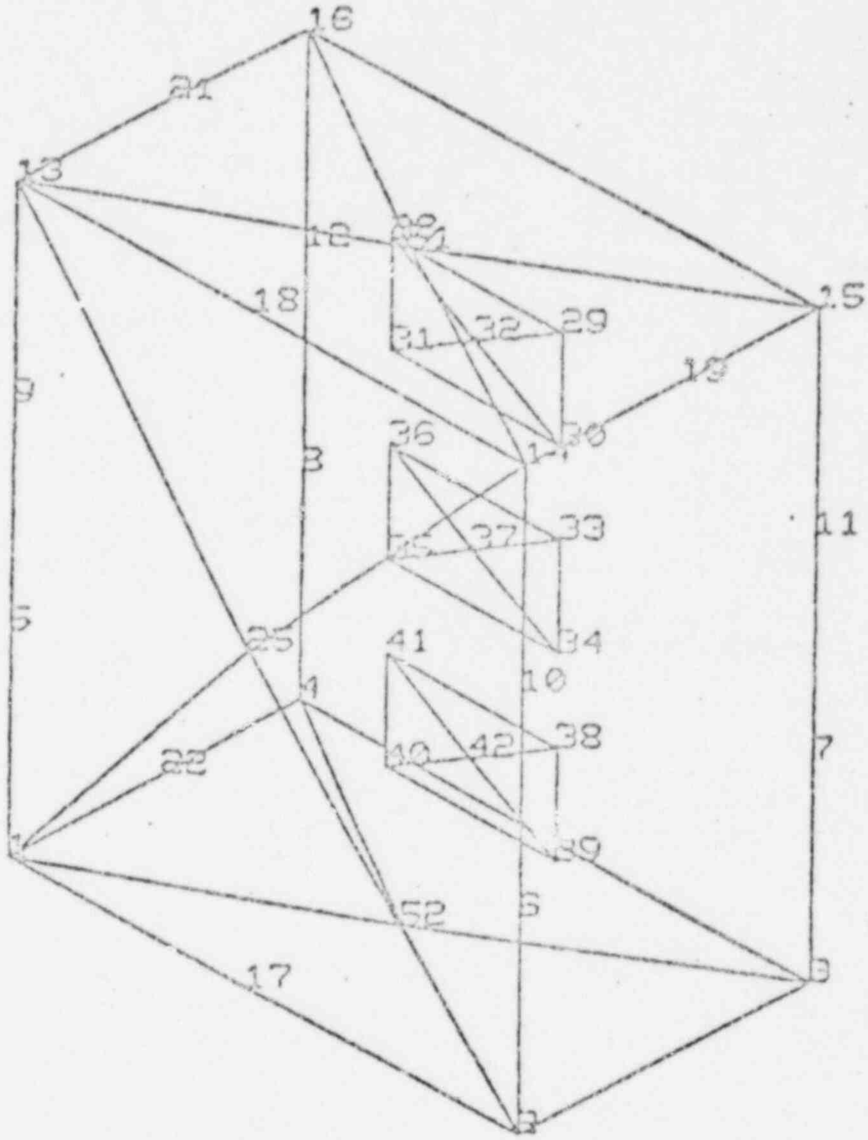

FIGURE 5

GEOMETRY OF THE SRM/IRM PANEL
(IMPEDENCE TEST)

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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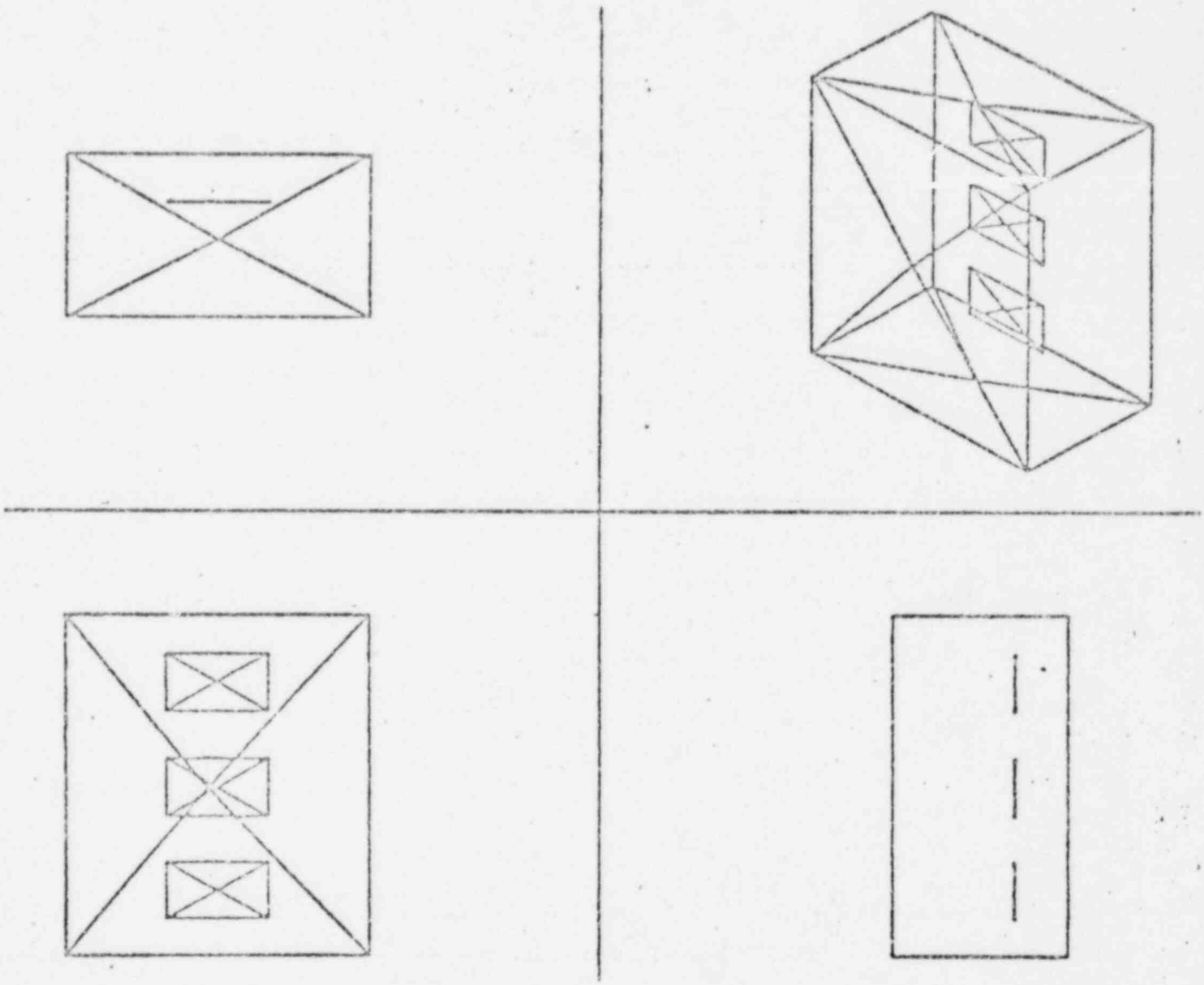

FIGURE 6

FOUR VIEWS OF THE SRM/IRM PANEL
(IMPEDENCE TEST)

SARGENT & LUNDY ENGINEERS CHICAGO	Calc. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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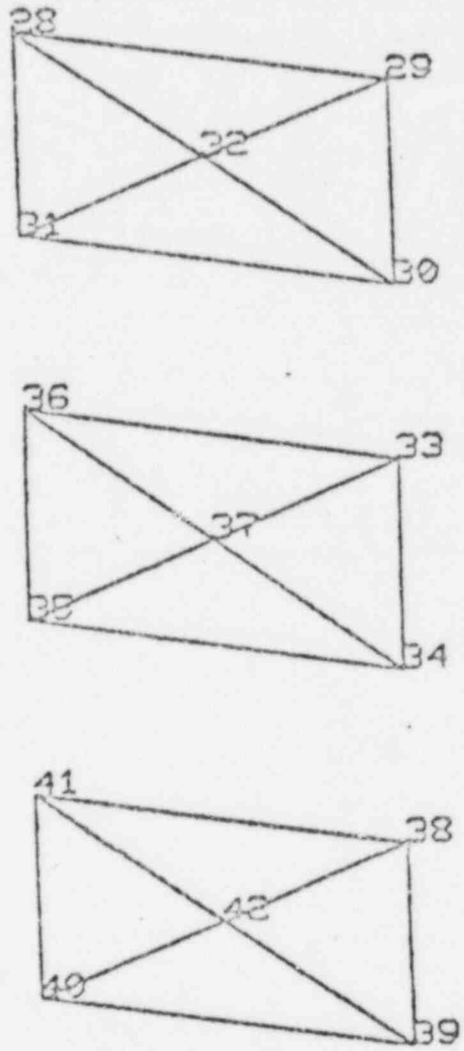

FIGURE 7

GEOMETRY OF THE SRM/IRM PANEL PREAMPLIFIERS IMPEDENCE TEST

SARGENT & LUNDY ENGINEERS CHICAGO

Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469
X Safety-Related	Non-Safety-Related	Rev. 00 Date 06/01/81
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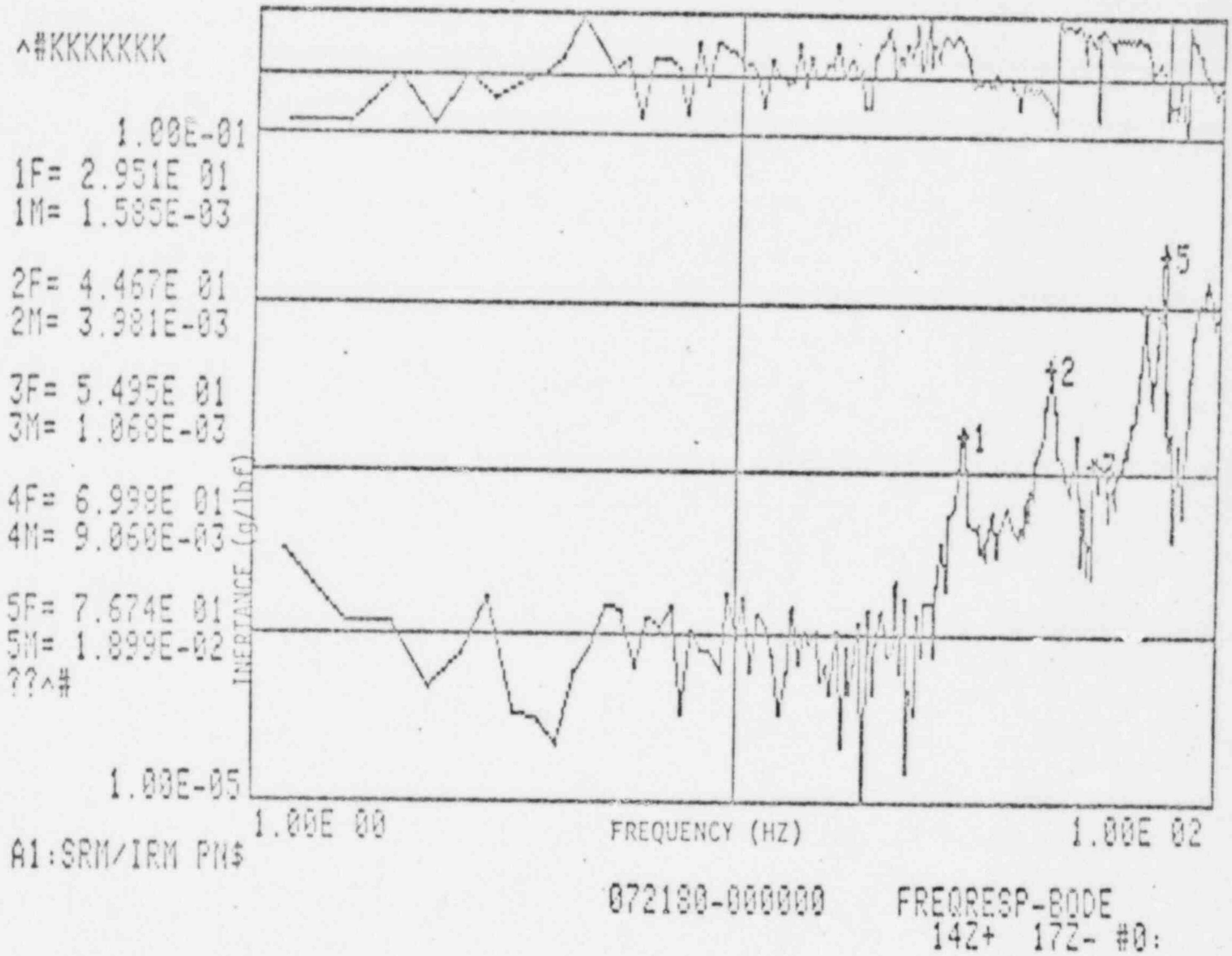

FIGURE 8

REPRESENTATIVE TRANSFER FUNCTION IN THE Z DIRECTION FOR THE SRM/IRM PANEL
(HAMMER TEST DATA)

SARGENT & LUNDY ENGINEERS CHICAGO	Calc For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
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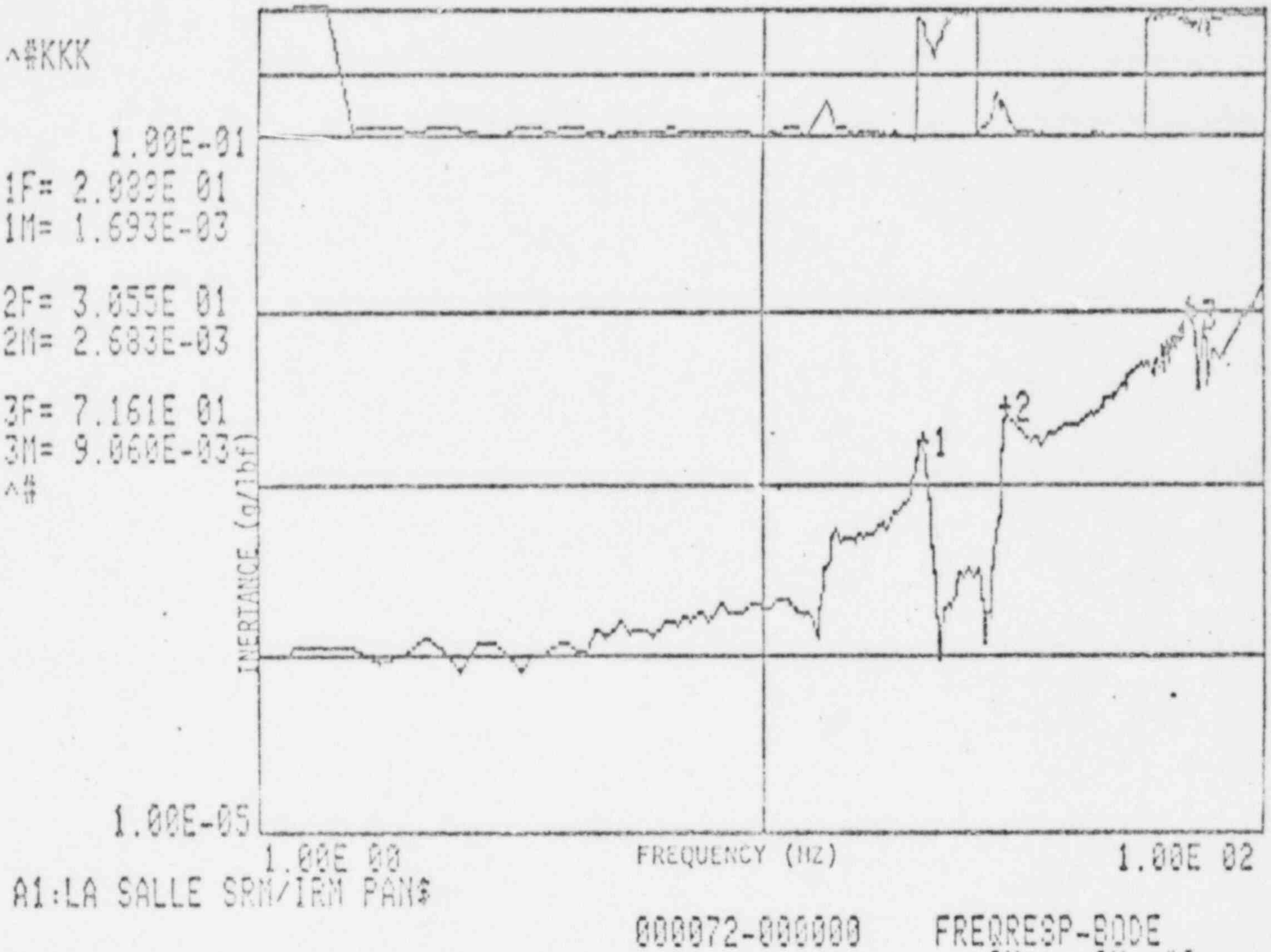

FIGURE 9

REPRESENTATIVE TRANSFER FUNCTION IN THE Y DIRECTION FOR THE SRM/IRM PANEL (SHAKER TEST DATA)

Calc. For SRM & IRM Preamplifier Enclosure			Calc. No. EMD-030469
X	Safety-Related	Non-Safety-Related	Rev. 00 Date 06/01/81
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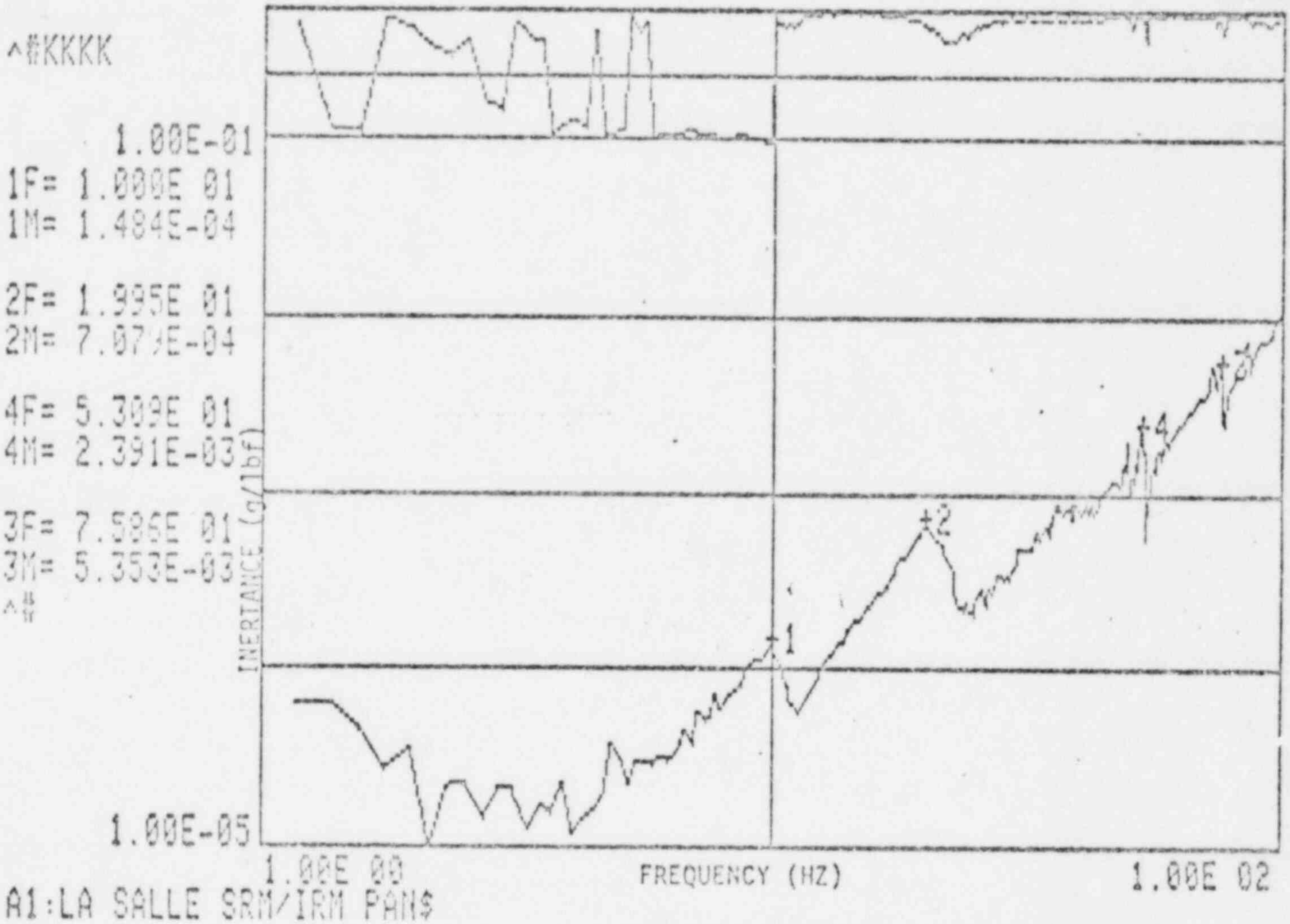

FIGURE 10

REPRESENTATIVE TRANSFER FUNCTION IN THE X DIRECTION FOR THE SRM/IRM PANEL
(SHAKER TEST DATA)

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469
	X Safety-Related	Non-Safety-Related	Rev. 00 Date 04/01/8?
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Proj. No. 4266/4267/6093-006 Equip. No.	Approved by	Date

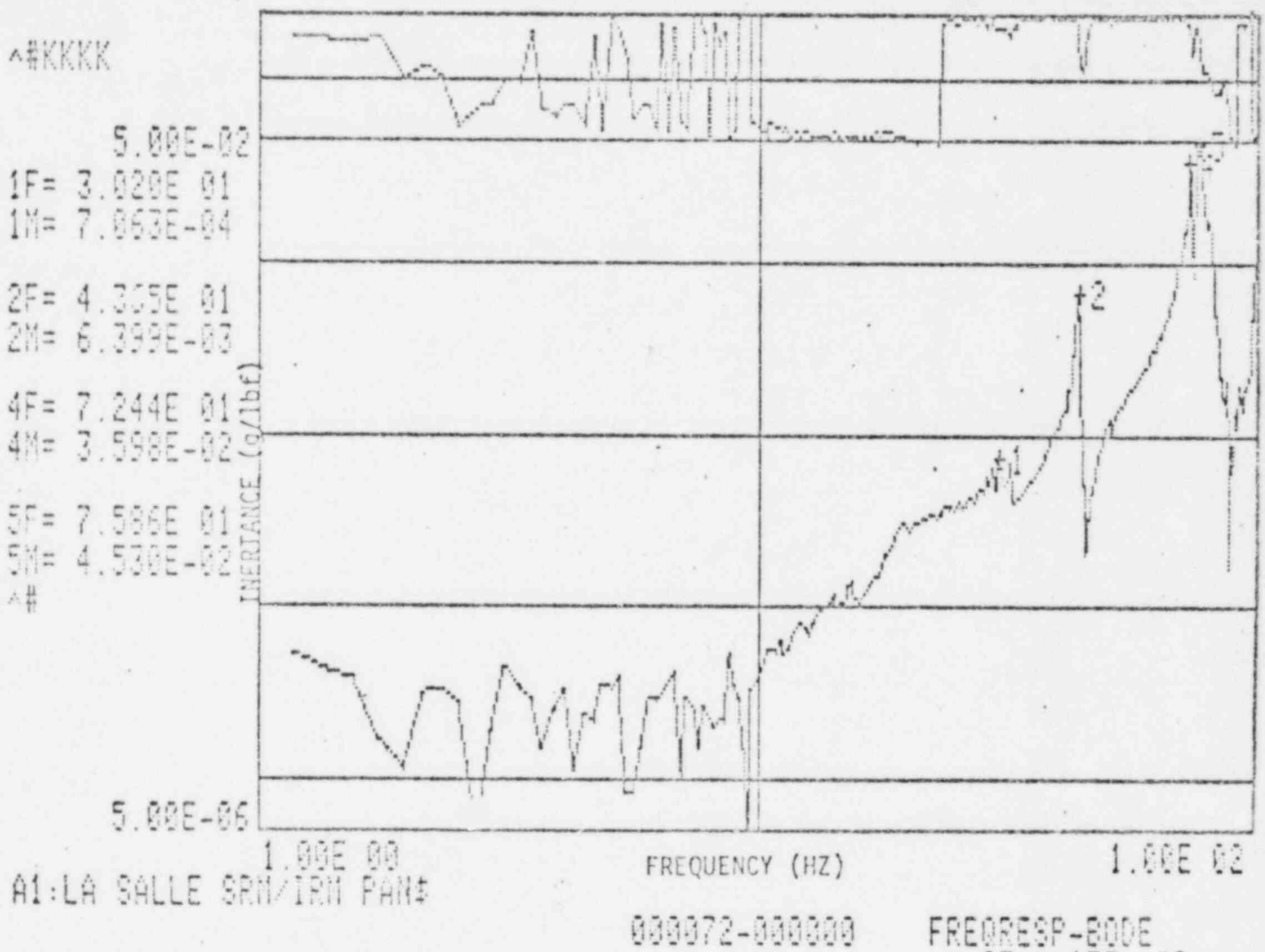

FIGURE 11

REPRESENTATIVE TRANSFER FUNCTION IN THE Z DIRECTION FOR THE SRM/IRM PANEL
(SHAKER TEST DATA)

SARGENT & LUNDY ENGINEERS CHICAGO	Calc. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/8?
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Proj. No. 4266/4267/6093-0 Basis No.	Approved by	Date

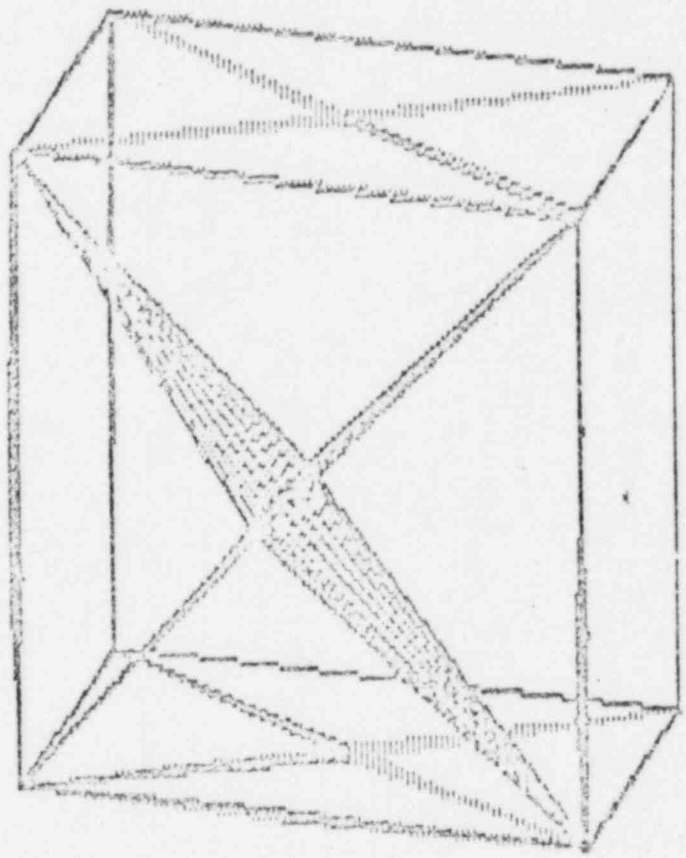

FIGURE 12

MODE SHAPE 1 ASSOCIATED WITH THE 29.5 HZ RESONANCE IN THE Z DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure			Calc. No. EMD-030469	
	X	Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

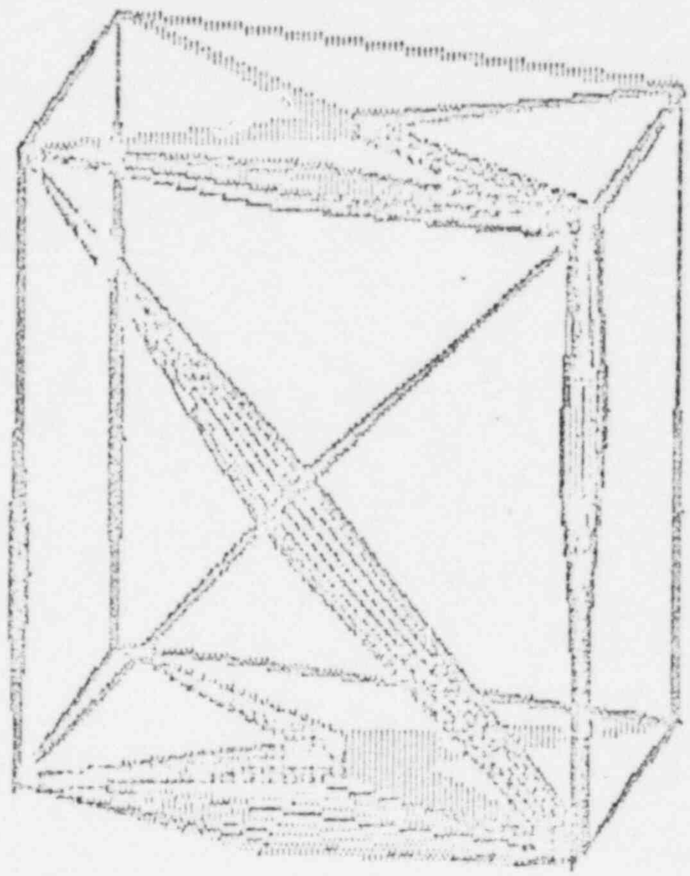

FIGURE 13

MODE SHAPE 2 ASSOCIATED WITH THE 45 HZ RESONANCE IN THE Z DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure			Calc. No. EMD-030469	
	X	Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

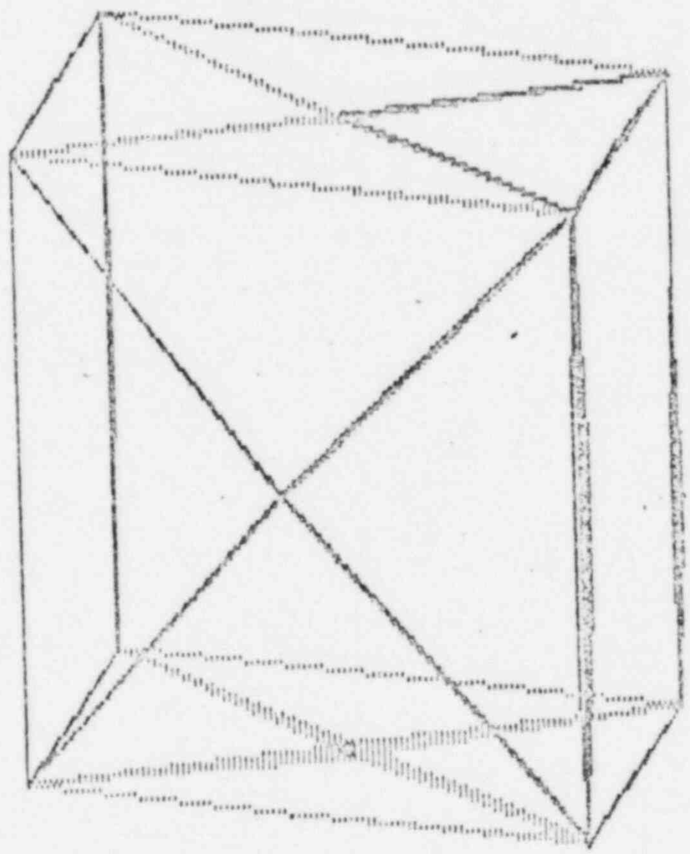

FIGURE 14

MODE SHAPE 3 ASSOCIATED WITH THE 54.1 HZ RESONANCE IN THE Z DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030769	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/8?
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Proj. No. 4266/4267/6093-09 Eqpt. No.	Approved by	Date

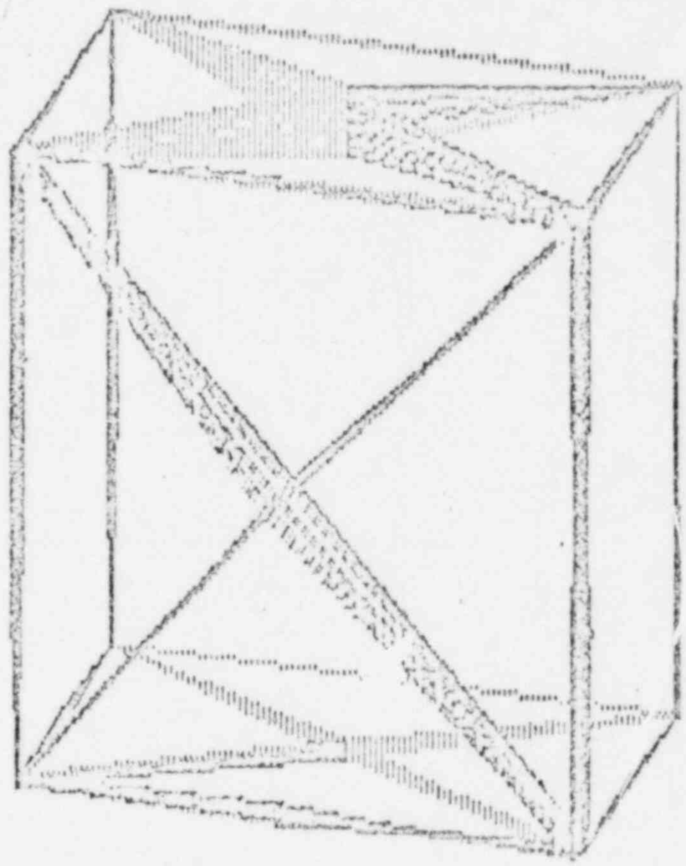

FIGURE 15

MODE SHAPE 4 ASSOCIATED WITH THE 70.9 HZ RESONANCE IN THE Z DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/8?
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Client Commonwealth Edison Company	Prepared by S. Yassin	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

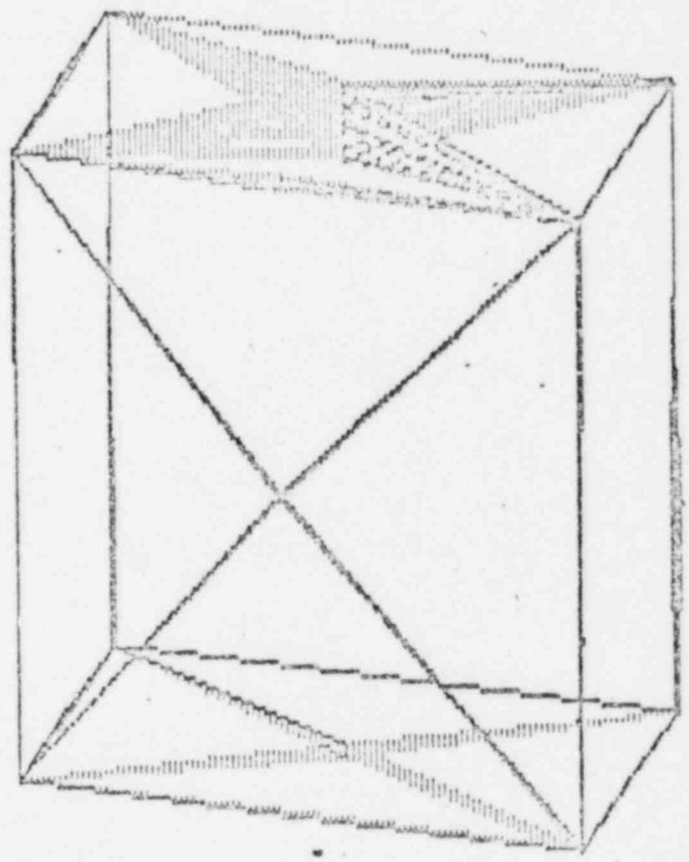

FIGURE 16

MODE SHAPE 5 ASSOCIATED WITH THE 76.0 HZ RESONANCE IN THE Z DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Calc. No.	Approved by	Date

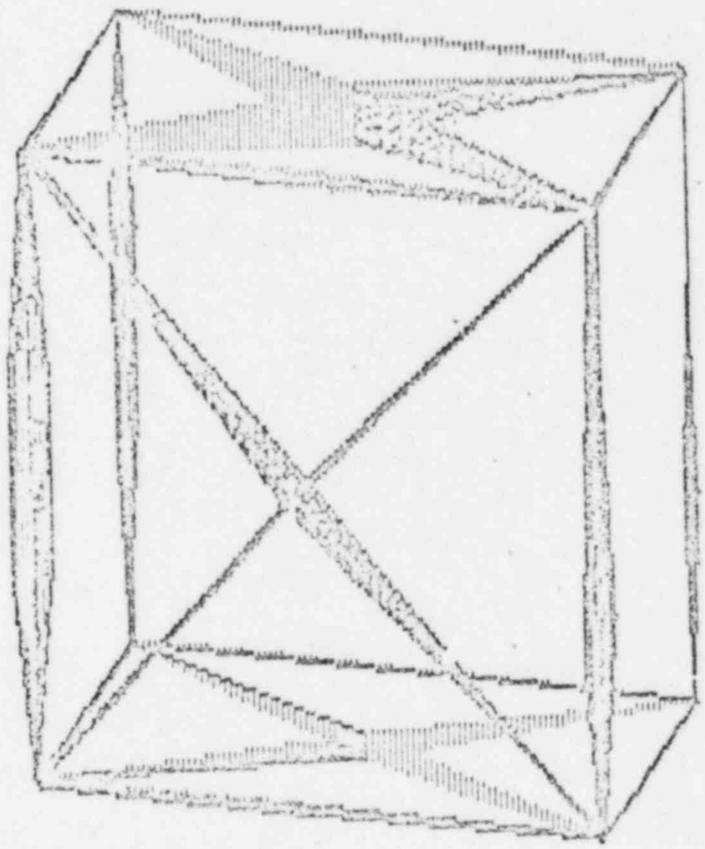

FIGURE 17

MODE SHAPE 6 ASSOCIATED WITH THE 96.2 HZ RESONANCE IN THE Z DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

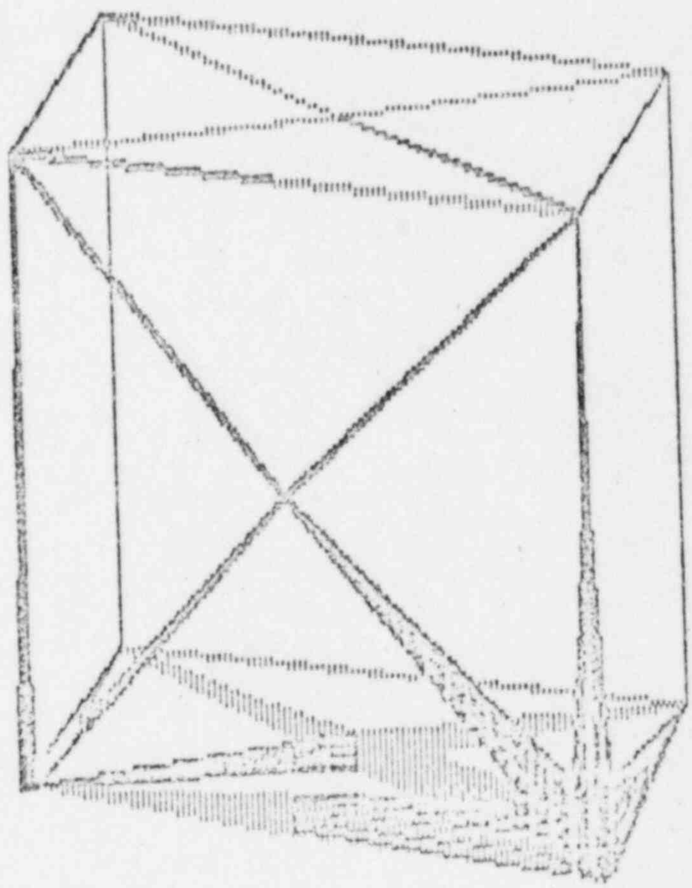

FIGURE 18

MODE SHAPE 7 ASSOCIATED WITH THE 21.1 HZ RESONANCE IN THE Y DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

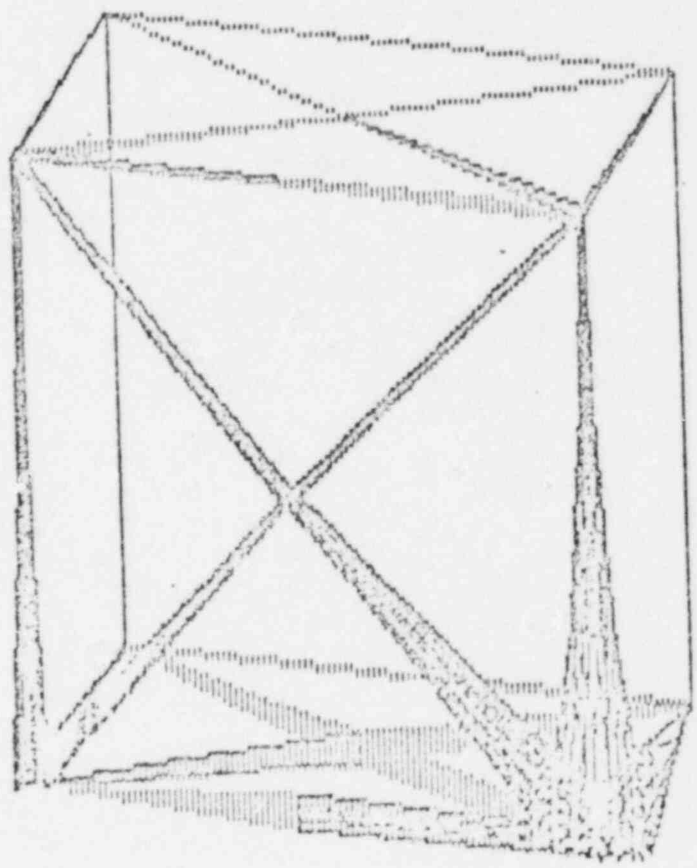

FIGURE 19

MODE SHAPE 8 ASSOCIATED WITH THE 30.7 HZ RESONANCE IN THE Y DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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Client Commonwealth Edison Company	Prepared by S. Yassin Date
Project LaSalle County, Units I & II	Reviewed by Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by Date

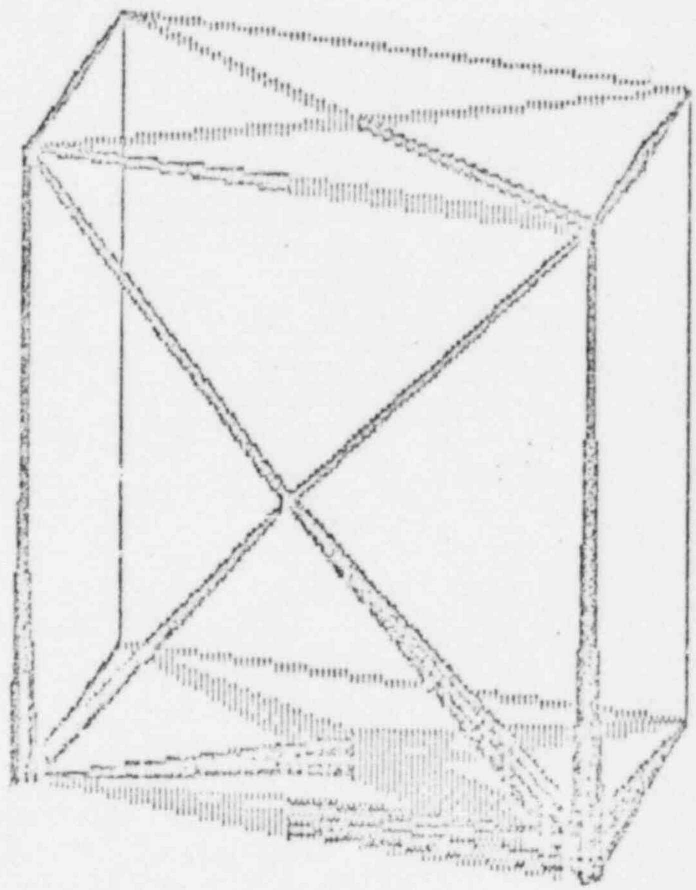

FIGURE 20

MODE SHAPE 9 ASSOCIATED WITH THE 72.5 HZ RESONANCE IN THE Y DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

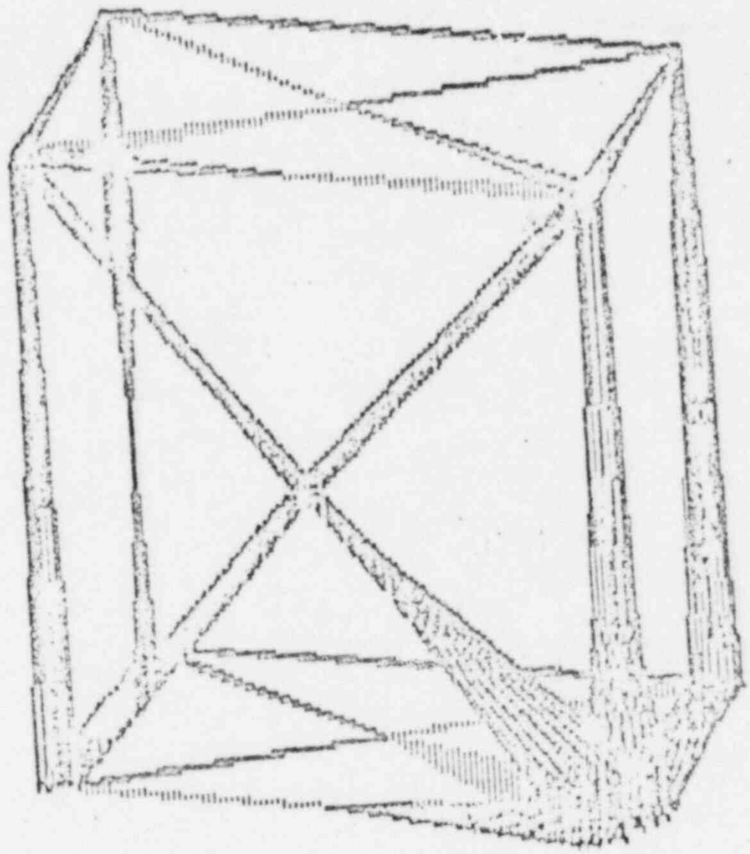

FIGURE 21

MODE SHAPE 10 ASSOCIATED WITH THE 10.4 HZ RESONANCE IN THE X DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure			Calc. No. EMD-036469	
	X	Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/8?
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Client Commonwealth Edison Company	Prepared by S. Yassin	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

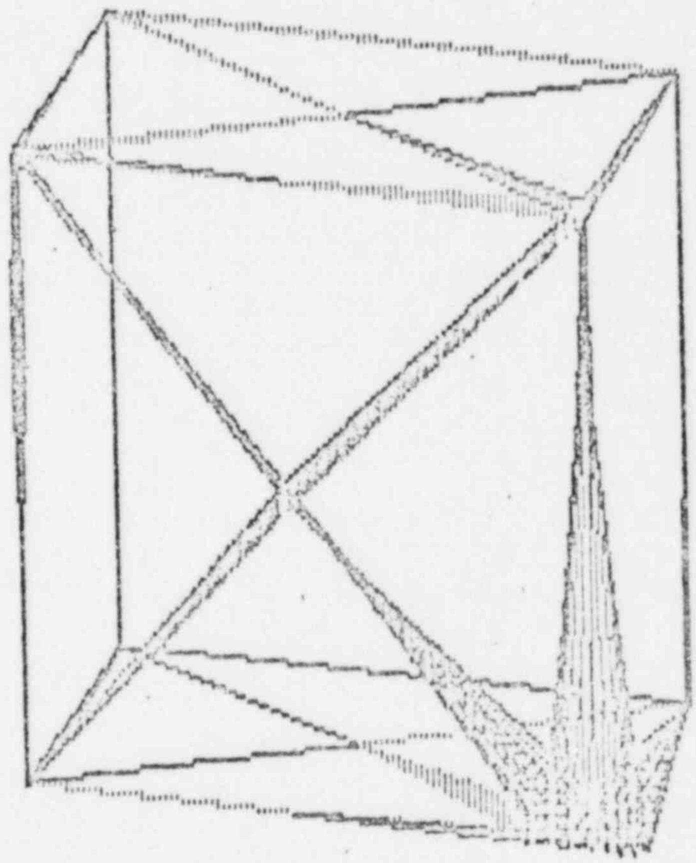

FIGURE - 22

MODE SHAPE 11 ASSOCIATED WITH THE 20.8 HZ RESONANCE IN THE X DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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Proj. No. 4266/4267/6093-006 Equip. No.	Approved by	Date

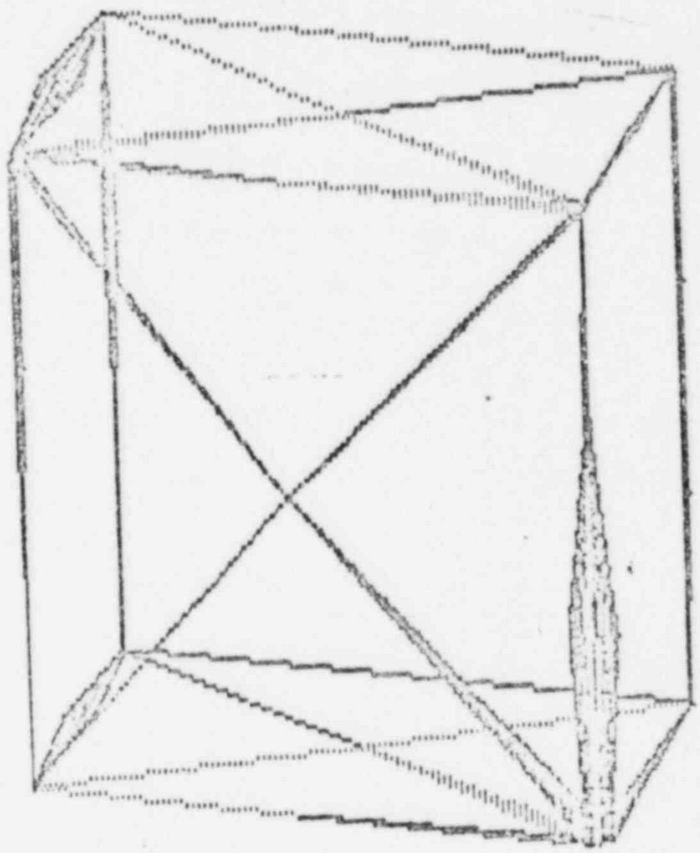

FIGURE 23

MODE SHAPE 13 ASSOCIATED WITH THE 75.9 HZ RESONANCE IN THE X DIRECTION

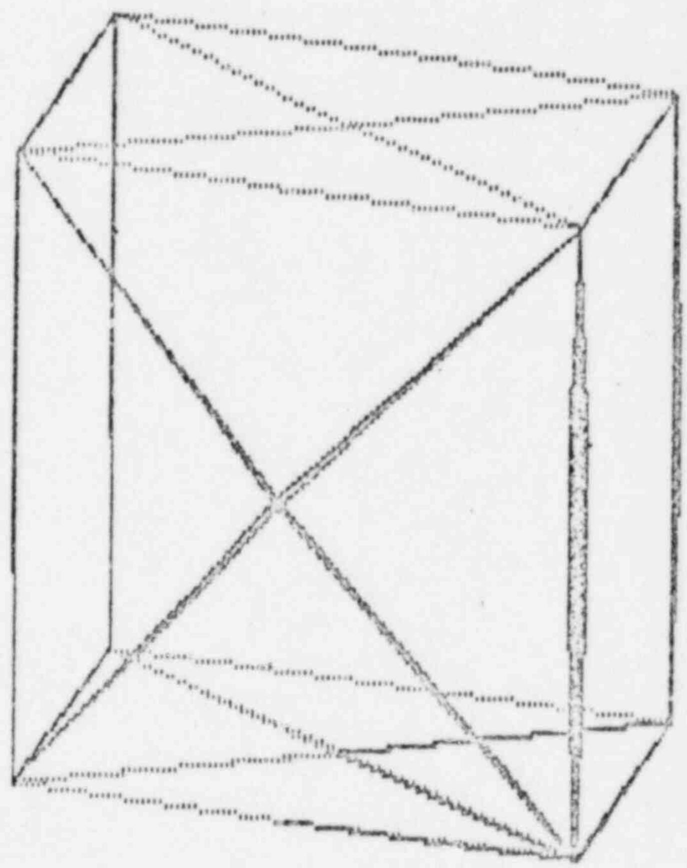

FIGURE 24

MODE SHAPE 12 ASSOCIATED WITH THE 53.2 HZ RESONANCE IN THE X DIRECTION

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-030469	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
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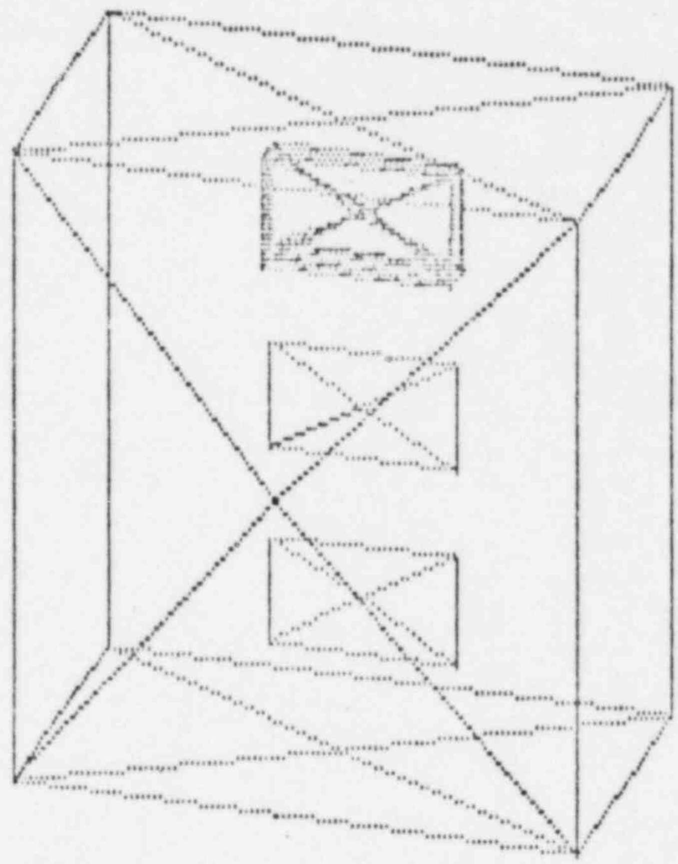

FIGURE 25

MODE SHAPE OF THE TOP PREAMPLIFIER IN THE SRM/IRM PANEL AT 37.2 HZ

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
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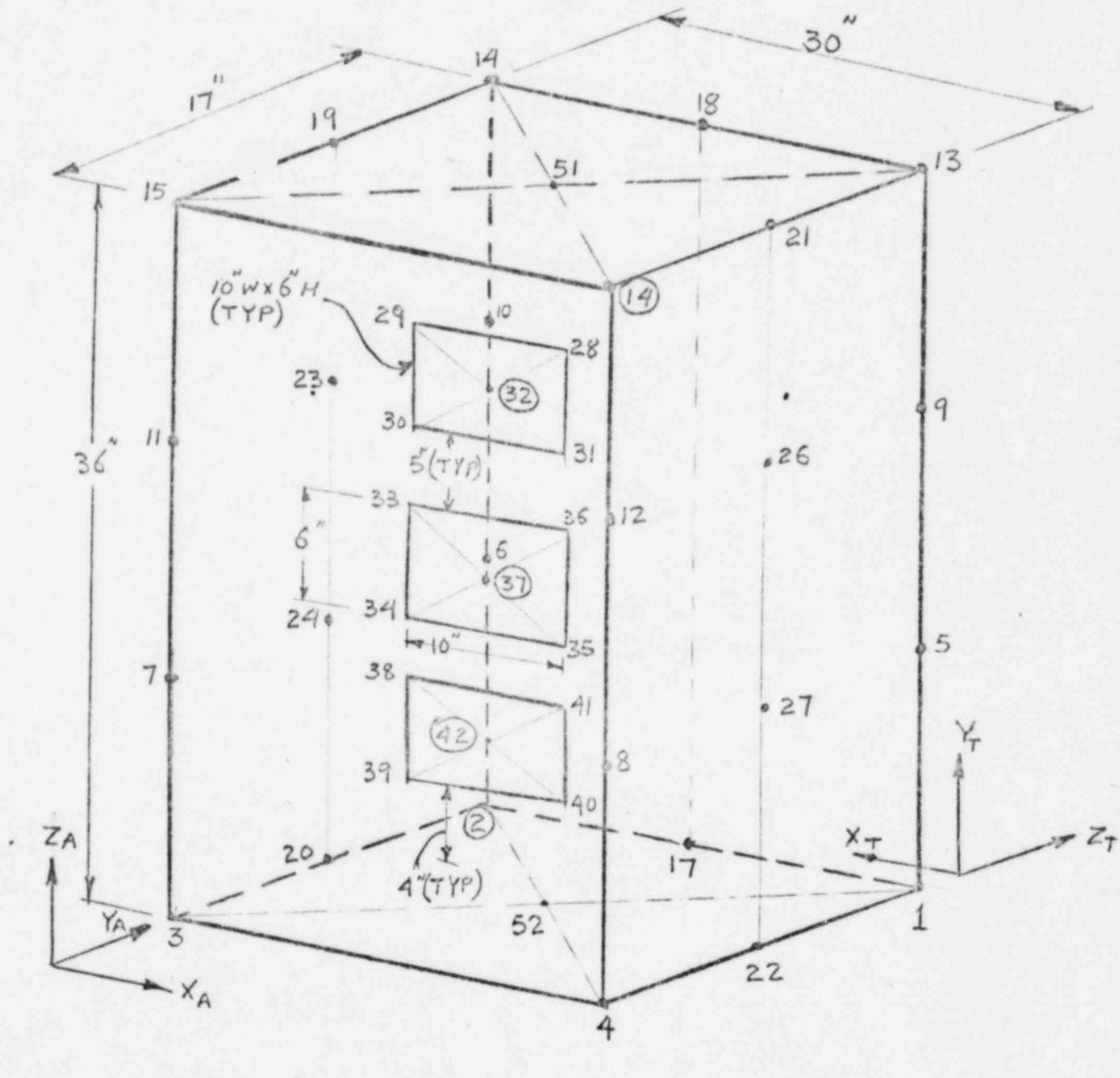
Proj. No. 4266/4267/6093-006 Calc. No.	Approved by	Date

FIGURE 26 : SRM/IRM PANEL VIEW IN Y_A DIRECTION (Z_T DIRECTION)



○ Nodes where Forcing Functions were applied during test

X_A, Y_A, Z_A = Global axes used in analysis

X_T, Y_T, Z_T = Global axes used in Transitek

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-036469
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Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

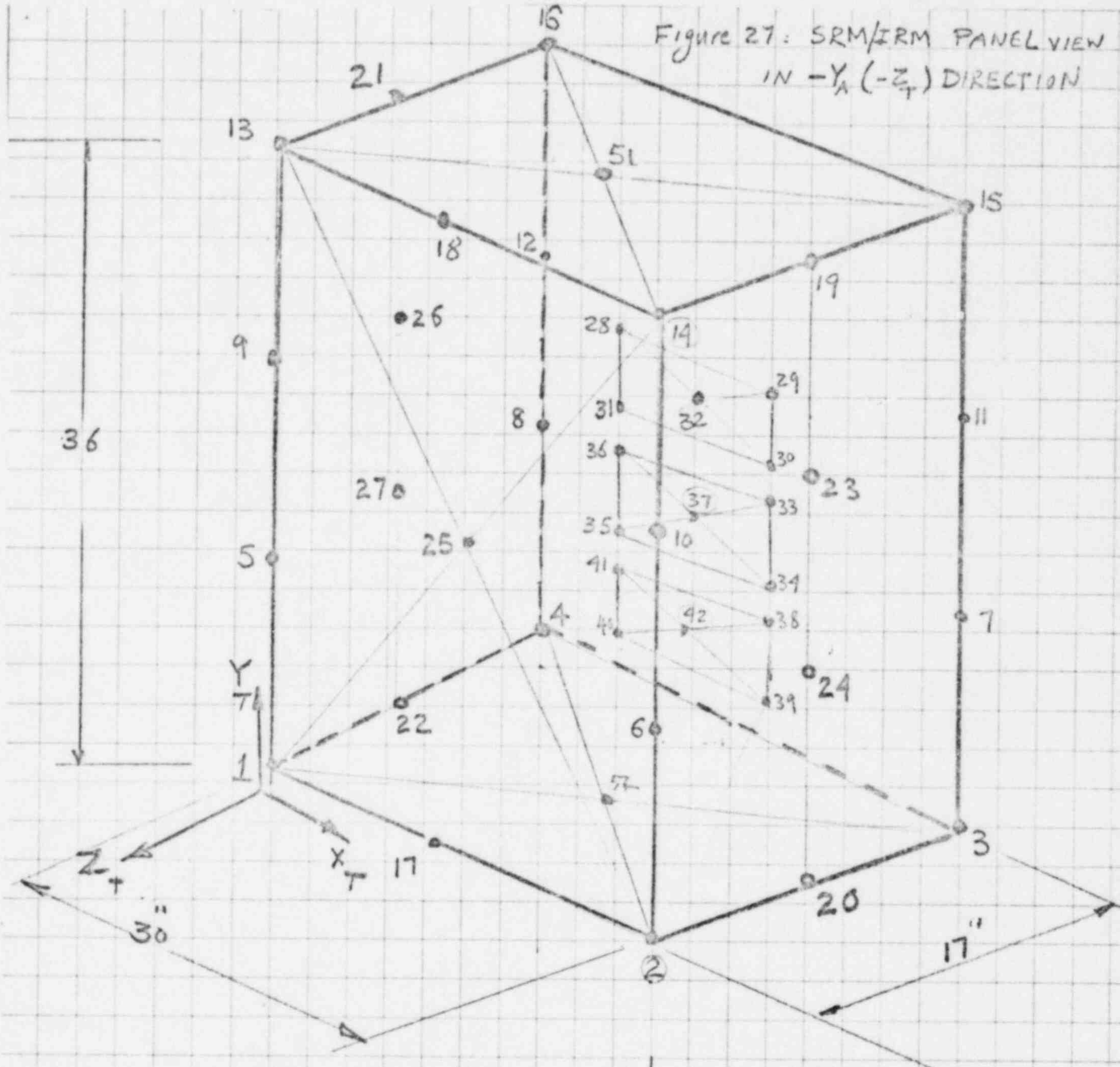
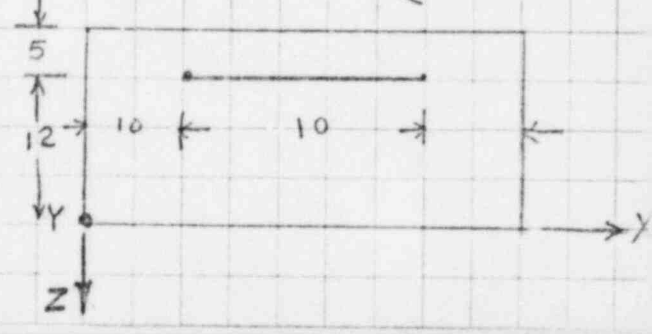


Figure 27: SRM/IRM PANEL VIEW IN $-Y_A$ ($-Z_T$) DIRECTION



○ Pt / Force application

$X_T = -X_A$

$Y_T = Z_A$

$Z_T = Y_A$

T ≡ Test

A ≡ Analysis

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
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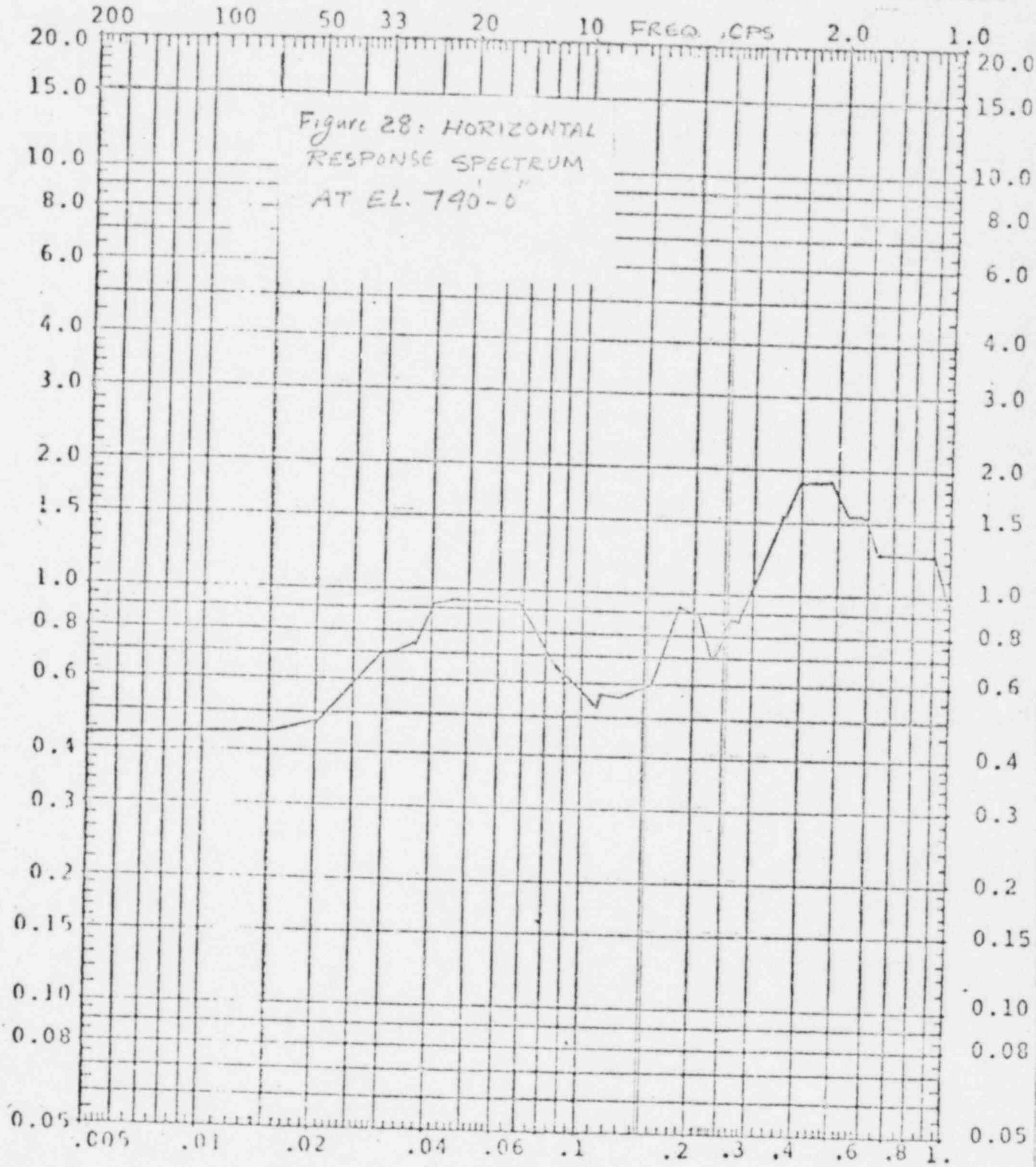

REACTOR BUILDING-ELEVATION: 740' 2% Damping Horizontal

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SRM & IRM Preamplifier Enclosure		Calc. No. EMD-038469
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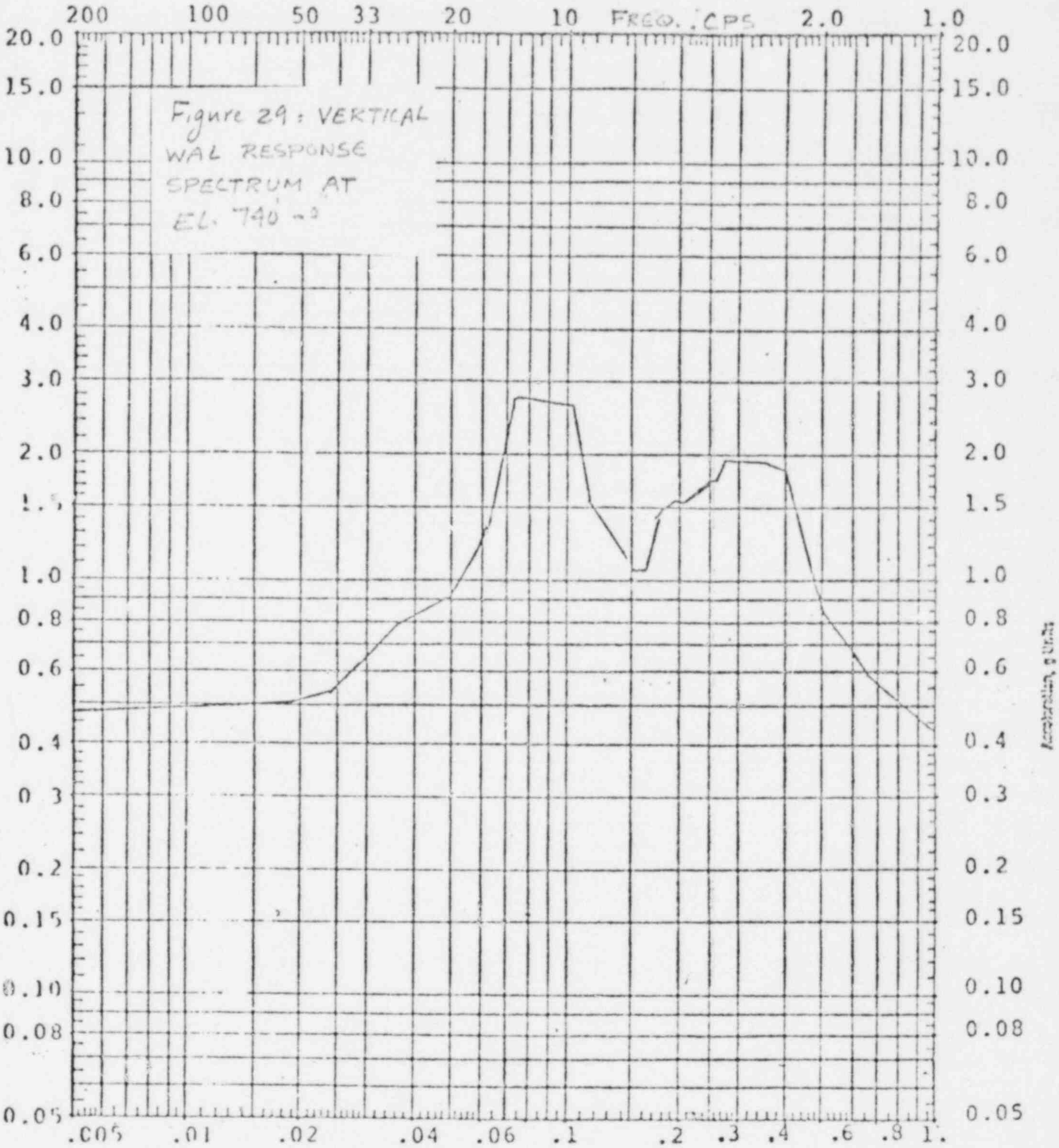

REACTOR BUILDING-ELEVATION: 740' 2% Damping Vertical Wall

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

Calc. For SRM & IRM Preamplifier Enclosure	Calc. No. EMD-030469
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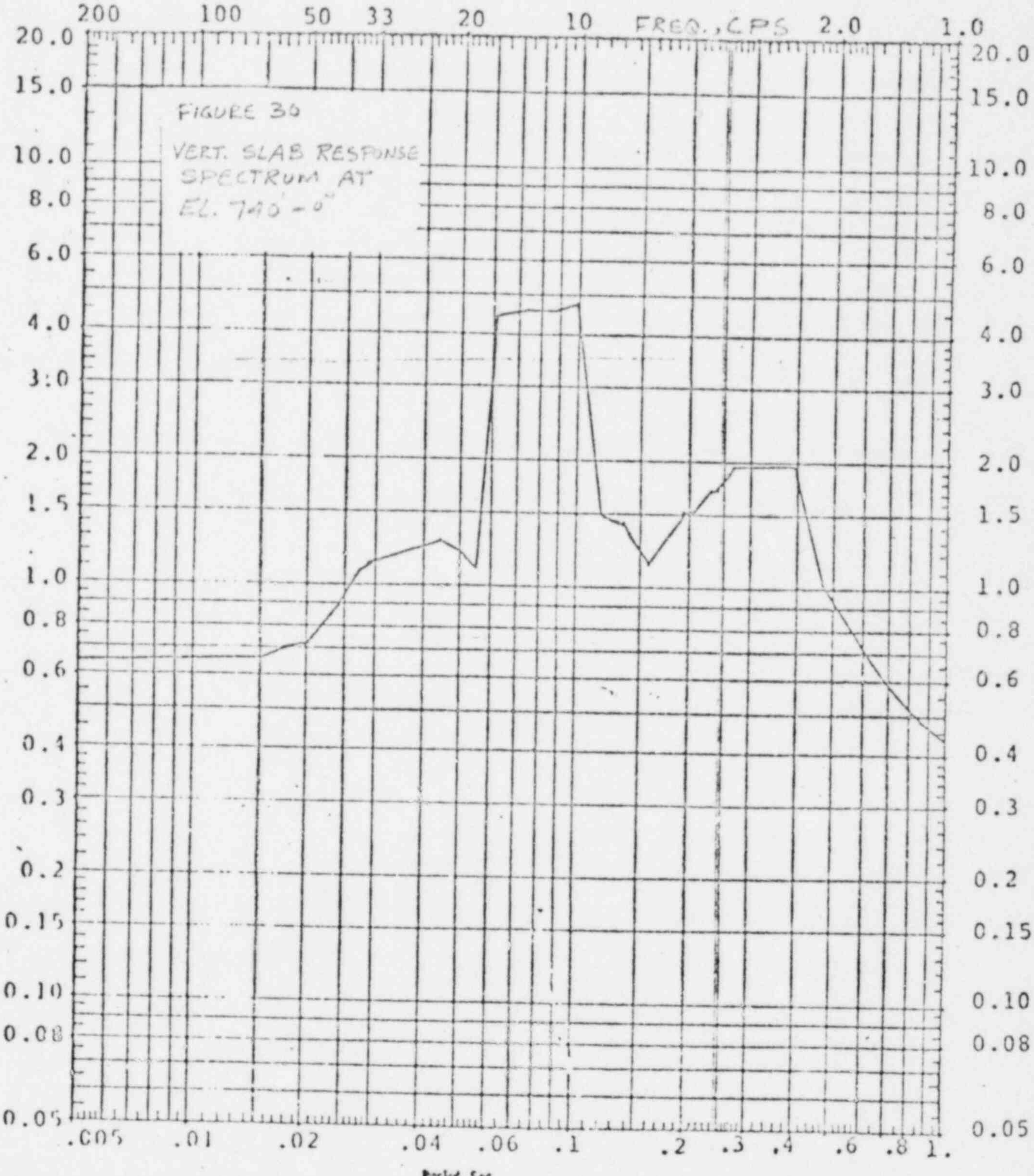

REACTOR BUILDING-ELEVATION: 740' 2% Damping Vertical Slab

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

TABLE 1: RESONANT FREQUENCIES FOUND IN ANALYSIS

PRINT OF FREQUENCIES

MODE NUMBER	CIRCULAR FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)	TOLERANCE
1	.4618+02	.7350+01	.1360+00	.7110-08
2	.1126+03	.1792+02	.5581-01	.4764-07
3	.1445+03	.2300+02	.4348-01	.5725-08
4	.1516+03	.2413+02	.4145-01	.2441-07
5	.2433+03	.3872+02	.2583-01	.6296-07
6	.2904+03	.4622+02	.2164-01	.4740-07
7	.3077+03	.4898+02	.2042-01	.5614-07
8	.3168+03	.5041+02	.1984-01	.3292-07
9	.3511+03	.5589+02	.1789-01	.3635-06
10	.3951+03	.6288+02	.1590-01	.1205-06

TABLE 2A: RESONANT FREQUENCIES FOUND IN IMPEDENCE TEST

```
S RECORDS IN USE
REC 1:    ✓29.500 HZ  SRM/IRM PANEL Z-AXIS
REC 2:    ✓45.100 HZ  SRM/IRM PANEL Z-AXIS
REC 3:    ✓54.100 HZ  SRM/IRM PANEL Z-AXIS
REC 4:    ✓70.900 HZ  SRM/IRM PANEL Z-AXIS
REC 5:     76.000 HZ  SRM/IRM PANEL Z-AXIS
REC 6:     96.200 HZ  SRM/IRM PANEL Z-AXIS
REC 7:    ✓37.200 HZ  SRM/IRM PREAMPLIFIER Z-AXIS
REC 8:    ✓72.500 HZ  SRM/IRM PANEL Y-AXIS
REC 9:    ✓30.700 HZ  SRM/IRM PANEL Y-AXIS
REC 11:   ✓21.100 HZ  SRM/IRM PANEL Y-AXIS
REC 12:   ✓53.200 HZ  SRM/IRM PANEL X-AXIS
REC 13:   ✓75.900 HZ  SRM/IRM PANEL X-AXIS
REC 14:   ✓20.800 HZ  SRM/IRM PANEL X-AXIS
REC 15:   ✓10.400 HZ  SRM/IRM PANEL X-AXIS
*
```

TABLE 2B

MODAL PARAMETERS OF THE SRM/IRM PANEL

MODE SHAPE	PARAMETER FREQUENCY	DAMPING (%)	DIRECTION
1	29.5	1.36	Z
2	45.1	1.96	Z
3	54.1	3.12	Z
4	70.9	.94	Z
5	76.0	.33	Z
6	96.2	3.01	Z
7	37.2	1.4	Z
11	21.1	2.08	Y
9	30.7	2.64	Y
8	72.5	2.31	Y
15	10.4	6.90	X
14	20.8	8.06	X
12	53.2	4.11	X
13	75.9	2.3	X

TABLE 3

CROSS COUPLING COEFFICIENTS FOR THE SRM/IRM PANEL

MODE SHAPE	FREQUENCY (HZ)	EXCITATION DIRECTION X		EXCITATION DIRECTION Y		EXCITATION DIRECTION Z	
		X→Y(%)	X→Z(%)	Y→X(%)	Y→Z(%)	Z→X(%)	Z→Y(%)
1	29.5					29.0	37.0
2	45.1					10.6	7.6
3	54.1					45.8	37.5
4	70.9					14.8	7.3
5	76.0					10.2	16.2
6	96.2					6.3	15.8
7	37.22					45.3	40.0
11	21.1			37.0	58.6		
9	30.7			137.9*	22.5		
8	72.5			32.3	38.7		
15	10.4	29.5	77.8				
14	20.8	134.3*	51.7				
12	53.2	4.7	43.8				
13	75.9	118.1*	338.4*				

TABLE 4: NODE NUMBERS OF TEST MODEL & THEIR EQUIV. NODES IN ANALYSIS

NODE NO.		NODE NO.		NODE NO.		NODE NO.		NODE NO.	
IMPED. TEST	ANALYS.	IMPED. TEST	ANALYS	IMPED. TEST	ANALYS.	IMPED. TEST	ANALYS.	IMPED. TEST	ANALYS
1	13	10	Bet. 46 & 54	19	69	28	58	37	℄ of PL #25
2	10	11	Bet 44 & 52	20	9	29	59	38	27
3	6	12	Bet. 41 & 49	21	64	30	51	39	19
4	3	13	63	22	14	31	50	40	18
5	23	14	70	23	Bet. 45 & 53	32	℄ of PL #26	41	26
6	30	15	68	24	29	33	43	42	℄ of PL #23
7	28	16	65	25	℄ of PL #65	34	35	51	Bet 73 & 74
8	25	17	Bet. 11 & 12	26	Bet 40 & 48	35	34	52	Bet 2 & 7
9	Bet 47 & 39	18	Bet. 71 & 72	27	24	36	42		

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TABLE 5: VALUES OF K FACTOR AT EACH RESONANT FREQUENCY

FREQUENCY FROM IMP. TEST Hz	K (SEE NOTE 1) HORIZ. DIREC. $g_{max} = 1.9$	VERT. DIREC WALL $g_{max} = 2.8$	K_{max}	SEE NOTE 2 σ_{max} Ksi
20.8	1.25	1.205	1.25	20.13
21.1	1.25	1.188	1.25	20.13
29.5	1.184	1.125	1.184	19.06
30.7	1.184	1.125	1.184	19.06
37.2	1.158	1.107	1.158	18.64
45.1	1.132	1.093	1.132	18.23
53.2	1.126	1.091	1.126	18.13
54.1	1.126	1.091	1.126	18.13

NOTES

(1) $K = \frac{2 g_{max} + g}{2 g_{max}}$

(2) $\sigma_{max} = K\sigma = 16.1\ K$

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I. OBJECTIVES

The objectives of this report are as follows:

a) Comparison between the results of the impedance test and the existing qualification report for Reactor Building Isolation dampers.

b) To re-assess the adequacy of the dampers for the present pool dynamic loads especially in the high frequency zones reported by the impedence tests conducted in-situ. This comparison will be based on the response spectra at El. 791'00" for the Auxiliary Building (Spectra No.: 105DB-NA, 105DB-EW, 114DB-VW).

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORT

In this qualification report the valves were analyzed for static, seismic and dynamic loads (Ref.1).

Figure 1 illustrates a schematic descrpition of the dampers. As shown, the VR04YA&B valves are held open by air cylinders, and close to seal the building at 1/4" H_2O negative pressure. These two valves are made with aluminum valve plates. The VR05YA&B valves are also held open by air cylinders. With no flow through the valve and the air cylinders vented the springs will close the valve and will maintain the valve closed against a 1/4" H_2O reverse differential pressure trying to open the valve. These valves are made with steel valve plates and special bracing (struts) for high pressure strength.

Assuming the valve plate as a simply supported plate the natural frequency of the steel valve (worst case) was found to be 231 Hz. Since this frequency exceeds 33 Hz (ZPA frequency) the dampers were considered rigid. The ZPA accelerations at El. 786'6" were

used for the static analysis of the rigid parts.

Table 1 shows the ZPA and maximum g values used in both the horizontal and vertical directions.

As for the valve plates, which constituted a flexible system, a factor of 1.5 of the peak loads was used in the calculations to conservatively account for the higher mode participation.

Multiplying the maximum seismic horizontal loads (3.3 g) by a factor of 1.5 the equivalent static load would be 5.0 g which was the basis for the valve plates' design.

Using the value 5.1 g > 5 g the seismic equivalent pressure on the plates was calculated and it was shown that both types of valves, aluminum and steel plates, are safe where the stresses for the aluminum plates (VR04YA&B) did not exceed 0.5 S_y, i.e. 24.5 ksi. The stresses on the steel plates (VR05YA&YB) did not exceed the allowables 7.5 S_m in the upset conditions i.e. 26250 psi (SA-515 Gr 70 at 300°F).

The vertical supports of the valve plates were qualified based on a horizontal seismic load of 0.575g (Rigid part) which was larger than the resultant of the horizontal ZPA loads in Table 1 (0.538g). Table 2 illustrates a summary of the results based on which the dampers were qualified.

In the mean time ASCO Valves (831655 & 631667) were tested in the lab where it withstood 7.5g and 8.5g loads respectively in all altitudes and pressure ranges (10 to 125 Psig & 10-40 Hz). (Ref. 2 & 3).

III. SUMMARY OF PERTINENT RESULTS FROM IMPEDENCE TEST REPORT

SQRT in-plant impedence testing on the Reactor Building Isolation Dampers was done on August 20, 1980. The 1VR05YB steel damper was chosen to represent the worst case. The damper consisted of two plates (leaves) which are heavily reinforced bolted plates, pneumatic actuators and a square cross section vertical support member. The test has concentrated on the square vertical support and the right damper place as viewed from inside the ventillation tube. The wire diagrams for these parts are shown in Figures 2 and 3. The damper was fully installed and operational at the time of the test. The damper was tested with the plates in the closed position that is the position that would not permit flow through the vent (Ref. 4).

Method Of Testing

The damper was tested by the impulse technique in all data collection. The vertical support was impulsed in both the axial (Y) and horizontal (X&Z) directions. Testing on the plates was performed perpindicular to the direction of the plate (Z direction). Figures 4 through 16 depict the results of the impedence tests

along with the modes shapes. The modal parameters for the dampers are shown in Table 3. As shown the resonant frequencies ranged between about 17 and 90 Hz.

IV. COMPARISON OF RESULTS

An inspection of the wire frame diagram of the impedence test indicates that it represents the essential parts of the damper, namely one plate and the vertical support with the actuator. Therefore, the results would give a true representation of the behavior of the damper under seismic loading.

Figures 7 and 8 show the bending modes of the vertical support in Z direction . The principal resonances detected at 29 and 61 Hz are torsional and in-phase bending of the support to the spring. The ZPA frequency (Figures 17 & 18) is about 15 Hz where the resultant horizontal acceleration is $\sqrt{.36^2 + .4^2} = .538g$. From Reference 2 the vertical support was qualified for a horizontal load of 0.575g which is higher than .538g with a ratio of 1.07 hence it is safe.

Also from Figures 13, 14 & 15 the resonances of the vertical support in the cross axis direction perpindicular to the vent axis (X axis) are 19, 21 and 17 Hz respectively. As mentioned before these frequencies are higher than the ZPA horizontal frequency of 15 Hz. Since in the analysis the supports were designed for higher g values, hence it is safe. It must be noted that these three

modes (19, 21, 17) are essentially identical responses of the vertical support to its somewhat loose later ends. Figure 16 shows the 2nd bending mode curve of the support at 70 Hz > ZPA frequency of 15 Hz.

As for the valve plate (leaf) Figures 9 through 12 show the bending modes which are an expected bahavior of a simple plate bending modes with irregular restraints. The lowest frequency is 38 Hz for the plate (Fig. 9) which is almost two times the ZPA frequency at the damper elevation. Since the plates were qualified statically for 1.5 times the peak loads, therefore the damper load 5.1g is considered safe enough to qualify the plates.

V. CONSIDERATION OF HIGH FREQUENCY RESONANCE

The ZPA frequency in the response spectra curves is about 15 Hz in the horizontal and 25 Hz in the vertical directions. The highest resonant frequency in the horizontal direction from the impedence tests is about 17 Hz. There was no resonant frequency detected in the vertical direction from these tests. Therefore, no special calculation was required for the high frequency resonances.

VI. CONCLUSION

Comparison and discussion of the results indicate that the loads taken in the analysis as design basis confirm the fact that the damper plate and vertical support have natural frequencies higher than the ZPA frequencies specified in the latest response spectra. Therefore the qualification for this equipment is correct and adequate.

VI. <u>REFERENCES</u>

1. Techno Corp. Report, Rev. 1 Dated 2/22/79 EMD File Nos. 020785, 011866.

2. NAMCO Controls Certificate of Seismic Qualification Test and Report No. F-C3879, Model EA750-20100.

3. ASCO Valve Dept. Engineering Report No. 91, Proj. 1357 Valve 831655.

4. Damper Hammer Test, Transitek Inc. Report. File No. EMD-029475 Dated 3/17/81.

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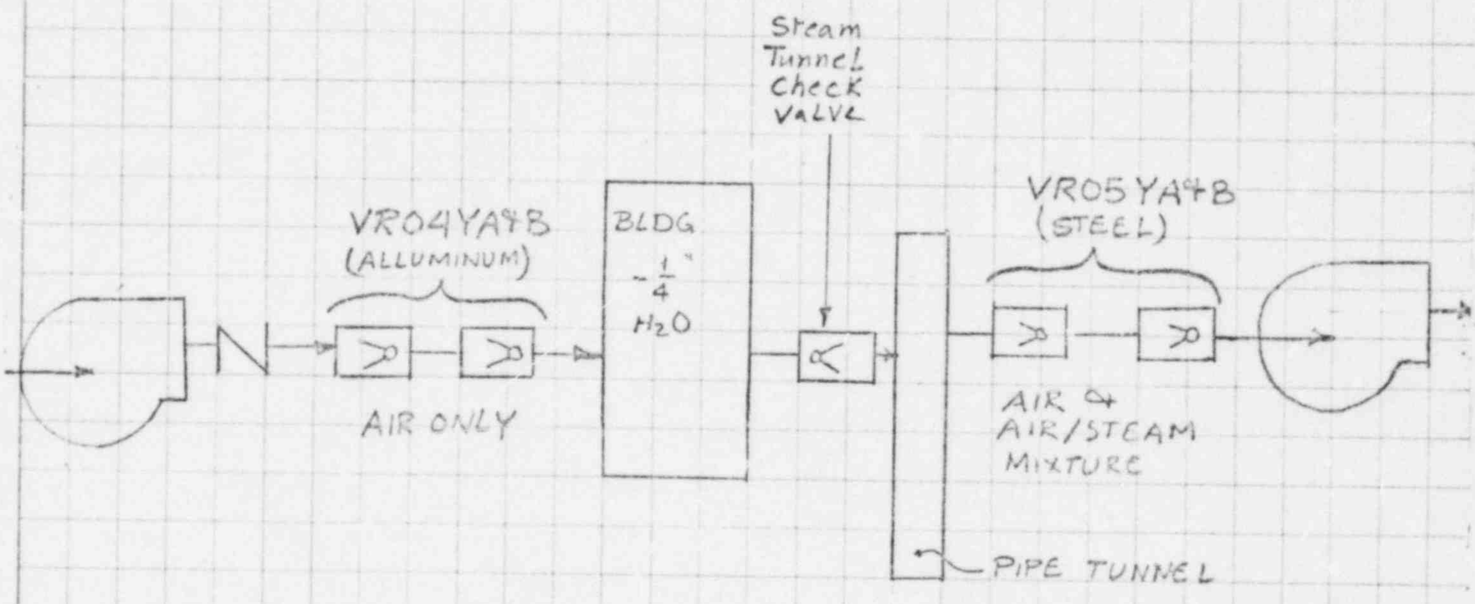

FIGURE 1: Schematic Flow Diagram

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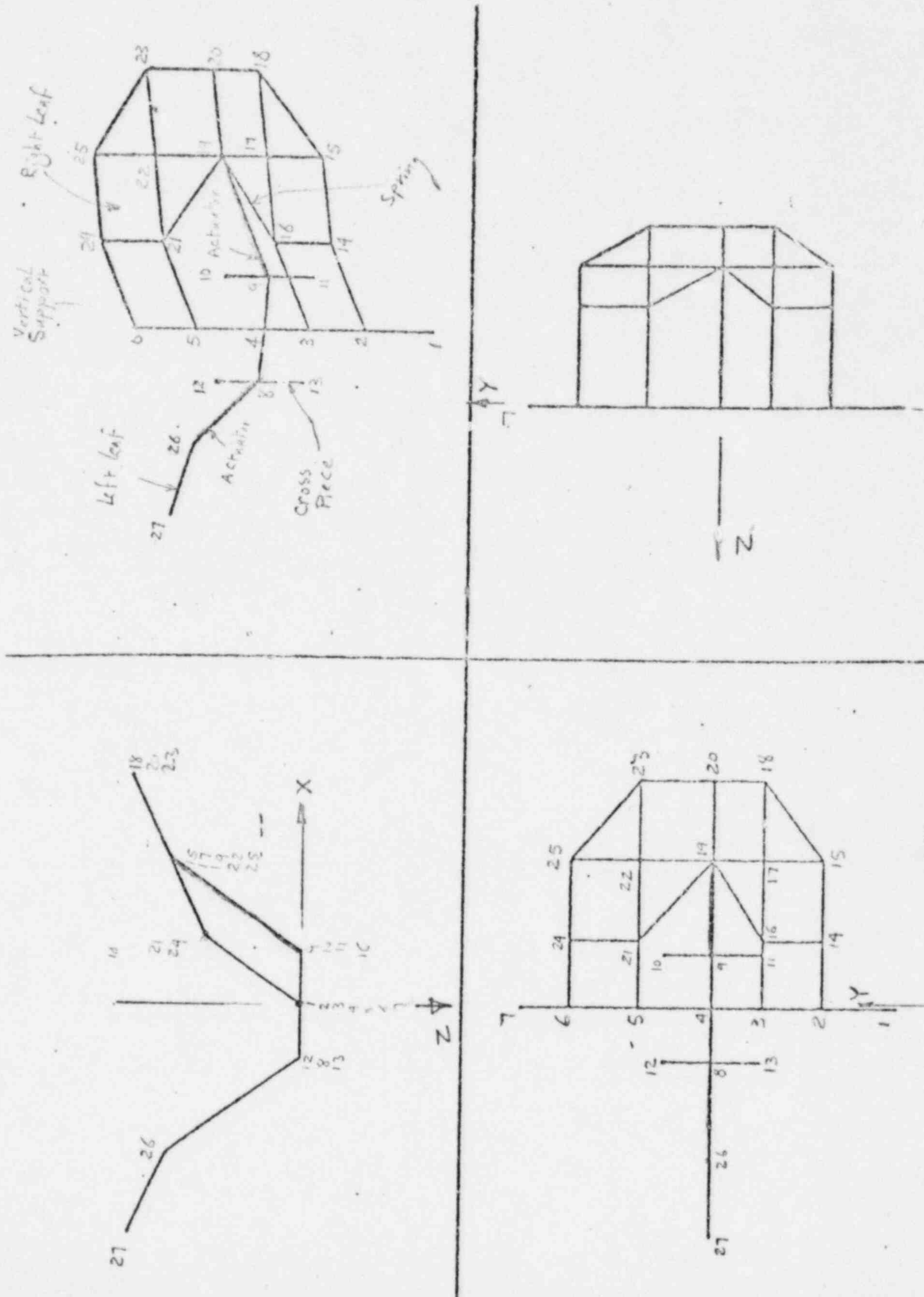

FIGURE 3
THREE ORTHOGONAL VIEW OF THE DAMPER GEOMETRY

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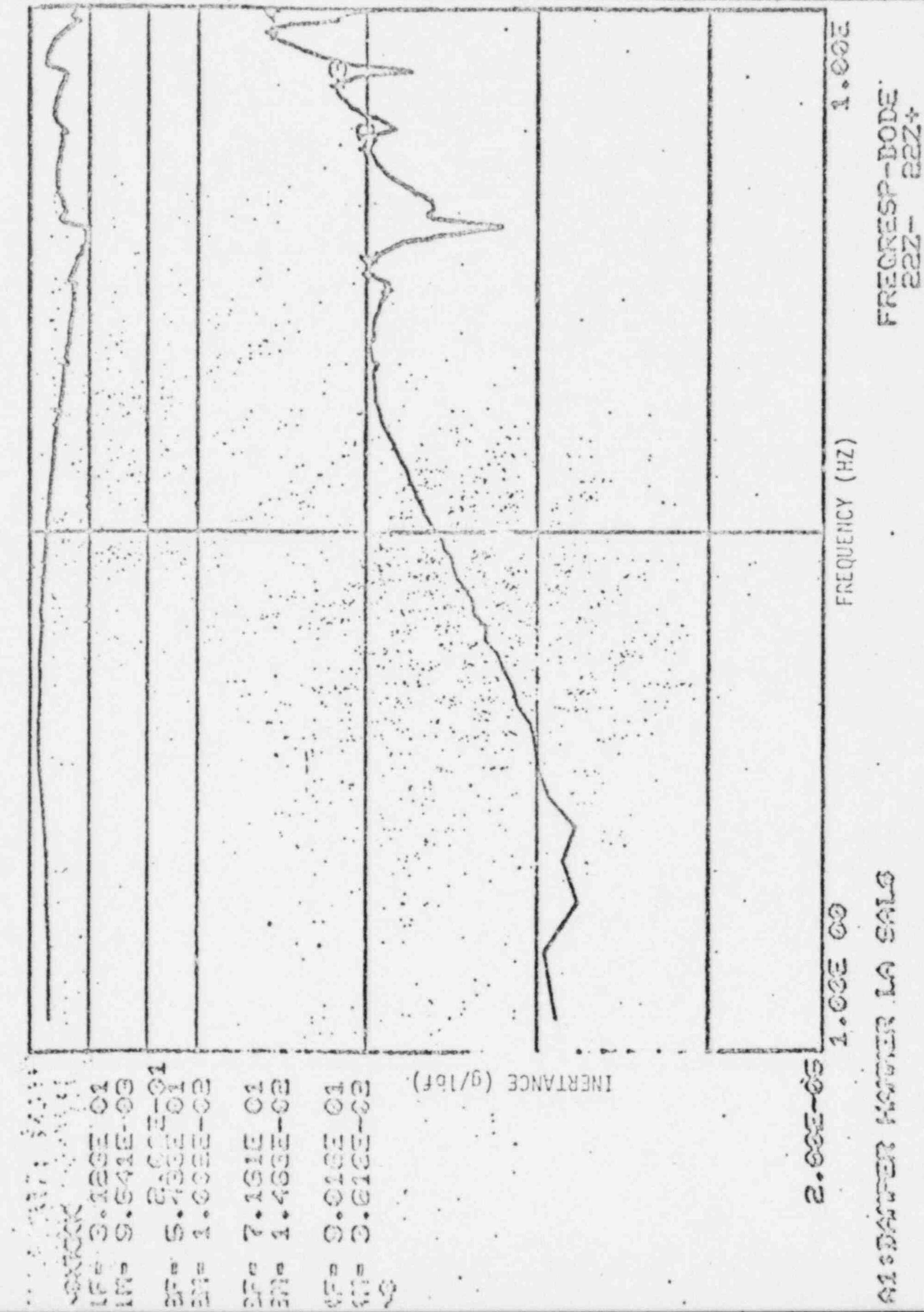

FIGURE 4

DRIVING POINT TRANSFER FUNCTION ON THE LEAF OF THE DAMPER (in Z-Direction)

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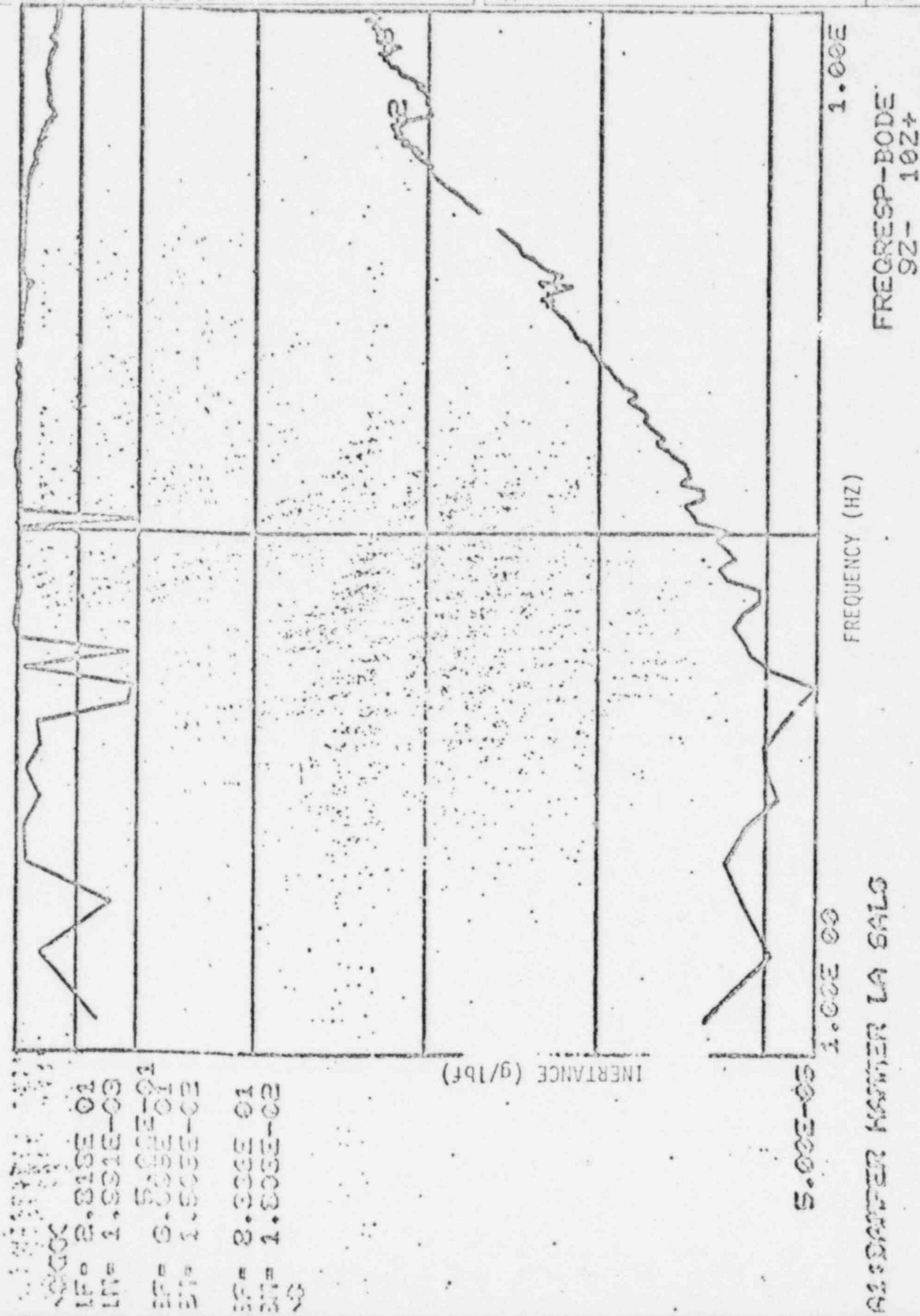

FIGURE 5

DRIVING POINT TRANSFER FUNCTION IN THE AXIAL DIRECTION OF THE VENT ON THE VERTICAL SUPPORT

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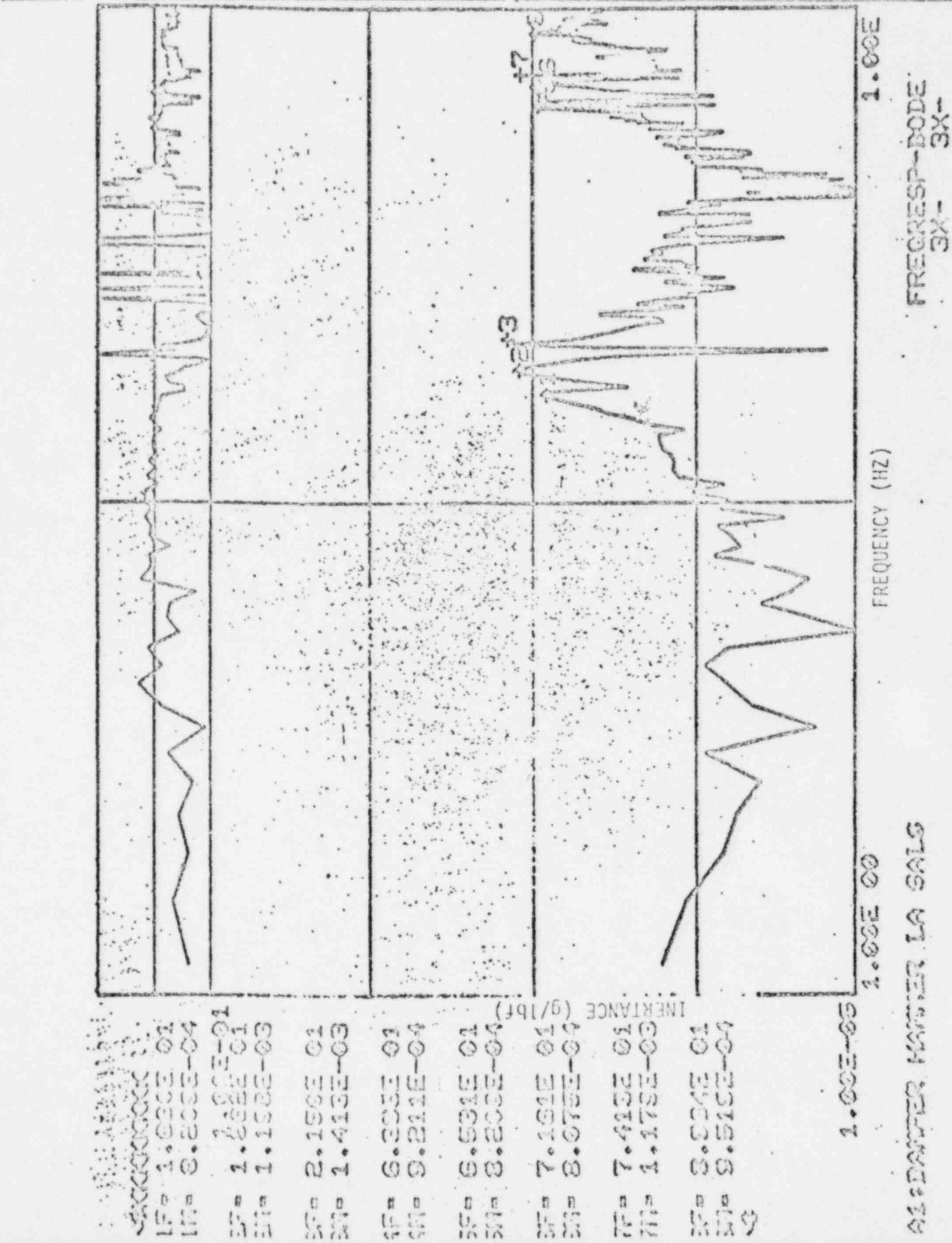

FIGURE 6

DRIVING POINT TRANSFER FUNCTION MEASURED CROSS AXIS TO THE VENT ON THE VERTICAL DAMPER SUPPORT (Y Dir.)

SARGENT & LUNDY ENGINEERS CHICAGO

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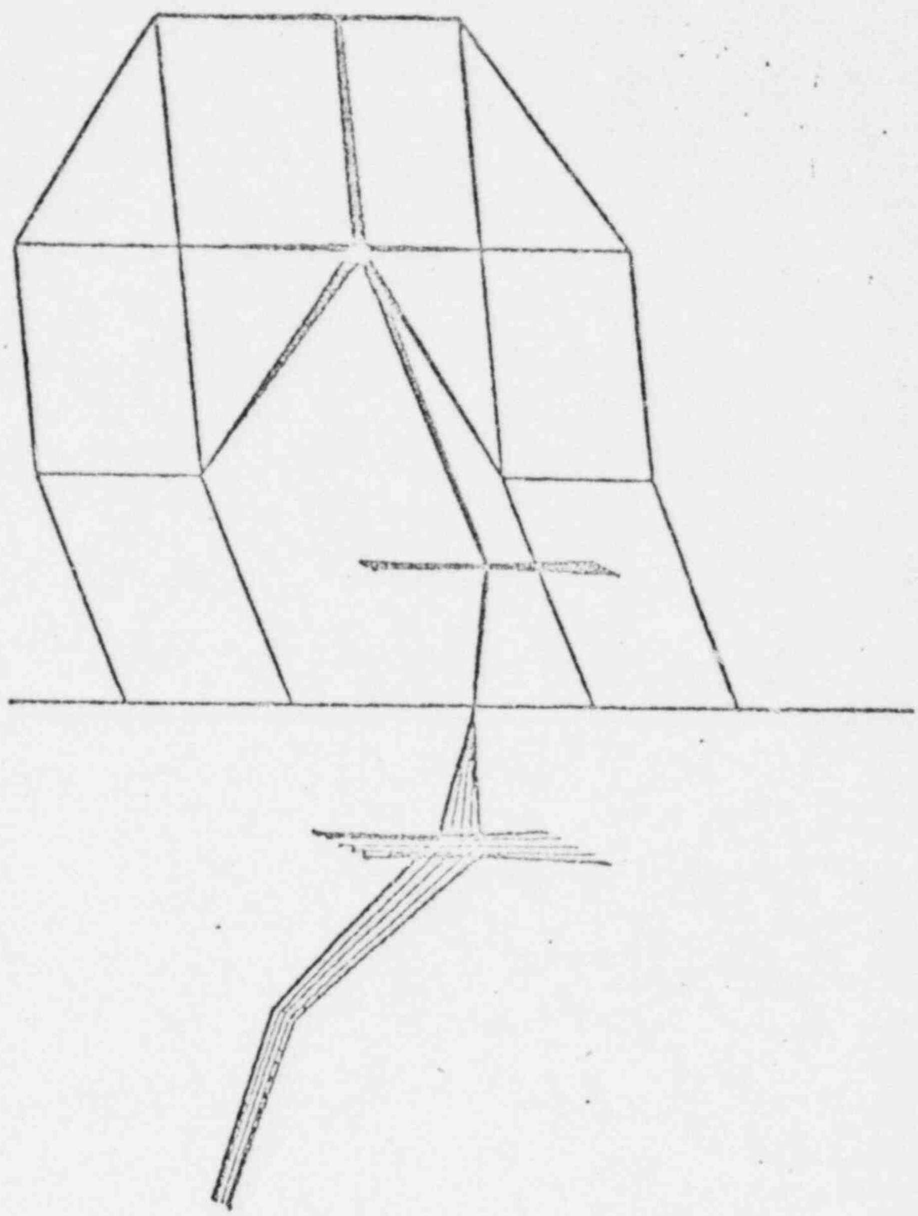

FIGURE 7

TORSIONAL MODE OF THE ARMS ON THE VERTICAL SUPPORT AT 29 HZ (in Z-Direction)

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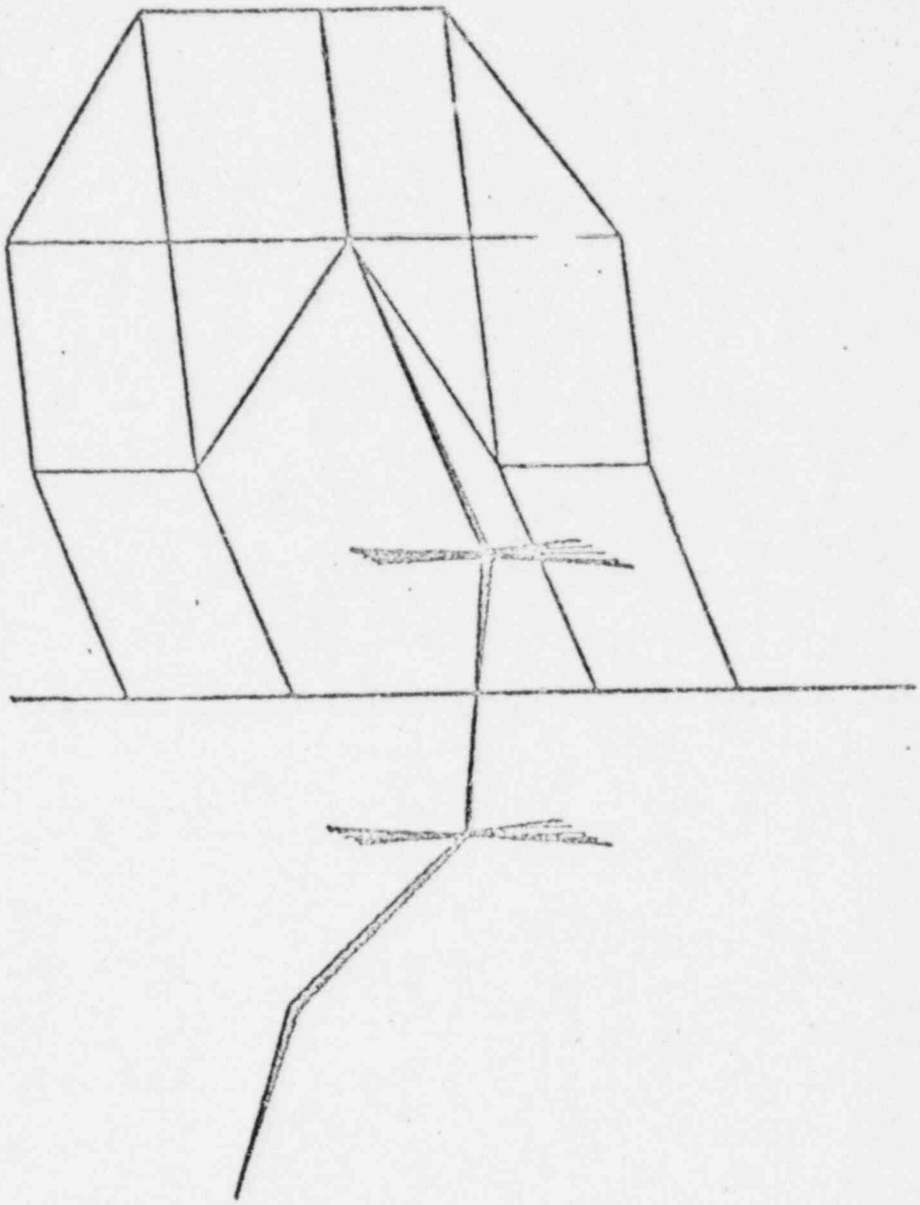

FIGURE 8

BENDING MODES ON THE LEAF SPRING RETURN ARMS OF THE VERTICAL SUPPORT AT 61 HZ (in Z-Direction)

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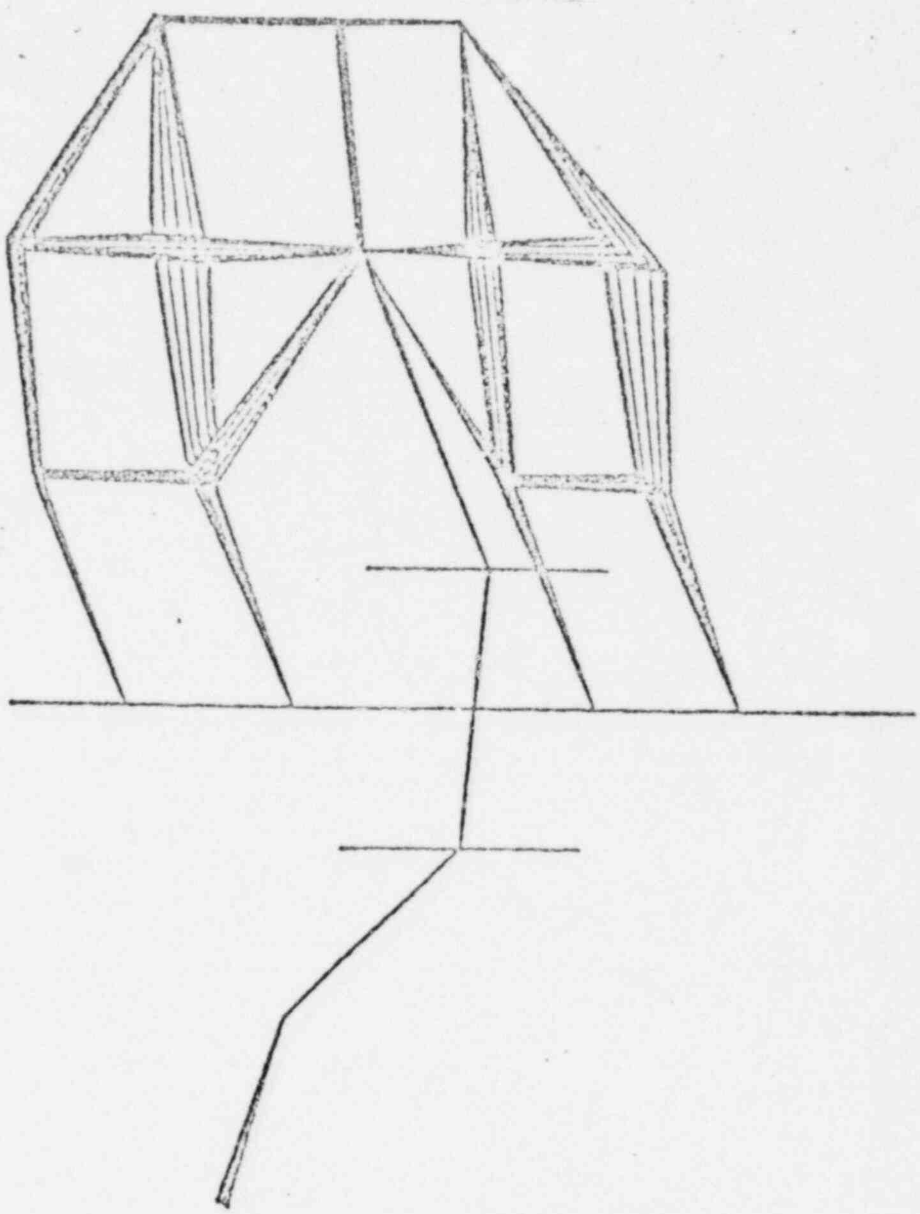

FIGURE 9

THE FIRST LEAF BENDING MODE AT 38 HZ

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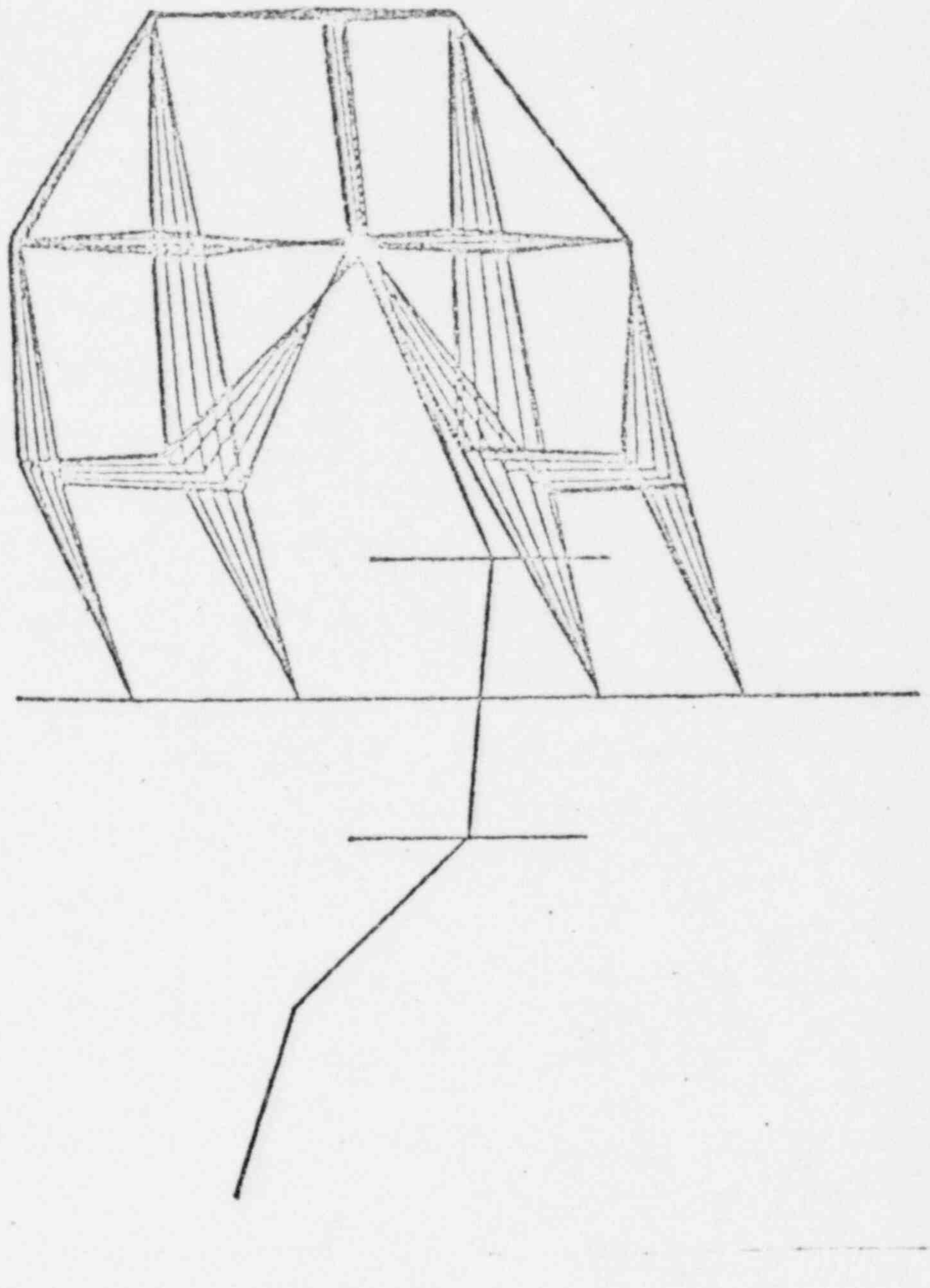

FIGURE 10

LEAF BENDING MODE AT 90 HZ

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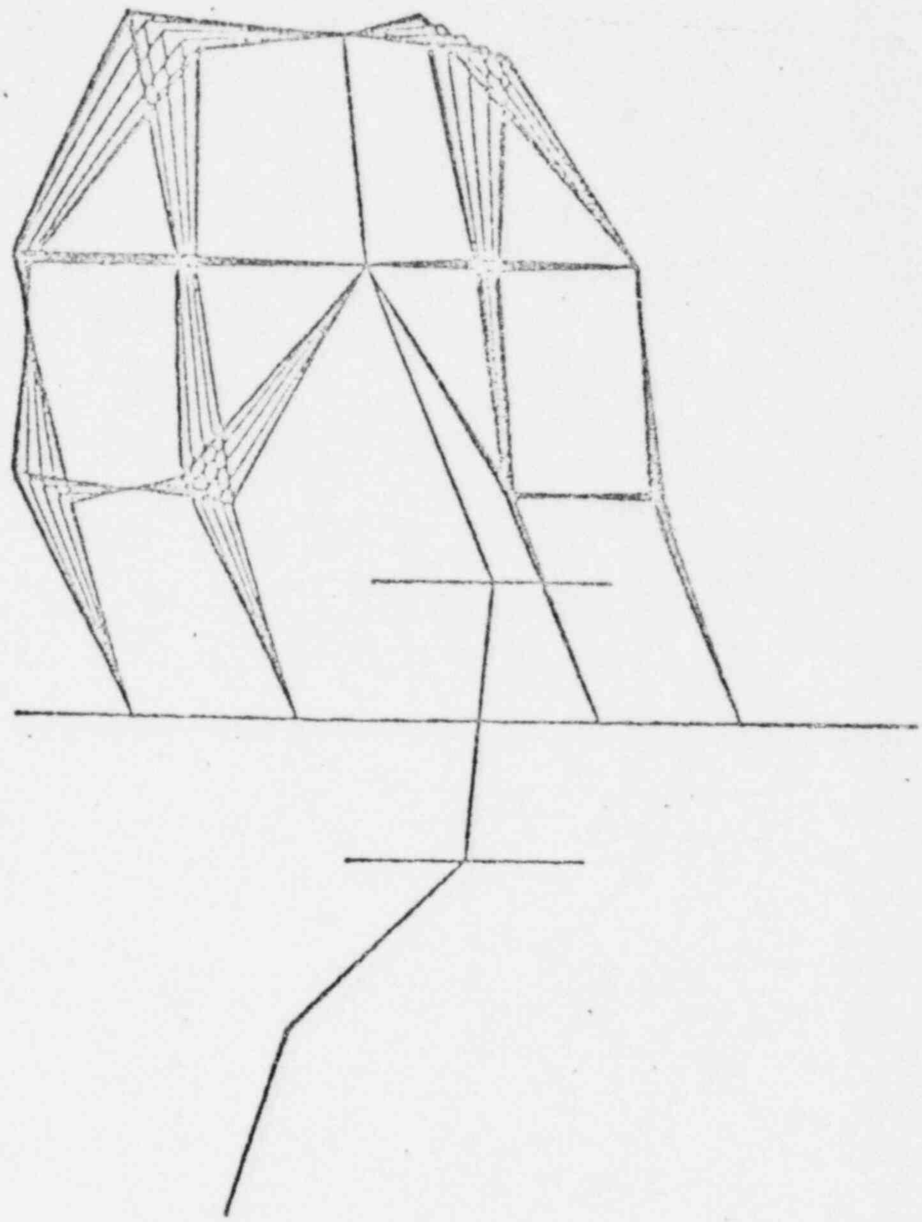

FIGURE 11

A HIGHER ORDER BENDING OF THE CORNERS OF THE LEAF AT 76 HZ

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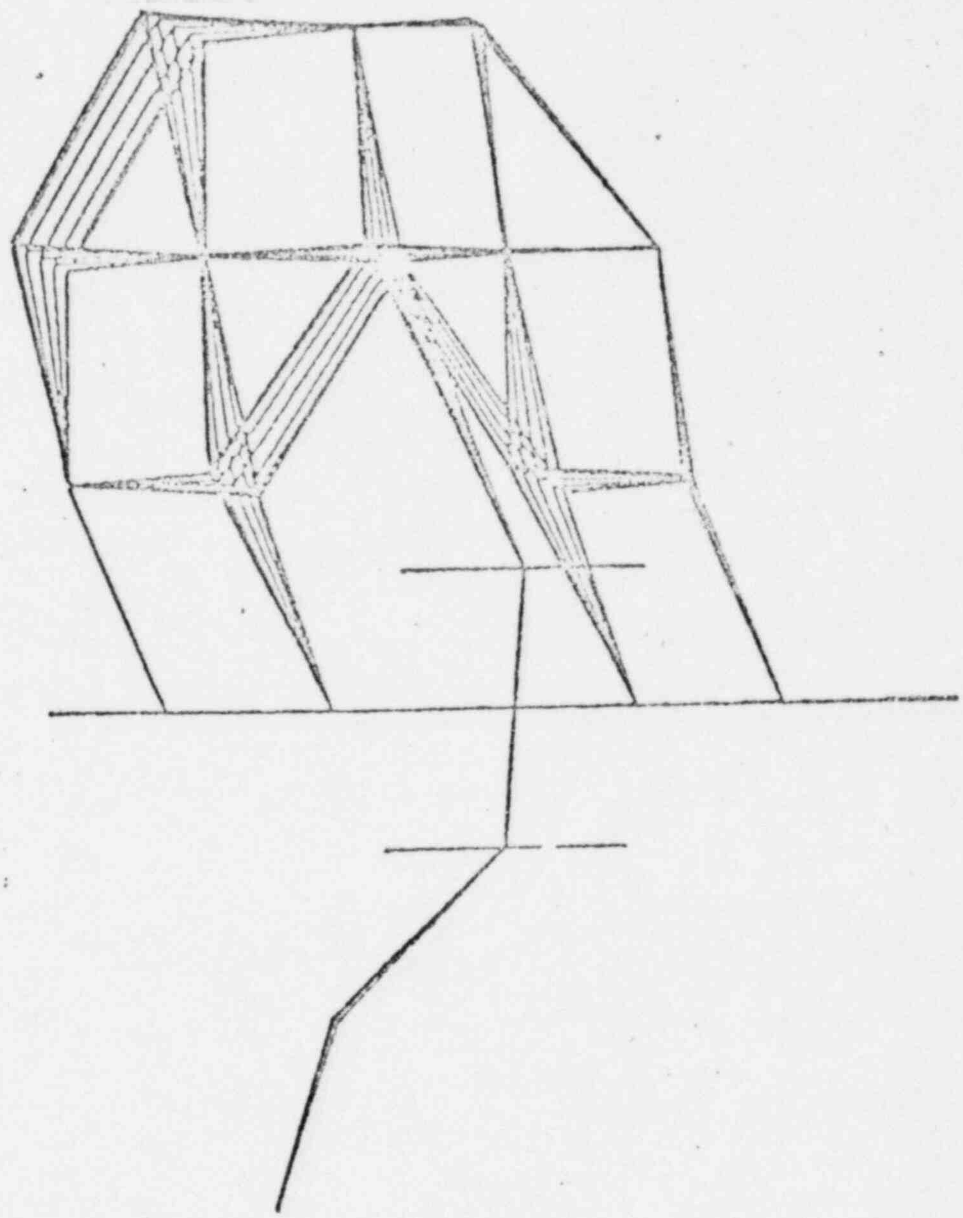

FIGURE 12

A BENDING MODE ABOUT THE VERTICAL AXIS OF THE DAMPER LEAF AT 59 HZ

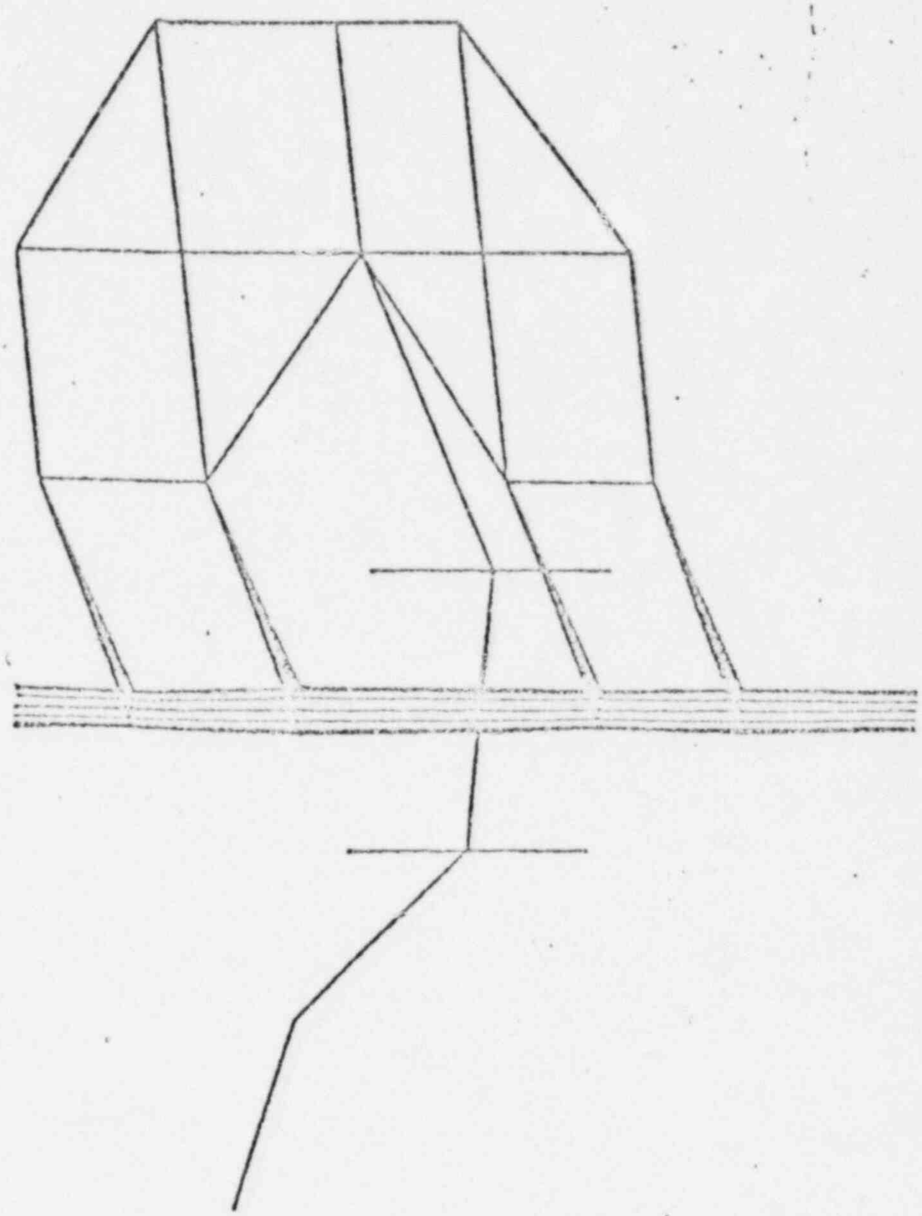

FIGURE 13

A LATERAL MODE OF THE VERTICAL DAMPER SUPPORT AT 19 HZ

THE MODES AT 17 AND 21 HZ ARE SIMILAR AND ARE THE SAME MODES EXCEPT THAT THE QUANTITY OF MASS INVOLVED IN MOVEMENT OF THE VERTICAL SUPPORT CHANGES WITH POSITION.

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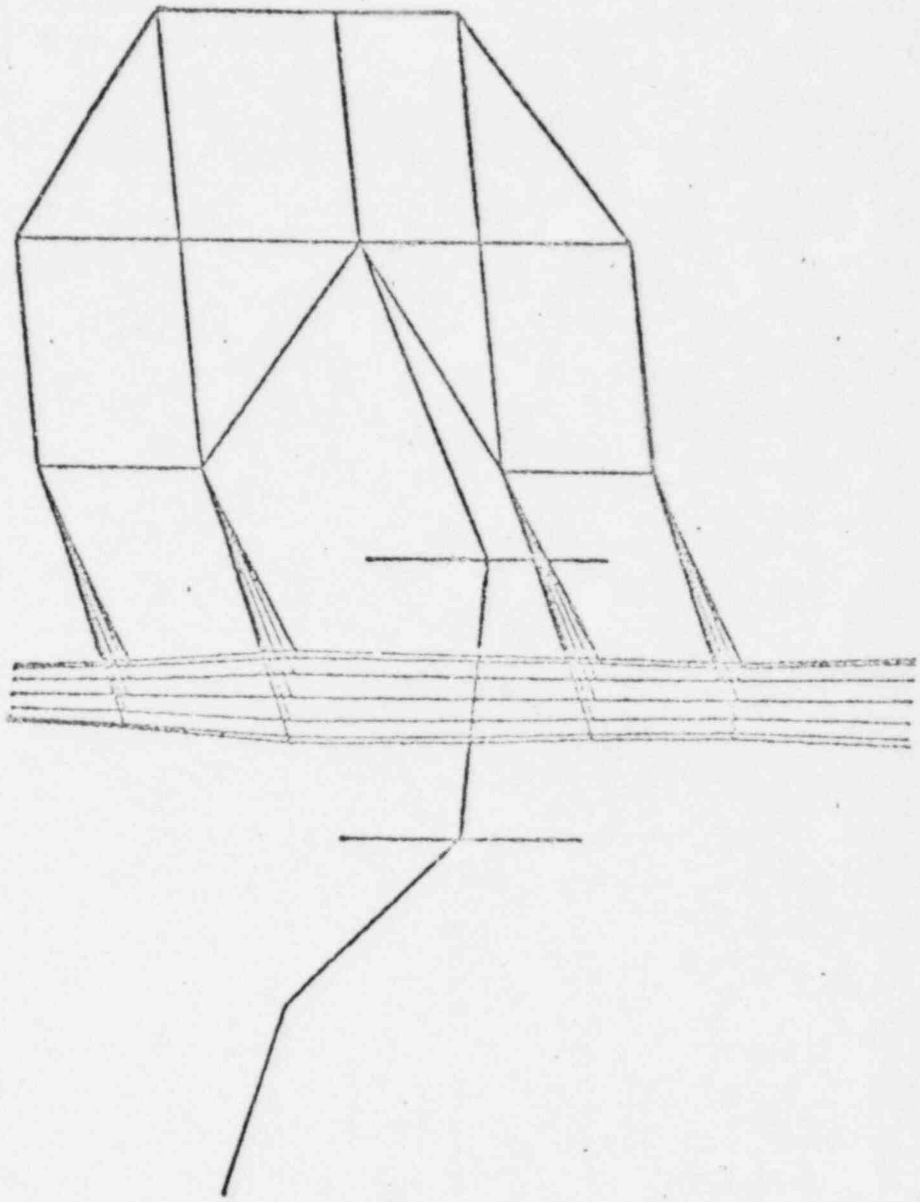

FIGURE 14

VERTICAL SUPPORT MODE AT 21 HZ

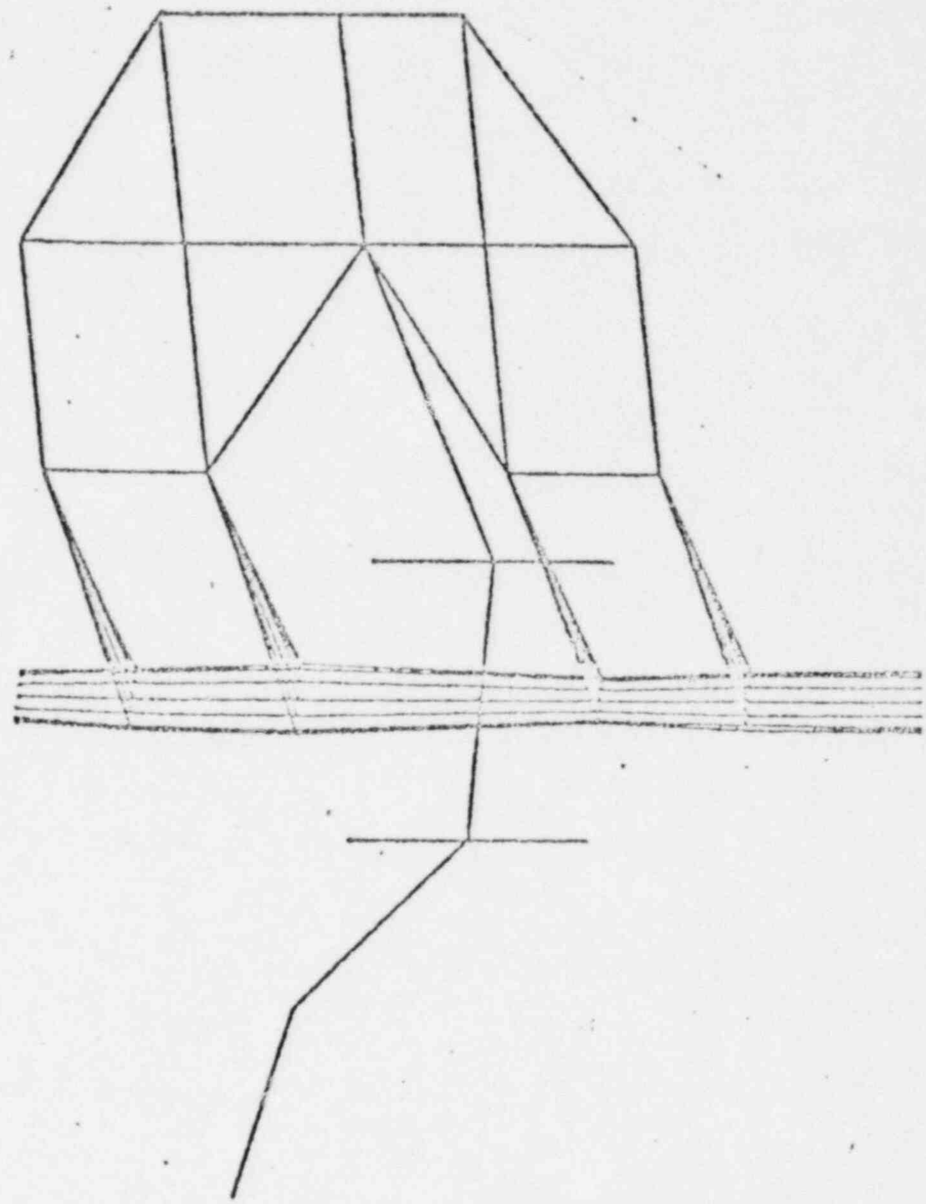

FIGURE 15

VERTICAL SUPPORT MODE AT 17 HZ

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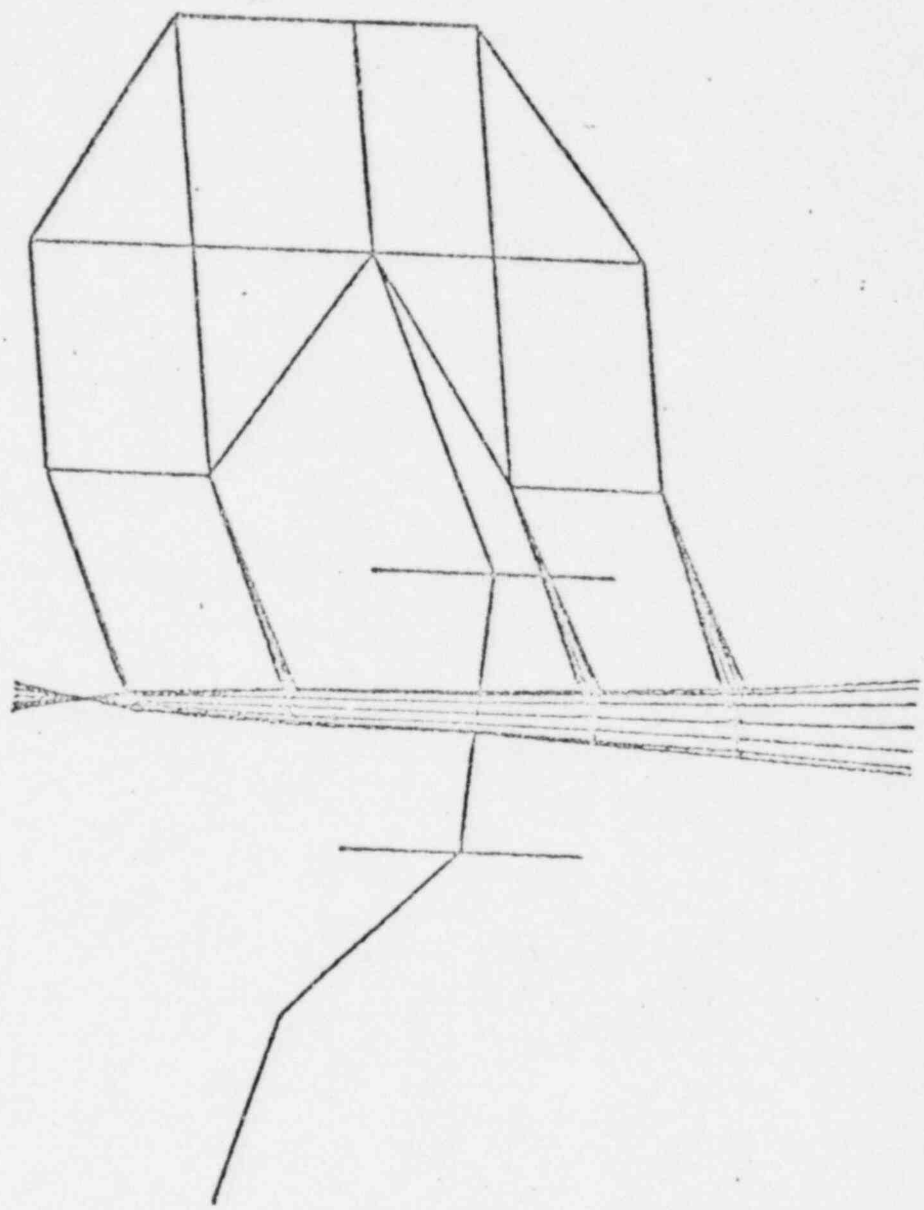

FIGURE 16

THE SECOND BENDING MODE OF THE VERTICAL SUPPORT AT 70 HZ

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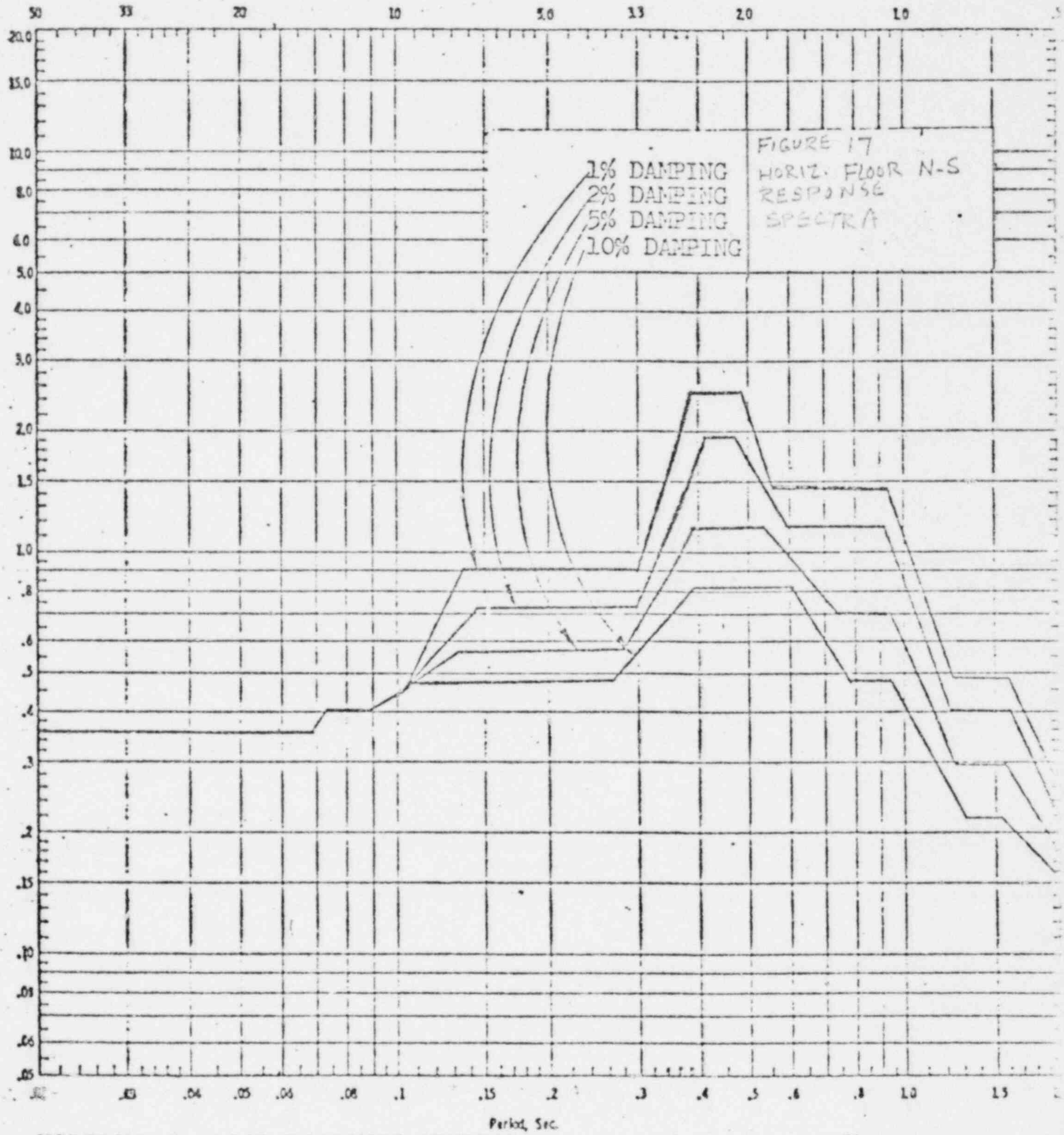

HORIZONTAL FLOOR RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
NORTH-SOUTH COMPONENT
ELEVATION 786'-6" (SLAB NO. 5)
REACTOR, AUXILIARY BUILDING

SPECTRA NO.
105-DB-NS
115-DB-NS
205-DB-NS

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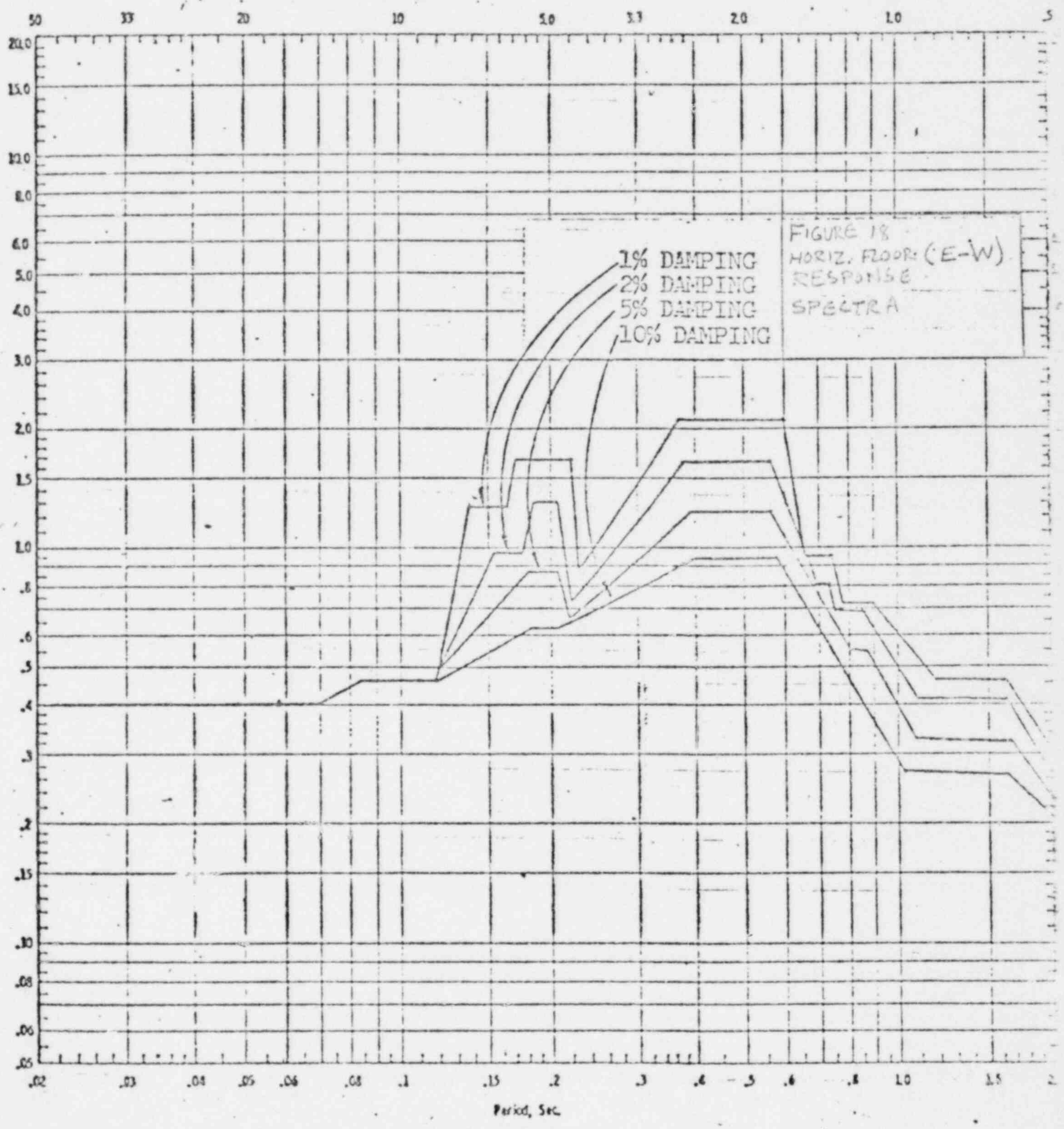

HORIZONTAL FLOOR RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
EAST-WEST COMPONENT
ELEVATION 7?5'-6" (SLAB NO. 5)
REACTOR, AUXILIARY BUILDING

SPECTRA NO.
105-DB-EW
115-DB-EW
125-DB-EW

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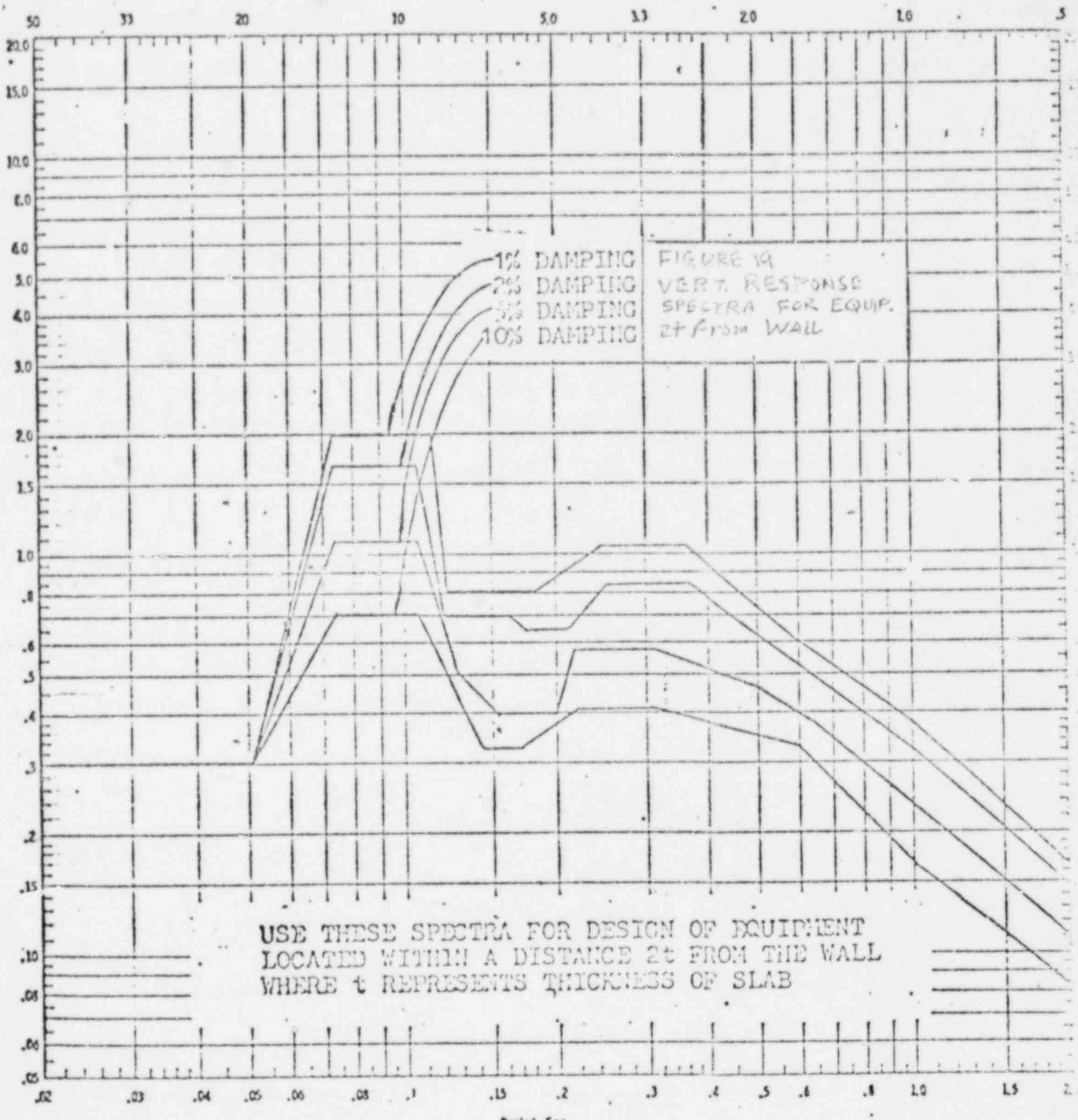
Client Commonwealth Edison Company	Prepared by S. Yassin	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

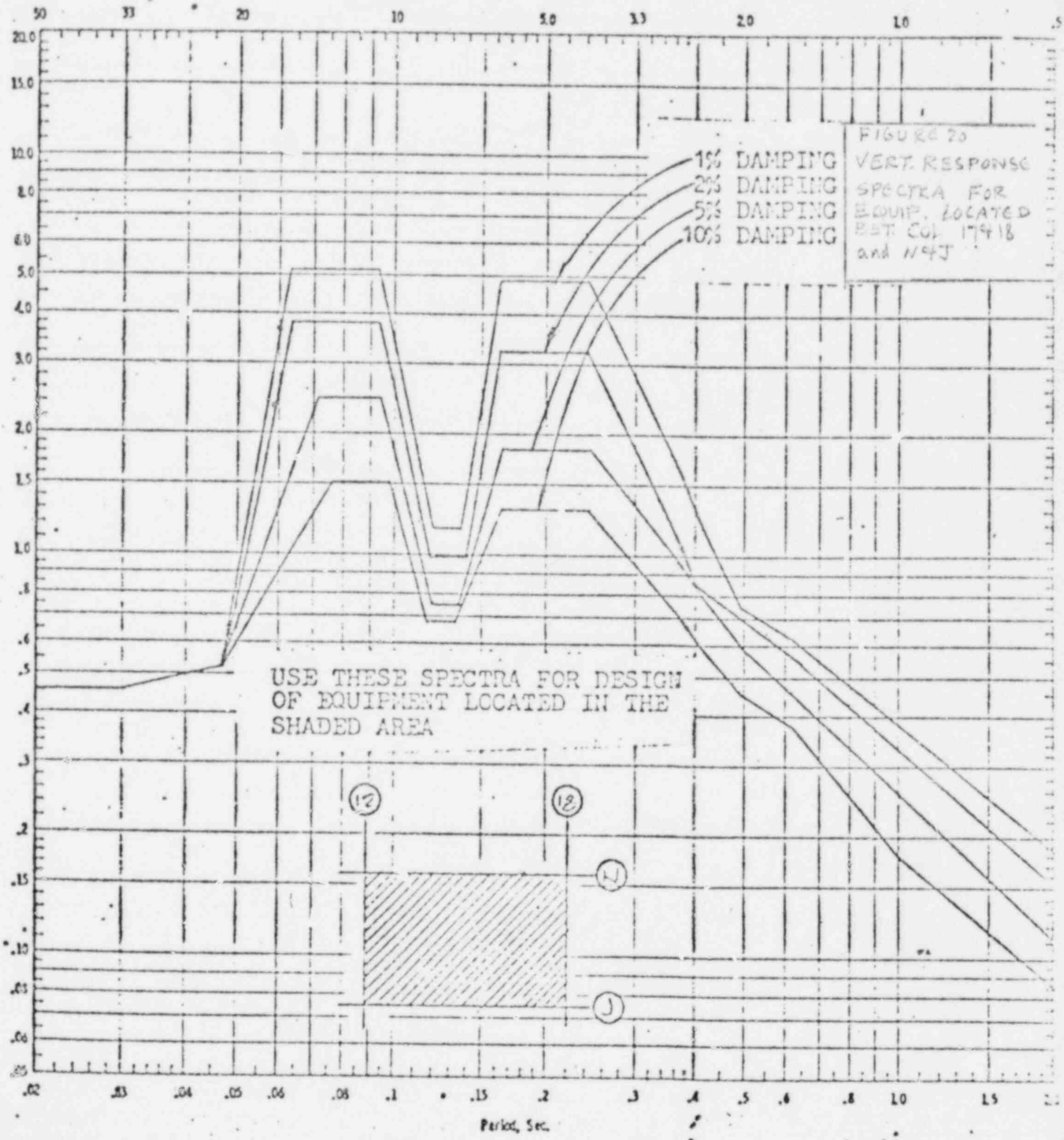


VERTICAL RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
AUXILIARY BUILDING WALLS
EL. 786'-6" TO EL. 768'-0"

SPECTRA NO.
114-DB-VW
115-DB-VW
125-DB-VW

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Reactor Building Isolation Dampers	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
		Page F26 of F29

Client Commonwealth Edison Company	Prepared by S. Yassin Date
Project LaSalle County, Units I & II	Reviewed by Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by Date



VERTICAL RESPONSE SPECTRA
DESIGN BASIC EARTHQUAKE
AUXILIARY BUILDING SLAB

SPECTRA NO.
125-DR-VS

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Reactor Building Isolation Dampers	Calc. No. EMD-030469
	X Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
		Page F27 of F29

Client Commonwealth Edison Company		Prepared by S. Yassin	Date
Project LaSalle County, Units I & II		Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No.	Approved by	Date

Table 1: ZPA and Maximum g-value at Elevation 786'-6"
(Ref. File No EMD-020785, 011866)

CONDITION		N-S	EW	VERTICAL	RESULTANT HORIZONTAL
		SH	SH	SH	
ZPA	OBE	0.195 (41)	0.36 (42)	0.45 (76)	0.41
	SSE*	0.36 (43)	0.4 (44)	0.46 (80)	0.538
MAX. value	OBE	1.45 (41)	2.75 (42)	5.0 (76)	3.11
	SSE*	2.55 (43)	2.1 (44)	5.2 (80)	3.3

Ref. Spectra # 105-DB-NS
105-DB-EW
105-DB-VW
125-DB-VS

Table 2
SUMMARY OF RESULTS

	VR04YA&B Aluminum	VR05YA&B Steel
Natural Frequency / Rigid Limit	Greater than 231.	231. hertz/33.
Valve Body Stress, psi / Allowable Stress, psi	508./13,700.	4,390./13,700.
Hinge Post Stress, psi / Allowable Stress, psi	5,815./15,750.	18,143./26,250.
Hinge Post Bolt Safety Factor	11.8 : 1	3.61 : 1
Valve Plate Stress, psi / Allowable Stress, psi	15,725./24,500.	18,255./26,250.
Strut Stress, psi / Allowable Stress, psi	Not Applicable	16,688./26,250.
Strut Bolt Safety Factor	" " "	2.68 : 1
Reverse Differential Springs can withstand / Required ΔP, "H_2O	1.63"H_2O/0.25"H_2O	1.63"H_2O/0.25"H_2O
Cylinder Pressure to hold Valve open against Flowing ΔP and Seismic Loads / Available, psi	Less than 60.726 psi	60.726 psi/80. psi
Valve meets requirements	Yes	Yes

TABLE 3

MODAL PARAMETERS OF THE REACTOR BENDING ISOLATION DAMPER

LABEL	FREQUENCY	DAMPING	REF.	RES.	MODE
1	28.996	0.055	9Z-	10Z+	1
2	61.329	0.046	9Z-	10Z+	10
3	90.396	0.058	22Z-	22Z+	3
4	76.108	0.036	22Z-	22Z+	4
5	59.544	0.051	22Z-	22Z+	5
6	38.316	0.079	22Z-	22Z+	2
8	21.080	0.009	3X-	3X-	7
7	18.867	0.018	3X-	3X-	6
9	16.841	0.012	3X-	3X-	8
10	70.228	0.019	3X-	3X-	9

ASSESSMENT OF VIBRATION CHARACTERISTICS AND

ANALYTICAL SEISMIC QUALIFICATION

SIZE = 240' x 97' x 36'

I OBJECTIVE

To assess the vibration characteristics of above equipment determined analytically and by impedence test, and to determine adequacy of equipment under the additional hydrodynamic loadings, particularly in regard with the high resonances determined by impedence test.

II INTRODUCTION

In conducting this assessment, one must recognize the practical limitations of available analytical and experimental techniques. For example, the finite element method is limited when representing a structure by number of nodes, number of elements, nodal masses, nodal stiffnesses, idealized boundary conditions and by the type of functional relations between the nodes.

On the other hand, experimental techniques such as impedence testing is also limited by the number of locations utilized in applying vibration inputs and in measuring vibration response. Other limitations include inaccessability to certain areas, coherence of signals, cross coupling between natural modes of equipment and cross coupling with other natural modes of attached structures.

Therefore, assessment of the results obtained by both methods, has to consider these listed limitations and consequently has to be based on engineering judgement of obtained results.

III SUMMARY OF IMPEDENCE TEST RESULTS

The equipment is represented by the wire diagram shown on Page 6. The panel was shaken with a small weight attached to the hydraulic actuator at two locations as shown on Page G8. The nominal force utilized is 1000 lbs.

The panel response was measured each time at 50 locations in 86 directions. The resonant frequencies and damping were determined from analytical fits of test data. The determined natural frequencies are as follows:

f_n H_z	Direction *		
17.02	x		z
19.62		y	
22.54		y	
33.66		y	
37.18	x	y	z
41.42	x	y	z
43.39	x		z
45.32	x	y	z
54.10	x	y	z
55.25	x	y	z
64.12	x		
70.5	x		z
78.03	x		z
92.73	x		z

* Axes referenced here are those of finite element model

IV SUMMARY OF ANALYTICAL RESULTS

The reactor cooling core bench board has been represented by a detailed and rigorous mathematical model.

The mathematical model consisted of 146 nodes, 174 beam elements of 35 different beam types and 112 plate elements. The distributed masses of the structure (beams and plate) are computed and distributed at all respective nodes. The concentrated masses of mounted instruments and devices are calculated in detail for each of 112 supporting nodes.

A schematic representation of the board by finite elements is shown on page G9.

Computed Natural Resonances of Main Bench Board

Modal Participation Along Global Axes *

Natural Frequencies Hz	X	Y	Z
14.16	- .11	.01	.57
15.88	1.25	- .01	- .07
21.02	.01	2.48	- .00
30.05	1.06	- .01	.19
31.18	.02	.44	- .03
32.97	.03	1.10	.01
34.64	.09	- .05	- .02
36.38	.03	- .04	- .01
48.33	- .28	.02	- .01
52.76	.02	.03	- .05
56.81	.11	.09	- .11
57.58	.04	.08	.01
58.19	.10	- .05	.03
59.62	.00	.02	- .53
64.76	.85	.09	- .07

* Global axes of Finite Element Model

IV FREQUENCIES IN AGREEMENT

ANALYTICAL	EXPERIMENTAL
15.66	17.02
21.02	22.54
32.97	33.66
36.88	37.18
48.33	45.79
52.76	54.10
56.81	55.25
64.76	64.12

V EFFECT OF RESONANT FREQUENCIES WHICH ARE NOT DETERMINED EXPERIMENTALLY

It is advantageous that more natural frequencies are determined analytically than by testing, since the dynamic stresses in the final Qualification Report are based on analytically determined resonants and their node participation factors.

In this case of the bench board there are three frequencies that fall in this category, below ZPA level of 33 Hz. These are 14.16 Hz, 30.05 Hz and 31.18 Hz.

If these natural frequencies do exist, they are already included in the stress computation. If they do not exist, this could be an added conservative element in the seismic qualification. Investigation of transfer functions obtained in impedence test report show that there is no peak of g level at 14.16 Hz, at 30.05 and 31.18 Hz there are high levels in some transfer functions and very few peaks in some others, see pages G17,G18&G19. The conclusion is that inclusion of 14.16 Hz as a natural frequency in the Finite Element

analysis is considered an added conservation, and the inclusion of 30.05 Hz and 31.18 Hz is considered an added accuracy of the analytical analysis over the experimental analysis.

VI EFFECT OF RESONANT FREQUENCIES DETERMINED EXPERIMENTALLY AND NOT INCLUDED IN ANALYTICAL RESULTS

1) Resonants Below ZPA Level

This is generally a cause of concern especially to the seismic stresses calculated analytically, however, in this equipment only one frequency of 19.34 falls in this category.

The investigation of transfer functions indicates that there is only one peak of the g level curve at this frequency, page . This transfer function resulted from the test when the shaker (weight 122 lbs) was attached to the side of the board and input vibration was directed along + X direction at node 27 and the response was measured along - X direction at the same node. The effect of adding the mass of the shaker at this location would be a lowering of the actual frequencies i.e.. The actual frequency of 21.02 which was confirmed both analytically and experimentally was temporarily lowered to a level of 19.34 Hz. Therefore, we conclude that this frequency is not an added mode which was not picked up by the analytical analysis but rather an artificially lowering of an existing mode of vibration. It must be added, however, that the g level at this frequency in this direction (horizontal) lie in the ZPA range if .42 g's, hence contribution of this mode is not significant.

2) Resonants Above ZPA Level

There are three natural frequencies which fall into this category. These are 70.5 Hz, 78.03 Hz and 92.73 Hz. Since these frequencies are higher than the ZPA level, there will be no added seismic loads on the board structure due to these frequencies. Therefore, the qualification of this equipment which is based on considering the analytical frequencies alone are still valid.

VII CONCLUSIONS

Based on the fact that the analysis considered the additional hydrodynamic loads, and based on above assessment of analytical and experimental vibration characteristics, it is concluded that the analytical result has been verified by the impedence test and that the qualification of above equipment is based on sound and verifiable technique.

It is also concluded that extending the qualification of this board (1H13-P601) to qualify the two boards [1H13-P602 and 1H13-P603] which are sim lar in structure and contain less and lighter equipment is therefore adequate. The adequacy of this extended qualification is based on the following reasoning. Since the structures of the two other boards are simular to that of 1H13-P601 board, and the masses of mounted instruments/devices are lower the natural frequencies of the two boards will be higher in magnitude and the seismic stresses will be lower.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For		Calc. No. EMD-033169	
	Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
			Page G7	of G 27

Client Commonwealth Edison Company		Prepared by	Date
Project LaSalle County, Units I & II		Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No.	Approved by	Date

VIII REFERENCES

1) Seismic qualification of reactor core cooling bench board #1H13-P601, EMD-028690. Dt. __________.

2) Impedence test report for main control bench board #H13-P601. EMD File #029472 Dated 3/17/81.

3) Final test report SQRT in plant impedence testing, LaSalle Co. 1, Transitek, Inc. Job No. 80042, EMD-029601-00.

204

Calc. No. EMD-030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-4
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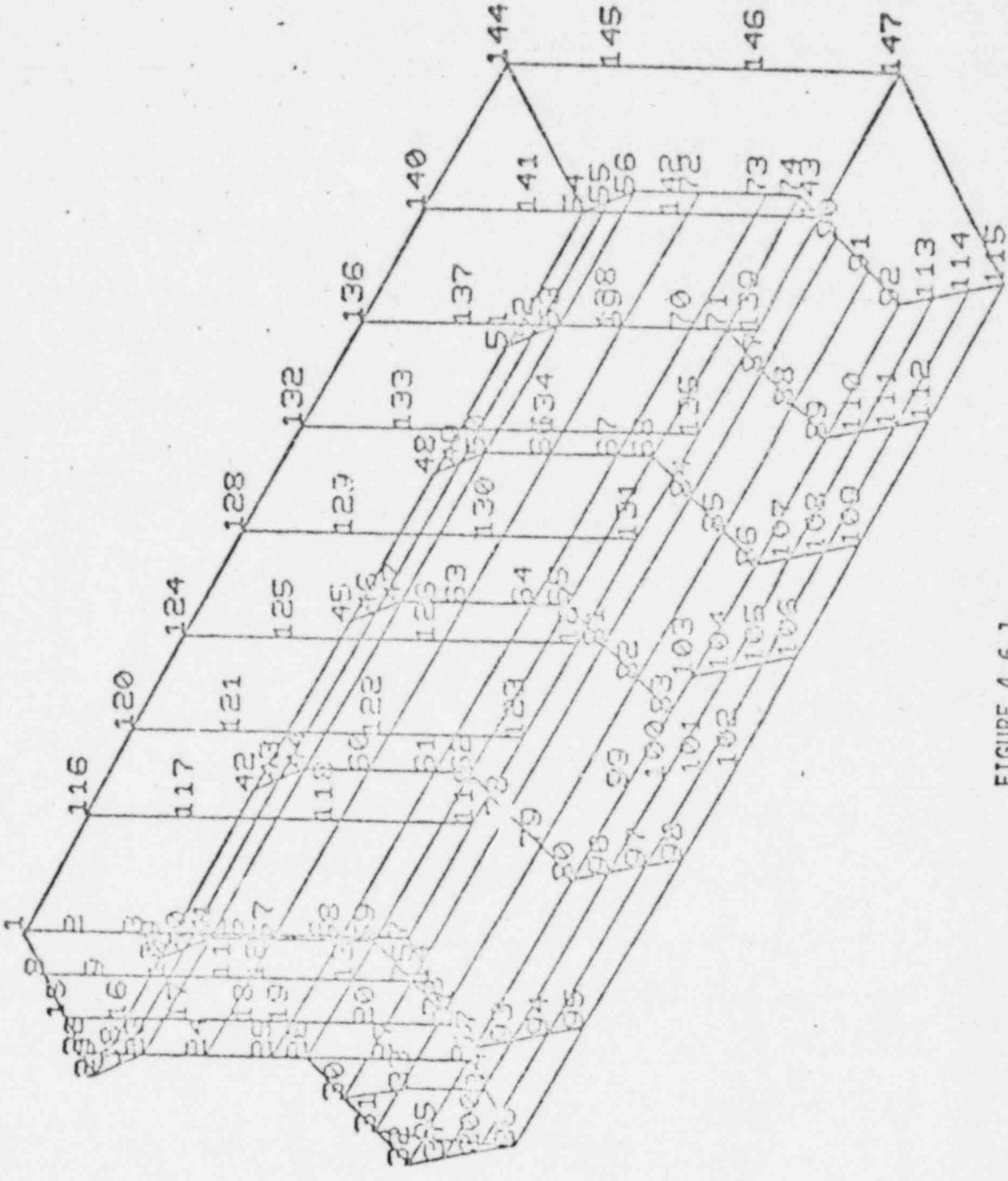
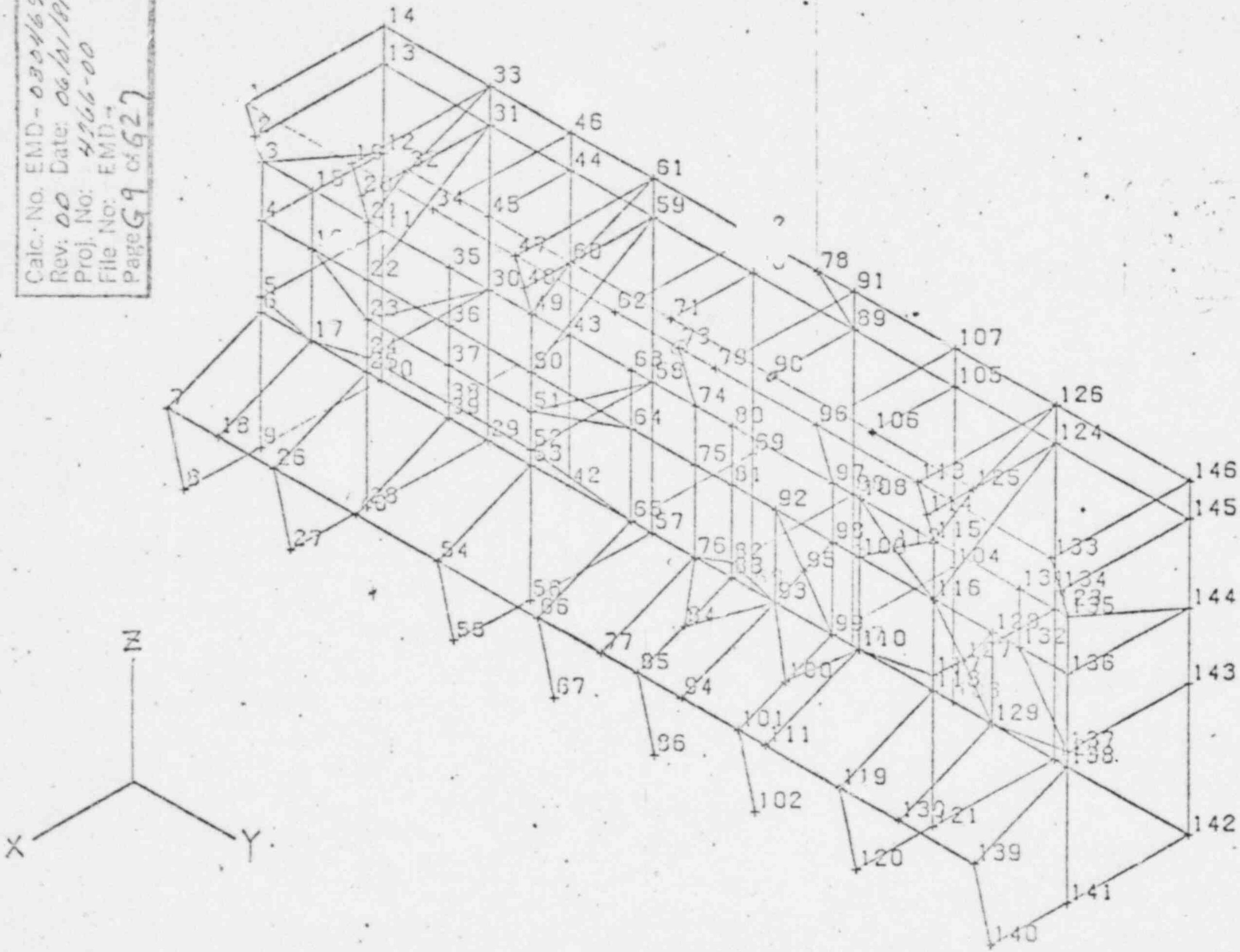


FIGURE 4.6.1

GEOMETRY FOR THE REACTOR CONTROL BENCH PANEL
(ARROWS DENOTE POINTS WHERE SHAKER WAS ATTACHED.)

Calc. No. EMD-030469
Rev: 00 Date: 06/21/91
Proj. No: 4266-00
File No: EMD-
Page G9 of G27



DYNAMIC ANALYSIS OF REACTOR CORE COOLING BB. PNL. 1&2H13-P601 LASALLE 609300

CLIENT COMMONWEALTH EDISON CO. 15

PROJECT LA SALLE COUNTY STATION JOB NO.

DESIGN BY A.J. DATE 11-14-72

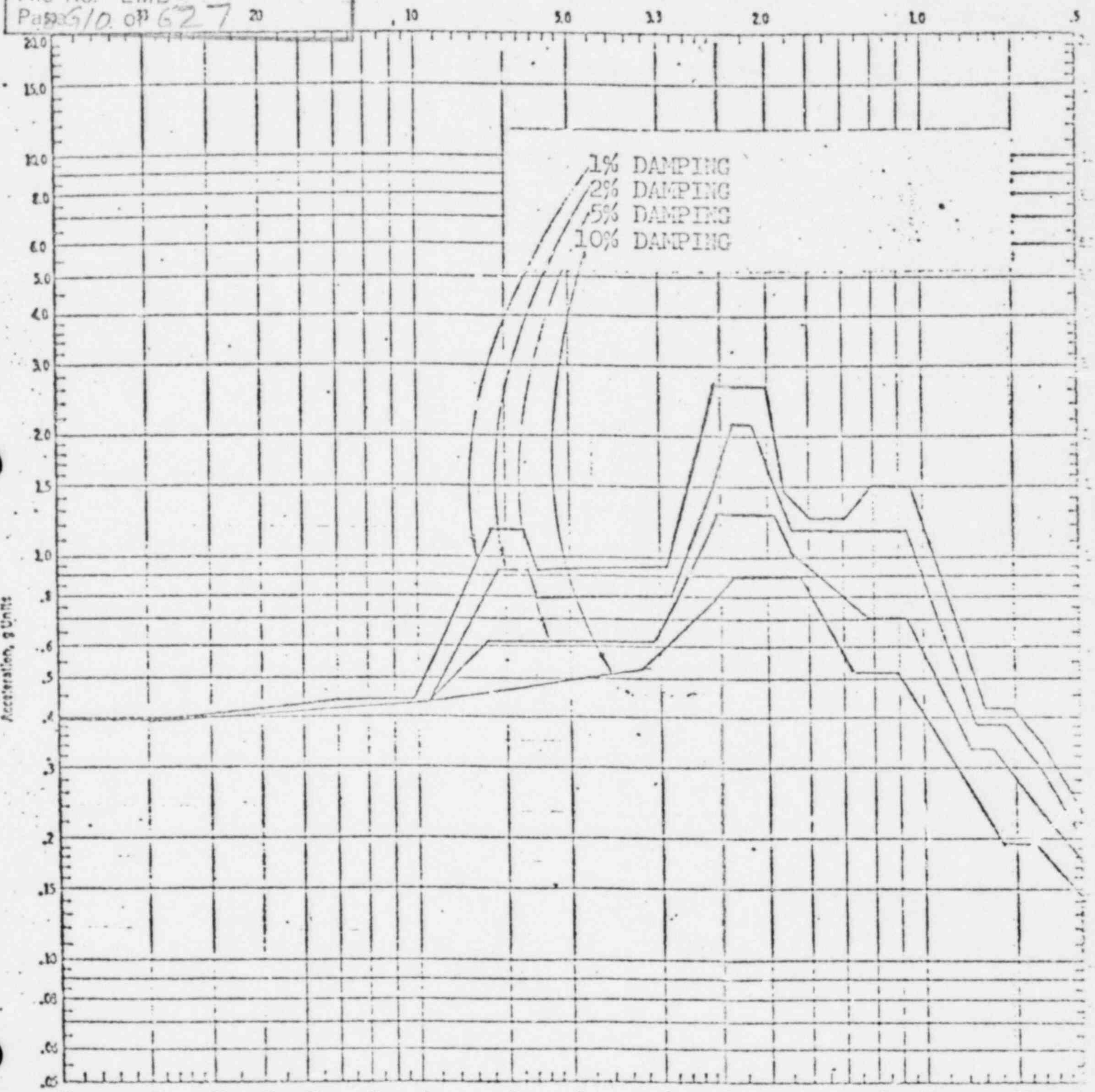
CHECKED BY B.D. DATE 11-15-72 SHEET OF

SARGENT & LUNDY ENGINEERS

MAIN CONTROLE BOARD

REV. NO.	1						
DATE	1-27-73						
INITIALS	RS						

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
Page: G10 of G27



LATEST 4/22/81

HORIZONTAL FLOOR RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
NORTH-SOUTH COMPONENT

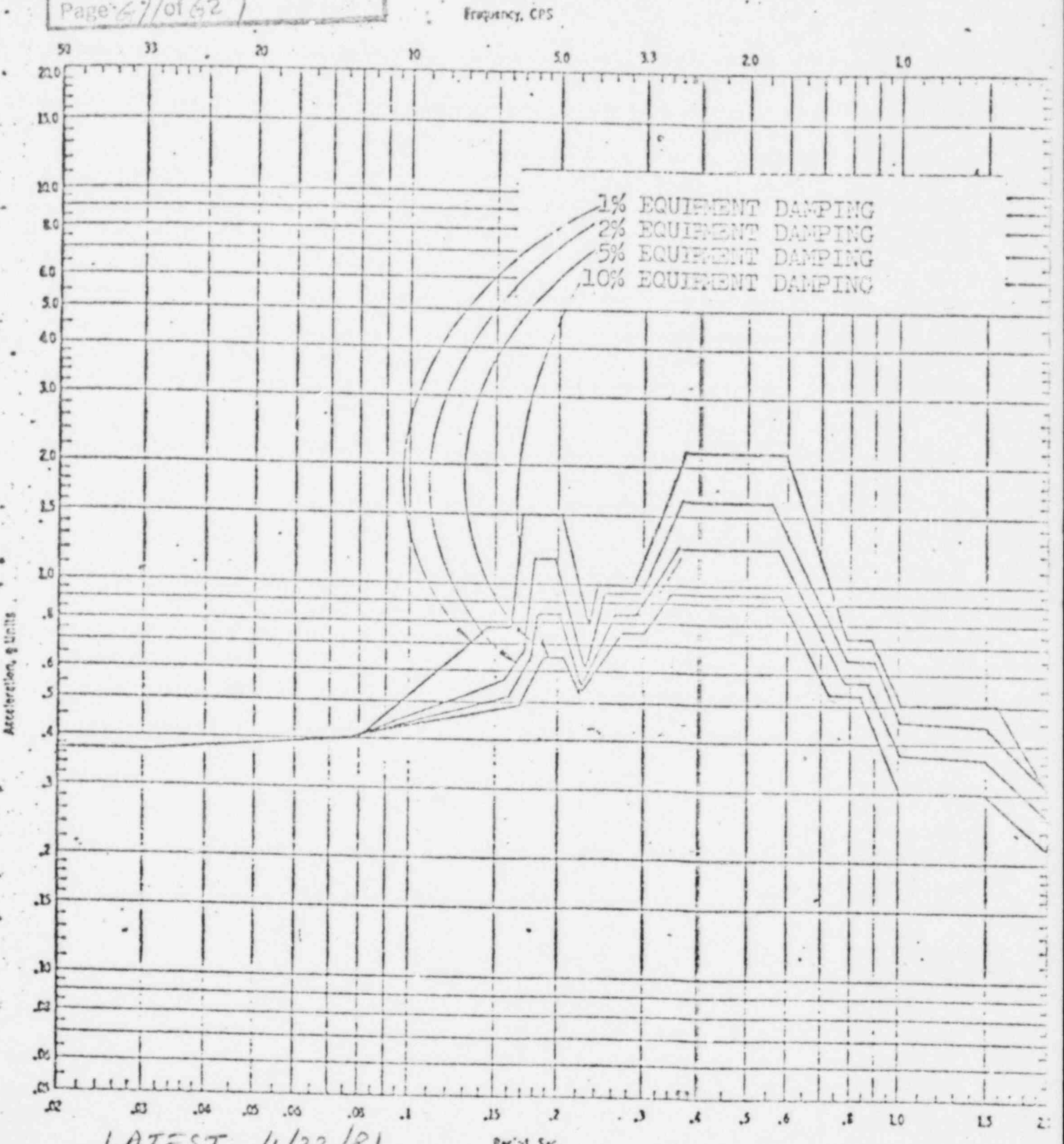
SPECTRA NO.
120-DB-NS
114-DB-NS

SARGENT & LUNDY ENGINEERS

PROJECT LA SALLE COUNTY STATION JOB NO. [illegible]
DESIGN BY A.M. DATE 11-14-72
CHECKED BY B D DATE 11-15-72 SHEET [illegible] OF [illegible]

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No. 4266-00
File No. EMD-
Page 67 of 627

REV. NO.	1						
DATE	4-27-73						
INITIALS	RS						



LATEST 4/22/81

HORIZONTAL FLOOR RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
EAST-WEST COMPONENT
ELEVATION 768'-0" (SLAB NO. 14)
AUXILIARY, TURBINE BUILDING, HEATER BAY, RADWASTE BUILDING

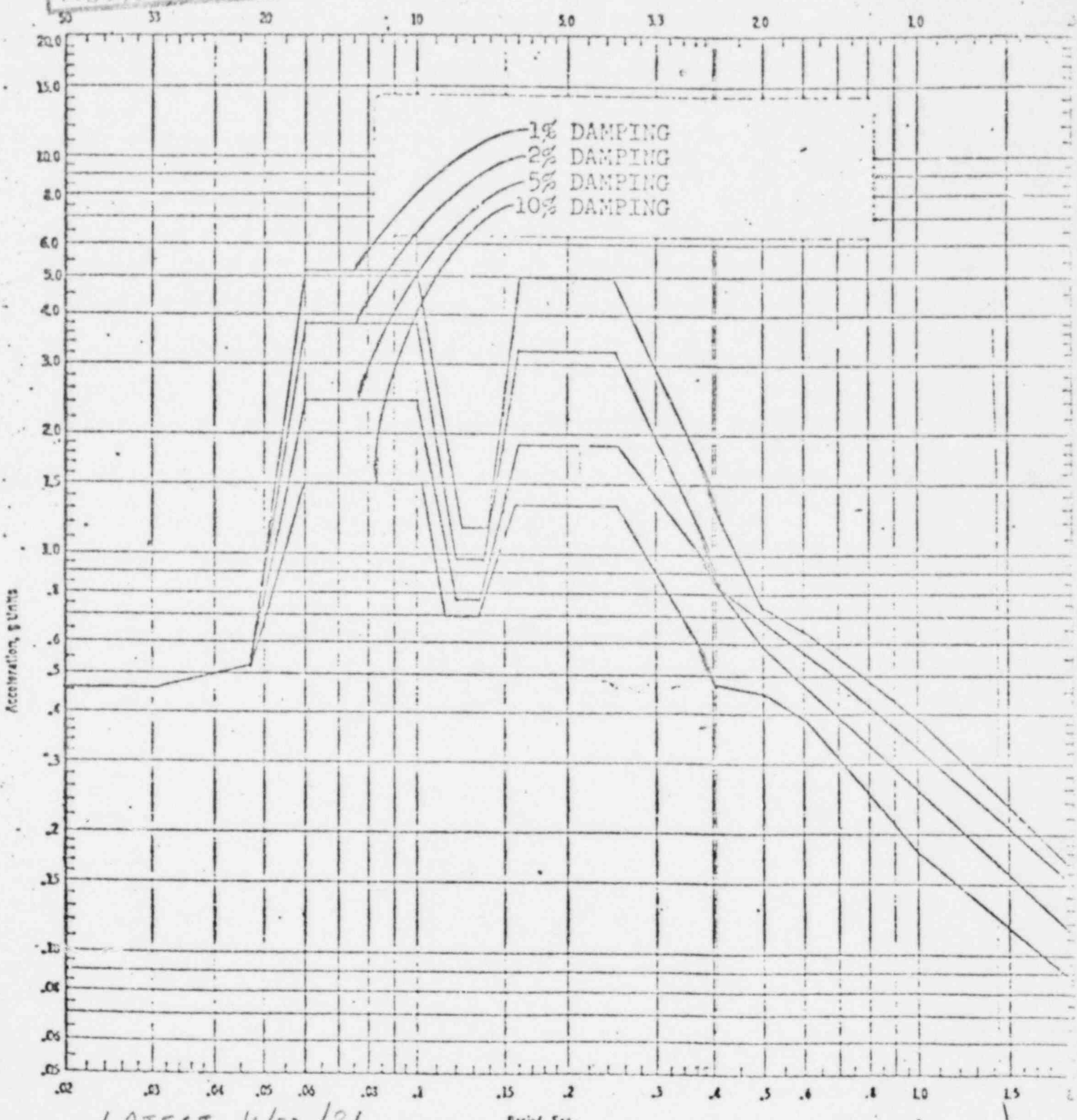
SPECTRA NO.
120-DB-EW
114-DB-EW

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LASALLE COUNTY STA. JOB NO. 4266
DESIGN BY V.H.R. DATE 7-15-72
CHECKED BY H.H.S. DATE 7-15-72 SHEET 94 OF 215

Calc. No. EMD-030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-4
Page G12 of G27

REV. NO.	1						
DATE	7-21-73						
INITIALS	R.S.						



LATEST 4/22/81

VERTICAL RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
AUXILIARY BUILDING SLAB
EL. 815'-0" TO 768'-0"

SPECTRA NO.
116-DB-VS
115-DB-VS
114-DB-VS

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY

PROJECT LASALLE COUNTY STA. JOB NO. 4266

DESIGN BY [illegible] DATE 7-15-72

CHECKED BY [illegible] DATE 7-16-72 SHEET 693 OF 817

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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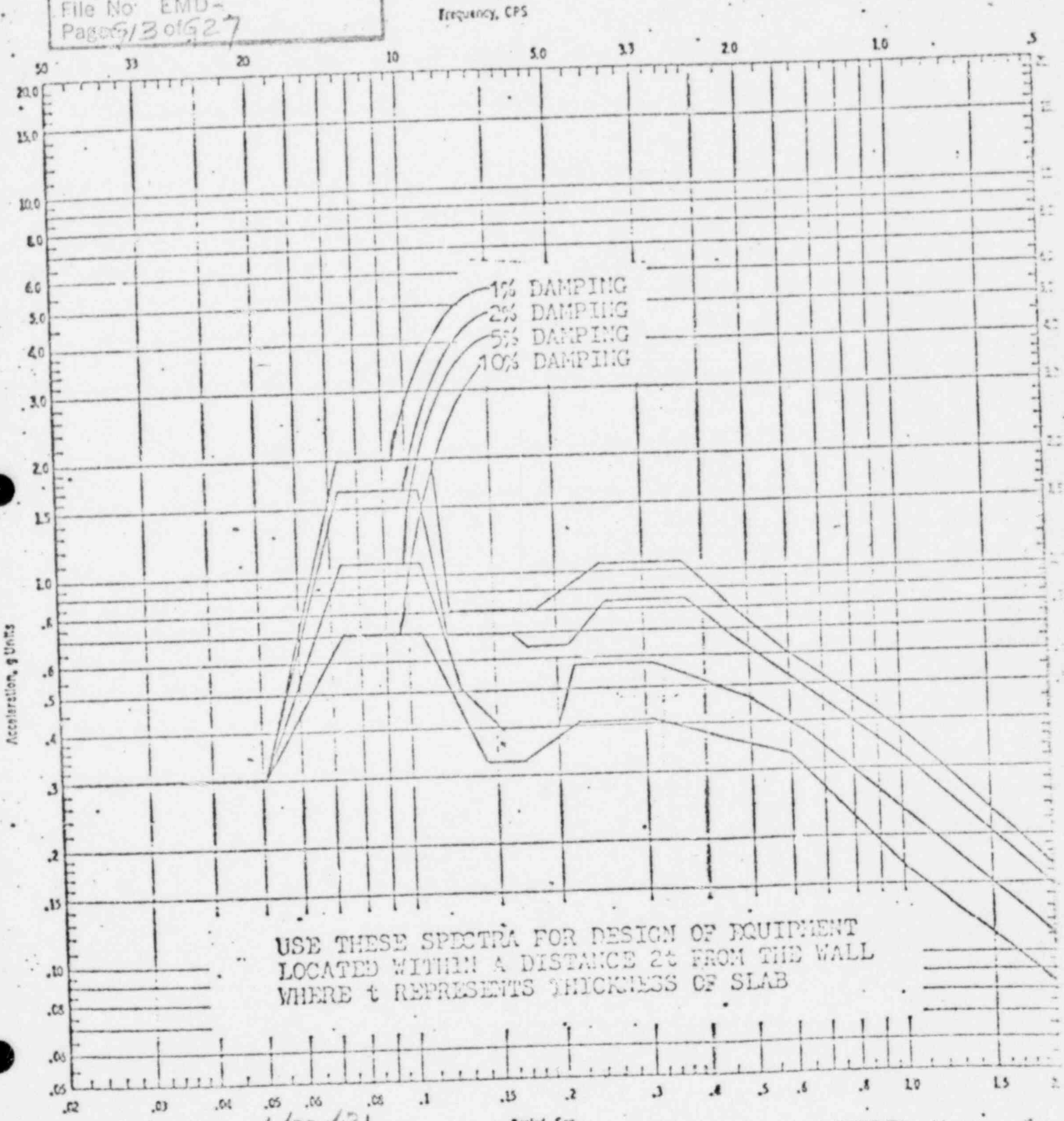
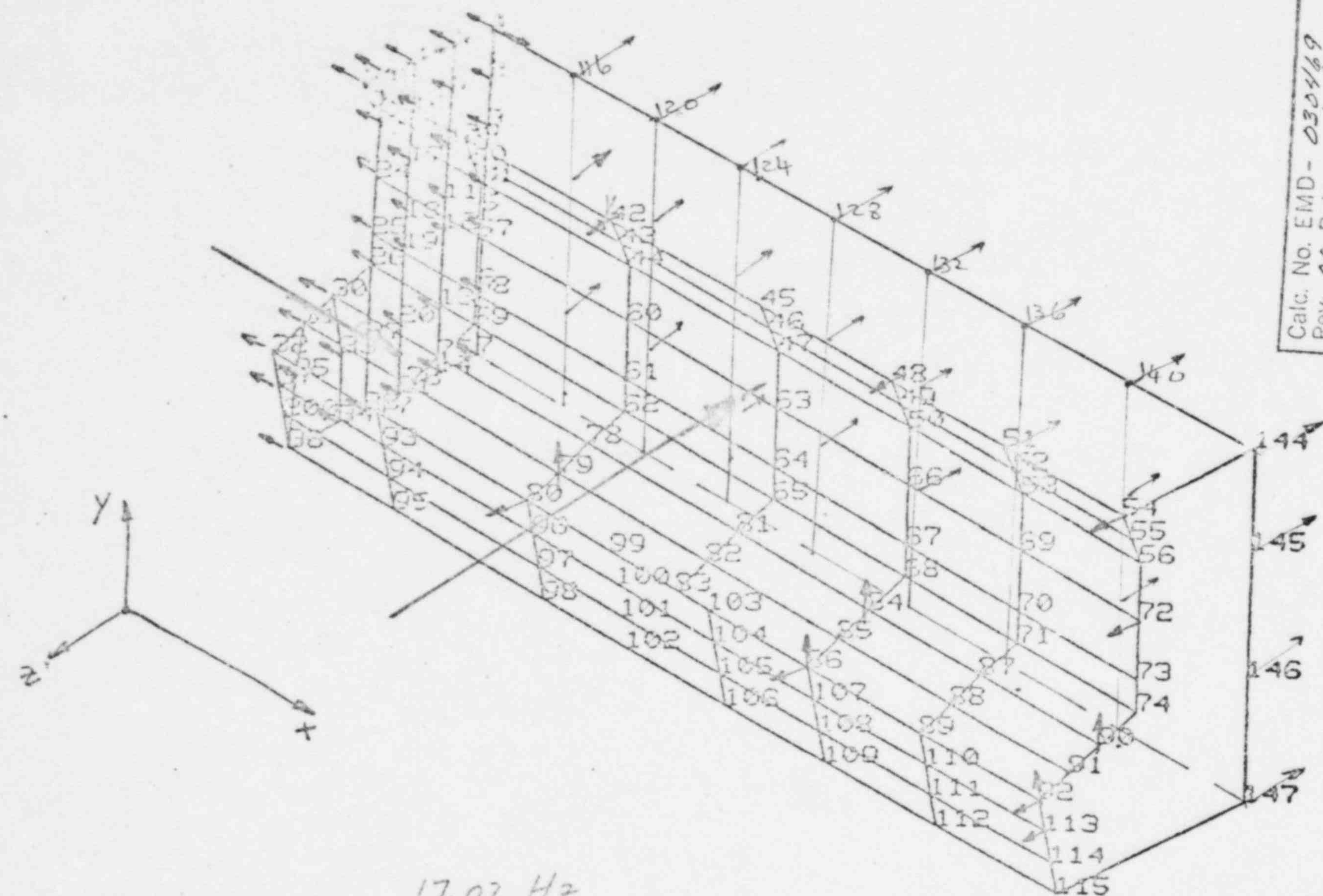
DATE	7-23-75						
INITIALS	[illegible]						



LATEST 4/22/81

VERTICAL RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
[illegible] BUILDING WALLS

SPECTRA NO.
114-DB-VW
115-DB-VW



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EXPERIMENTAL

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Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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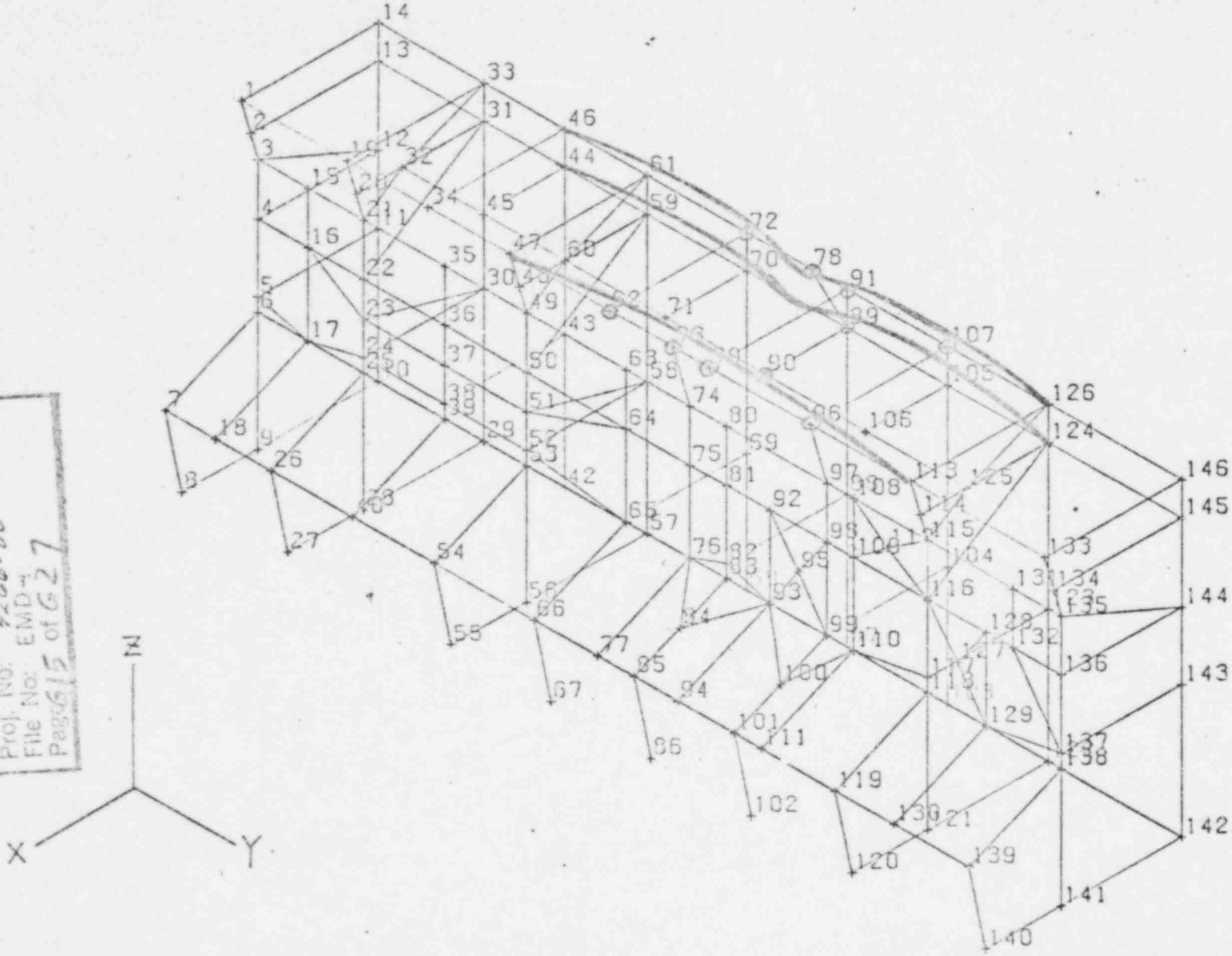

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Rev. 00 Date: 06/01/81
Proj. No. 4266-00
File No. EMD-1
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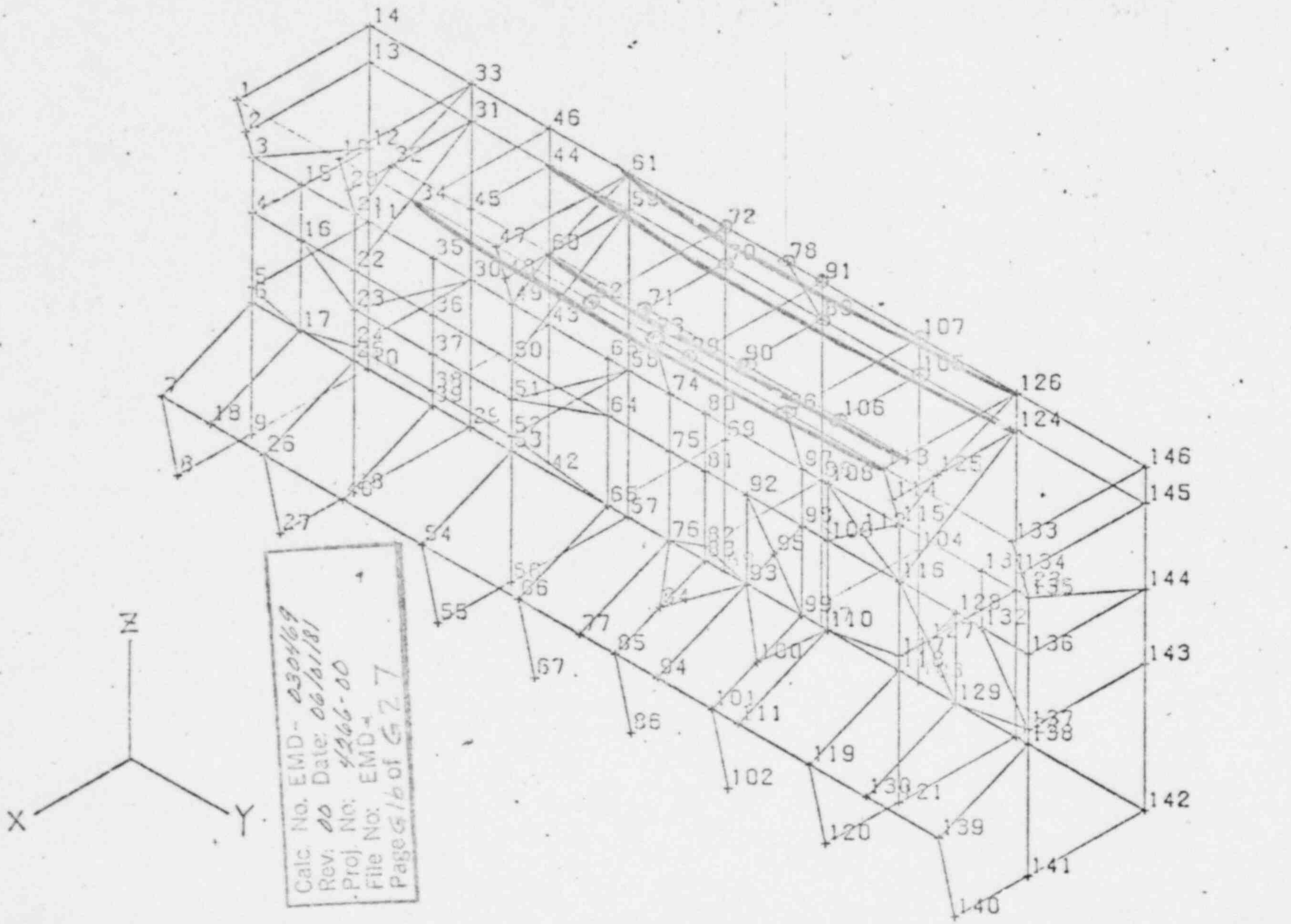
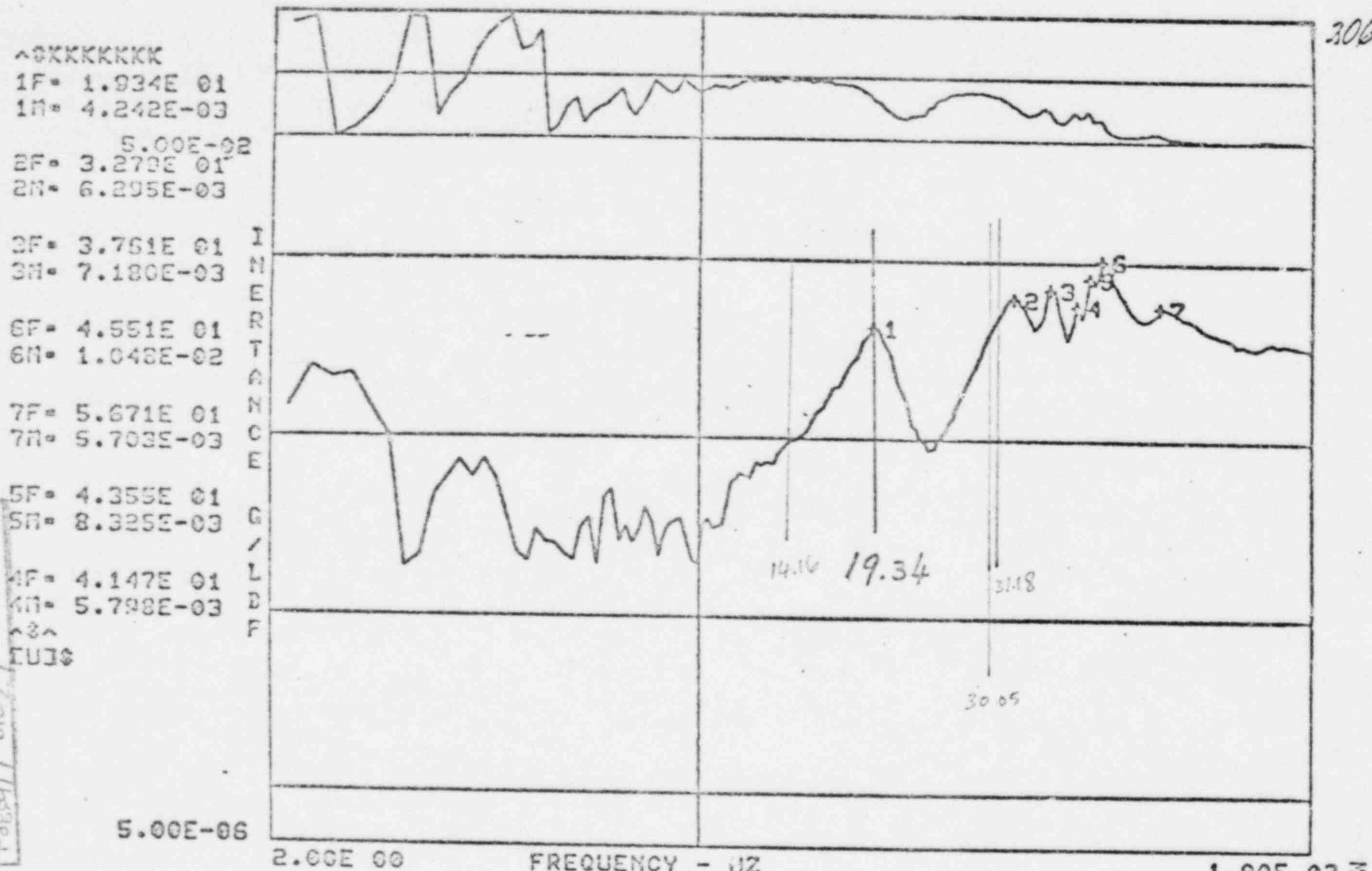
DYNAMIC ANALYSIS OF REACTOR CORE COOLING BB. PNL. 1&2H13-P601 LASALLE 609300



DYNAMIC ANALYSIS OF REACTOR CORE COOLING BB. PNL. 1&2H13-P601 LASALLE 609300



Calc. No. EMD-030469
Rev. 00 Date: 06/01/81
Proj. No. #266-00
File No. EMD-
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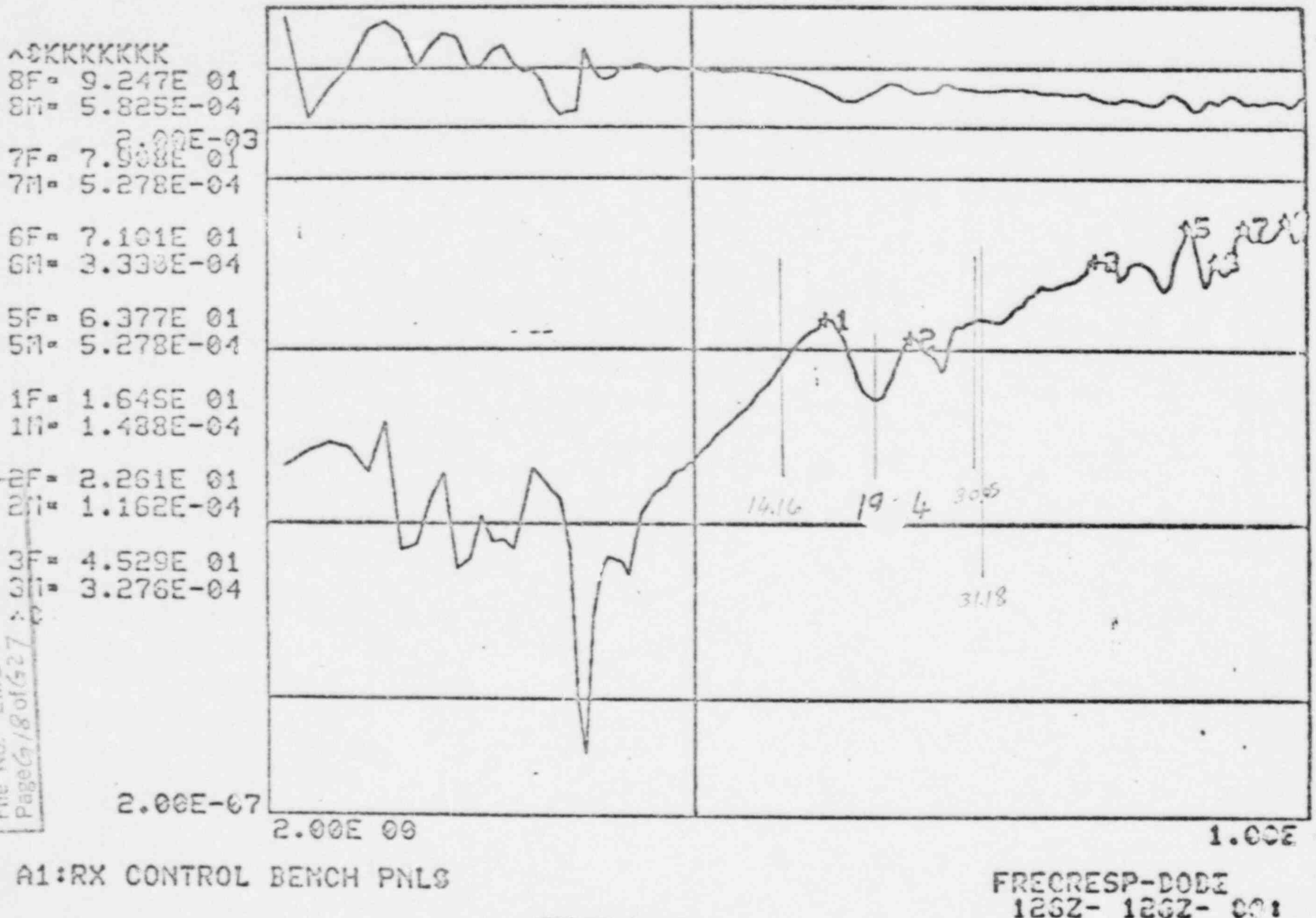
A1:RX CONTROL BENCH PNLS

FREQRESP-BODE
27X+ 27X- $0:

TI-80042-4
March 20, 1981

FIGURE 4.6.3
REPRESENTATIVE TRANSFER FUNCTION - END PANEL



Calc. No. EMD-030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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FIGURE 4.6.12

REPRESENTATIVE TRANSFER FUNCTION ON THE REACTOR CONTROL BENCH PANEL

TI-80042-4
March 20, 1981

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Rev: 00 Date: 06/01/81
Proj. No. 4266-00
File No. EMD-
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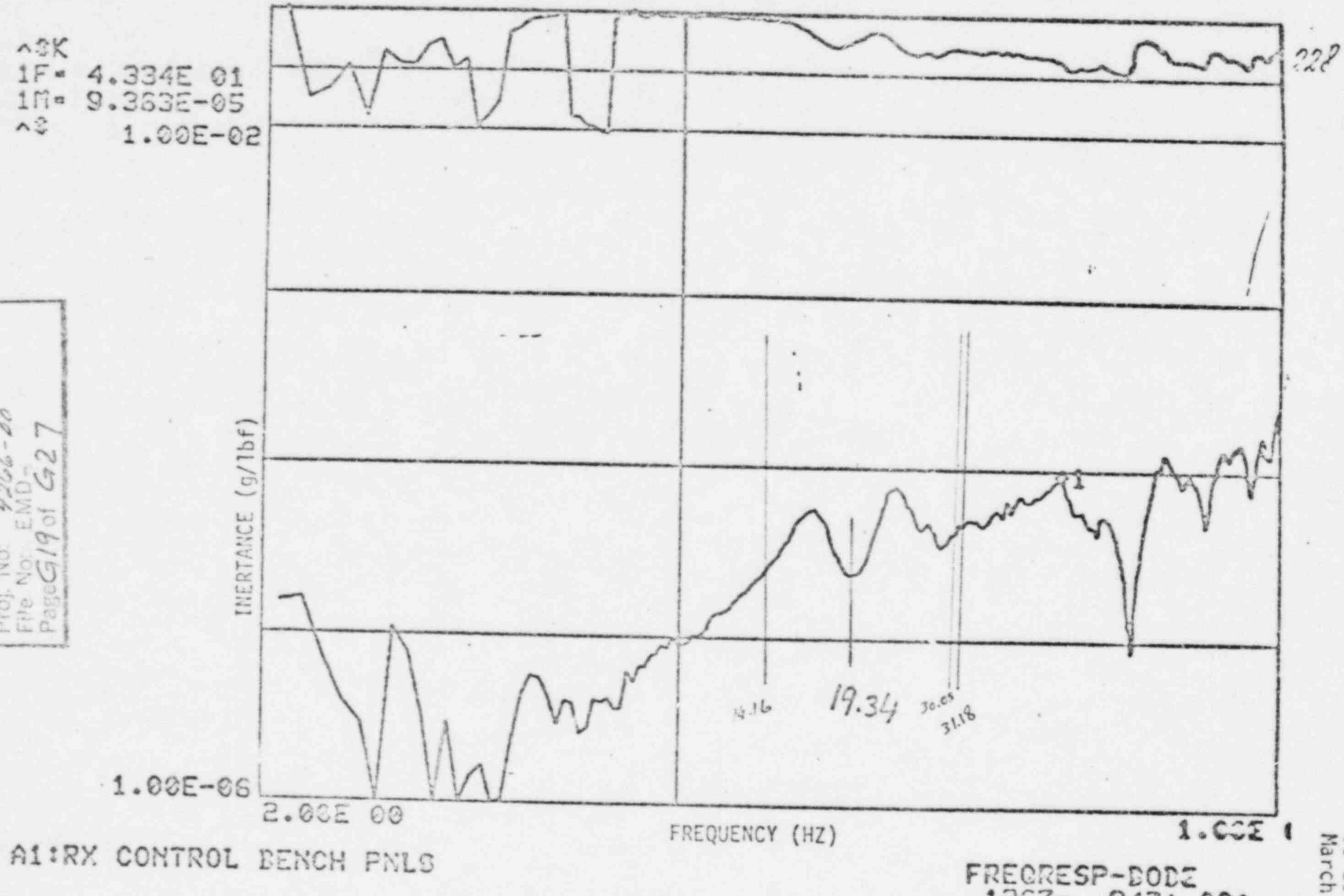

FIGURE 4.6.22

REPRESENTATIVE TRANSFER FUNCTION ON THE BACK COLUMNS OF THE REACTOR CONTROL BENCH PANEL

PRINT OF FREQUENCIES

MODE NUMBER	CIRCULAR FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)	PERIOD (SEC)	TOLERANCE
1	.8898+02	.1416+02	.7061-01	.2397-07
2	.9975+02	.1588+02	.6299-01	.2375-07
3	.1321+03	.2102+02	.4757-01	.4840-08
4	.1888+03	.3005+02	.3327-01	.2281-07
5	.1959+03	.3118+02	.3208-01	.7196-08
6	.2072+03	.3297+02	.3033-01	.1179-07
7	.2176+03	.3464+02	.2887-01	.2928-07
8	.2286+03	.3638+02	.2748-01	.2119-08
9	.3037+03	.4833+02	.2069-01	.2448-07
10	.3315+03	.5276+02	.1895-01	.1020-08
11	.3569+03	.5681+02	.1760-01	.8272-08
12	.3618+03	.5758+02	.1737-01	.4758-07
13	.3656+03	.5819+02	.1718-01	.6348-08
14	.3746+03	.5962+02	.1677-01	.4791-08
15	.4069+03	.6476+02	.1544-01	.8576-05

PRINT OF EIGENVECTORS

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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S RECORDS IN USE
REC 1: 17.020 HZ
REC 2: 22.540 HZ
REC 3: 45.790 HZ
REC 4: 54.100 HZ
REC 5: 64.123 HZ
REC 6: 70.500 HZ
REC 7: 78.030 HZ
REC 8: 92.730 HZ
REC 10: 43.280 HZ
$

S RECORDS IN USE
REC 1: 19.620 HZ
REC 2: 33.660 HZ
REC 3: 37.180 HZ
REC 4: 41.420 HZ
REC 5: 43.390 HZ
REC 6: 45.320 HZ
REC 7: 55.250 HZ
REC 8: 77.360 HZ
$

Calc. No. EMD-030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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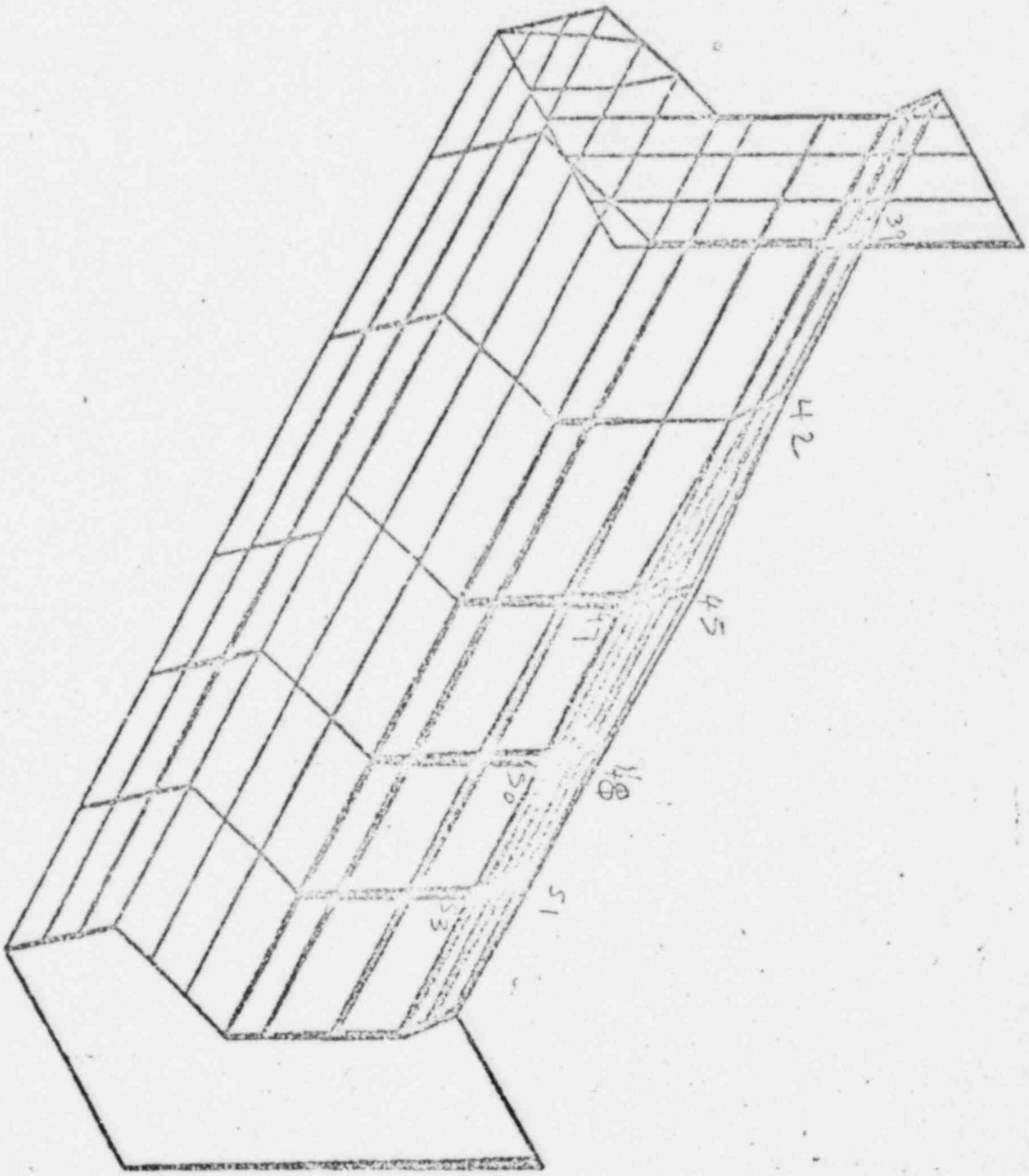

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313

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/01
Proj. No: 4266-00
File No: EMD-
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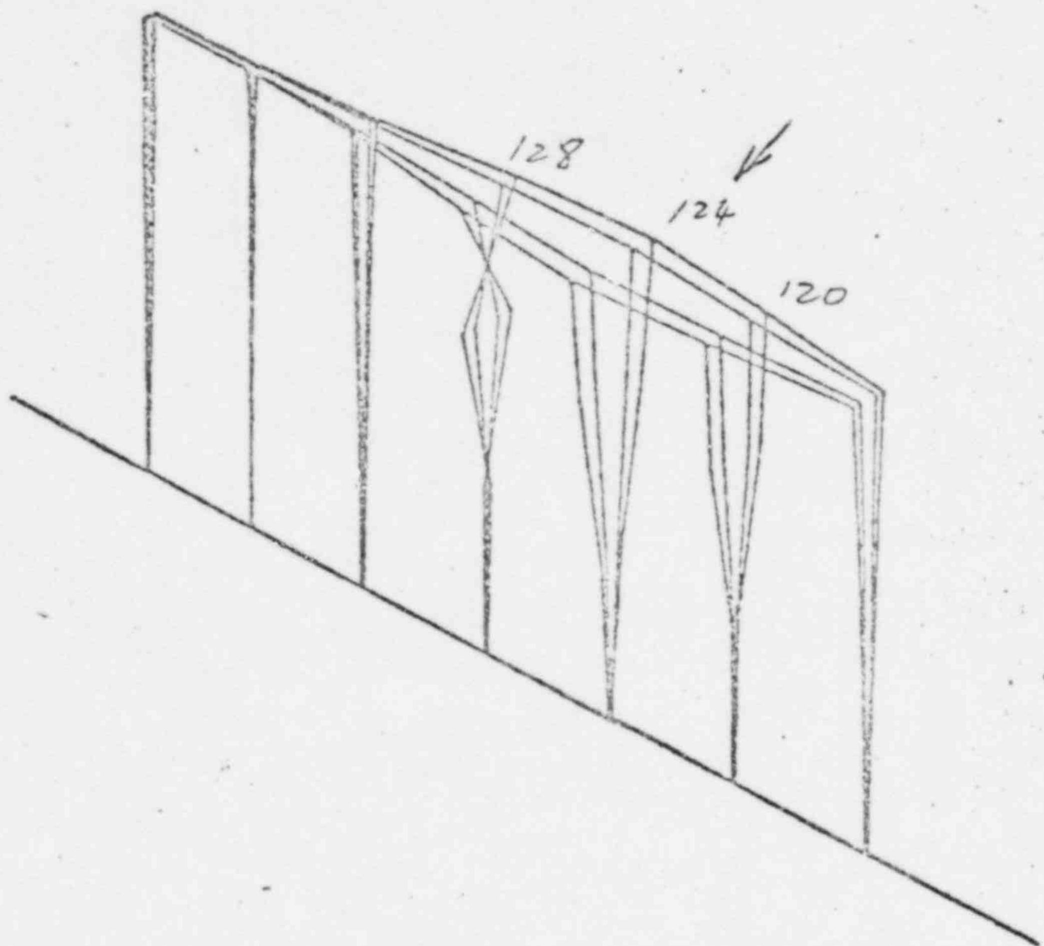

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Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
Page G23 of G27

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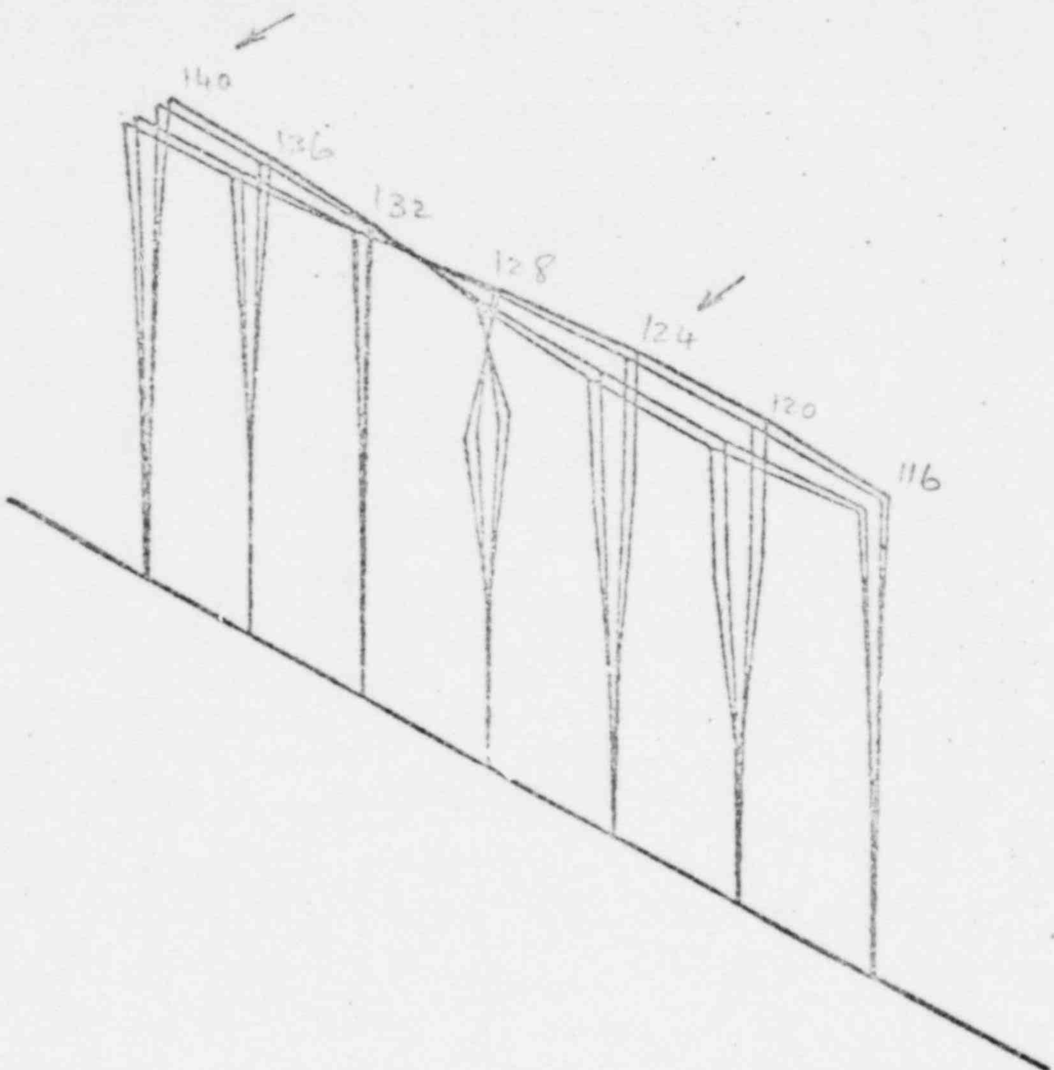

FIGURE 4.6.30

MODE SHAPE OF REACTOR CONTROL BENCH PANEL BACK COLUMNS AT 22.54 HZ

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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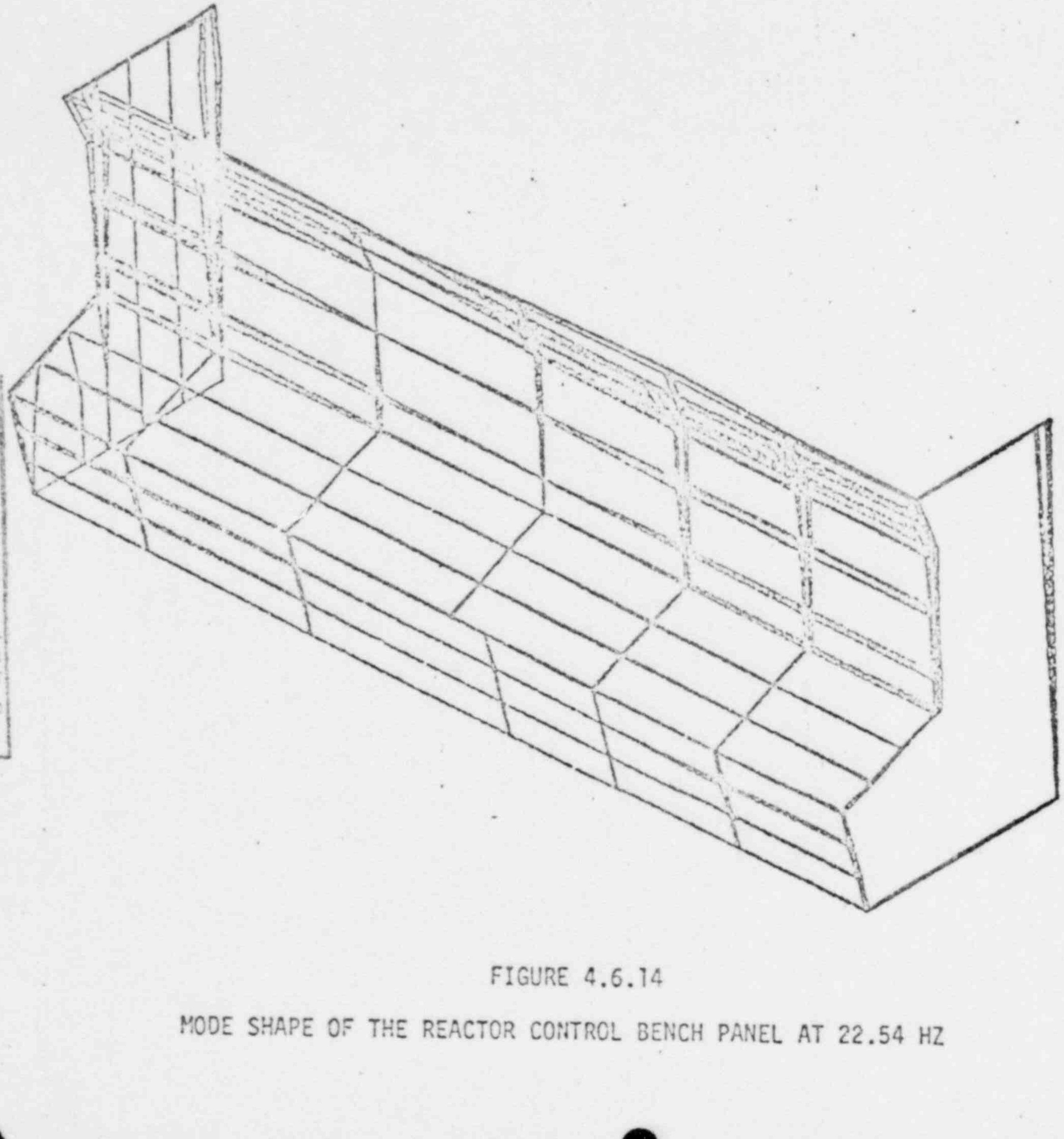

FIGURE 4.6.14

MODE SHAPE OF THE REACTOR CONTROL BENCH PANEL AT 22.54 HZ

220

Calc. No., EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-4
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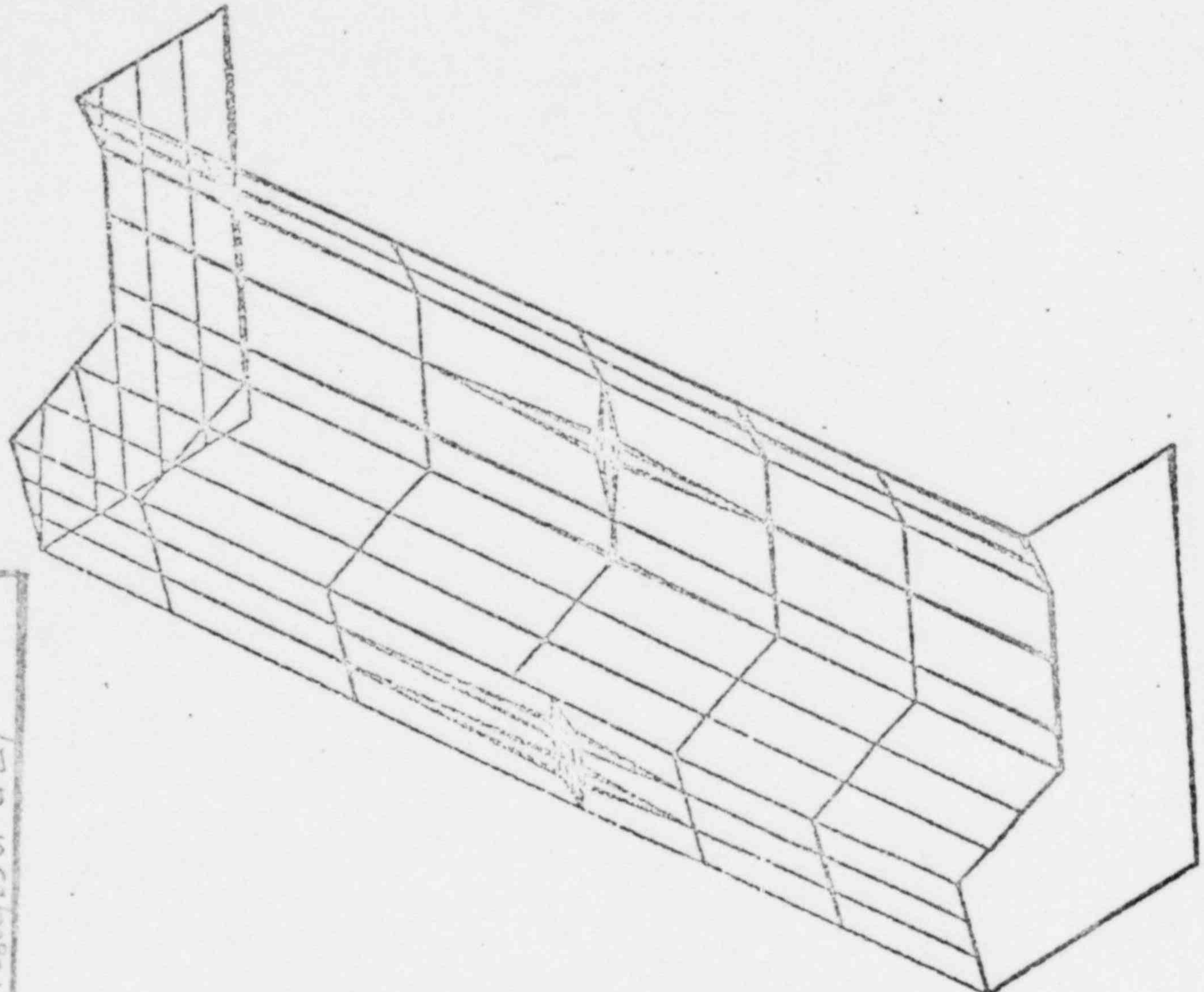

FIGURE 4.6.15

MODE SHAPE OF THE REACTOR CONTROL BENCH PANEL AT 45.79 HZ

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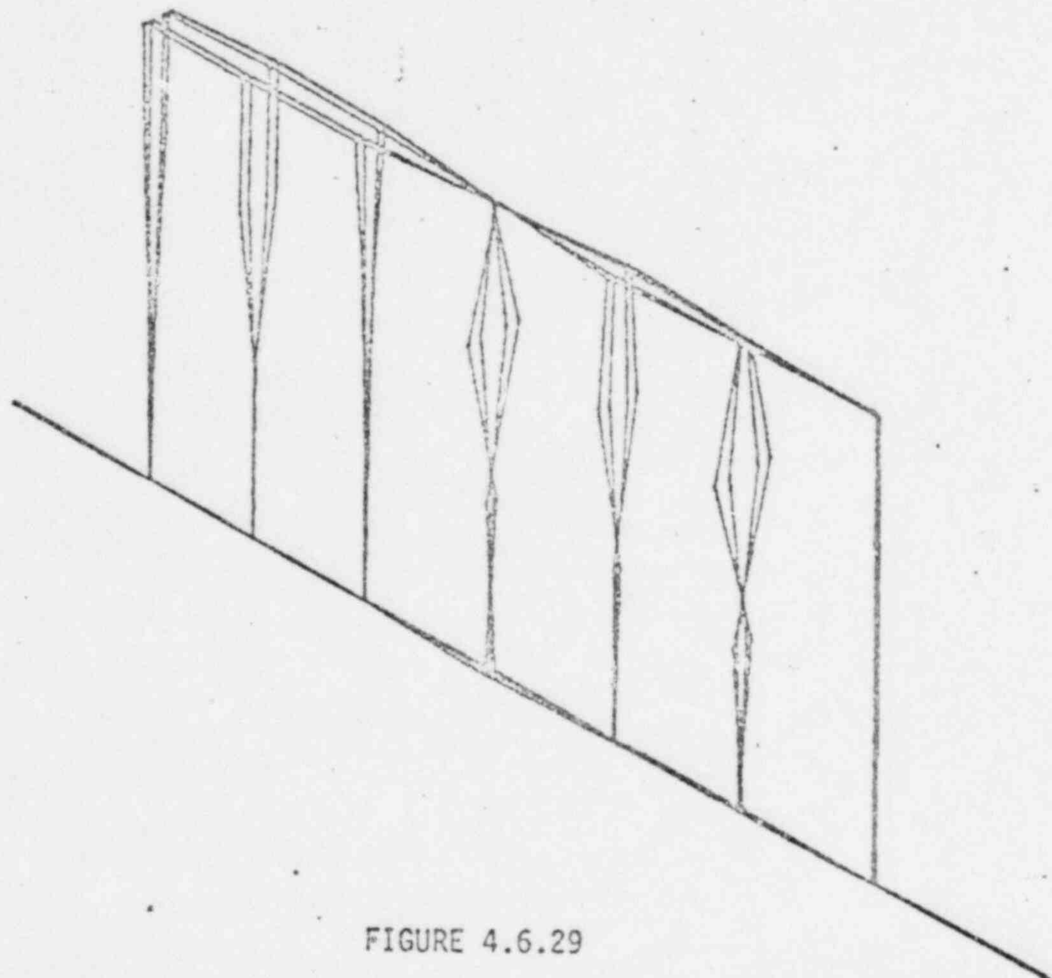


FIGURE 4.6.29

MODE SHAPE OF REACTOR CONTROL BENCH PANEL BACK COLUMNS AT 45.79 HZ

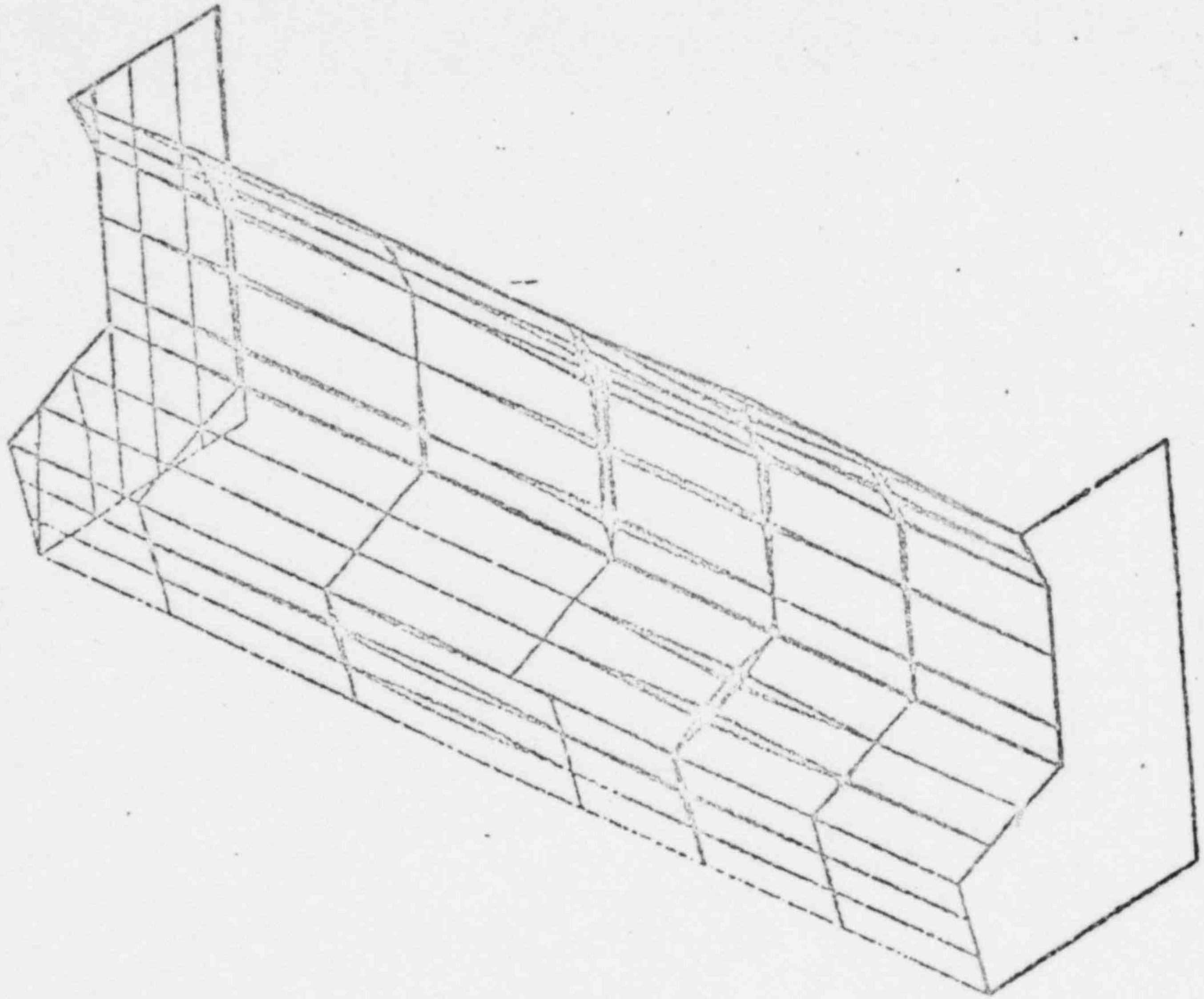


FIGURE 4.6.17

MODE SHAPE OF THE REACTOR CONTROL BENCH PANEL AT 64.123 HZ

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For MSIV VALVE			Calc. No. EMD 030469	
				Rev. 00	Date 06/01/81
	X	Safety-Related	Non-Safety-Related	Page H1	of H29

Client Commonwealth Edison Company		Prepared by I. Elgindy	Date
Project LaSalle County, Units I & II		Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No. B21-F022A/D	Approved by	Date

I. OBJECTIVE

To assess the vibration characteristics of above equipment determined analytically and by impedance testing, and to determine adequacy of equipment under the additional loadings, particularly in regard with the high resonances determined by impedance test.

II. INTRODUCTION

In conducting this assessment, one must recognize the practical limitations of available analytical and experimental techniques. For examples, the finite element method is limited when representing a structure by number of nodes, number of elements, nodal masses, nodal stiffnesses, idealized boundary conditions and by the type of functional relations between the nodes.

On the other hand, experimental techniques such as impedance testing is also limited by the number of locations utilized in applying vibration inputs and in measuring vibration response. Other limitations include inaccessability to certain areas, coherence of signals, cross coupling between natural modes of equipment and cross coupling with other natural modes of attached structures.

Therefore, assessment of the results obtained by both methods, has to consider these listed limitations and consequently has to be based on engineering judgement of obtained results.

III. SUMMARY OF IMPEDANCE TEST RESULTS

The valve and part of attached pipe are represented by the wire diagram shown in page H8. The small weight (122 lbs) was attached to the Transitek hydraulic actuator. The positions in which the hydraulic actuator provided force are shown in page H9. The top of valve actuator was tested by hammer impulse in the direction parallel with the valve actuator stem.

Representative transfer functions resulted from shaker positions 1, 2 and 3 are shown in pages H10 through H12.

The results of the impedance test are listed as follows:

FREQUENCY Hz	DESCRIPTION
17.5	Bending of yoke section along y* axis
21.2	Bending of yoke section along x* axis
53.8	Torsion of yoke section around z* direction
30.4	Coupled resonants of pipe in Bending and Test line.
37.3	Coupled resonants of pipe-valve body and limit switch bracket
66.4	Pipe-valve body bending mode
75.6	Pipe-valve body bending mode
89.6	Pipe-valve body bending mode
86.9	Pipe bending mode
93.4	Pipe bending mode

*Axes referenced here are those utilized in impedance test, page H8

The first three modes are the fundamental frequencies of the upper yoke section. The remaining seven modes are typical bending modes of pipe and valve body vibration. As shown in the attached mode shapes pages H16 through H22. Five of the seven modes are decoupled completely from the yoke section modes. It is important to note that there are two resonants of the pipe 30.4 Hz and 37.3 Hz. which are coupled with a resonant frequency of the test line and that of the limit switch bracket respectively. The mode shapes of these two critical frequencies are shown in pages H16 and H19.

IV. SUMMARY OF ANALYTICAL RESULTS

Only the yoke section was modeled for finite element analysis to determine the determine the natural frequencies and the maximum dynamic stresses of the yoke section. Page H23 shows the finite element model. The results are as follows:

FREQUENCY Hz	DESCRIPTION
16.66	Bending mode along y* direction
16.74	Bending mode along x* direction
41.31	Torsional mode
77.14	Combined bending & torsion
88.82	Combined bending & torsion

* Axes referenced here are those of finite element model page H23

The mode shapes determined analytically are shown in page H24 through H26.

V. NATURAL FREQUENCIES IN AGREEMENT

The following is a list of frequencies which are determined analytically and were confirmed by the impedance test. The first three modes represent the three fundamental modes of the yoke section. The fourth resonant is that of the limit switch bracket assembly.

ANALYTICAL Hz	IMPEDANCE TEST Hz	DESCRIPTION
16.66	17.5	Bending along y*
16.74	21.2	Bending along x*
41.31	53.8	Torsional
35.12	37.4	Limit Switch Bracket
77.14	75.6	Pipe mode coupled with twisting of yoke section
88.82	89.6	Pipe mode coupled with twisting of yoke section

*Axes referenced here are these of finite element model.

VI. FREQUENCIES DETERMINED BY IMPEDENCE TEST WHICH ARE NOT INCLUDED IN THE ANALYTICAL RESULTS

There are four modes which fall in this category. These modes concerns only the valve body and the attached piping. The mode shapes at these frequenices are shown in pages H19 through H22.

These modes were not picked up in the dynamic run because the finite element model did not consider the valve body or the attached pipe. It is important to note, however, that the impedance test results clearly showed definite separation between the modes of vibration of the upper yoke section and five other modes concerning the valve body and attached pipe. It is therefore concluded that the additional seven modes determined by the impedance test shall have no effect on the analytical results which was intended for the upper yoke section.

VII. ANSWERS TO THE COMMENTS MADE BY TRANSITEK, INC. IN THE IMPEDENCE TEST REPORT

Two comments were included in the impedence test report of the MSIV valve. The first is a recommendation to analyze the fatigue life of the limit switch bracket in light of the coupling of frequencies between one of the pipe modes and that of the bracket. The second comment is a recommendation to secure the 1" test line since there is a coupling between one of the pipe Modes and that of the test line.

The Limit Switch Bracket

The Final Qualification report of the MSIV valve EMD-029523 did include determination of three fundamental modes of vibration of the bracket. One of these modes is torsional about the center of mounting bolts of 37.6 Hz. This mode is coupled with one of the

pipe modes measured by impedence test. However, the detailed fatigue analysis included in the Final Qualification report did indicate that the fatigue life of the bracket is sufficiently secured.

The 1" Test Line

Based on field assessment conducted by the preparer on May 22, 1981 it was concluded that the coupling of frequencies reported in the impedance test report Ref. (2) is due to the fact that the 1" test line of the tested valve 1B21-F022A was not yet supported at the corner of two long arms as it should according to the installation procedures.

After inspection of the 1" test line of 1B21-F00C valve which is supported at the corner it was concluded that adding this support to all eight valves will increase the natural frequency of the test line and will reduce the amplitude of vibration of the new natural mode.

Therefore, it is concluded that the recommendation included in the impedance test is based on temporary conditions and that the installation of the corner support will resolve this problem completely.

VIII. CONCLUSIONS

Based on the fact that the analysis considered the additional hydraudynamic loads and on above assessment of analytical and

experimental vibration characteristic and based on the answers provided to Transitek comments it is concluded that the analytical results has been verified by the impedance test and that the qualification of above equipment is based on sound and verifiable technique.

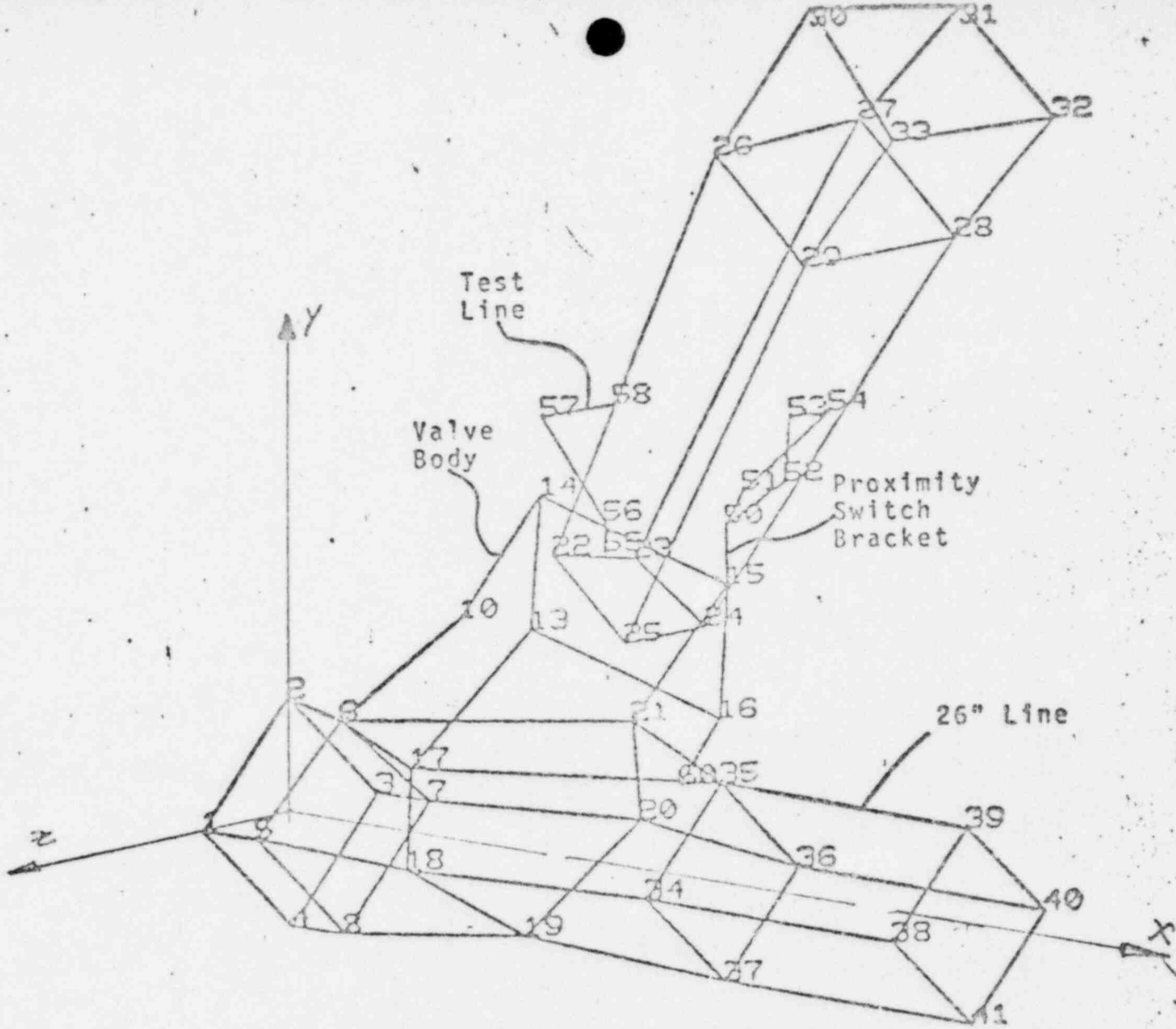
It is also concluded that extending the qualification of this MSIV valve (1B21-F022A) to qualify the other sever MSIV valves (1B21-F022B,C,D) and (1B21-F028A,B,C & D) is adequate. The adequacy of this extended qualification qualification is based on the fact that all eight MSIV valves are similar in structure and subject to similar loads.

IX. REFERENCES

1) Seismic qualification of MSIV valve #1B21-F022A/D,
EMD- dated Rev. 0.

2) Impedance test report for MSIV valve 1B21-F022A
EMD- dated 3/17/81.

3) Final test report SQRT in plant impedance testing,
LaSalle Co. 1. Transitek, Inc. Job No. 80042,
EMD-029601-00 dated



A WIRE FRAME DRAWING OF THE VALVE ACTUATOR AND PIPING
FOR THE MAIN STEAM ISOLATION VALVE

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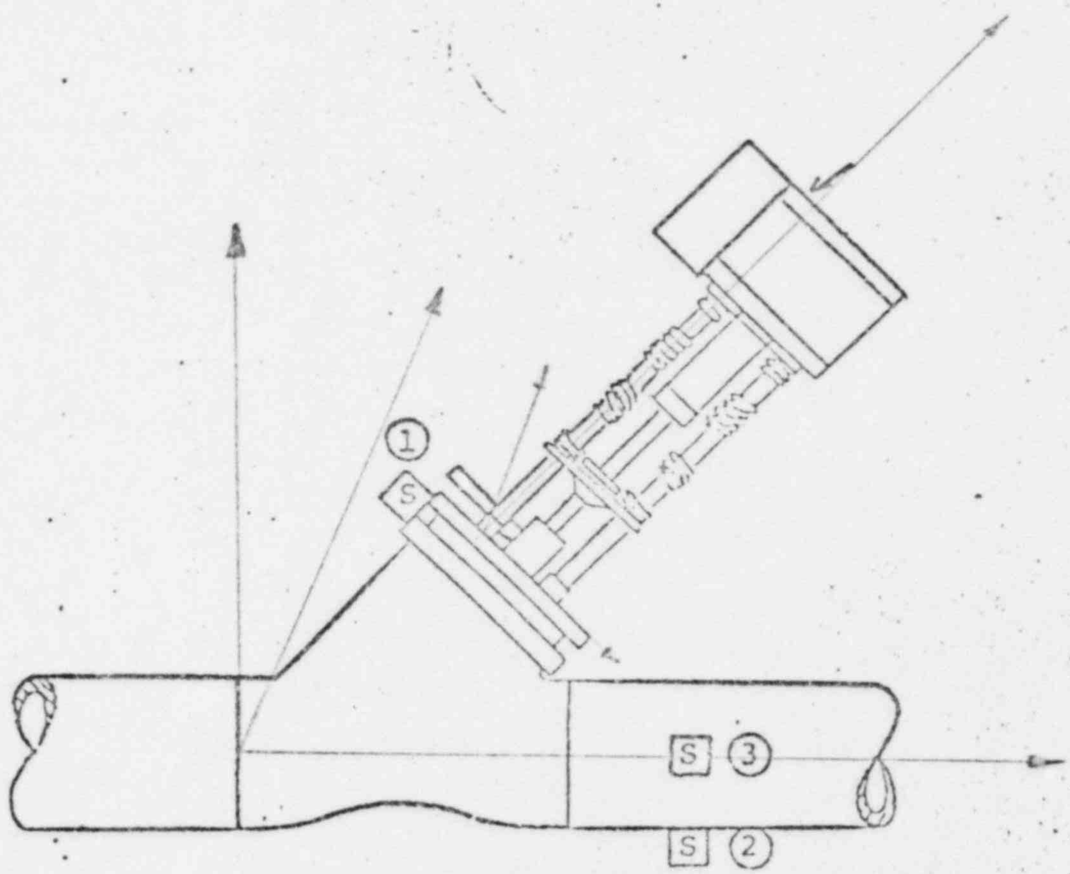
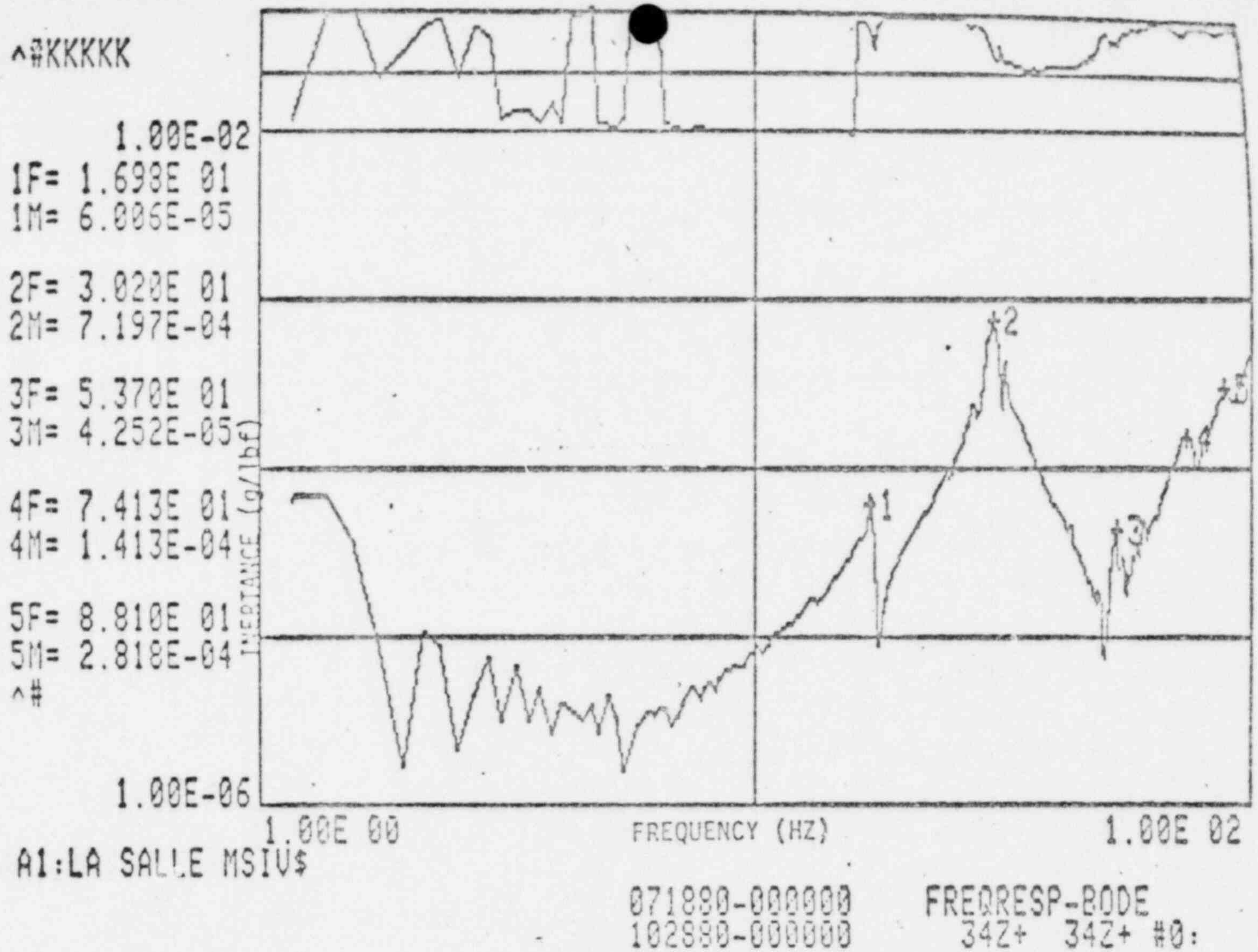


A SKETCH OF THE MAIN STEAM ISOLATION VALVE
SHOWING THE SHAKER POSITIONS AND AN OUTLINE OF THE VALVE
THE ARROW AT THE TOP OF THE ACTUATOR DENOTES THE ORIENTATION FOR IMPULSE TEST.



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File No. EMD-
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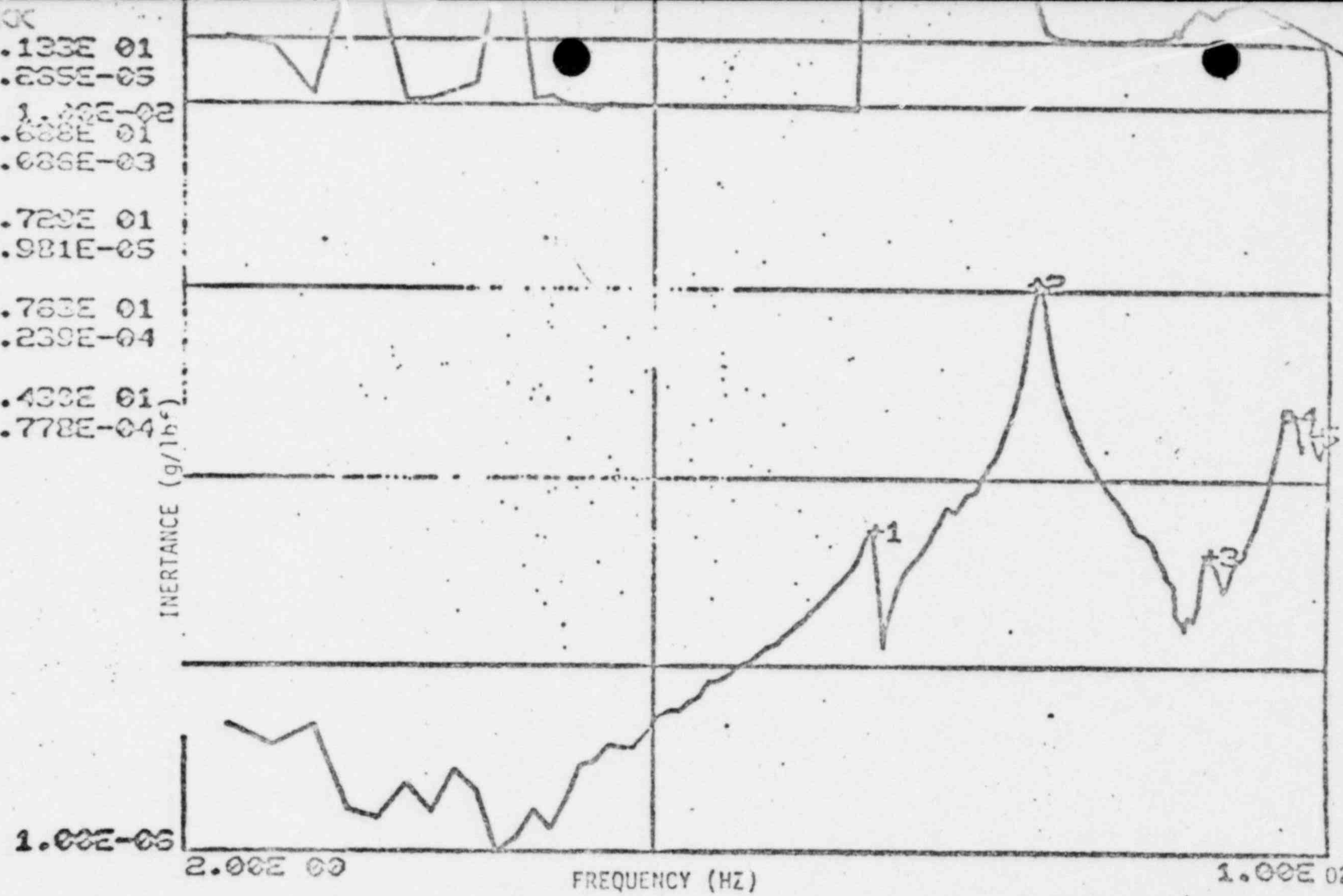
A REPRESENTATIVE TRANSFER FUNCTION MEASURED IN THE X ORIENTATION OF THE SHAKER (POSITION 3)

1F= 2.133E 01
1M= 5.255E-05
1.##E-02
2F= 3.688E 01
2M= 1.686E-03

3F= 6.729E 01
3M= 3.981E-05

4F= 8.763E 01
4M= 2.239E-04

5F= 9.433E 01
5M= 1.778E-04



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Rev: Date:
Proj. No:
File No: EMD-
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A1:LA SALLE MSIV3

FREGRESP-BODE
37Y- 37Y-

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File No: EMD-
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A REPRESENTATIVE TRANSFER FUNCTION FOR THE SHAKER APPLYING FORCE IN THE VERTICAL DIRECTION
(SHAKER POSITION 3)

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Proj. No: 4266-00
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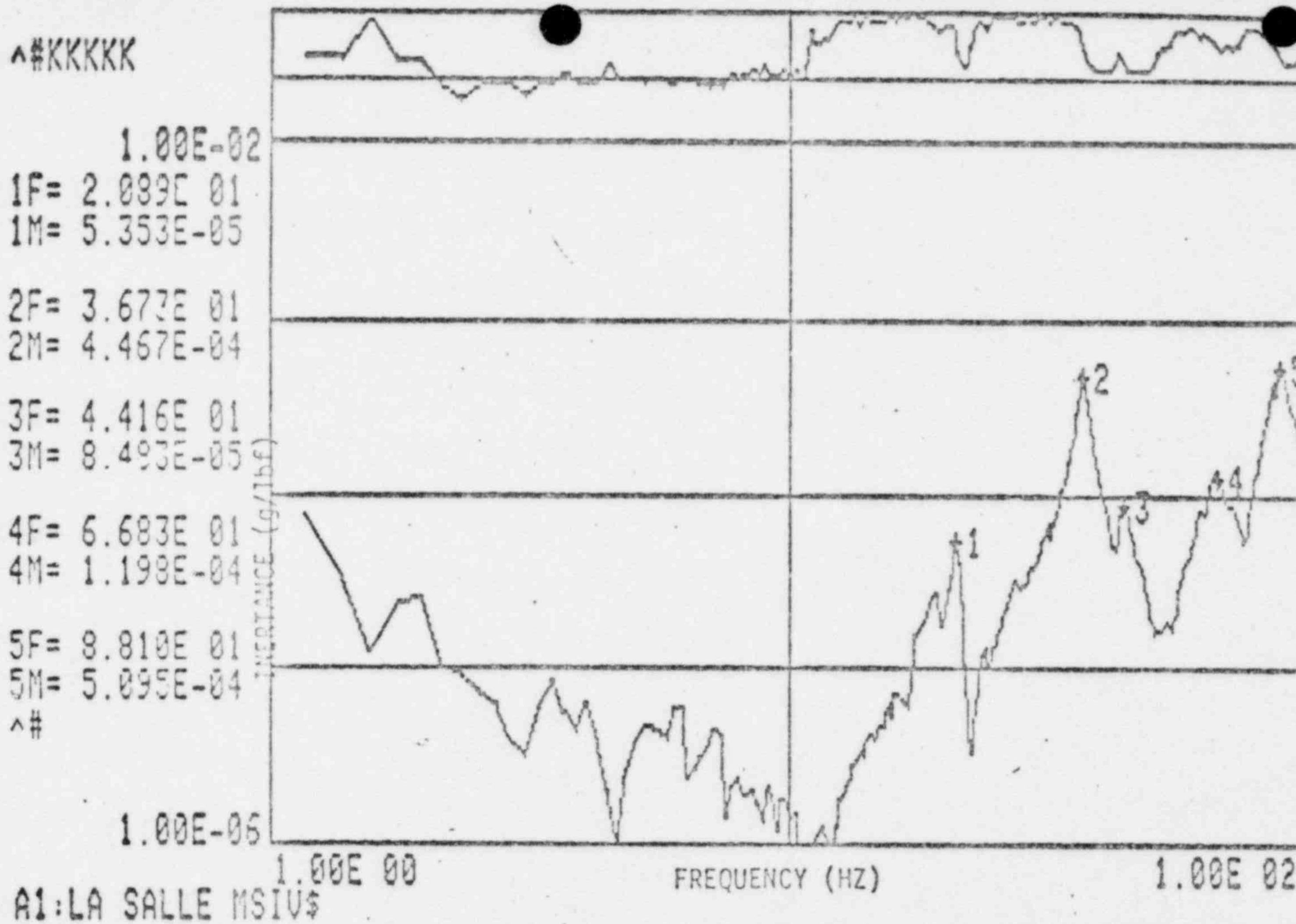
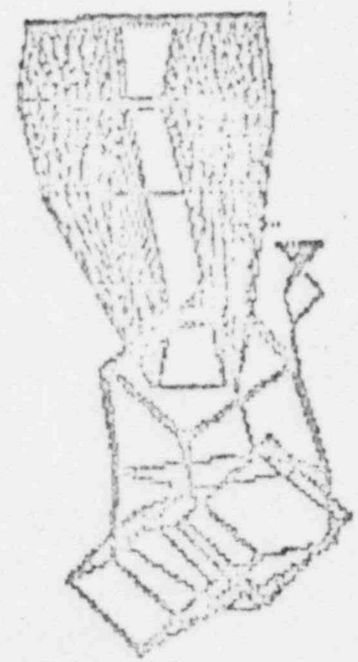


A REPRESENTATIVE TRANSFER FUNCTION MEASURED IN THE X-Y ORIENTATION OF THE SHAKER
(POSITION 1)



CANTILEVER BENDING MODE OF VALVE ACTUATOR IN Z DIRECTION AT 17.5 HZ
VALVE VIEWED FROM BEHIND

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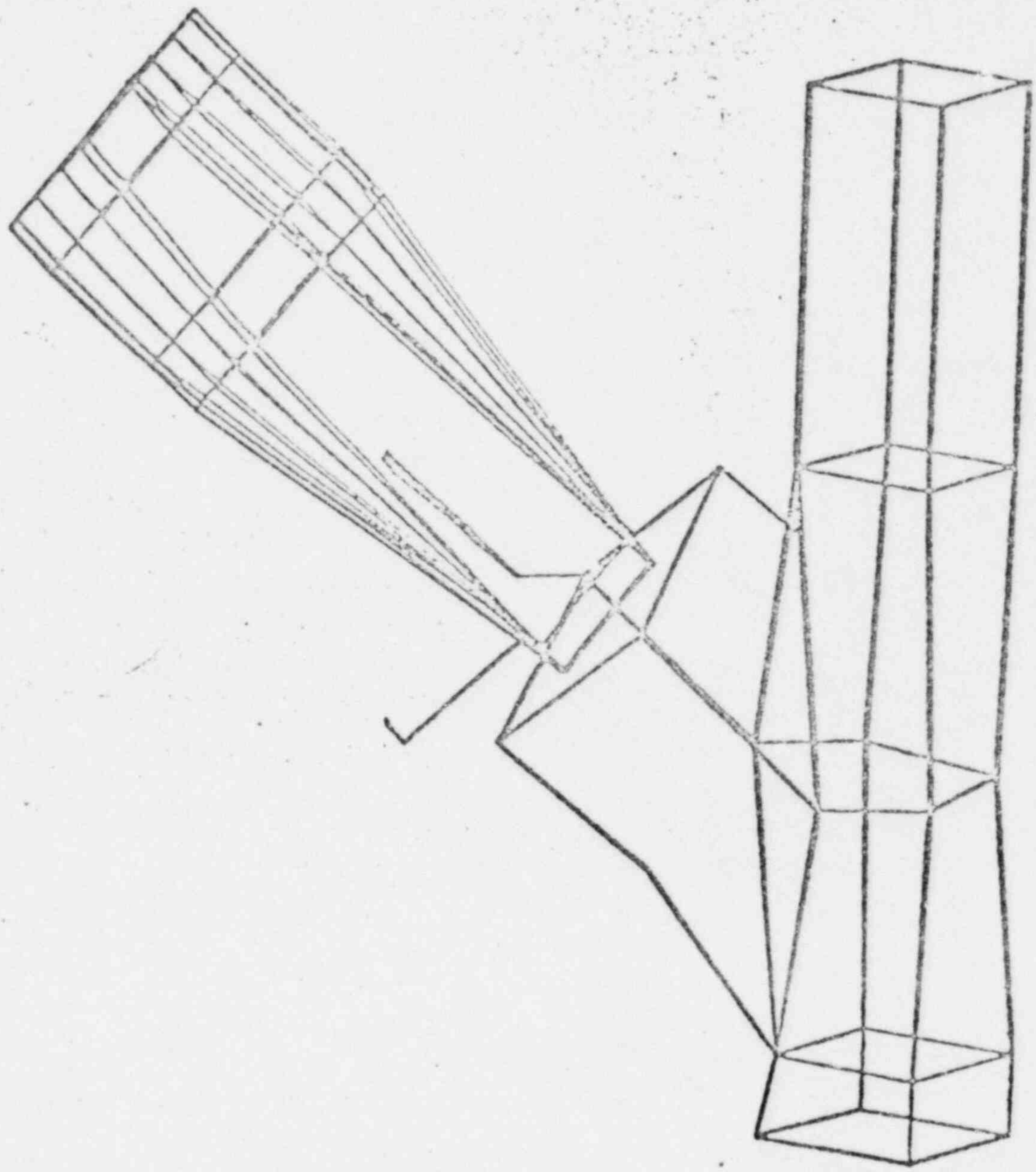

X-Y DIRECTION CANTILEVER RESONANCE OF THE VALVE ACTUATOR AT 21 HZ

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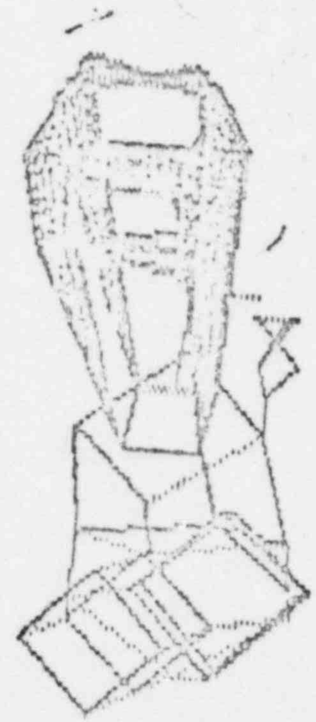

TORSIONAL MODE OF VALVE ACTUATOR AT 53.8 HZ

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Proj. No: 4266-00
File No: EMD-
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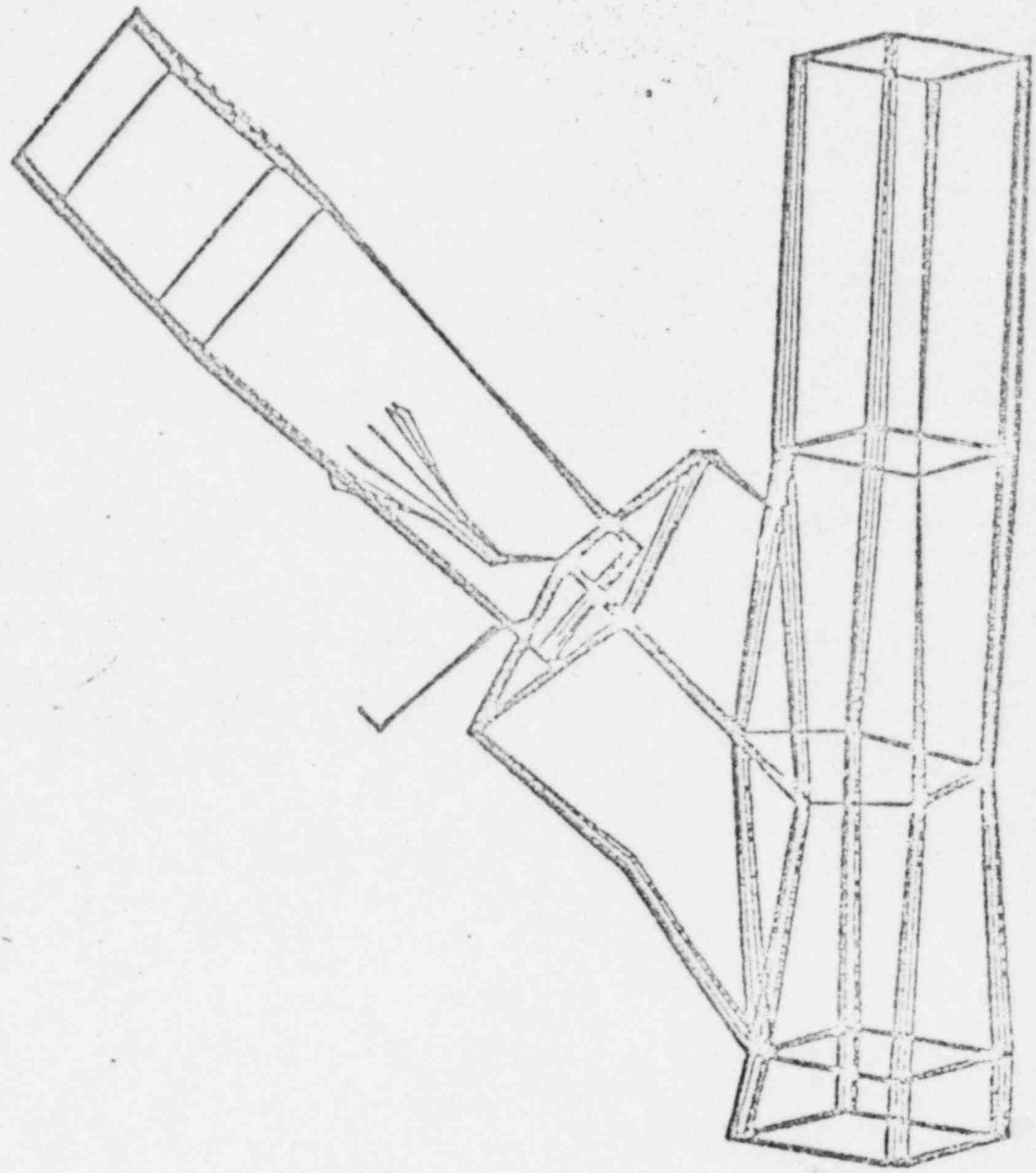

COUPLED RESONANCE OF PIPING SYSTEM AND LIMIT SWITCH BRACKET AT 37.3 HZ

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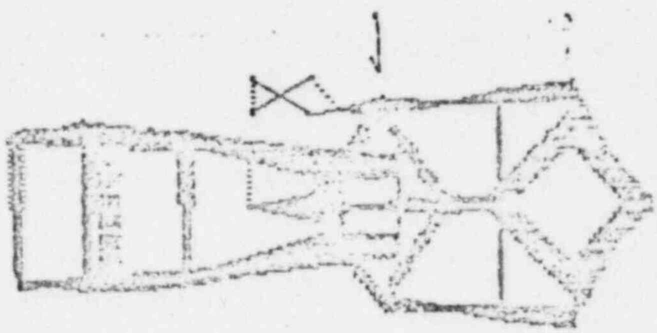

VALVE BODY BENDING MODE AT 75.65 HZ

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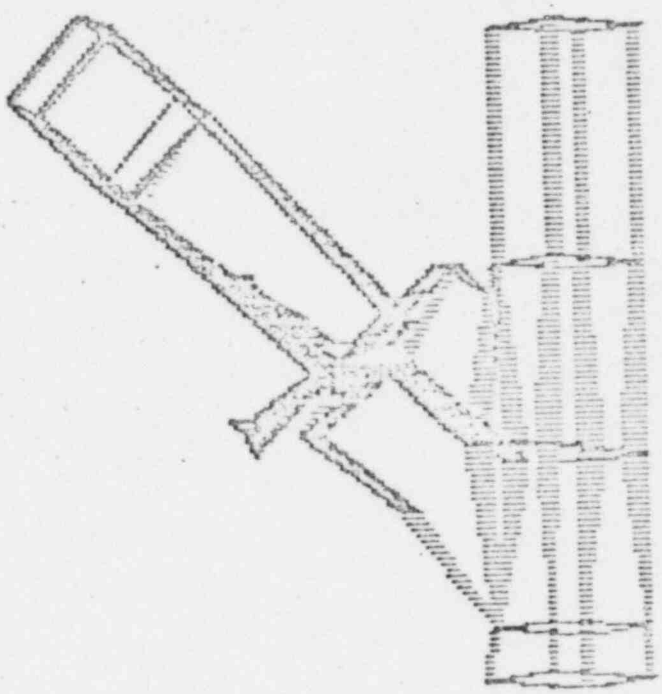

PIPE AND VALVE BODY BENDING MODE AT 89 HZ

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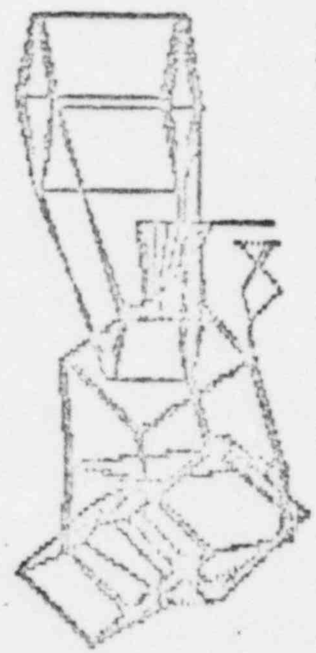

PIPE BENDING MODE IN Z DIRECTION AT 30.44 HZ
VIBRATION GREATLY AMPLIFIED ON TEST LINE.

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Rev: 00 Date: 06/01/81
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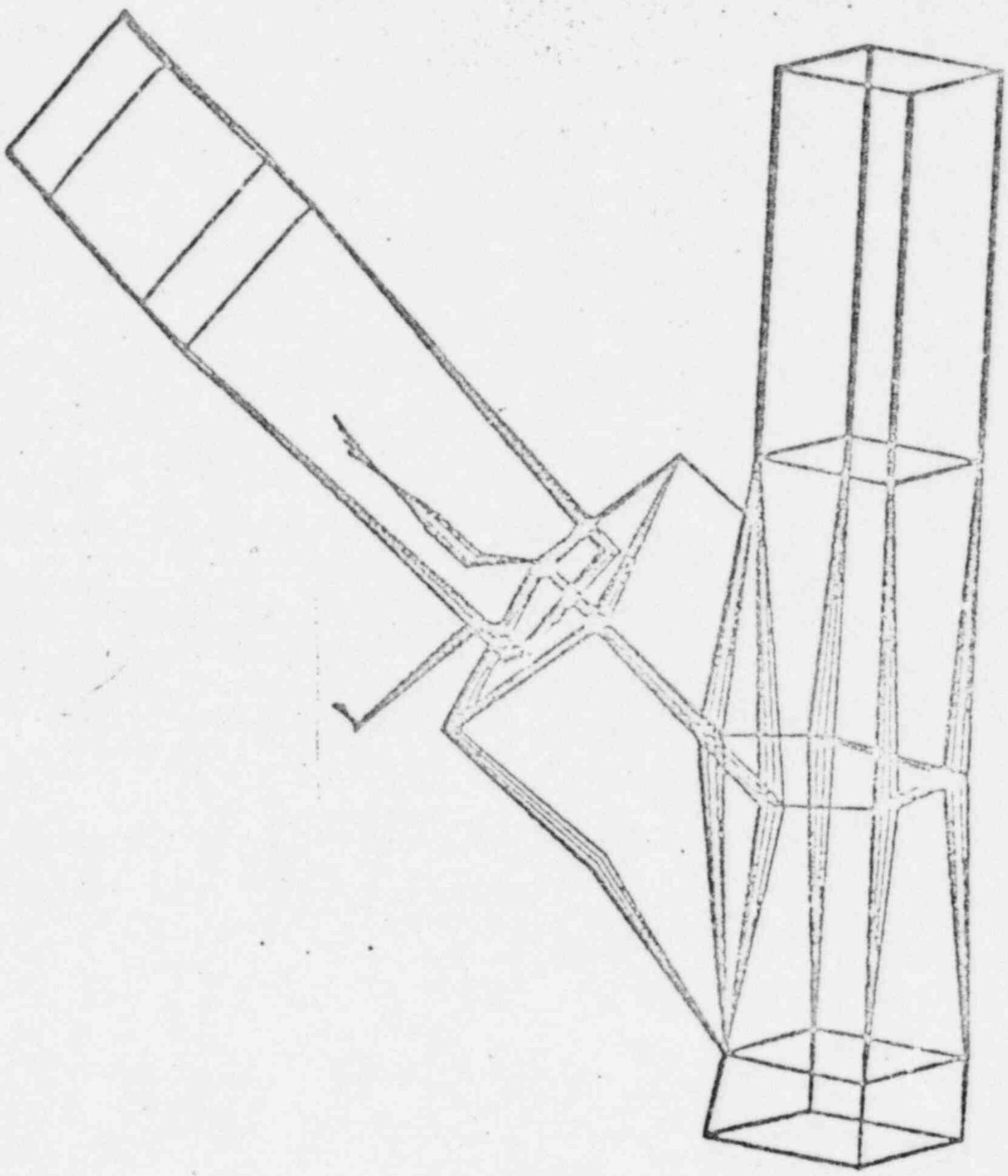

PIPE AND.VALVE BODY BENDING MODE AT 66.4 HZ

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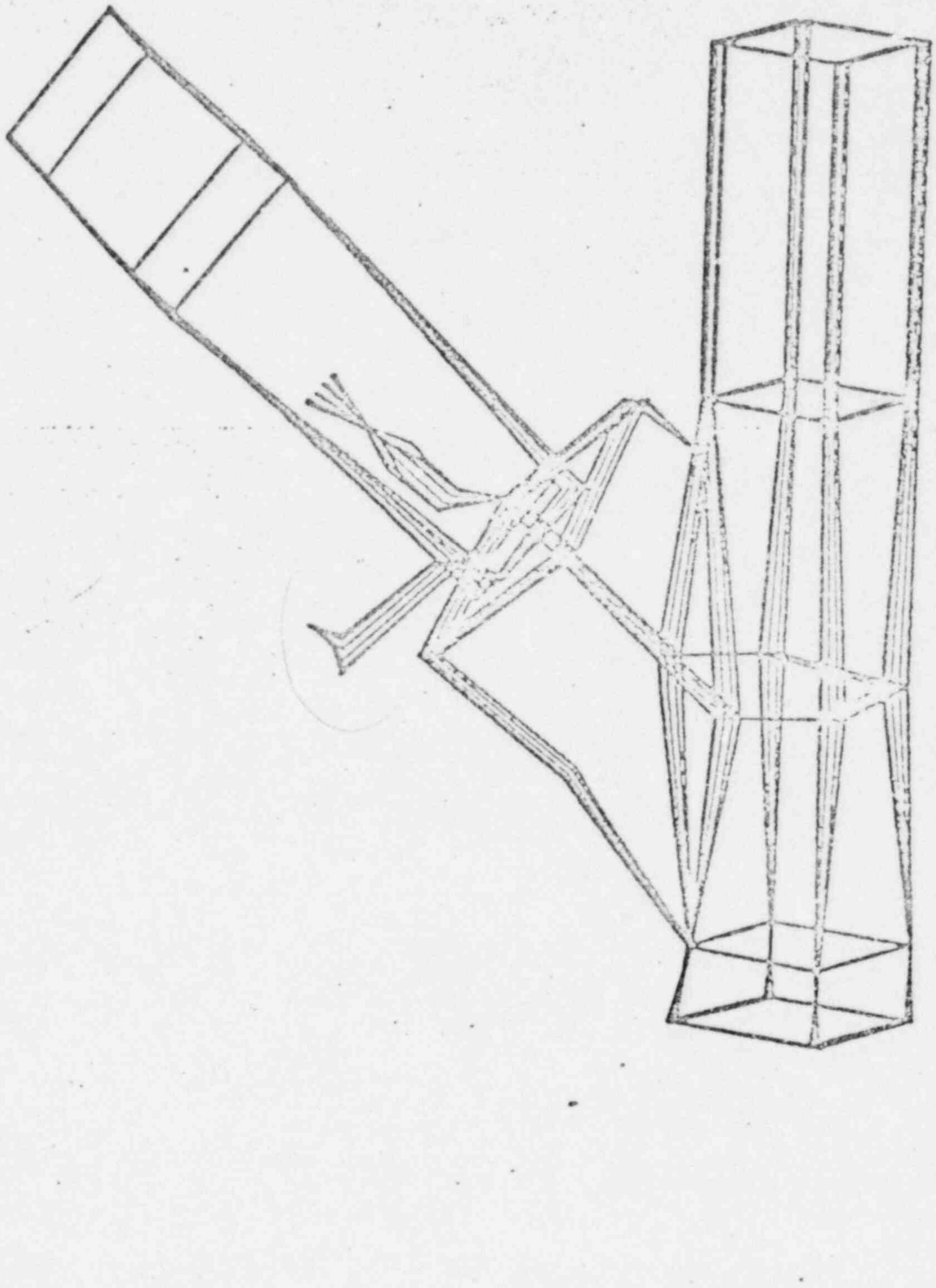

PIPE BENDING MODE AT 86.9 HZ

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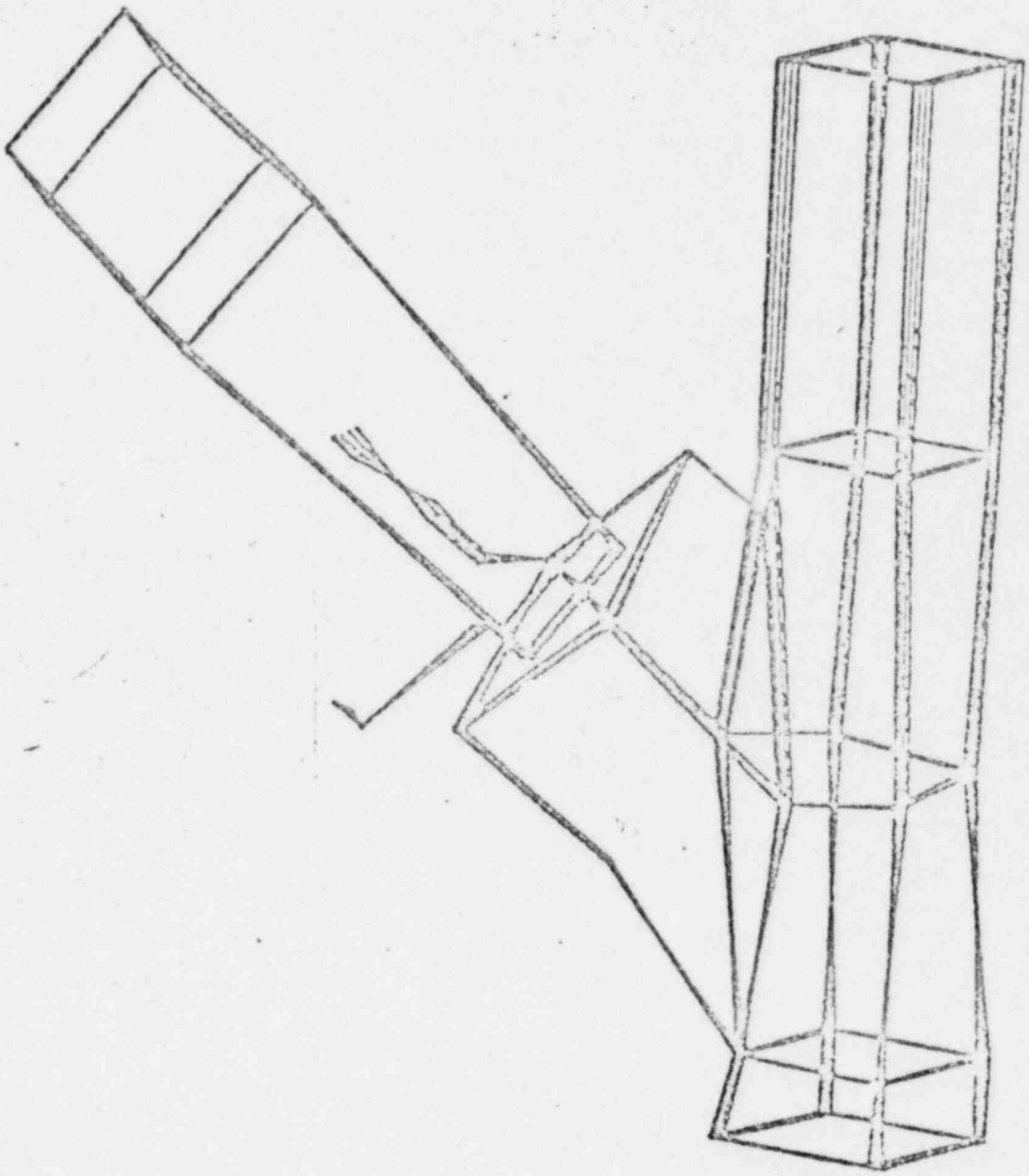

PIPE BENDING MODE AT 93.36 HZ

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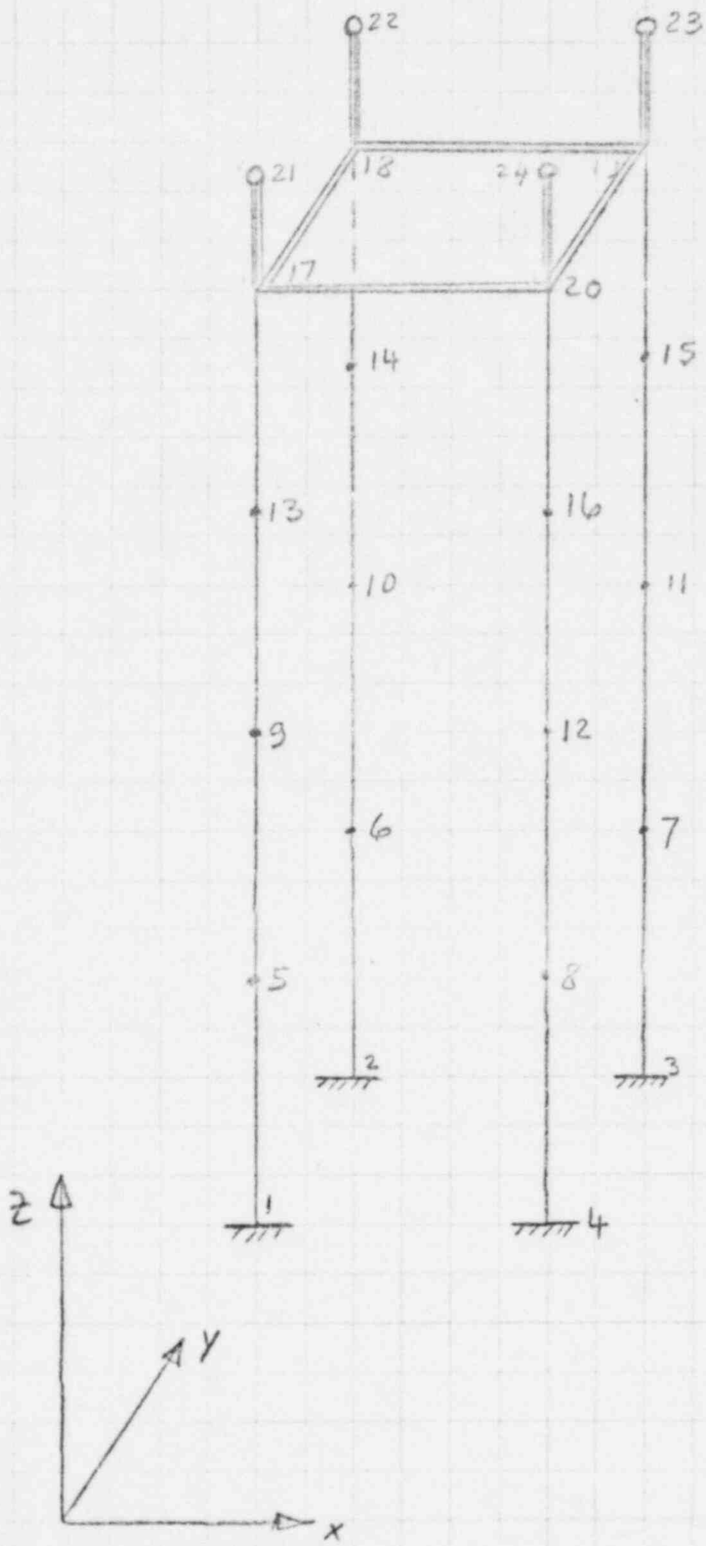
Client	Prepared by	Date
Project	Reviewed by	Date
Proj. No. Equip. No.	Approved by	Date



FINITE ELEMENT MODEL OF UPPER YOKE SECTION.

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ENGINEERS
CHICAGO

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	Rev. 00 Date 06/01/81
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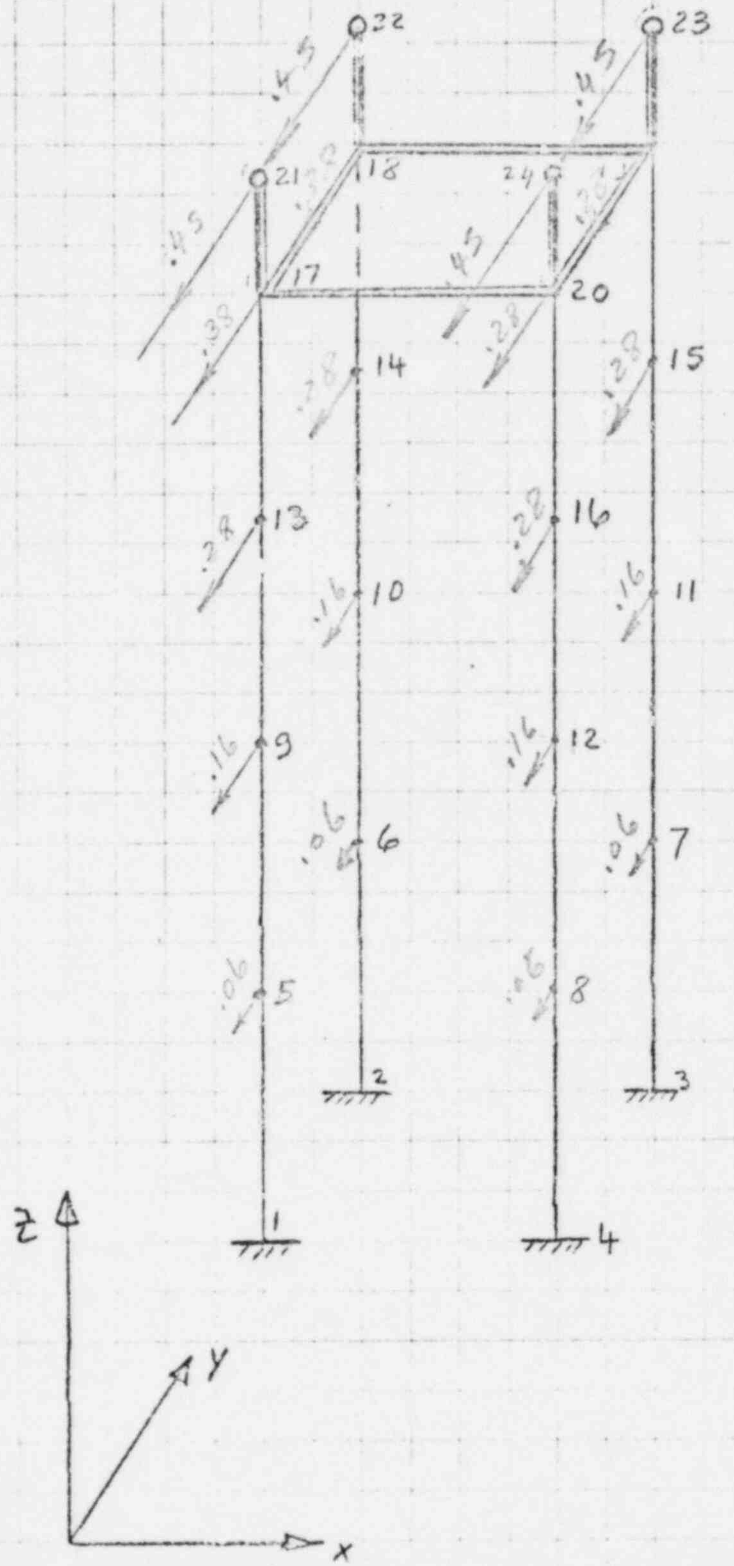
Proj. No. Equip. No.	Approved by	Date



① F_1 = 16.66 Hz

Bending Along Y axis

Form GQ 3.08.1 Rev. 2

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs For		Calc. No. EMD-030469
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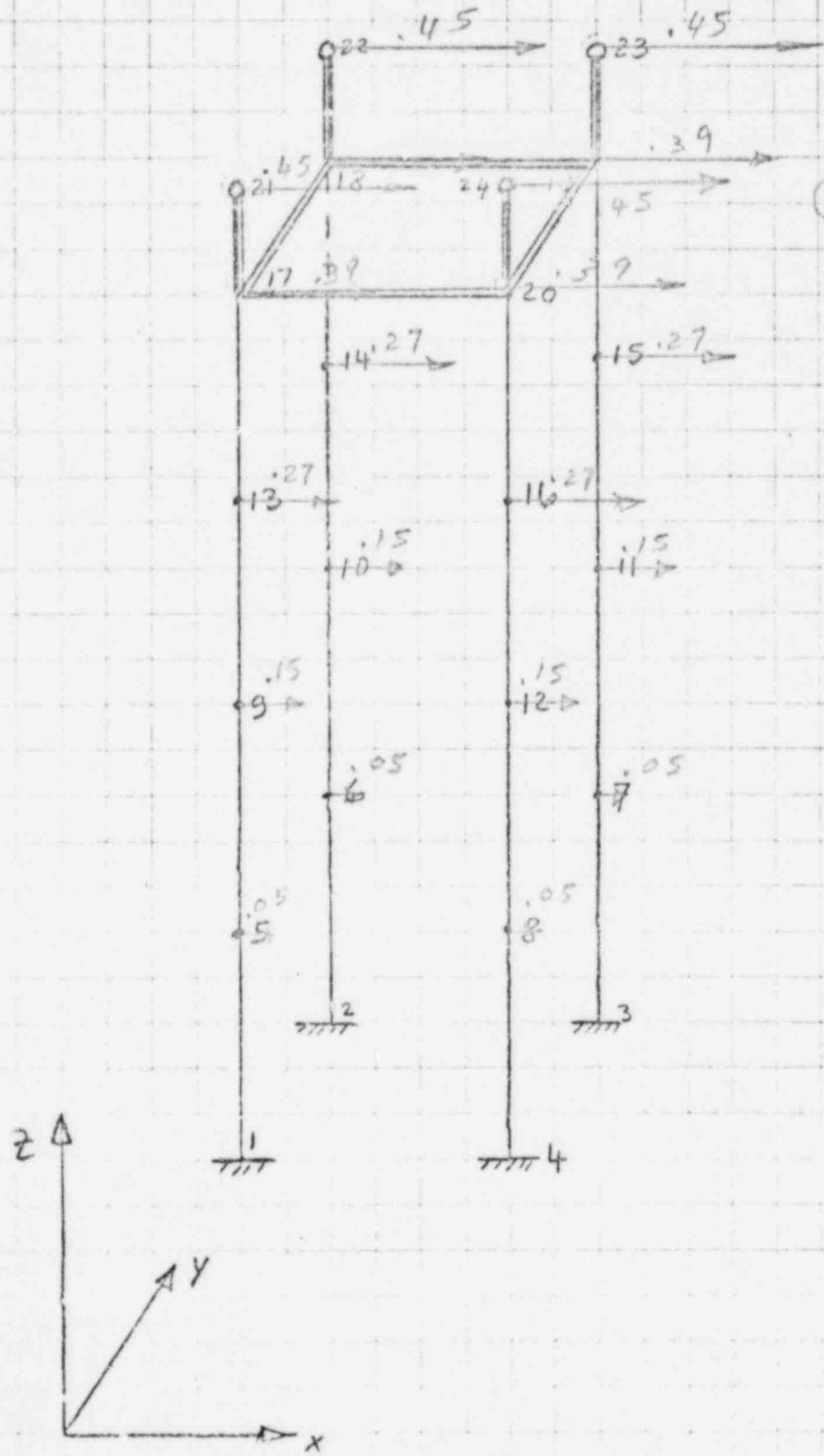
Project		Reviewed by	Date
Proj. No.	Equip. No.	Approved by	Date



(2) $F_2 = 16.74$ Hz

Bending About X axis

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Project	Reviewed by / Date
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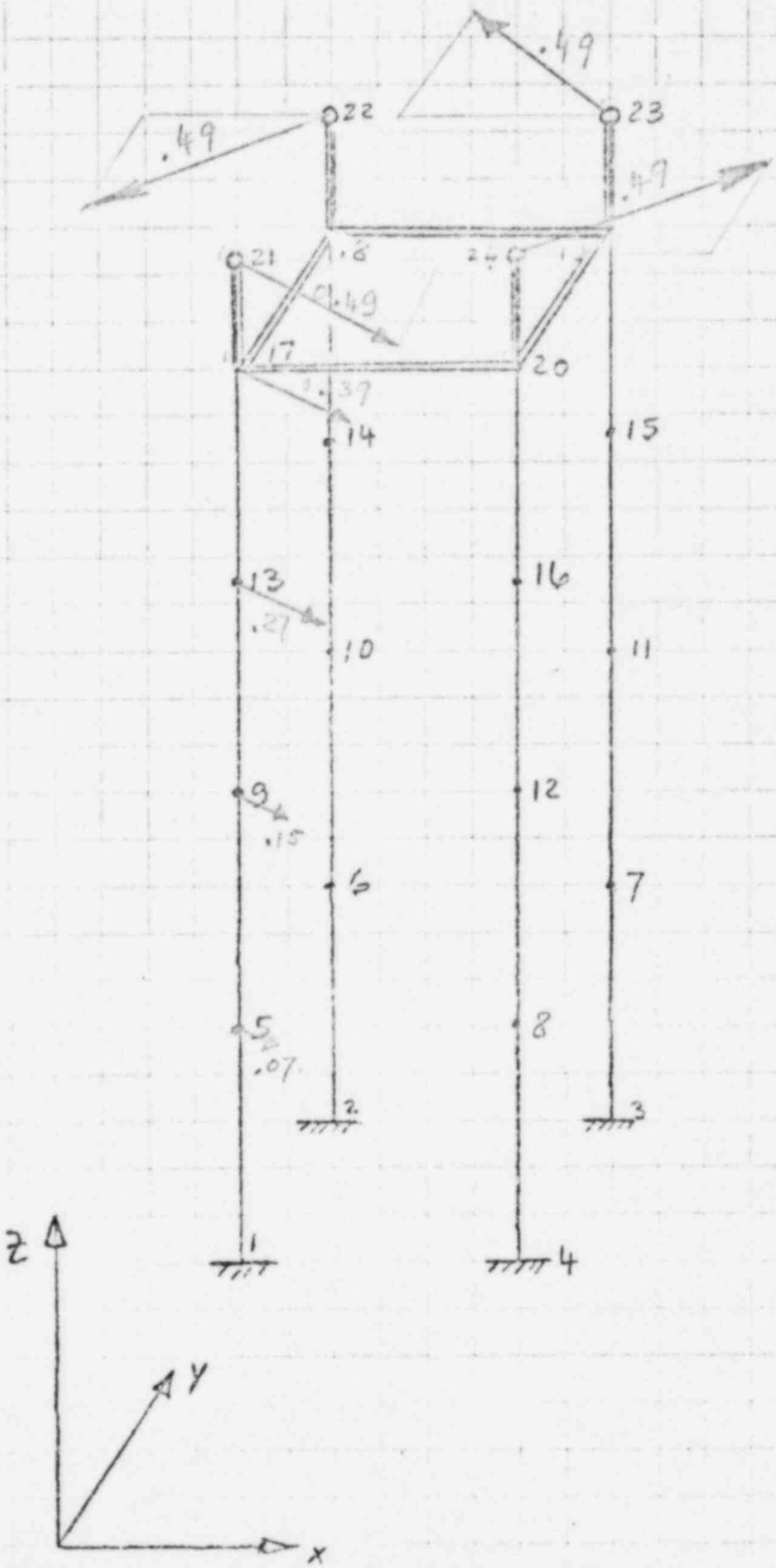

(5) $f_5 = 41.31$ Hz

Torsional Around Z axis

Form GQ 3.08.1 Rev. 2

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CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4385-18
DESIGN BY [illegible] DATE 1/22/80
CHECKED BY [illegible] DATE 1-22-80 SHEET 10 OF 27

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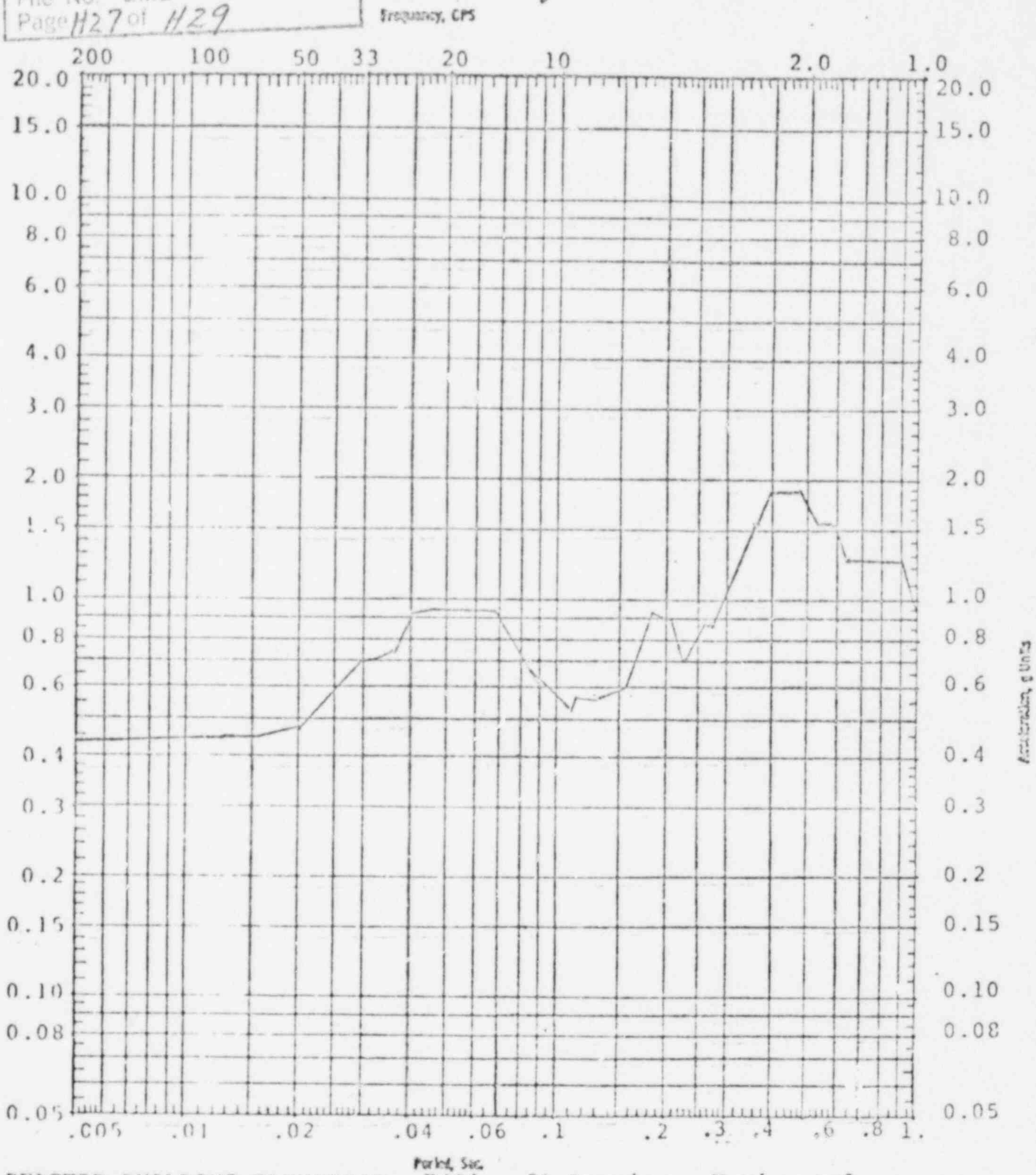

REACTOR BUILDING-ELEVATION: 740' 2% Damping Horizontal

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-00
DESIGN BY [illegible] DATE [illegible]
CHECKED BY [illegible] DATE [illegible] SHEET 12 OF 27

Calc. No. EMD- 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
File No: EMD-
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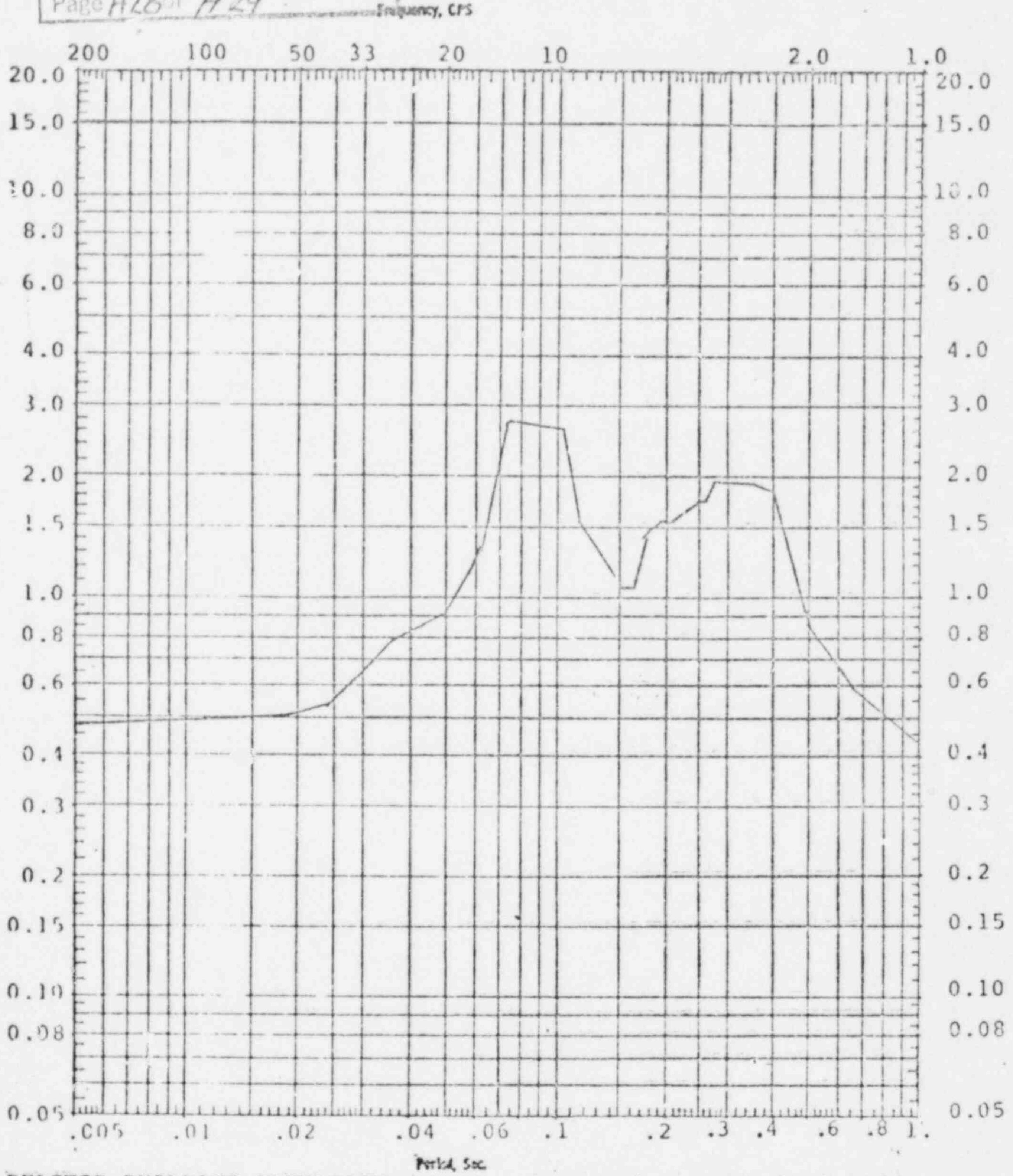

REACTOR BUILDING-ELEVATION: 740' 2% Damping Vertical Wall
Envelop of a) SSE + CO_{LEVY-1}
b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})
c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY
ENGINEERS

PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4389-48
DESIGN BY
DATE
CHECKED BY DATE 1-22-80 SHEET 11 OF 27

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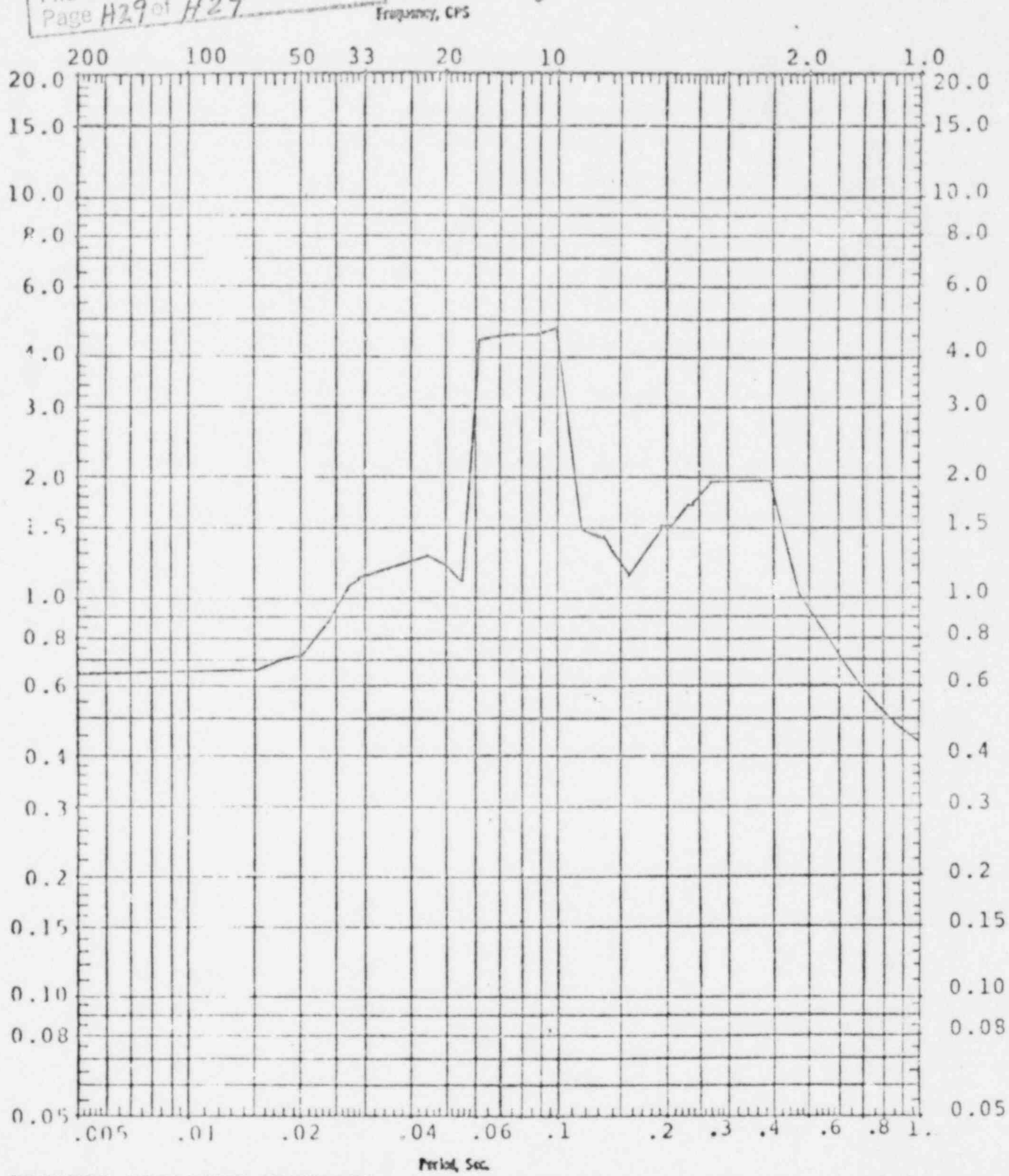

REACTOR BUILDING-ELEVATION: 740' 2% Damping Vertical Slab

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For MSIV BLOWER		Calc. No. EMD-030469	
	Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
			Page J1	of J23

Client Commonwealth Edison Company	Prepared by I. Elgindy — Date
Project LaSalle County, Units I & II	Reviewed by — Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by — Date

ASSESSMENT OF VIBRATION CHARACTERISTICS AND OF SEISMIC QUALIFICATION

I. OBJECTIVE

To assess the analytical and experimental vibration characteristics of above equipment and to determine adequacy of equipment under the additional hydraudynamic loadings, particularly in regard with the high resonants determined by impedance test.

II. INTRODUCTION

In conducting this assessment, one must recognize the practical limitations of available analytical and experimental techniques. For example, the finite element method is limited when representing a structure by number of nodes, number of elements, nodal masses, nodal stiffnesses, idealized boundary conditions and by the type of functional relations between the nodes.

On the other hand, experimental techniques such as impedance testing is also limited by the number of locations utilized in applying vibration inputs and in measuring vibration response. Other limitations include inaccessability to certain areas, coherence of signals, cross coupling between natural modes of equipment and cross coupling with other natural modes of attached structures.

Therefore, assessment of the results obtained by both methods,

has to consider these listed limitations and consequently has to be based on engineering judgement of obtained results.

III. SUMMARY OF IMPEDANCE TEST RESULTS

The MSIV blower is represented by the wire diagram shown in page J6 This unit was teste by both Electromagnetic shaker and hammer testing to demonstrate the equivalence of the two test procedures. The results of the impedance test are eight natural modes as listed below:

Natural Frequency Hz	Description
11.7	Torsional Mode around z* axis
17.5	Bending mode along y* direction
22.65**	Reported but not confirmed
39.75	Bending along x* direction
42.5	Springing mode on the thrust bearing
84.55	Pitching mode (I beam as simply supported)
92.5	Rocking mode as a result of motor shaft bending
97.	Pitching mode, tail plate is restraint

* Directions referenced here are these used in dynamic run.

** This mode was reported to be in doubt by Transitek and evidence of its existence could not be substantiated.

IV. SUMMARY OF ANALYTICAL RESULTS

The blower assembly is represented by finite element model shown in page in which the blower is represented by its mass concentrated at its c.g. (node 9). The results are listed below, and mode shapes of the first three modes are shown in pages , through

Natural frequency	Description
7.5	Torsional mode around z* axis
17.1	Combined bending along y* axis and torsion around $z_1 - z_1$ axis
49.39	Bending mode along x* direction
151.1	Bending mode along y*, support beam as simply supported, tail plate is not restraint

* Axes referenced here are those utilized in finite element analysis.

V. FREQUENCIES IN AGREEMENT IN Hz.

Analysis	Impedance Test
7.5	11.7
17.1	17.5
47.4	39.8

These three modes represent the fundamental modes of vibration which are needed to compute the dynamic stresses of the equipment structure.

VI. FREQUENCIES DETERMINED BY IMPEDANCE TEST WHICH ARE NOT DETERMINED IN THE ANALYSIS

Five frequencies fall in this category, the first is 22.66 Hz. analysis of obtained transfer functions indicate that this frequency is not of one of the natural modes and therefore it is excluded. The second and third are 42.5 Hz and 92.5 Hz. These two modes are local modes of the blower unit and they do not contribute any vibration to the structure supporting the blower. Furthermore, the analysis could not determine such local modes because the finite element model recognizes the blower unit as a concentrated mass located at its c.g. It is therefore concluded that the exclusion of these two local modes from the final qualification report does not affect the adequacy of the qualification. The last two resonants which fall in this category are 84.55 Hz and 97.0 Hz. These two modes are above the ZPA level and will not contribute additional stresses to the blower structure. It is therefore concluded that all five natural frequencies which fall in this category shall not have any effect on the adequacy of the final qualification report.

VII. CONCLUSIONS

Based on the fact that the analysis considered the additional hydraudynamic loads, and based on above assessment of analytical and experimental vibration characteristics, it is concluded that

the analytical result has been verified by the impedance test and that the qualification of above equipment is based on sound and verifiable technique.

VIII. REFERENCES

1) Seismic Qualification Report of MSIV Blower #E32-C001/2, EMD- dated Rev. 0.

2) Impedance Test Report for MSIV Blower #E32-C001/2, EMD-029469 dated 3/17/81.

3) Final Test Report SQET in plant impedance testing, La Salle Co. 1, Transitek, Inc. Job. No. 80042, EMD-029601-00.

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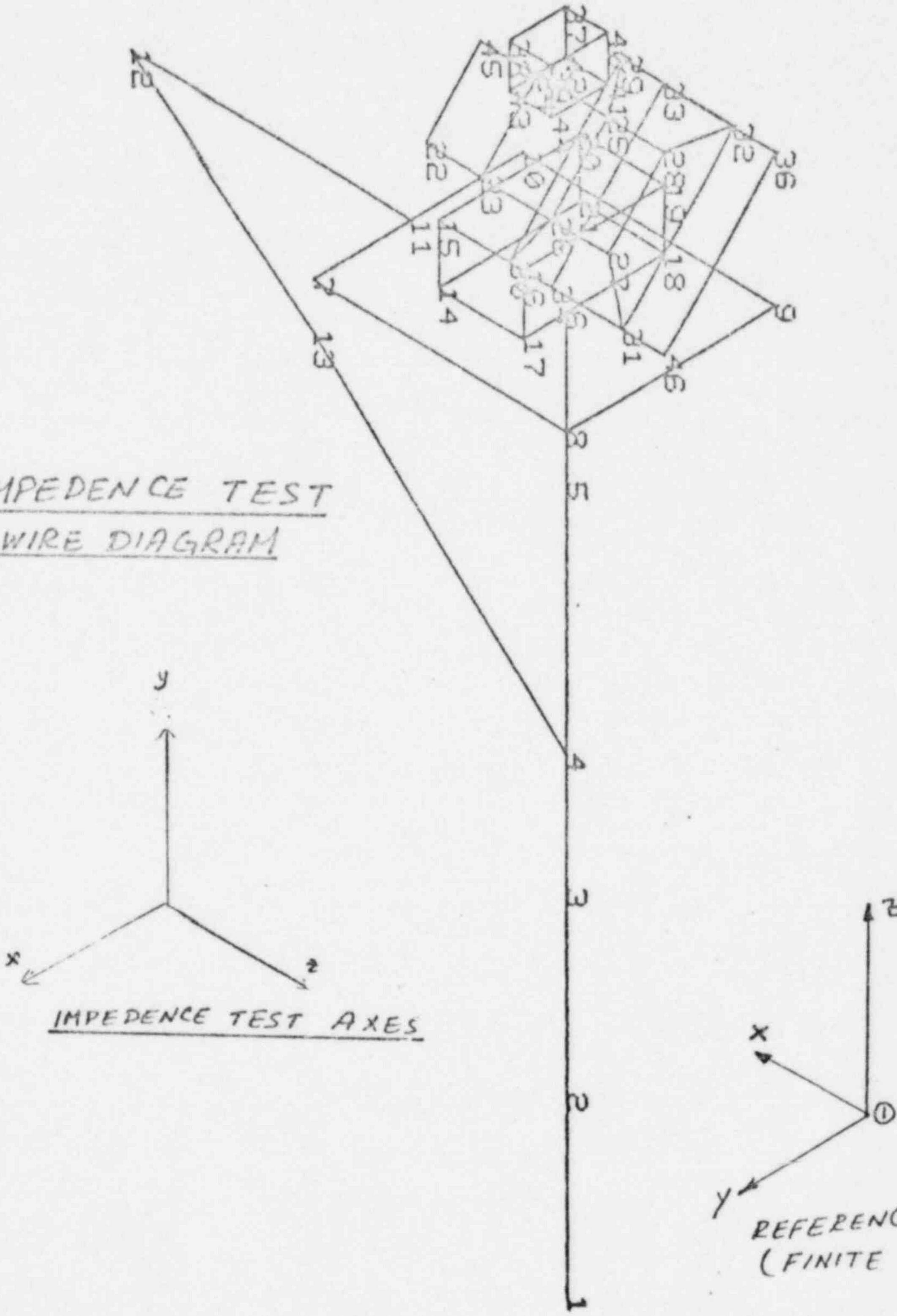
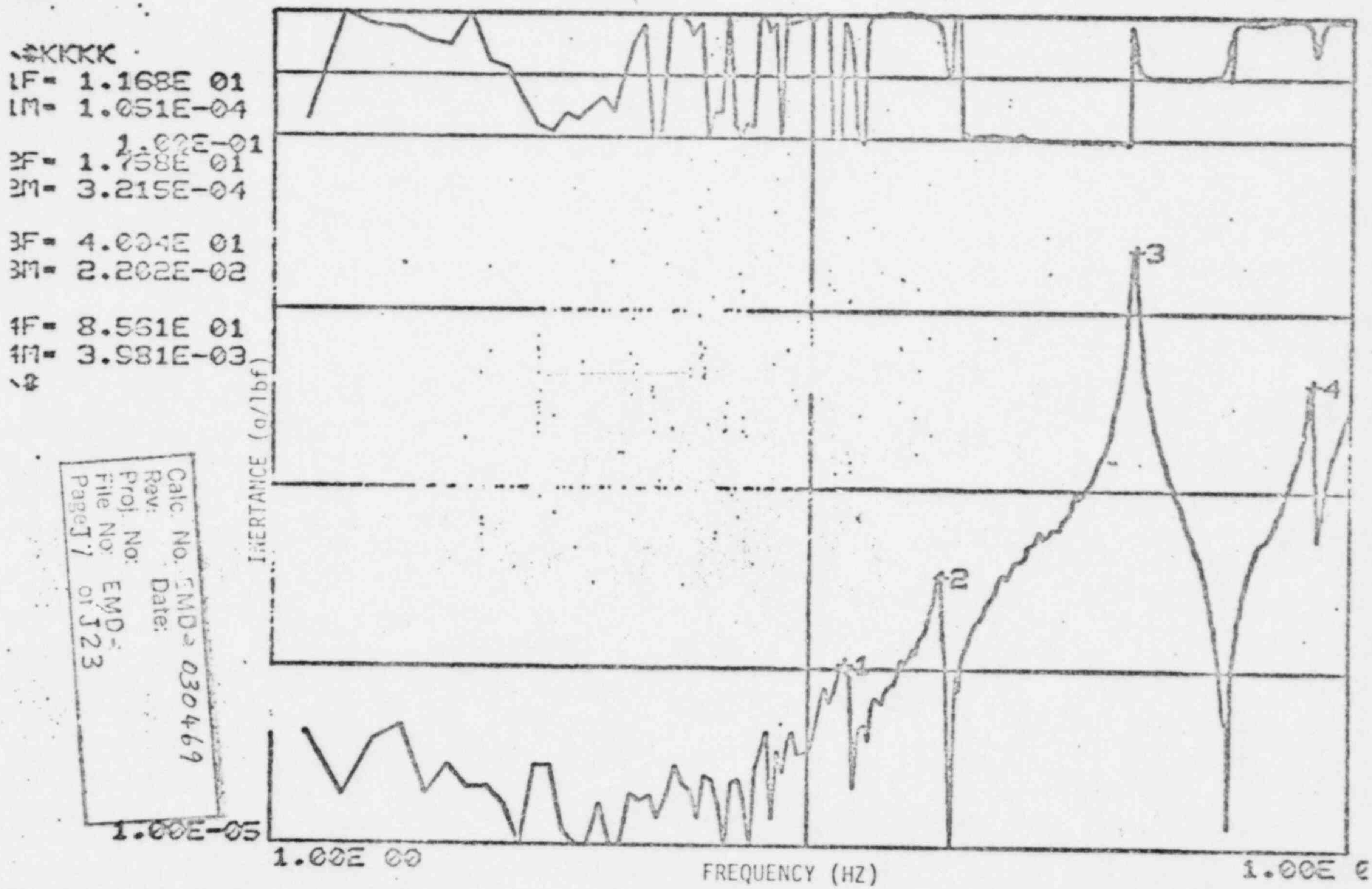


IMPEDENCE TEST
WIRE DIAGRAM

IMPEDENCE TEST AXES

REFERENCE AXES
(FINITE ELEMENT)



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File No: EMD-
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A1:LA SALLE MSIV BLOWERS

FREQRESP-BODE
4X+ 4X+
000072-000000
101680-000000

FIGURE 4.14.3

DRIVING POINT TRANSFER FUNCTION IN THE X DIRECTION

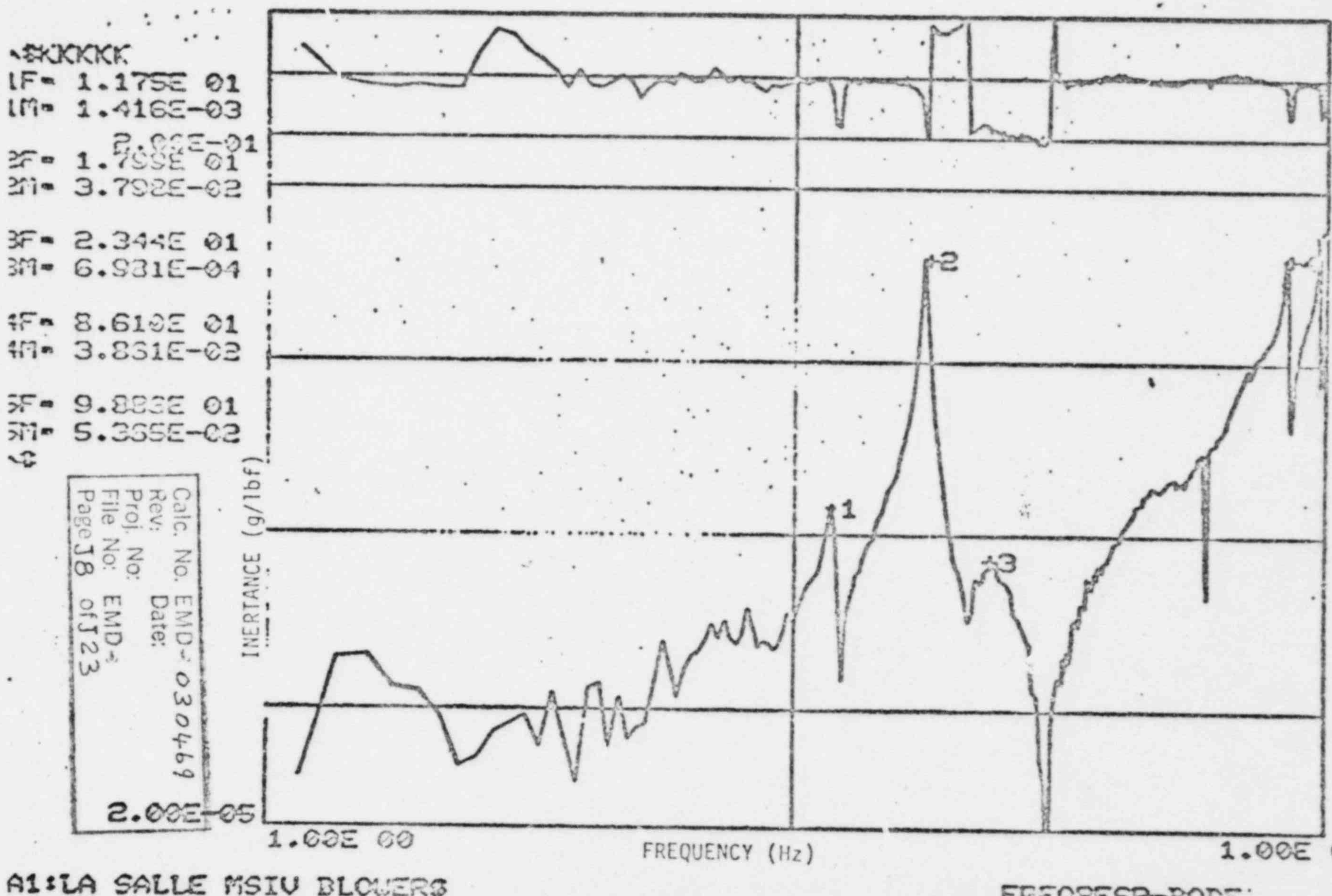

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FIGURE 4.14.4

DRIVING POINT IMPEDANCE FUNCTION IN THE Z DIRECTION

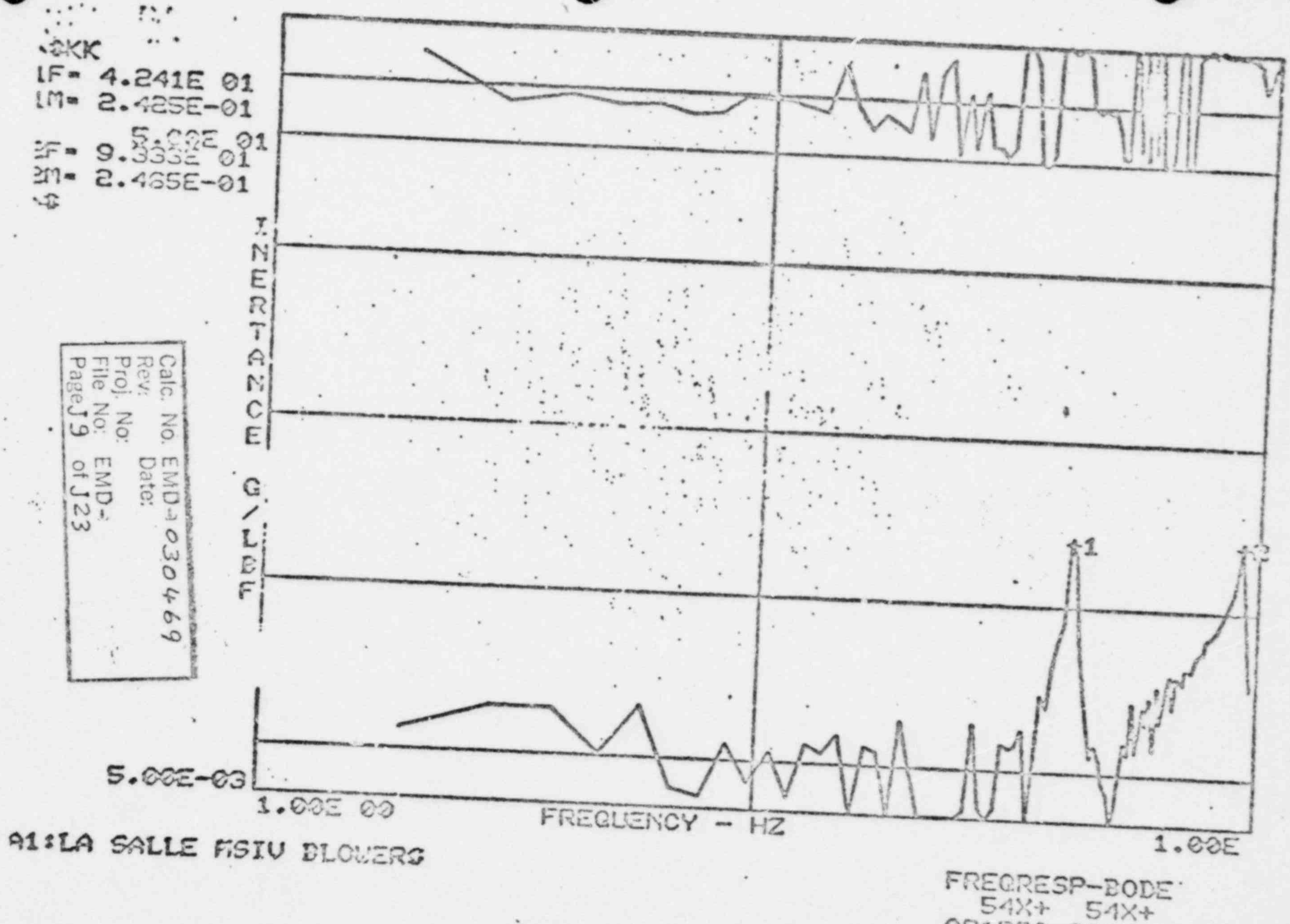

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FIGURE 4.14.5

DRIVING POINT IMPEDANCE FUNCTIONS ON THE MSIV BLOWER PLATE

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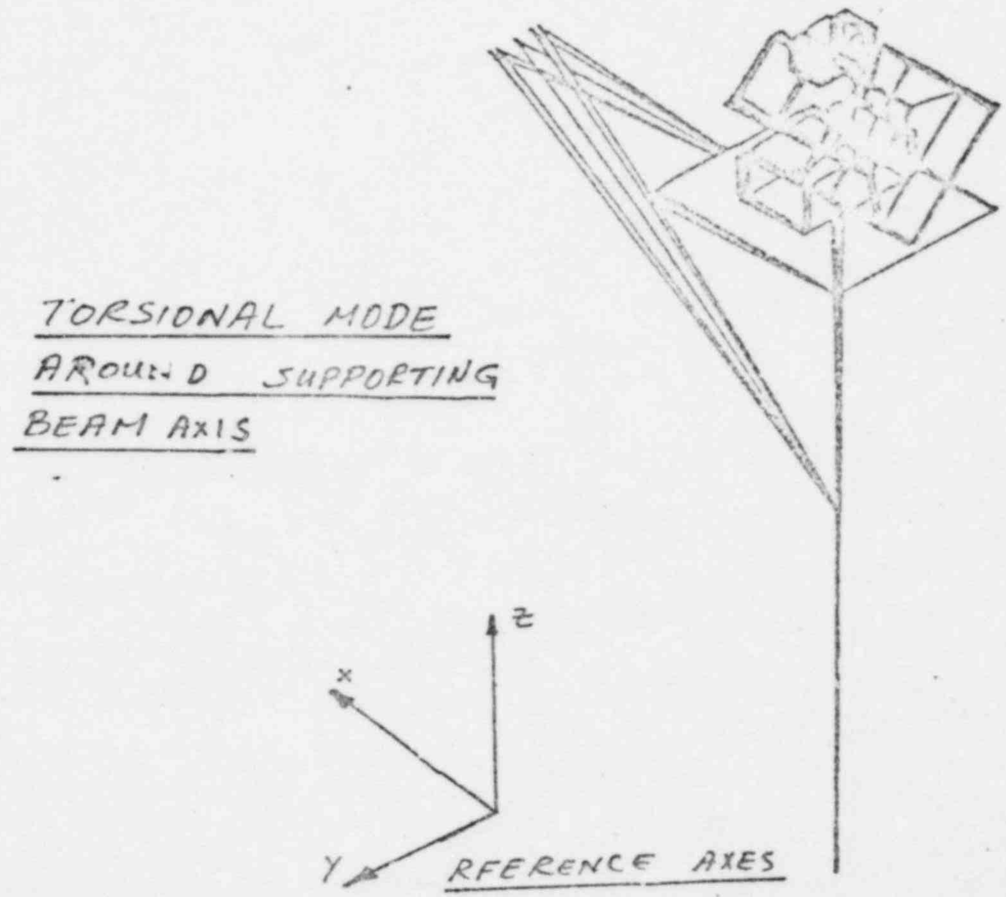

1: 4Z+ COMP,F= 11.730 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

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File No: EMD-
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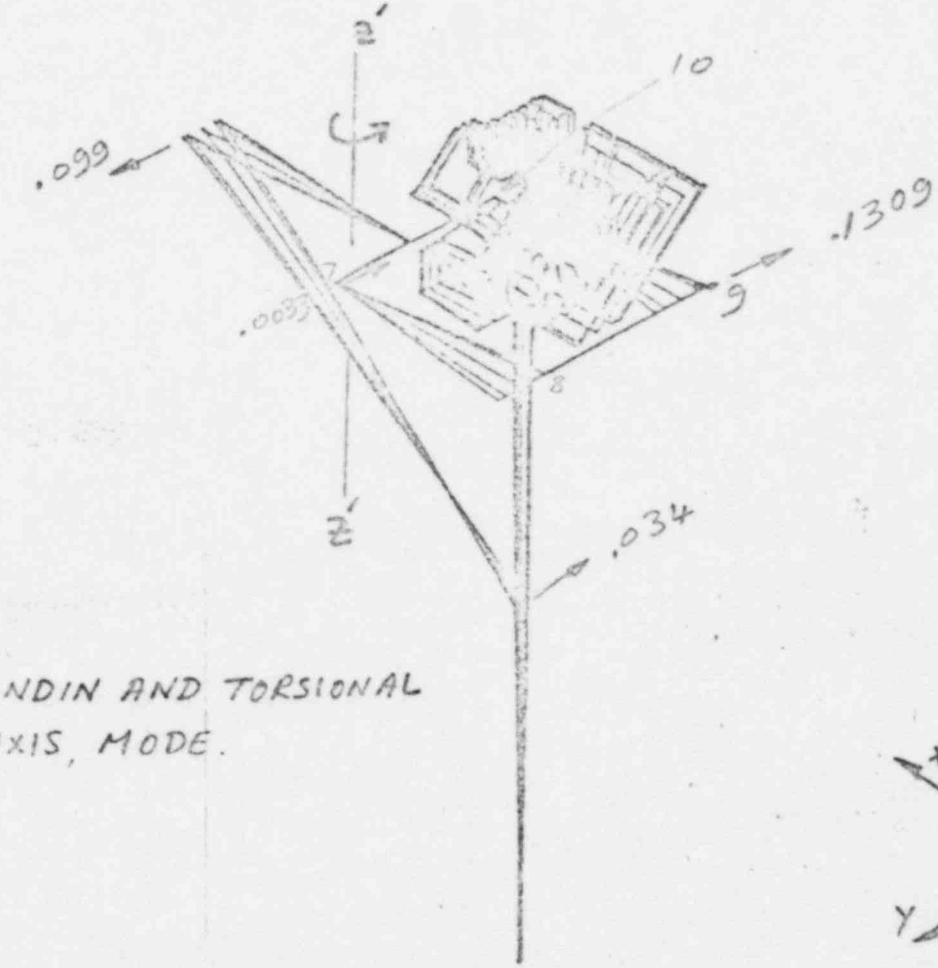
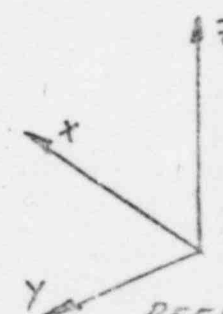


COMBINED BENDIN AND TORSIONAL
ABOUT z'-z' AXIS, MODE.



REFERENCE
AXES

2: 4Z+ COMP, F= 17.540 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No. EMD-030469
Rev: Date:
Proj. No:
File No: EMD-
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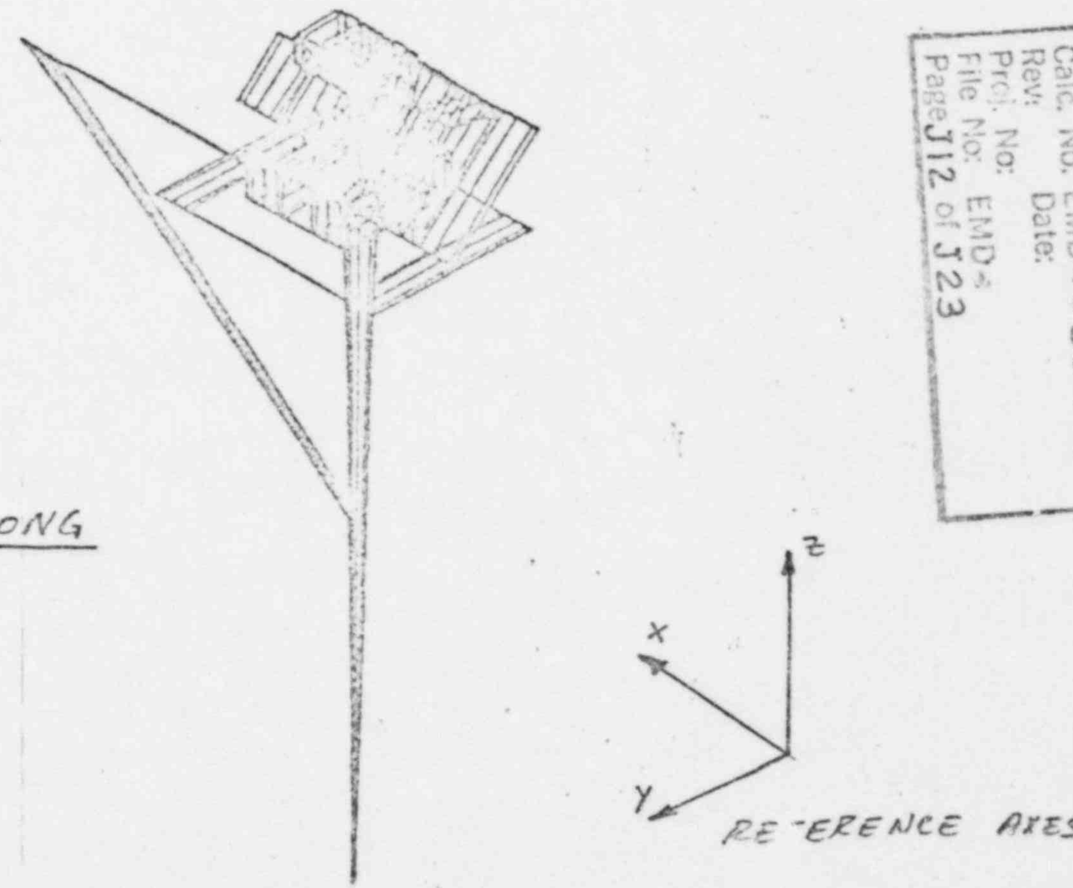
BENDING MODE ALONG
X AXIS



8: 4X+ COMP,F= 39.750 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No. EMD- 030469
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Proj. No:
File No: EMD-
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LOCAL MODE

SUPPORTING STRUCTURE IS STATIONARY

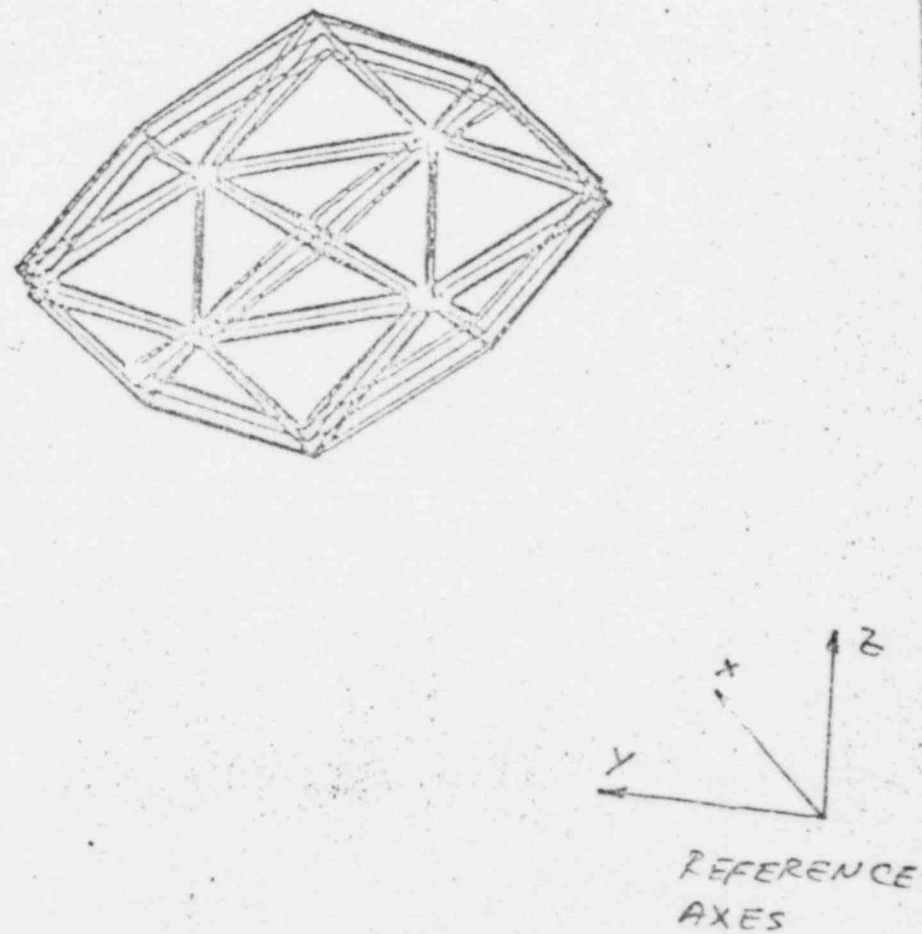

FIGURE 4.14.12

SPRINGING MODE ON THE THRUST BEARING - 42.5 HZ

Calc. No. EMD-4 030469
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File No: EMD-4
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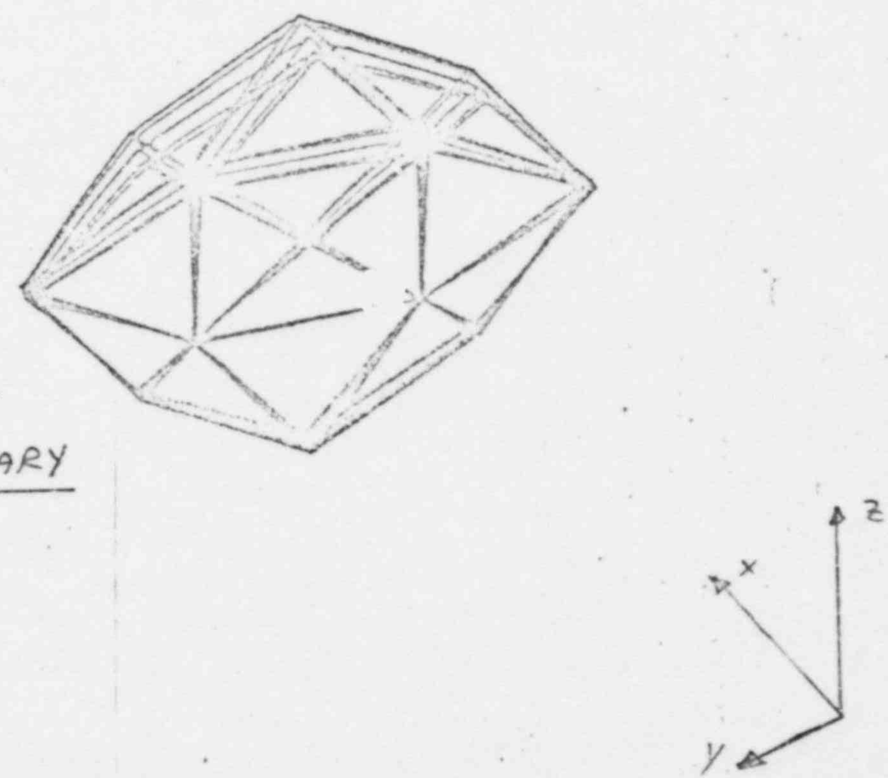
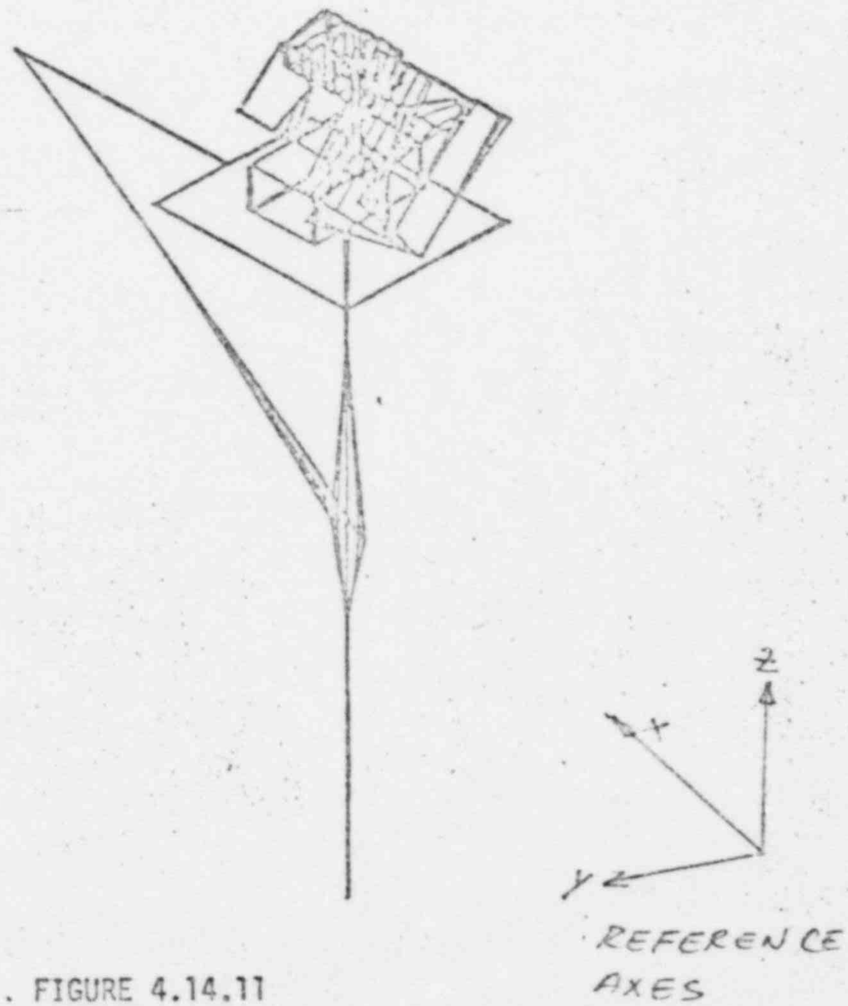
LOCAL MODE DUE
TO SHAFT BENDING

STRUCTURE IS STATIONARY



REFERENCE
AXES

11: 54X+ COMP,F= 92.500 HZ (1.0, 1.0, 0.3, 0.0)=VIEW



. FIGURE 4.14.11

PITCHING MODE AT 84.8 HZ

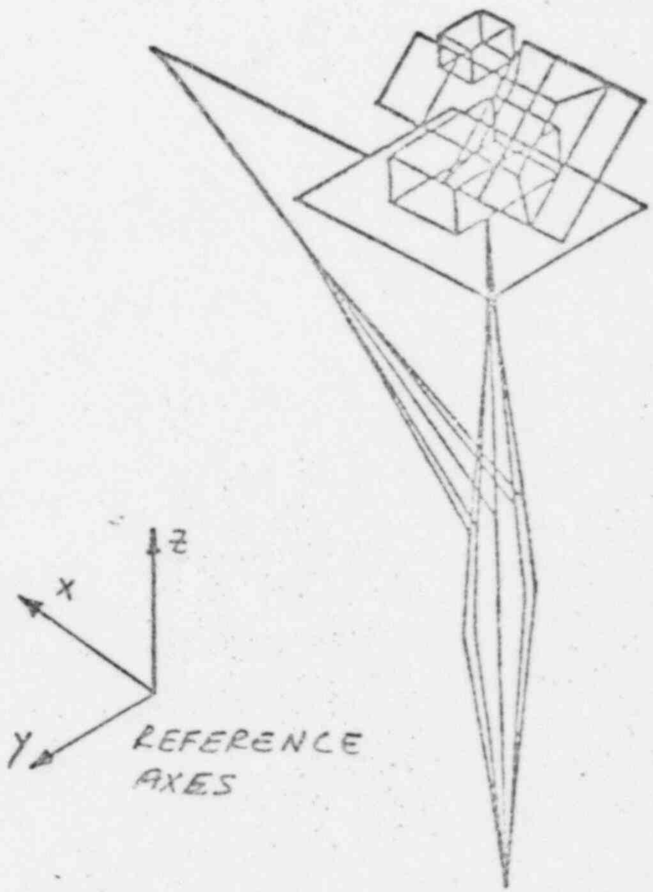


FIGURE 4.14.9

SUPPORT BEAM BENDING WITH TAIL PIECE ACTING IN RESTRAINT - 97 HZ

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File No: EMD-a
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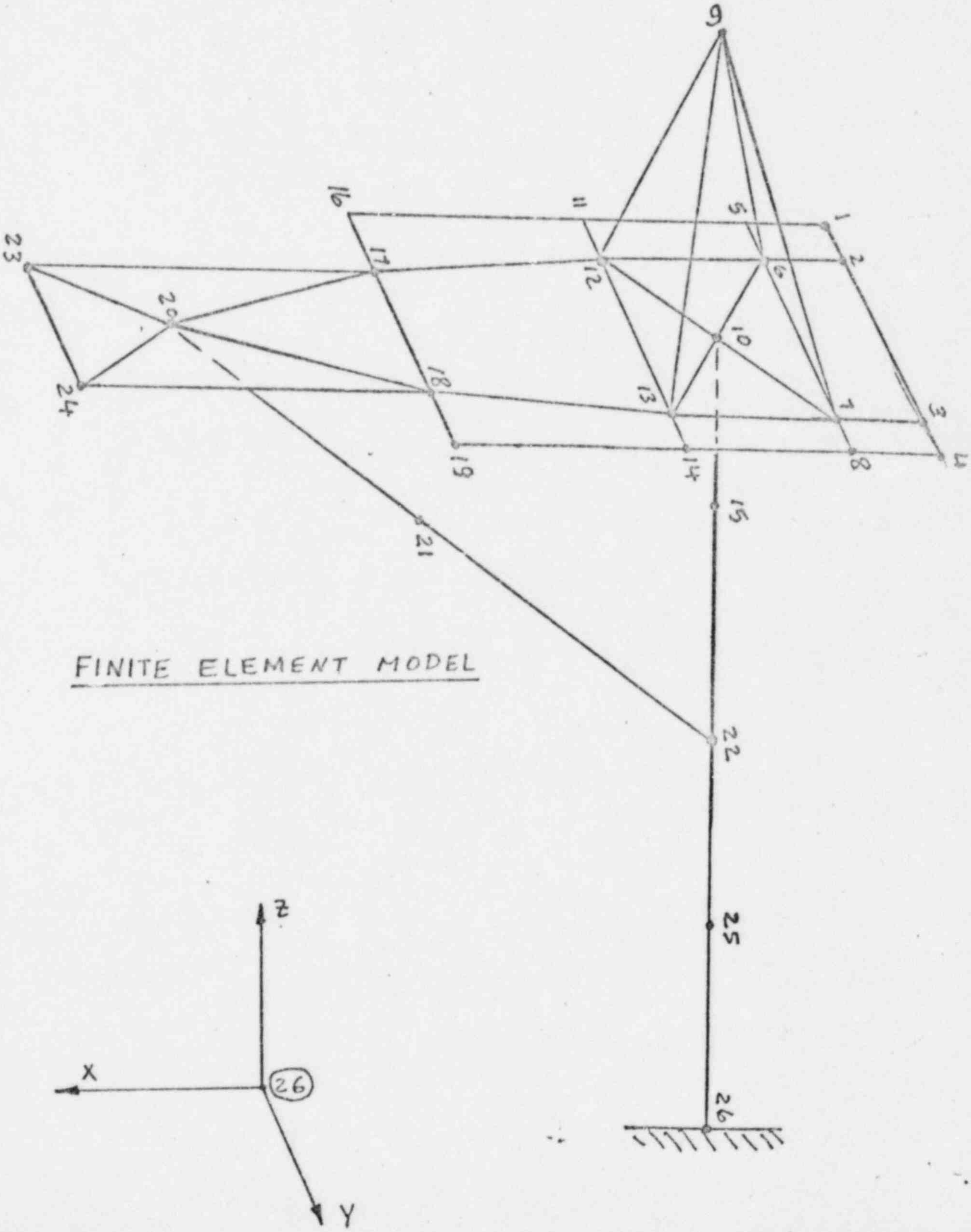

FINITE ELEMENT MODEL

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File No: EMD-
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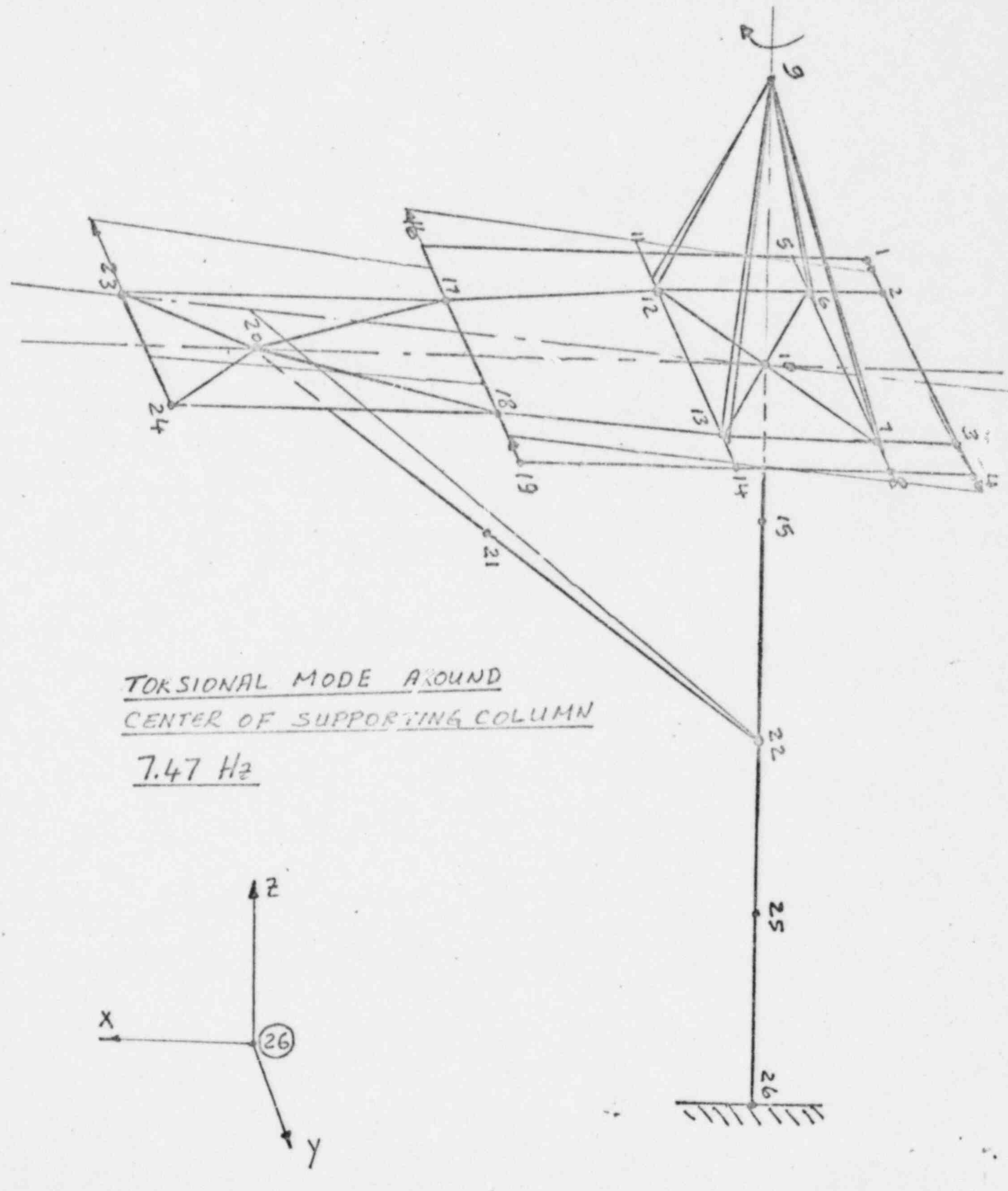

TORSIONAL MODE AROUND CENTER OF SUPPORTING COLUMN

7.47 Hz

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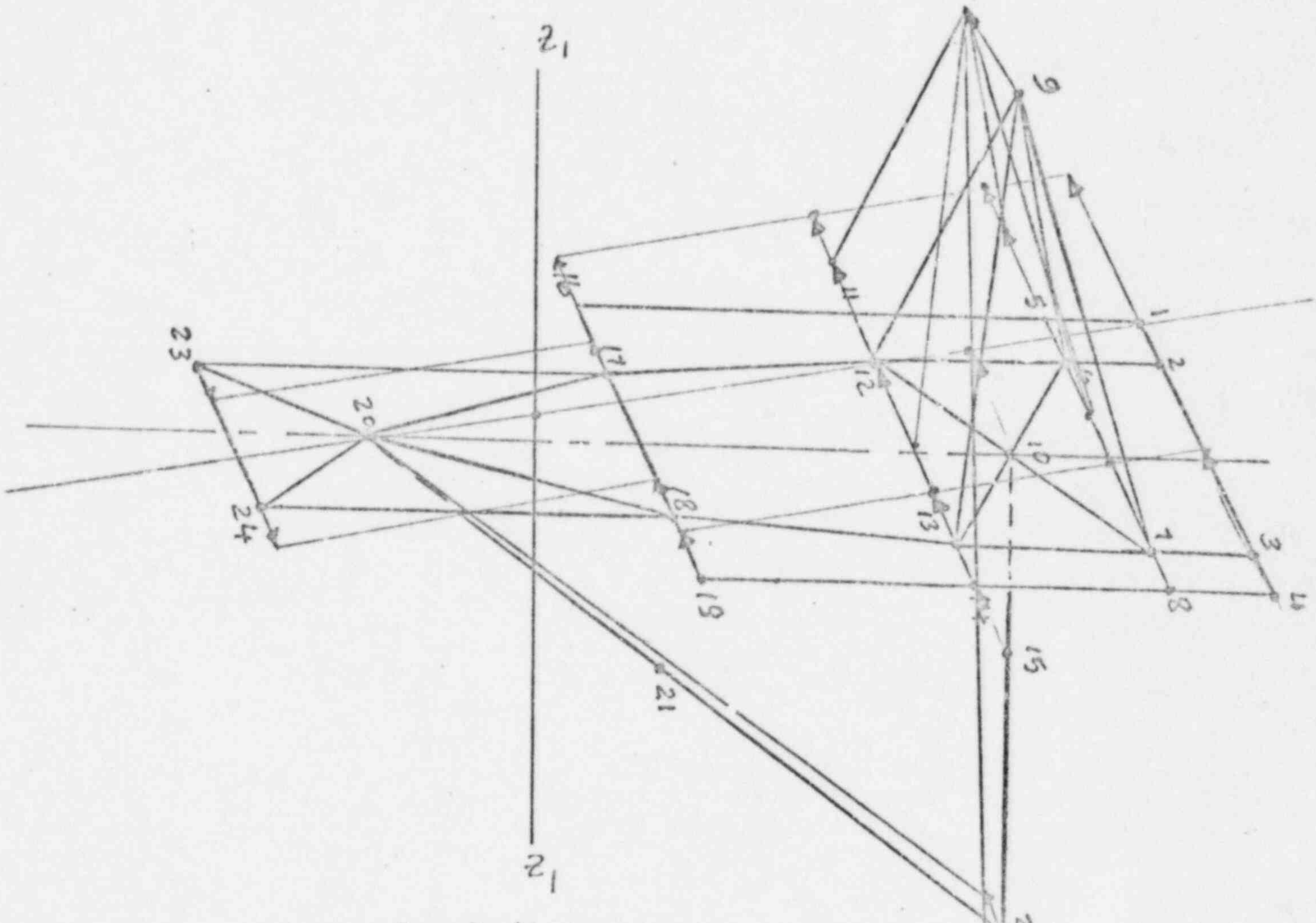
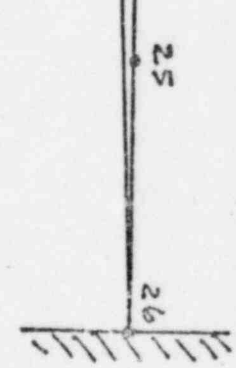
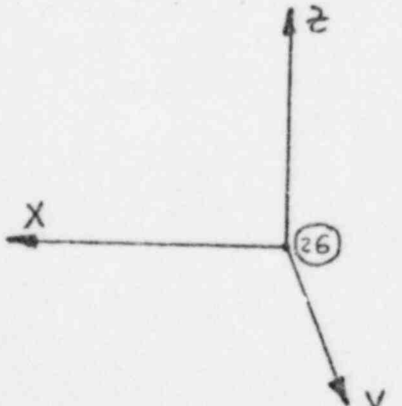


COMBINED BENDING AND TORSIONAL AROUND Z_1-Z_1 AXIS MODE

17.10 Hz





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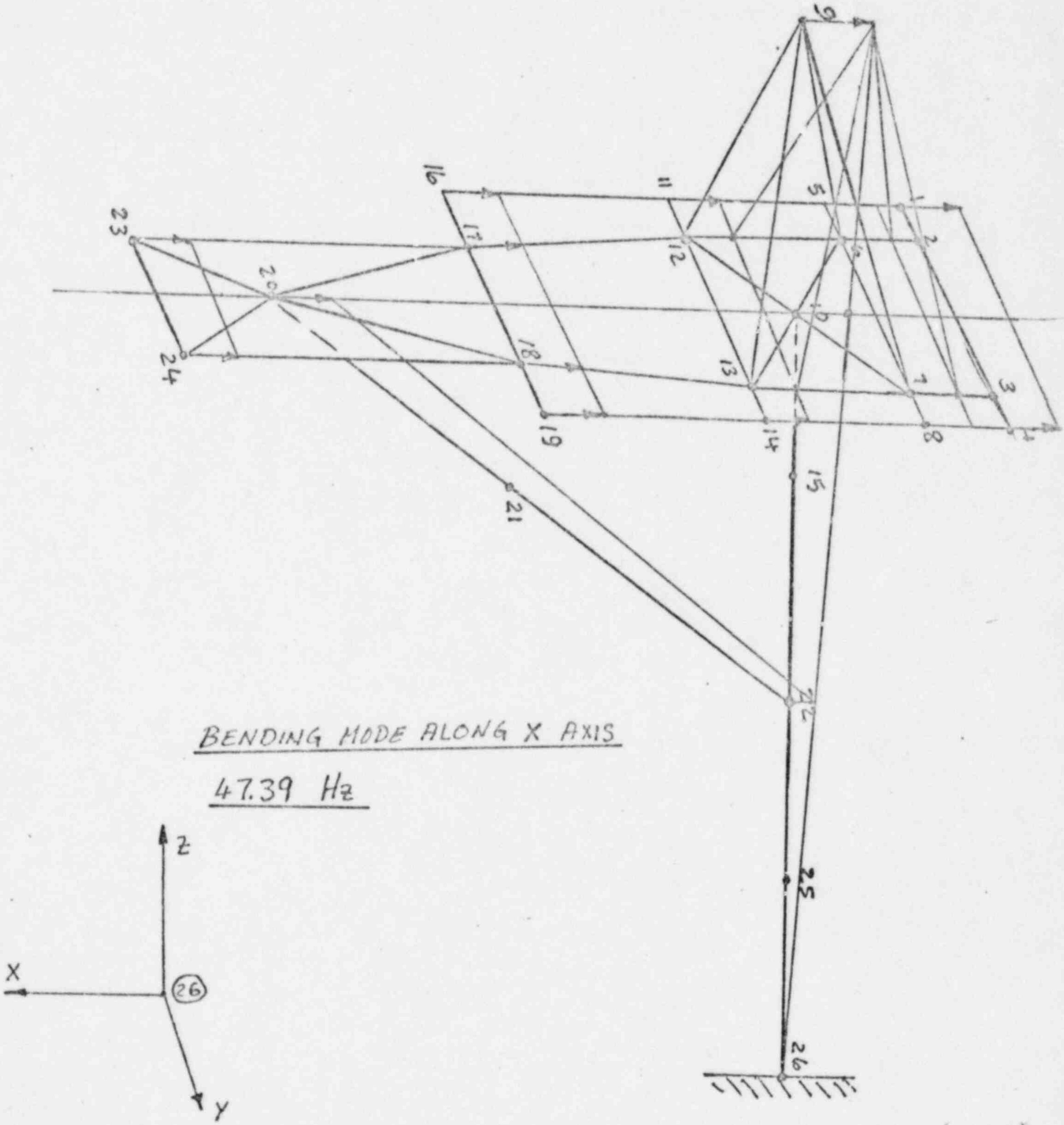

BENDING MODE ALONG X AXIS

47.39 Hz

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 5489-18
DESIGN BY S.Vaiga DATE 1/22/80
CHECKED BY [illegible] DATE [illegible] SHEET 1 OF 27

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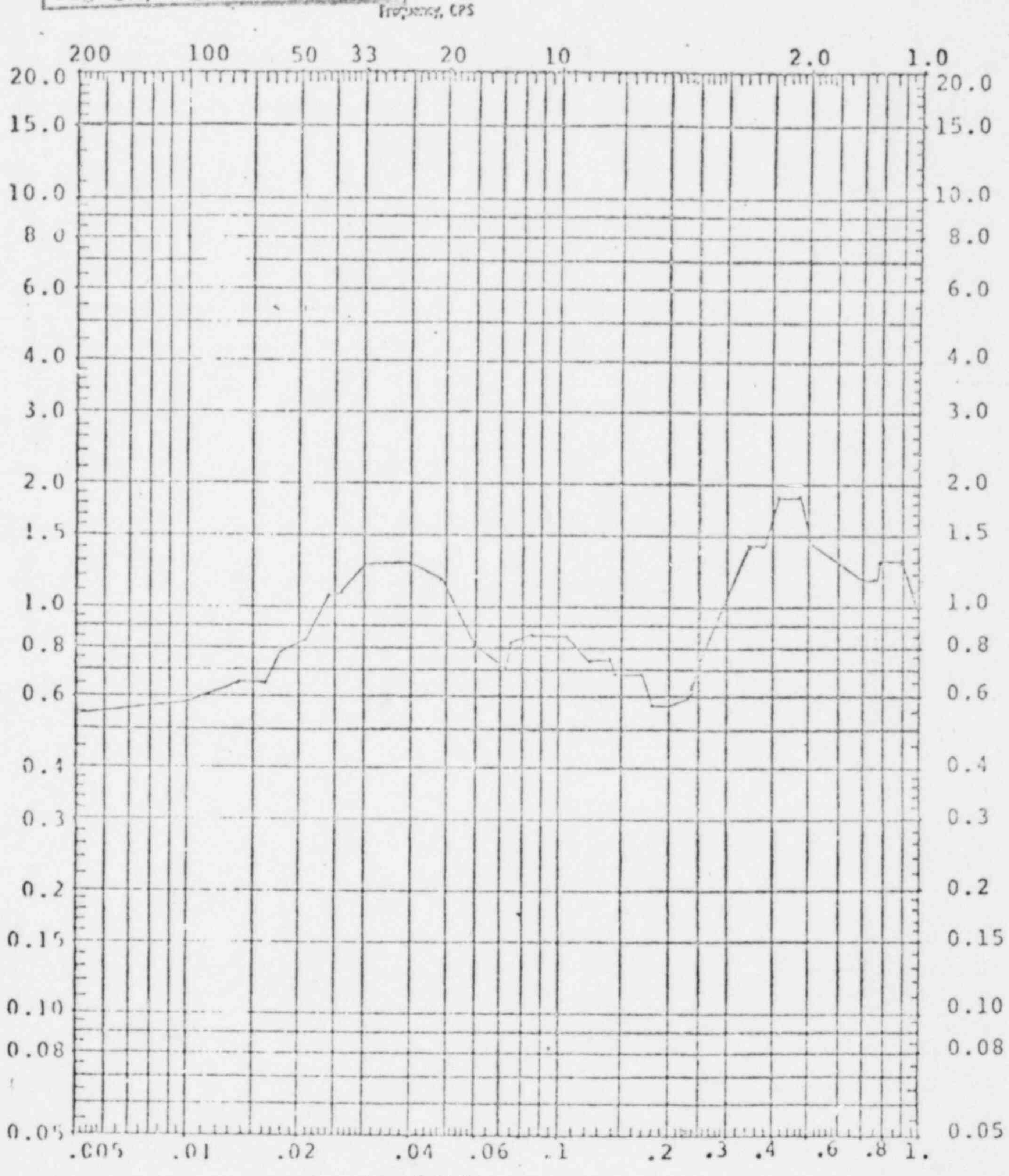
DATE	1-22-80						
INITIALS	GS						



REACTOR BUILDING-ELEVATION: 673'4" 2% Damping Horizontal Slab NS-EW

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-48 4267-48
DESIGN BY S. Jones DATE 1/22/80
CHECKED BY [illegible] DATE 1-22-80 SHEET 3 OF 27

Calc. No. EMD- 030469
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File No: EMD-
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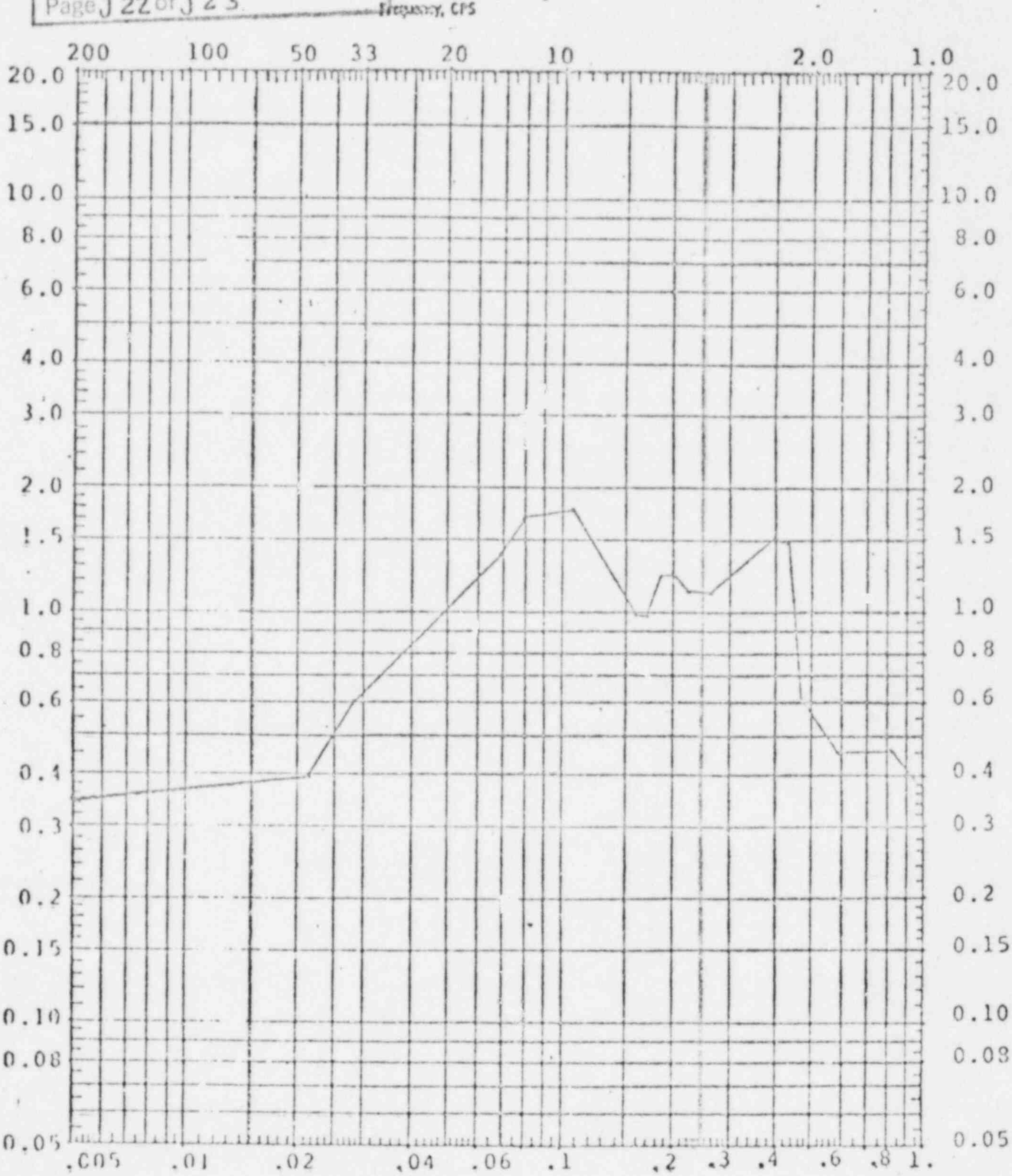
DATE	1-22-80							
INITIALS	JS							



REACTOR BUILDING-ELEVATION: 673'4" 2% Damping Vertical Wall
Envelop of a) SSE + CO_{LEVY-1}
b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})
c) SSE + CHUG + Envelop of (SRV + SRV)

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. [illegible]
DESIGN BY [illegible] DATE 1/29/80
CHECKED BY [illegible] DATE 1-22-80 SHEET 2 OF 27

Calc. No. EMD- 030469
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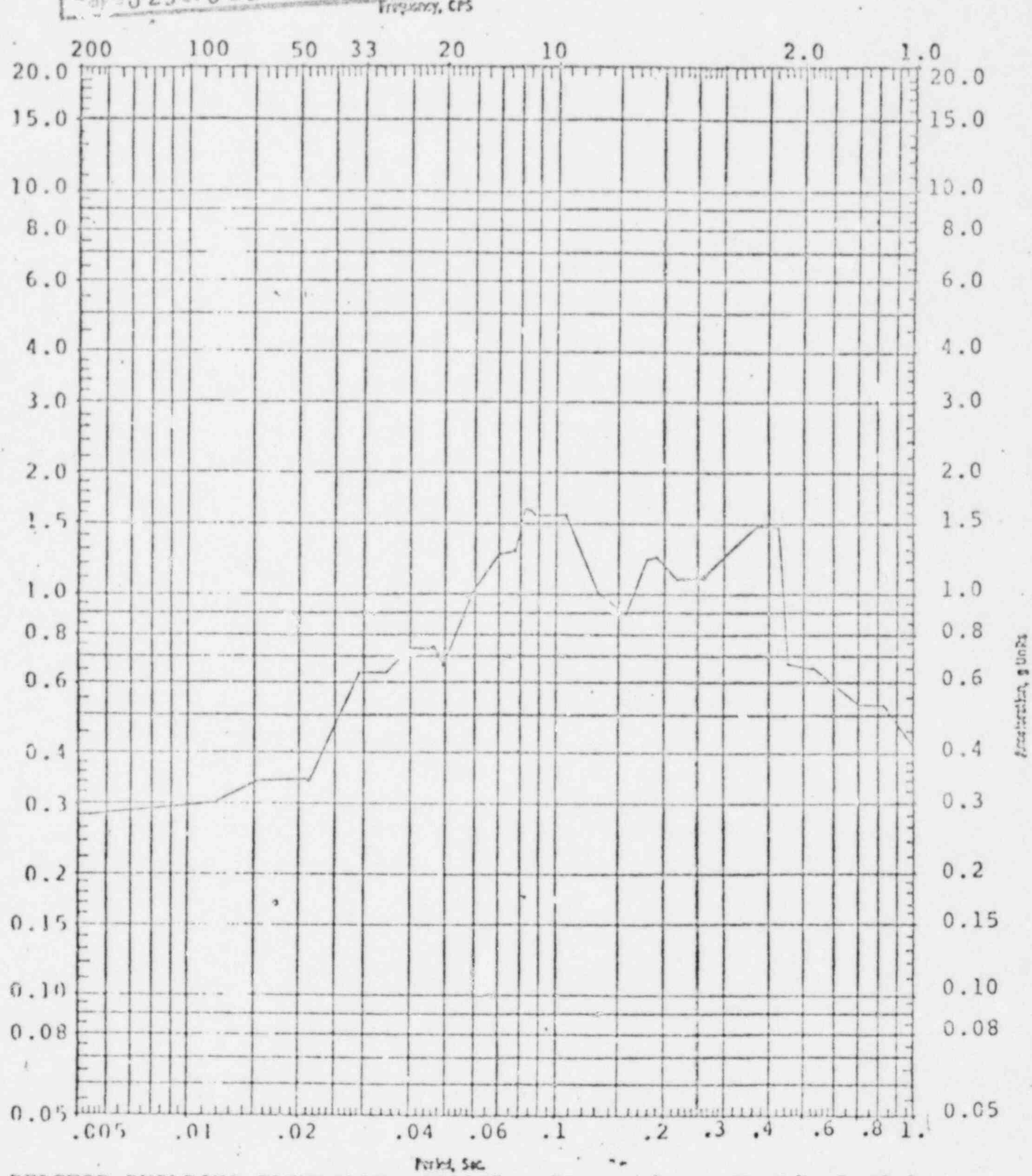


REACTOR BUILDING-ELEVATION: 673'4" 2% Damping Vertical Slab

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) [illegible]

I. PURPOSE

SBGTS Control Panel 1PL17J was originally qualified on 12/4/1979 by Systems Control Corporation using resonant search and sine beat tests. The sine beat test was completed using the ZPA values of the response spectra for seismic loads only. Recently, Transitek, Inc. has performed an on site test program. The purpose of this test program was, to determine on site the dynamic characteristics of the equipment.

This study has been initiated to utilize the test results of Transitek, Inc. and has the following goals:

a. To show that the test results of the Systems Control Corporation are in agreement with those obtained by Transitek, Inc. and the original tests were accurate enough to qualify the Control Panel 1PL17J

b. Using the test results and applicable response spectra curves to prove that, in addition to the seismic loads, the hydrodynamic loads also can be safely resisted by the subject panel. The final response spectra are plotted on pages 22-24

c. During the test performed by Systems Control Corporation the panel was excited separately of each eigenfrequency so that contributions of the other eigenfrequencies to the test frequency are not accounted for. It will be shown in this study, that in case of the SBGTS panel the single frequency test is an acceptable one

II. CONCLUSION

The Systems Control Corporation determined as the first three natural frequencies of the panel (See pp. 8-16)

f = 18 Hz, 26 Hz, 28 Hz

The natural frequencies recorded by Transitek, Inc. are as follows (See pp.17-20)

f(in Hz) = 26.6, 28.45, 33.57, 38.02 for main panel,

f(in Hz) = 28.5, 52.8, 84.8 for interior panel

Based on a comparison of both test results, obtained by Systems Control Corporation and Transitek, Inc. and taking into consideration the applicable response spectra attached to this report, the followings can be concluded:

a. The original test, performed by Systems Control Corporation show a first natural frequency of 18 Hz which is in horizontal direction and not contained in the results of Transitek, Inc.. Sine beat test is performed starting f = 18 Hz.

b. Second and third frequencies of both tests are coinciding; both tests show an eigenfrequency of f_2 = 26 Hz and f_3 = 28.0 Hz

c. The original test does not cover frequencies beyond 28 Hz, such as 33.57 Hz, 38.02 Hz and 41.69 which are identified by Transitek, Inc.. But, as it can be seen from the applicable response spectra curves (See pp.21-24) these values of the natural frequencies are in a range of low spectral acceleration.

d. ZPA value of the response spectra for seismic and hydrodynamic loads are equal or smaller than the ZPA value of the original test spectra (See pp.21-24 and Ref. 2, p. 7):

Panel 1PL17J, ZPA values:

SSE: $g_o = 0.54$ Horizontal
$g_o = 0.94$ Vertical

SSE: & Hydrodynamic : $g_o = 0.54$ Horizontal
$g_o = 0.75$ Vertical

Since there is no peak in the response spectra in the frequency range of interest; f = 33-100 Hz, and ZPA values of the original test are higher than those of the seismic & hydrodynamic, the subject panel can be qualified based on the results of Systems Control Corporation for seismic plus hydrodynamic loads also.

e. The natural frequencies 18 Hz, 26 Hz and 28 Hz, identified by the test programs are in horizontal directions (See pp.13-16, and Ref. 1). Since all the frequencies fall in the applicable seismic and hydrodynamic response spectra curve for horizontal direction into the ZPA range (See p.22), none of them would excite the subject panel. Therefore, none of these frequencies contribute to the final response of the panel.

f. The original test performed by Systems Control Corporation was adequate to qualify the panel 1PL17J for the specified seismic loads.

III. SOME DETAILS ON THE TEST PROCEDURES

a. Description of the Panel: (See pp.6-7)

SBGTS Control Panel 1PL17J is located in Reactor Building of the elevation 820'-0". It consists of a main panel with 90" height, 30" wide and 30" deep and a subpanel, which is attached to the main panel at the interior side of X-Y plane (See pp 6-7), at a distance Z=6", parallel to the X-Y plane.

b. Test of Systems Control Corporation

Control Panel 1PL17J was originally qualified by resonance search and sine beat tests on Date 12/4/1979, completed by Systems Control Corporation, Iron Mountain, Michigan. The loads were applied at the points 1 and 3 (See pp.13-16) and the acceleration were read at points 2, 4, 5 and 6. The following natural frequencies were determined (See pp. 8-16): 17 Hz, 18 Hz, 25 Hz, 26 Hz, 28 Hz

c. Test of Transitek, Inc.

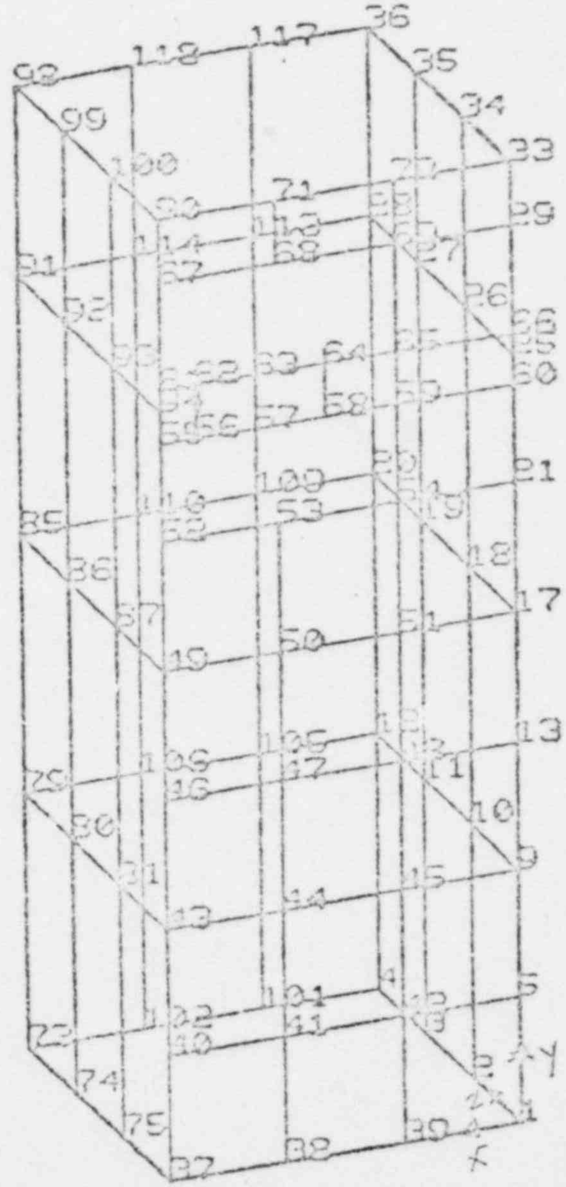
Transitek, Inc. performed an on site test program to determine the dynamic characteristics of the subject panel. The wire diagram of the panel is shown on Page 6. Input loads are applied and natural frequencies are measured at several locations of the panel. The following natural frequencies were recorded (See pp.17-20):

Main Panel:	26.6, 28,45, 33.57
(in Hz)	38.02, 41.69, 54.8
	61.2, 76.97, 76.57
Interior Panel	28.5, 52.8, 84.8
(in Hz)	

IV. REFERENCES

1. "Transitek, Inc., SBGTS Control Panel"
2. "Seismic Test Report on Control Panels 1PL17J, 2PL17J"
   EMD File Number: EMD-018952 Dated, July 16, 1979

9



0: 0 UND.,F= UNDEFINED (0.4, 0.5, -1.0, 0.0)=VIEW

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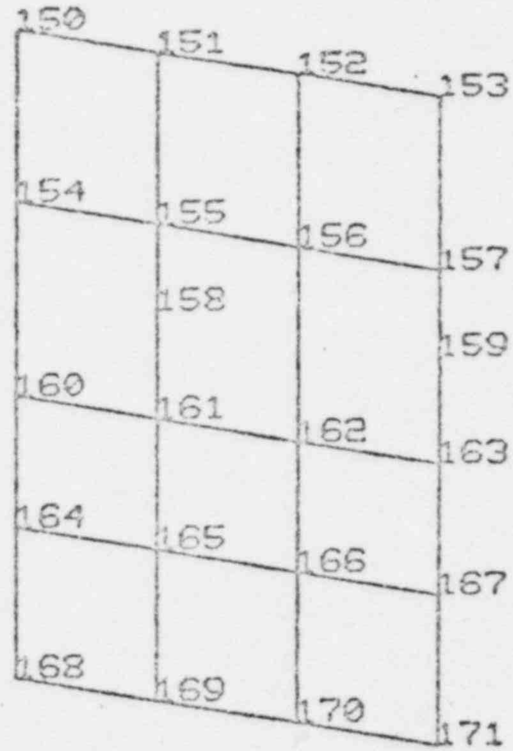

EXTERIOR PANEL

9: 57Z- COMP,F= 91.300 HZ (0.4, 0.5, 1.0, 0.0)=VIEW

SEISMIC TEST SHEET

CUSTOMER Commonwealth Edison Company

CUSTOMER ORDER NO. 186455

EQUIPMENT TESTED Control Panels 1PL17J & 2PL17J

DATE OF TEST 12-4-79

MANUFACTURER Systems Control Corp.

TYPE OF TEST Resonant Search & Sine Beats

WITNESS None

FREQUENCY RANGE 1-50 Hz.

TYPE OF CONSTRUCTION Welded

MAIN FUNCTION OF EQUIPMENT Stby. Gas Treatment

METHOD OF FASTENING TO TABLE Clamped with (6) ½-13 A-325F Bolts

COMMENTS

Panels passed seismic qualification, see following report. Only panel 1PL17J was tested, other panel qualified by identical design.

TABLE NO. 9

TYPE OF TEST-OBE BEAT TEST

PER FIG. 5

FREQ.	ACCELERATION IN G'S					
	ACCEL NO.1	ACCEL NO.2	ACCEL NO.3	ACCEL NO.4	ACCEL NO.5	ACCEL NO.6
1	.78	.78	.46	.46	.47	.21
2	.78	.78	.46	.46	.46	.20
3	.79	.79	.47	.48	.47	.21
4	.78	.79	.47	.48	.48	.21
6	.78	.80	.46	.47	.47	.20
8	.79	.79	.47	.49	.48	.22
12	.80	.81	.48	.52	.50	.22
16	.81	.83	.48	1.04	.87	.23
17	.81	.83	.47	1.07	.89	.22
18	.80	.81	.47	.74	.67	.20
24	.80	.81	.46	.49	.47	.21
25	.78	.80	.46	.58	.51	.20
26	.79	.81	.47	.51	.49	.20
32	.78	.80	.47	.48	.46	.20
48	.79	.79	.46	.47	.46	.21

ACCEL NO. 1 - Z-VERT. IN
ACCEL NO. 2 - Z-VERT. OUT
ACCEL NO. 3 - X-HORZ. IN
ACCEL NO. 4 - X-HORZ. OUT H1
ACCEL NO. 5 - X-HORZ. OUT H2
ACCEL NO. 6 - Y-HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2 -
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 67278
PANEL 1PL17J

Calc. No: EMD - 030469
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TABLE NO. 10

TYPE OF TEST-SSE BEAT TEST

PER FIG. 5

ACCELERATION IN G'S

FREQ.	ACCEL NO.1	ACCEL NO.2	ACCEL NO.3	ACCEL NO.4	ACCEL NO.5	ACCEL NO.6
1	.94	.94	.54	.54	.54	.31
2	.94	.94	.54	.54	.54	.41
3	.94	.94	.54	.54	.54	.31
4	.95	.95	.56	.54	.56	.31
6	.95	.96	.56	.56	.56	.31
8	.96	.96	.56	.58	.56	.32
12	.96	.97	.56	.62	.59	.32
16	.96	1.02	.56	1.21	.92	.32
17	.96	1.03	.56	1.26	.95	.32
18	.95	1.01	.56	.87	.72	.31
24	.96	1.0	.56	.59	.56	.32
25	.96	1.02	.56	.59	.57	.31
26	.95	.97	.55	.58	.56	.31
32	.95	.96	.55	.55	.57	.31
48	.95	.96	.55	.57	.56	.30

ACCEL NO. 1 - Z-VERT. IN
ACCEL NO. 2 - Z-VERT. OUT
ACCEL NO. 3 - X-HORZ. IN
ACCEL NO. 4 - X-HORZ. OUT H1
ACCEL NO. 5 - X-HORZ. OUT H2
ACCEL NO. 6 - Y-HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 67278
PANEL 1PL17J

TABLE NO. 11

TYPE OF TEST-OBE BEAT TEST

PER FIG. 6

ACCELERATION IN G'S

FREQ.	ACCEL NO.1	ACCEL NO.2	ACCEL NO.3	ACCEL NO.4	ACCEL NO.5	ACCEL NO.6
1	.78	.78	.46	.46	.46	.21
2	.78	.78	.46	.46	.47	.20
3	.79	.79	.46	.46	.46	.20
4	.78	.79	.47	.47	.47	.21
6	.78	.79	.47	.47	.47	.21
8	.79	.79	.47	.47	.48	.21
12	.80	.81	.48	.48	.49	.23
16	.81	.83	.49	.54	.56	.23
18	.82	.83	.49	.64	.68	.20
19	.81	.82	.48	.66	.70	.21
24	.82	.83	.47	.49	.51	.21
26	.79	.81	.47	.49	.51	.21
28	.80	.81	.46	.53	.52	.20
32	.79	.80	.46	.49	.48	.21
48	.79	.81	.47	.48	.49	.21

ACCEL NO. 1 - Z-VERT. IN
ACCEL NO. 2 - Z-VERT. OUT
ACCEL NO. 3 - Y-HORZ. IN
ACCEL NO. 4 - Y-HORZ. OUT H1
ACCEL NO. 5 - Y-HORZ. OUT H2
ACCEL NO. 6 - X-HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 67278
PANEL 1PL17J

TABLE NO. 12

TYPE OF TEST-SSE BEAT TEST

PER FIG. 6

ACCELERATION IN G'S

FREQ.	ACCEL NO.1	ACCEL NO.2	ACCEL NO.3	ACCEL NO.4	ACCEL NO.5	ACCEL NO.6
1	.94	.94	.54	.54	.54	.31
2	.94	.94	.54	.54	.54	.32
3	.94	.94	.54	.54	.54	.31
4	.95	.94	.54	.55	.56	.31
6	.95	.96	.56	.58	.58	.31
8	.95	.96	.56	.58	.59	.31
12	.95	.96	.56	.59	.61	.32
16	.95	.96	.57	.73	.79	.33
18	.94	1.09	.58	.82	.88	.32
19	.95	1.05	.56	.89	.93	.32
24	.96	.97	.57	.62	.66	.33
26	.95	.96	.55	.61	.63	.31
28	.95	1.01	.56	.57	.59	.30
32	.94	.95	.56	.58	.57	.31
48	.96	.96	.57	.58	.58	.32

ACCEL NO. 1 - Z-VERT, IN
ACCEL NO. 2 - Z-VERT, OUT
ACCEL NO. 3 - Y-HORZ, IN
ACCEL NO. 4 - Y-HORZ, OUT H1
ACCEL NO. 5 - Y-HORZ, OUT H2
ACCEL NO. 6 - X-HORZ, OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 67278
PANEL 1PL17J

FIGURE 5

LASALLE COUNTY STATION UNITS 1&2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 188455
SYSTEMS CONTROL CORP. PROJECT NO. 67278
PANEL 1PL17J

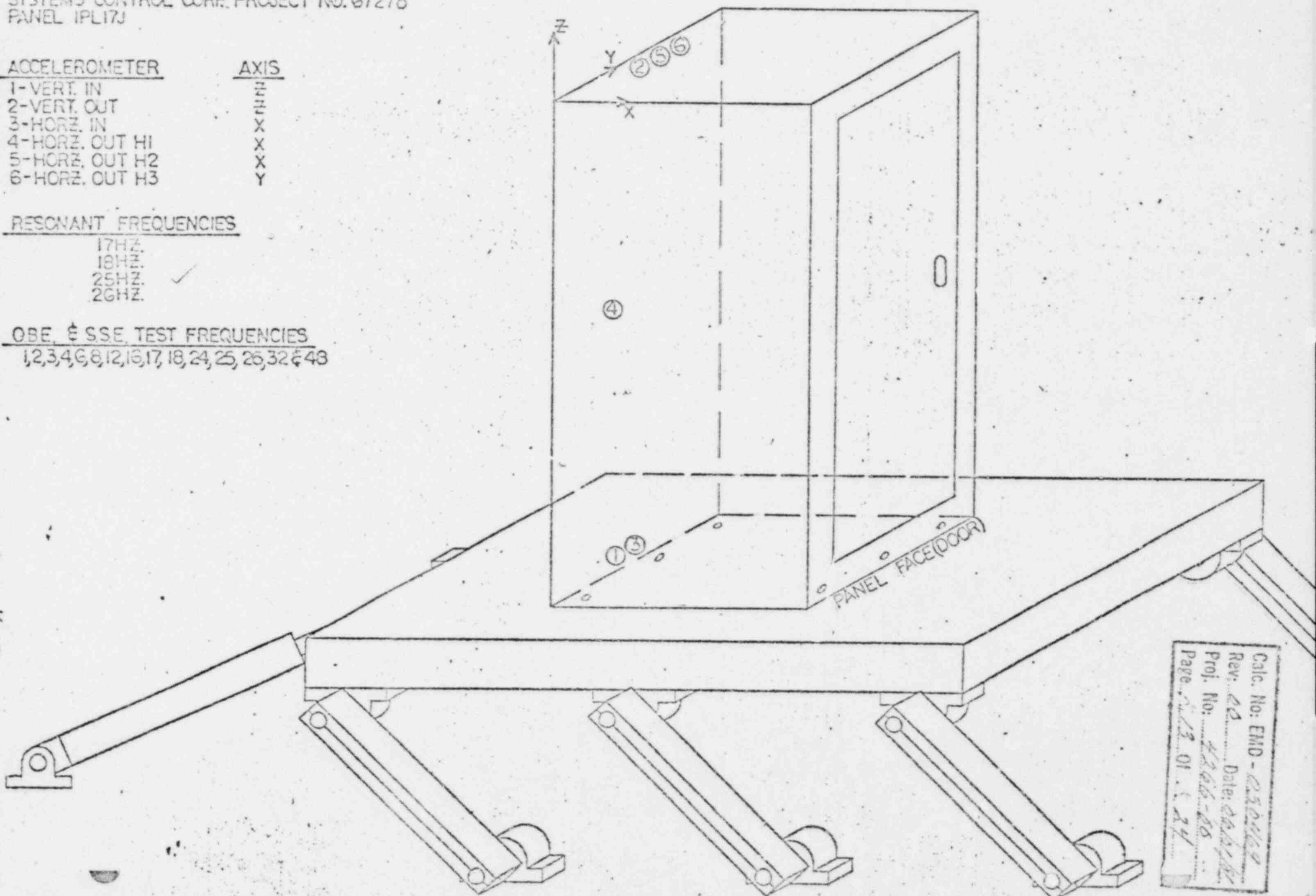
ACCELEROMETER	AXIS
1-VERT. IN	Z
2-VERT. OUT	Z
3-HORZ. IN	X
4-HORZ. OUT H1	X
5-HORZ. OUT H2	X
6-HORZ. OUT H3	Y

RESONANT FREQUENCIES

17HZ.
18HZ.
25HZ.
26HZ.

OBE. & S.S.E. TEST FREQUENCIES

1,2,3,4,6,8,12,16,17, 18, 24, 25, 26, 32 & 48



- K 13 -

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Rev: ... Date: ...
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Page ... of ...

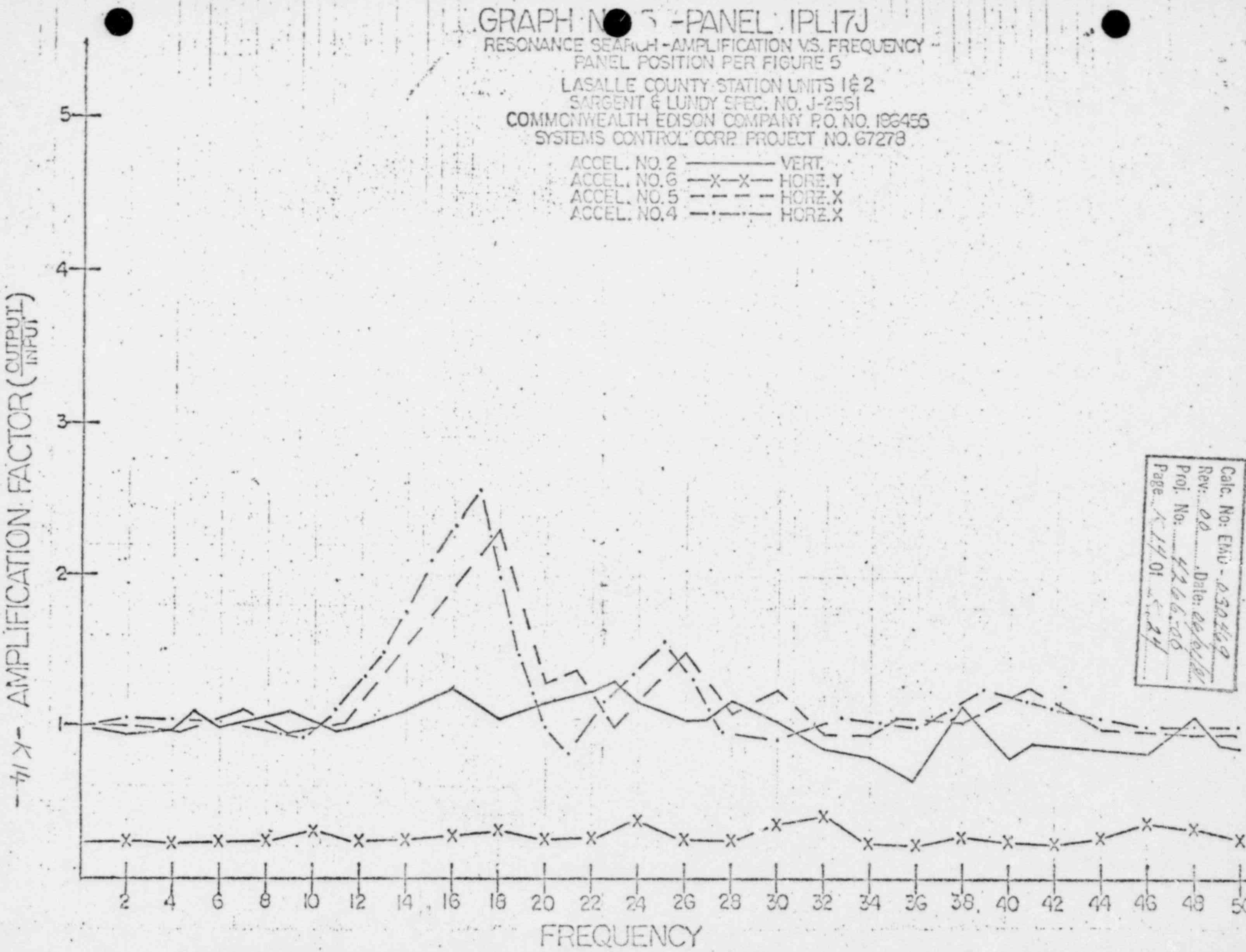

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FIGURE 6

LASALLE COUNTY STATION UNITS 1&2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 67278
PANEL 1PL17J

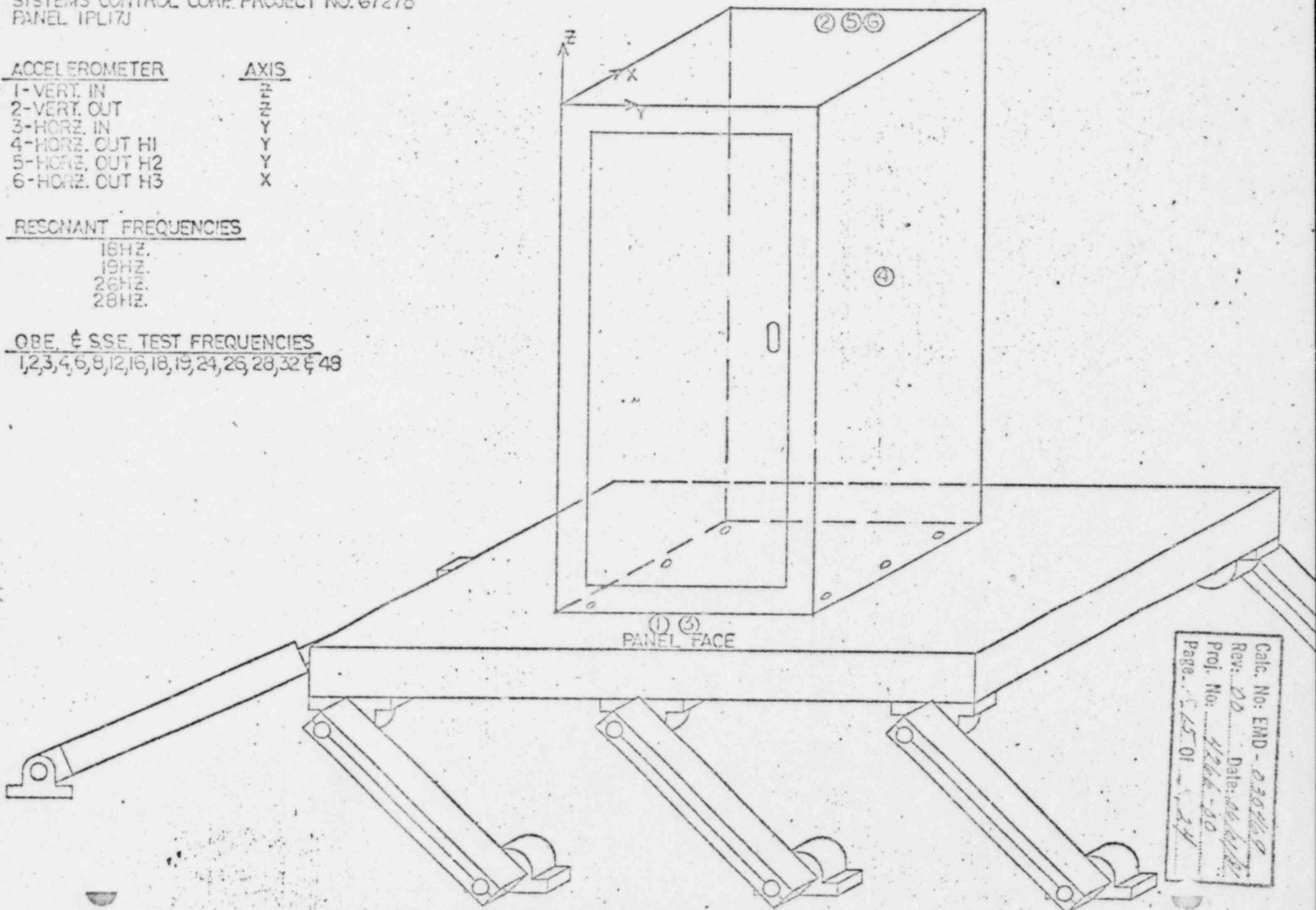
ACCELEROMETER	AXIS
1-VERT. IN	Z
2-VERT. OUT	Z
3-HORZ. IN	Y
4-HORZ. OUT H1	Y
5-HORZ. OUT H2	Y
6-HORZ. OUT H3	X

RESONANT FREQUENCIES

18HZ.
19HZ.
26HZ.
28HZ.

O.B.E. & S.S.E. TEST FREQUENCIES

1,2,3,4,6,8,12,16,18,19,24,26,28,32 & 48



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Date:	06/01/81
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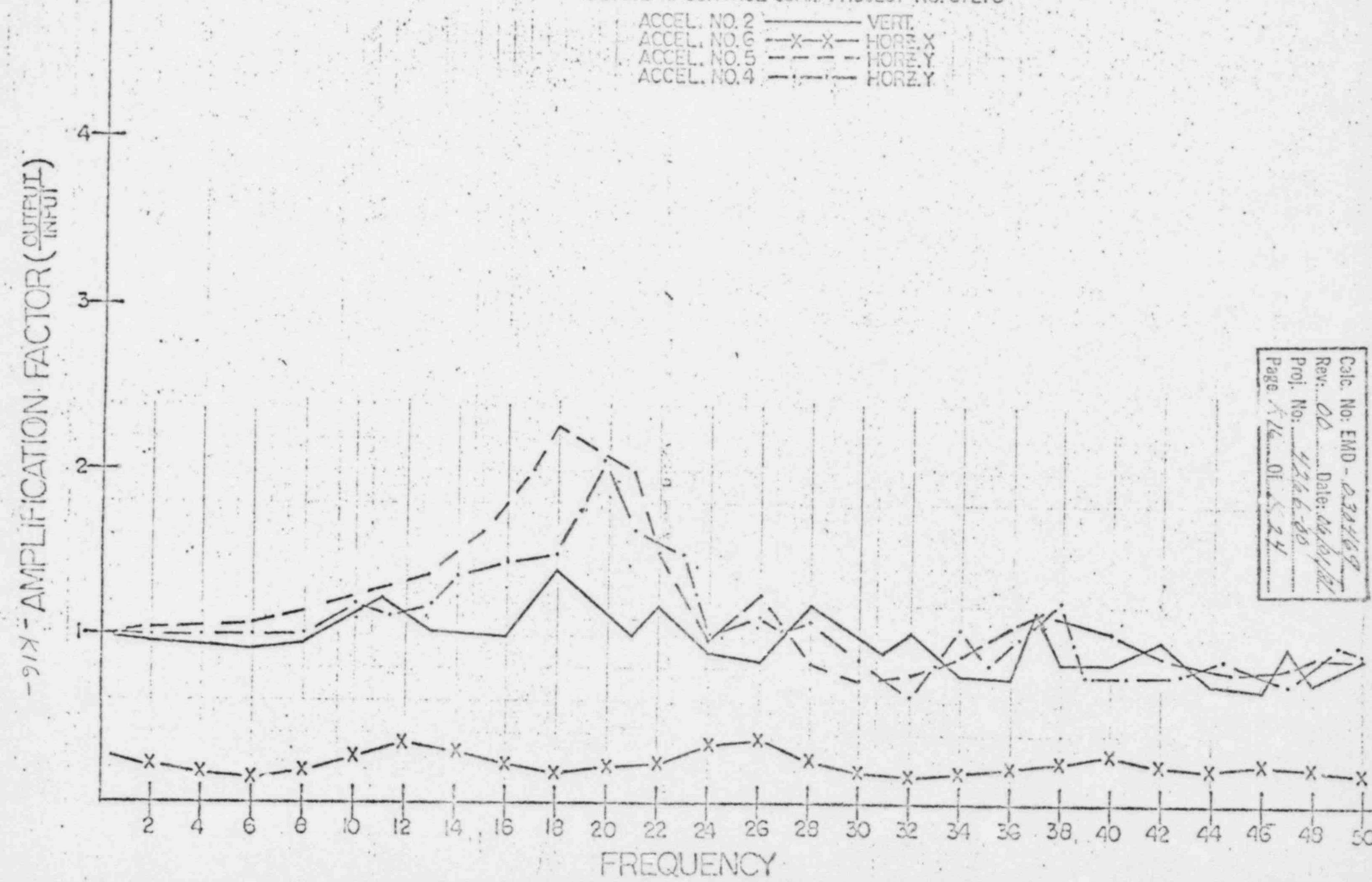
GRAPH No. 6 - PANEL IPL17J

RESONANCE SEARCH - AMPLIFICATION VS. FREQUENCY
PANEL POSITION PER FIGURE 6

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 67278



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MODE PARAMETERS

LABEL	FREQ	DAMPING	AMPLITUDE	PHASE	REF	RES	MODE	FLAGS				
4	26.613	0.057420	2.109	-0.7809	58Z-	58Z+	4	0	0	0	1	1
6	33.573	0.013275	2.572	-1.8100	58Z-	58Z+	6	0	0	0	1	1
7	61.201	0.029139	0.8841	-2.4417	58Z-	58Z+	7	0	0	0	1	1
8	76.571	0.036473	5.015	-1.7577	58Z-	58Z+	8	0	0	0	1	1
9	91.382	0.023719	0.4499	-2.0933	58Z-	58Z+	9	0	0	0	1	1
10	41.695	0.008237	0.1147	-1.3531	58Z-	58Z+	10	0	0	0	1	1
5	28.455	0.025198	1.147	-0.6869	58Z-	58Z+	5	0	0	0	1	1
11	38.022	0.015230	0.2860	-1.7774	58Z-	58Z+	1	0	0	0	1	1
12	54.847	0.035878	0.3537	-2.2844	58Z-	58Z+	2	0	0	0	1	1

#

-K17-

Calc. No: EMD - 023162
Rev: 00 Date: 04/21/81
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\$KKKKKKKKK
1F= 2.876E 01
1M= 2.171E-01
2.00E 00
2F= 2.818E 01
2M= 3.385E-01

3F= 3.369E 01
3M= 1.002E 00

4F= 3.890E 01
4M= 2.138E-01

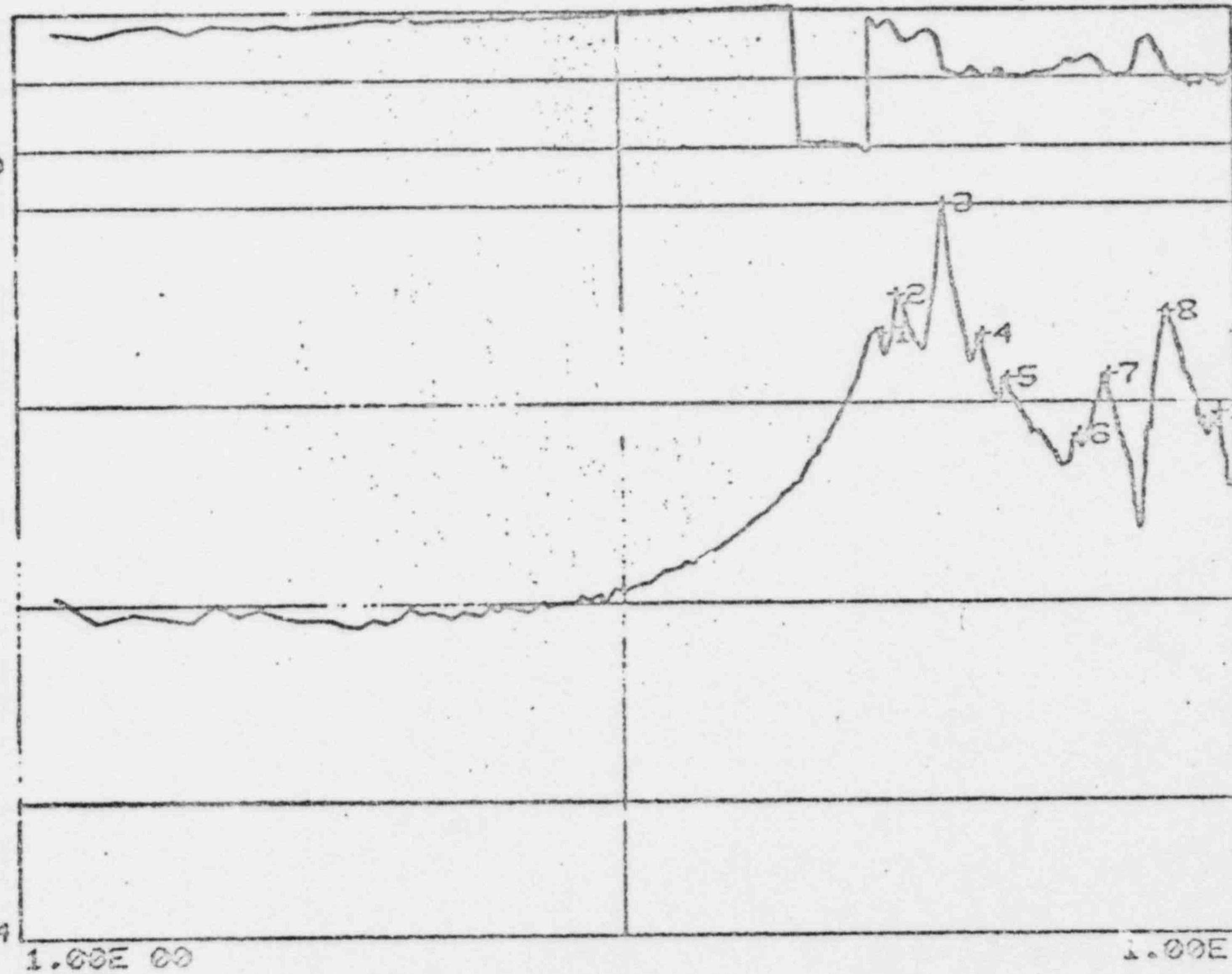
5F= 4.266E 01
5M= 1.304E-01

6F= 5.591E 01
6M= 6.755E-02

7F= 6.237E 01
7M= 1.348E-01

8F= 7.762E 01
8M= 2.734E-01

9F= 9.441E 01
9M= 8.645E-02
2.00E-04



A1:LSBGTS CONTROL PANELS

FREQRESP-BODE
58Z- 58Z+
071480-000000
101580-000000

Calc. No: EMD - 030469
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FIGURE 4.9.3

DRIVING POINT TRANSFER FUNCTION ON THE EXTERIOR PANEL

MODE PARAMETERS

LABEL	FREQ	DAMPING	AMPLITUDE	PHASE	REF	RES	MODE	FLAGS
1	28.500	0.030670	2.870	-1.7869	158Z+	158Z-	1	0 0 0 1 1
2	52.815	0.015492	3.457	-1.3008	158Z+	158Z-	2	0 0 0 1 1
3	84.795	0.021500	3.612	-1.5625	158Z+	158Z-	3	0 0 0 1 1

*

-K19-

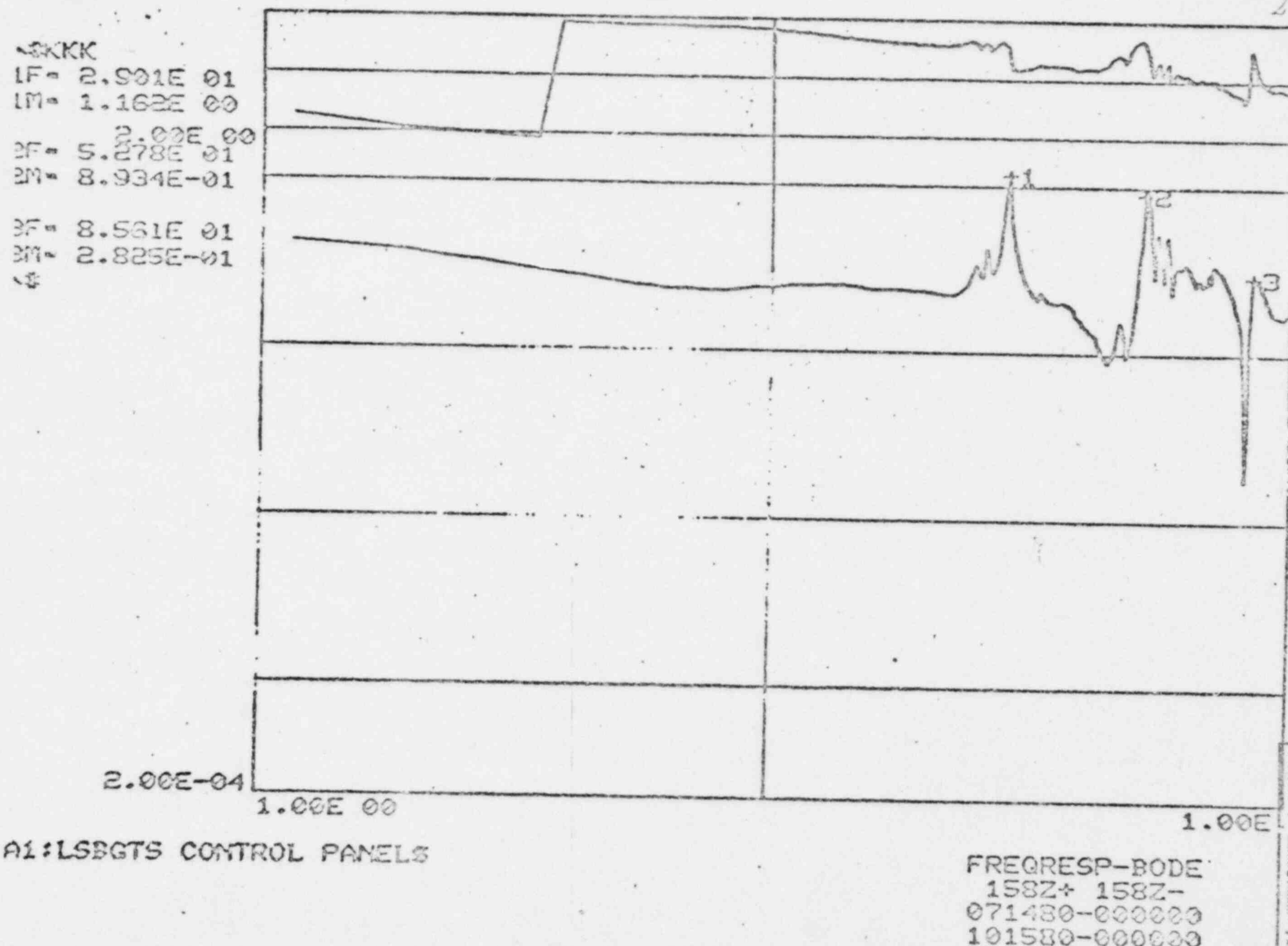

FIGURE 4.9.4

DRIVING POINT TRANSFER FUNCTION ON THE INTERIOR PANEL

Calc. No: EMD - 030469
Rev: 00 Date: 00/01/81
Proj. No: 4266-00
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REQUIRED RESPONSE SPECTRUM CURVE

(EMERGENCY CONDITION)

FOR

1 PL17J

SGTS CONTROL PANEL

LOCATED IN

REACTOR BUILDING El. 820'0"

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-10
DESIGN BY [illegible] DATE 1-21-80
CHECKED BY [illegible] DATE 1-22-80 SHEET 22 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/04/81
Proj. No: 4266-00
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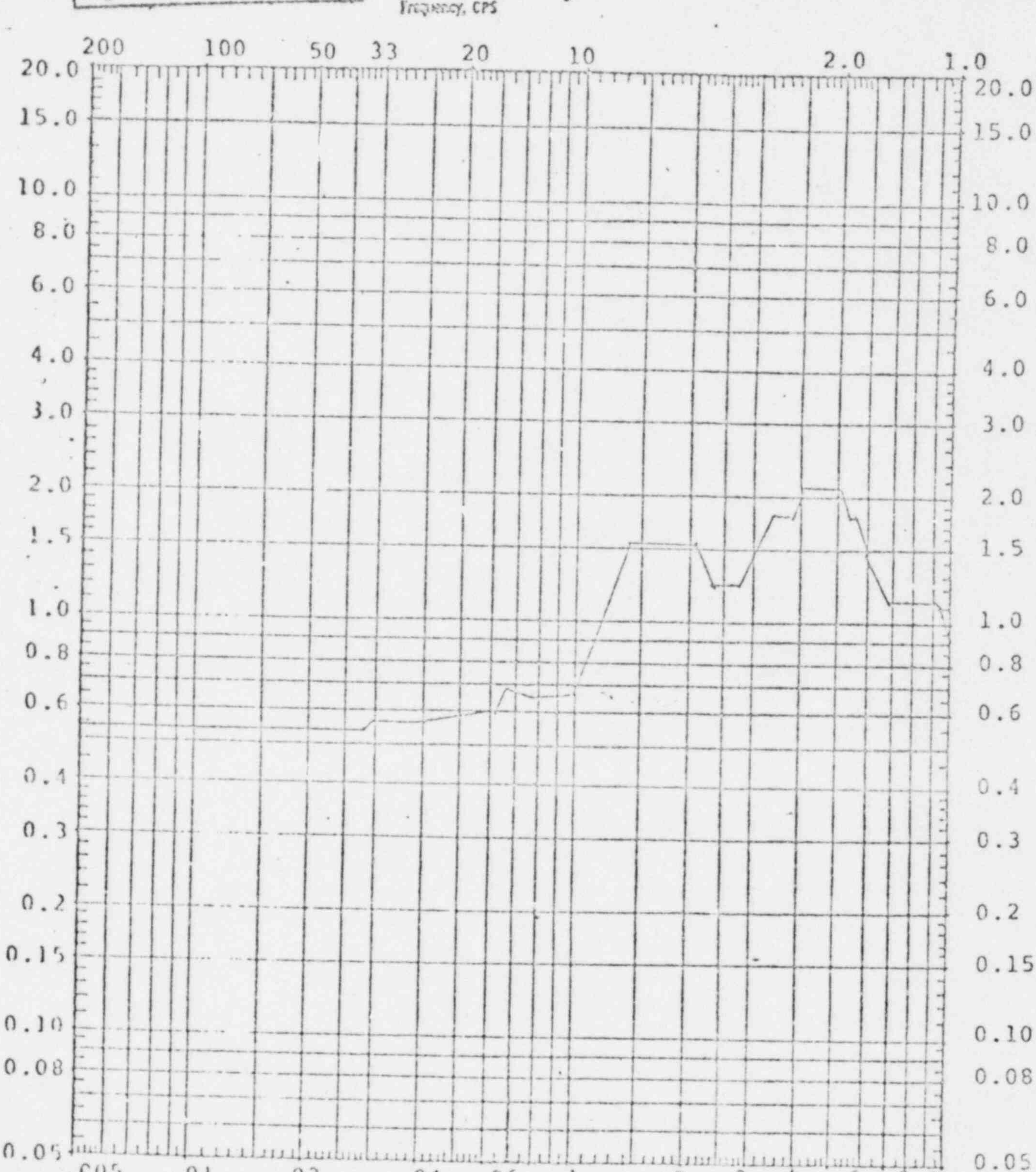
REV. NO.	0						
DATE	1-22-80						
INITIALS	JG						



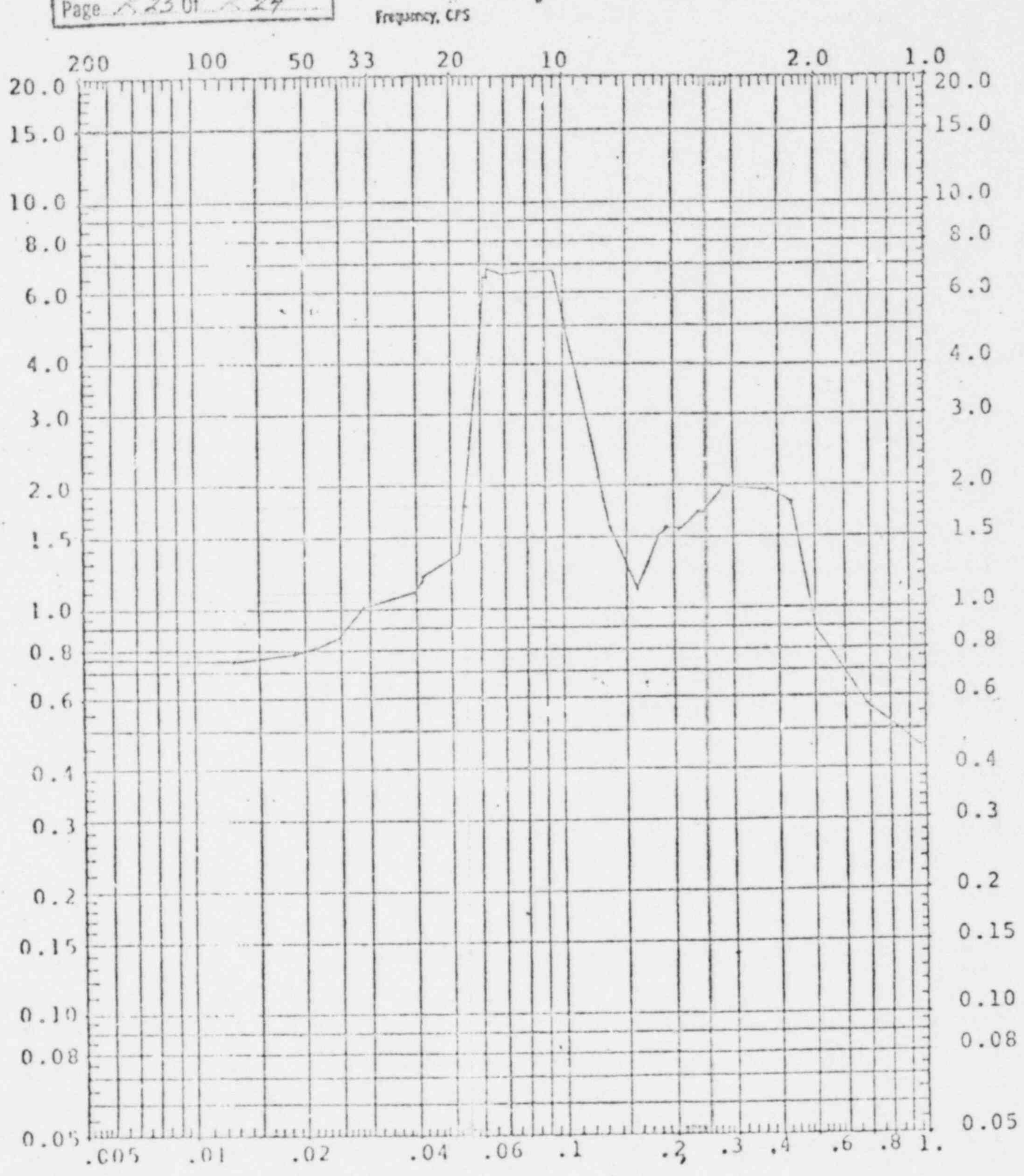
REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Horizontal Slab NS-EW
Envelop of a) SSE + CO_{LEVY-1}
b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-18
DESIGN BY L. Graves DATE 1-22-80
CHECKED BY [illegible] DATE 1-22-80 SHEET 23 OF 27

Calc. No: EMD - 036469
Rev: 00 Date: 06/01/81
Proj. No: 4266-06
Page K23 Of K24

REV. NO.	0						
DATE	1-22-80						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Slab

Envelope of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY}) -K23-

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-10
DESIGN BY Z. Cowman DATE 1-22-80
CHECKED BY [illegible] DATE 1-22-80 SHEET 24 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-06
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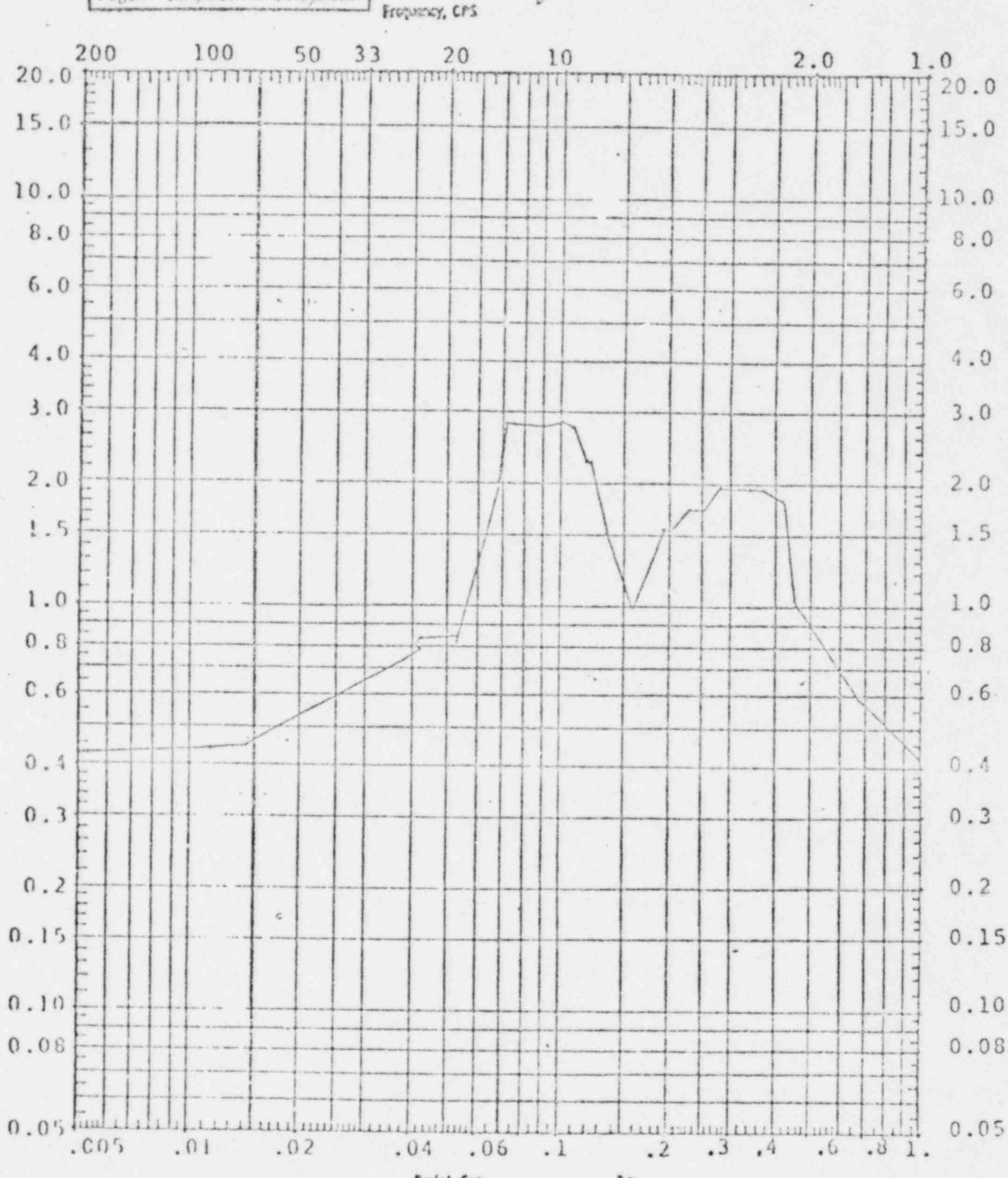
REV. NO.	0						
DATE	1-22-80						
INITIALS	ZC						



REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Wall

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

-K24-

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For 250 Volt Distribution Center Control Panel		Calc. No. EMD-03[illegible]69	
	X Safety–Related	Non–Safety–Related	Rev. 00	Date 06/01/81
			Page L1	of L27

Client Commonwealth Edison Company	Prepared by Talat Korman	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

I. PURPOSE

250 Volt Distribution Center Control Panel was originally qualified on 11/2/77 by Systems Control Corporation using resonant search and sine beat tests. The sine beat tests were completed using the ZPA values of the response spectra for seismic loads only. Recently, Transitek, Inc. has performed an on site test program. The purpose of this test program was, to determine on site the dynamic characteristics of the equipment.

Since the load conditions are changed due to introduction of T-Quencher loads, a new test has been performed in Wyle Laboratories, Huntsville, Alabama, to satisfy the latest Regulatory Guide, IEEE-344, 1975, and most recent load requirements. A new set of response spectra curves which account for seismic and hydrodynamic loads, have been employed during this test.

This report has been prepared to make a comperative study between the test results listed above and to confirm the requalification of the 250 Volt Distribution Center Control Panel according to the latest load requirements.

II. CONCLUSION

The Systems Control Corporation determined as the first two natural frequencies (See pp. 6-14):

$$f_n \text{ (Hz)} = 6,\ 12$$

The natural frequencies recorded by Transitek, Inc. are as follows (See pp. 15-23):

$$fn \text{ (Hz)} = 11.15,\ 13.74,\ 18.13,\ 30.79,\ 36.93$$

Wyle Laboratories found as minimum natural frequency:

$$f_n \text{ (Hz)} = 12, 14.5$$

Based on a comparison of the test results listed above, the following can be concluded:

a. The original test program performed by Systems Control Corporation show a natural frequency of 6 Hz, which is not contained in the results of Transitek, Inc. and Wyle Laboratories. In a private communication, Transitek, Inc. has stated that they have observed a very weak resonance in 6 Hz range, which they did not state in their report. Also in the attached response spectra curve (See p. 25), a frequency of 6 Hz gives very small response.

b. The second frequency of the three tests are in the same range:

$$f_2 = 12 \text{ Hz}$$

so that we have an agreement of the three test results.

c. The Systems Control Corporation did not identify any further eigenfrequency. The third frequencies recorded by Transitek, Inc. and Wyle Laboratories are very close:

$f_3 = 13.74$ Transitek, Inc
$f_3 = 14.5$ Wyle Laboratories

These results document the accuracy of the applied test methods. Since the subject panel is tested in Wyle Lab. for the latest load combinations, described by last version of Regulatory Guide and IEEE-344, 1975, the 250 Volt

Distribution Center Control Panel is qualified to resist the required seismic and hydrodynamic loads safely.

III. SOME DETAILS ON THE TEST PROCEDURES

a. Description of the Panel

250 Volt Distribution Panel is located in reactor building at the elevation 694'-0". It consists of a box which is 91" high, 19" wide and 180" long (See p. 5).

b. Test of Systems Control Corporation

250 Volt Distribution Panel was originally qualified by resonance search and sine beats test on 11/2/77, completed by Systems Control Corporation, Iron Mountain, Michigan. The loads were applied at the points 1 and 3 (See pp. 7-14) and the acceleration was read at points 2, 4, 5 and 6 . Only two natural frequencies were determined; 6 Hz and 12 Hz (See pp. 7-14).

c. Test of Transitek, Inc.

Transitek, Inc. performed an on site test program to determine the dynamic characteristics of the subject panel. The wire diagram of the panel is shown on page 5 . Input loads are applied and natural frequencies are measured at several locations of the panel. The following natural frequencies were recorded (See pp. 15-23):

$$f_n \text{ (Hz)} = 11.15, 13.74, 18.13, 30.79, 36.93, 41.13, 47.45$$

d. Test of Wyle Laboratory

The two lowest frequencies found by Wyle Laboratories are:

$$f_n \text{ (Hz)} = 12, 14.5$$

More details are not available about the test procedure in Wyle Laboratories at this time. But we are informed that the test satisfied the latest load requirements and the subject panel is qualified for seismic and hydrodynamic loads.

IV. REFERENCES

1. "Transitek, Inc. 250 Volt DC Control Panel"
2. "Seismic Test Report on DC Distribution Equipment"
   EMD File Number: EMD-011085, dated November 23, 1977
3. "Wyle Laboratories, Test of 250 Volt DC Control Panel"

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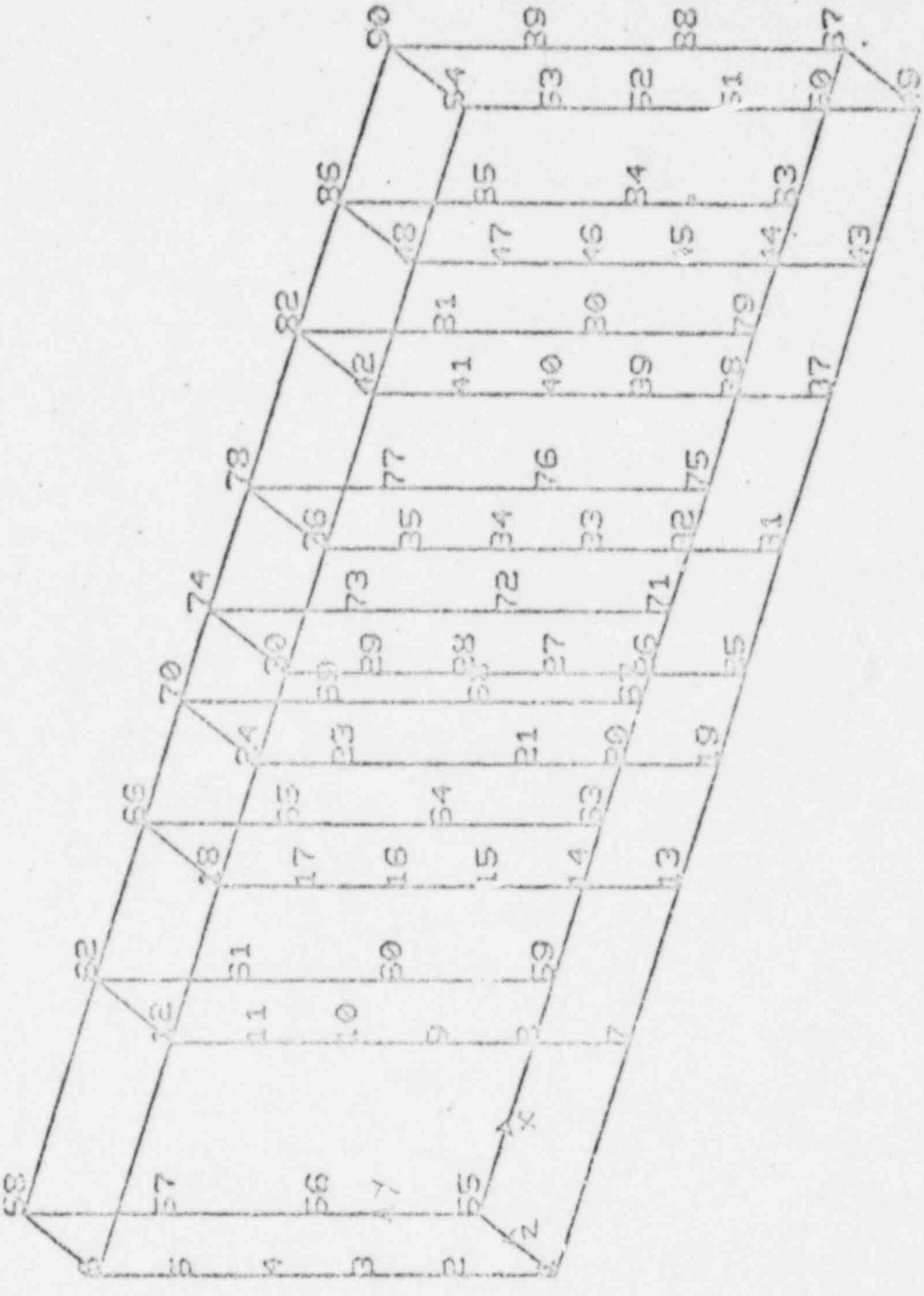

0: 0 UND., F= UNDEFINED (0.5, 1.0, 1.0, 0.0)-VIEW

Calc. No: EMD - 030462
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
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SEISMIC TEST SHEET

CUSTOMER Commonwealth Edison Company

CUSTOMER ORDER NO. 186455

EQUIPMENT TESTED D.C. Distribution Panels & Motor Control

DATE OF TEST October 17 & 18, 1977

MANUFACTURER Systems Control Corp.

TYPE OF TEST Resonant Search & Sine Beats

WITNESS None

FREQUENCY RANGE 1 - 50 Hz.

TYPE OF CONSTRUCTION Welded

MAIN FUNCTION OF EQUIPMENT D.C. Distribution & MCC

METHOD OF FASTENING TO TABLE (6) ½-13 A-325F Bolts

COMMENTS

Panels passed seismic qualification, see following report.

Prepared by Bruce H. Wright

Approved by Larry R. Roell
SYSTEMS CONTROL CORP.
CHIEF ENGINEER

QUALITY CONTROL
REVIEWED & APPROVED
BY James E. Pozzo
DATE 11-2-77

FIGURE 3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2591
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 13874
PANEL - UNIT 2, 250V.D.C., BUS NO. 2
& MCC 221X

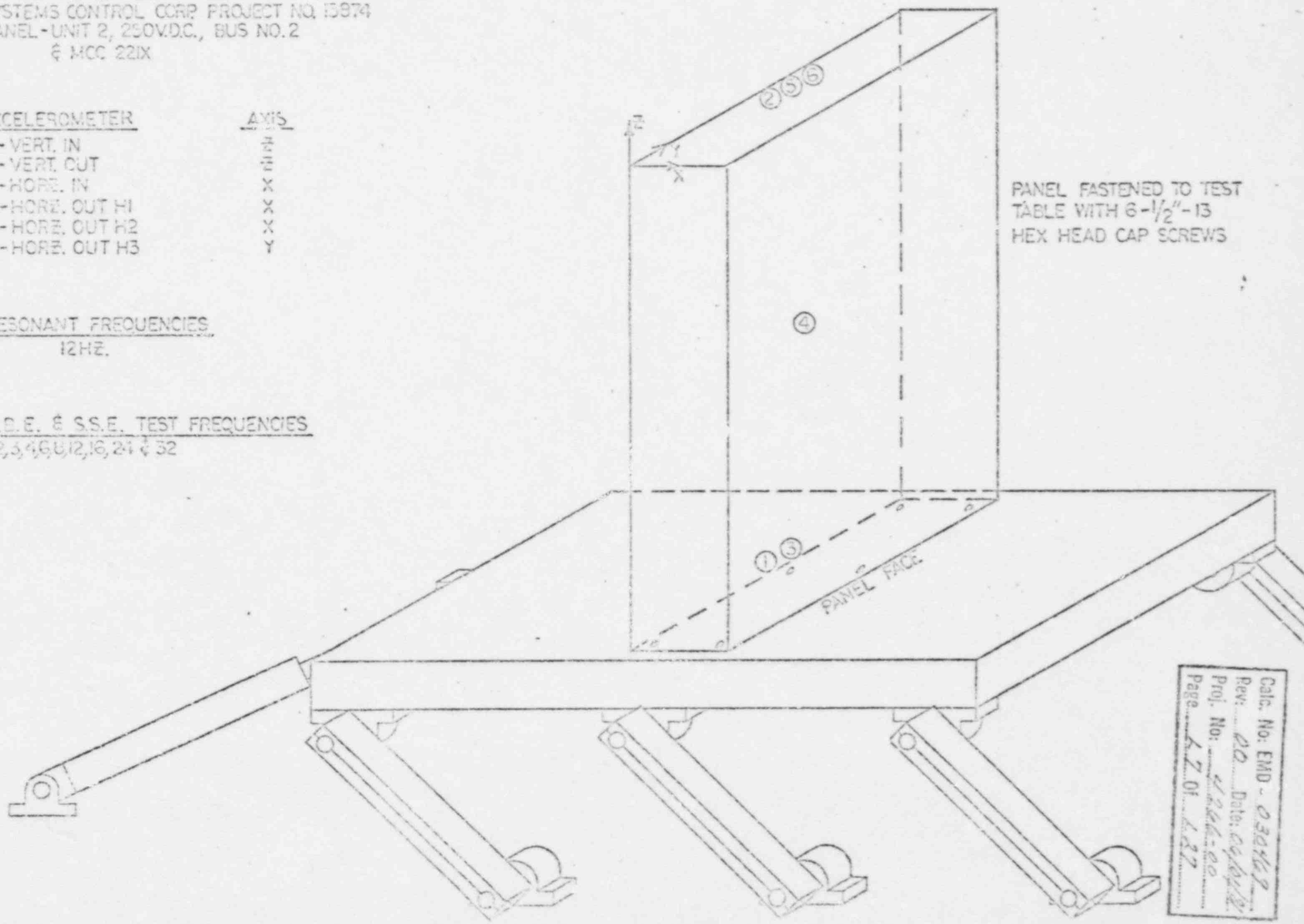
ACCELEROMETER	AXIS
1 - VERT. IN	Z
2 - VERT. OUT	Z
3 - HORZ. IN	X
4 - HORZ. OUT H1	X
5 - HORZ. OUT H2	X
6 - HORZ. OUT H3	Y

RESONANT FREQUENCIES

12 HZ.

O.B.E. & S.S.E. TEST FREQUENCIES

1, 2, 3, 4, 6, 8, 12, 16, 24 & 32



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LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL COR. PROJECT NO. 13474
PANEL-UNIT 2, 250V.D.C., BUS NO.2
& MCC 221X

ACCELEROMETER	AXIS
1 - VERT. IN	Z
2 - VERT. OUT	Z
3 - HORZ. IN	Y
4 - HORZ. OUT H1	Y
5 - HORZ. OUT H2	Y
6 - HORZ. OUT H3	X

RESONANT FREQUENCIES

6HZ.

O.B.E. & S.S.E. TEST FREQUENCIES

1,2,3,4,6,8,12,16,24 & 32

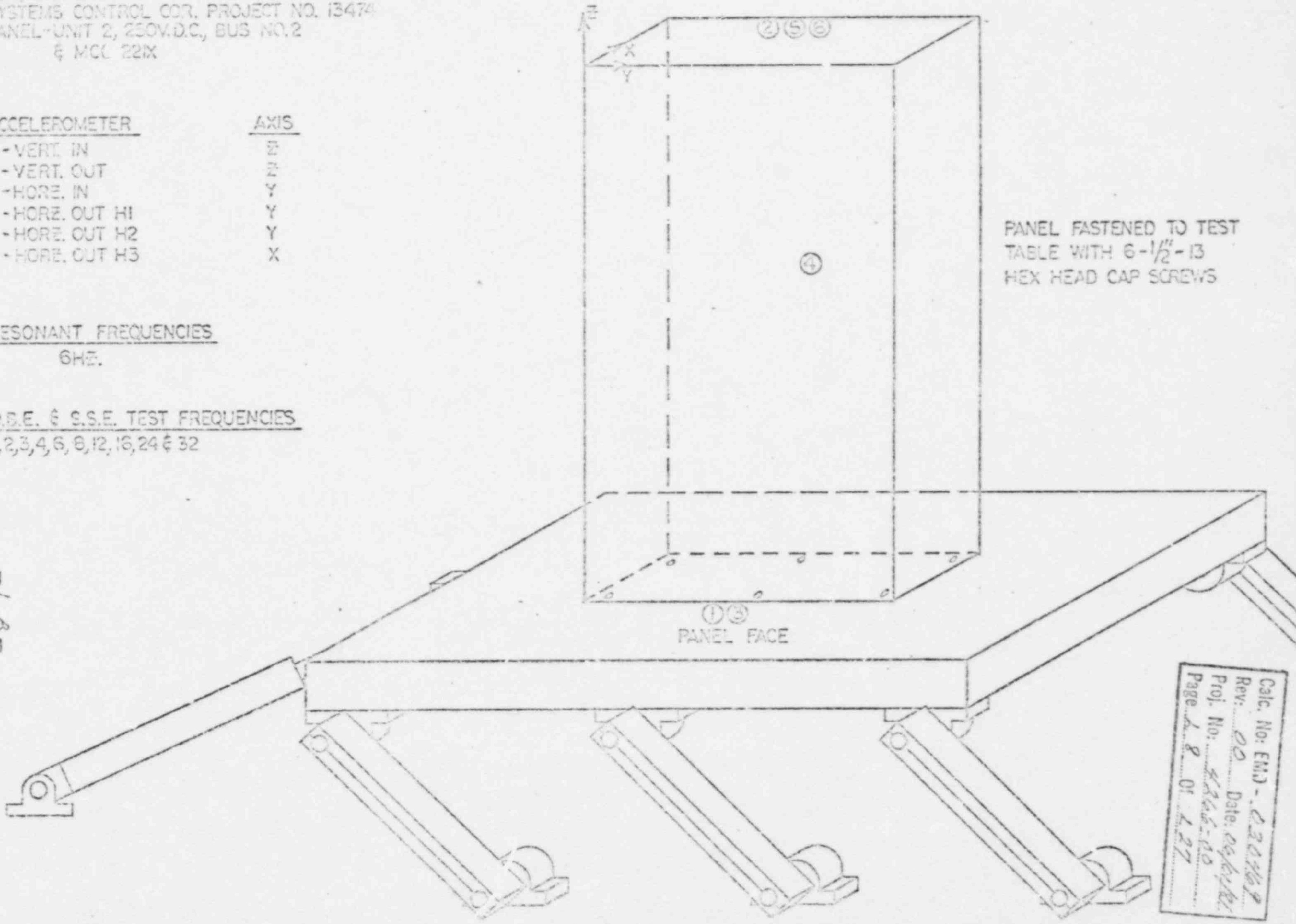

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TABLE NO.5

TYPE OF TEST - RESONANT SEARCH

PER FIG.3

FREQ.	ACCELERATION IN G'S					
	ACCEL. NO.1	ACCEL. NO.2	ACCEL. NO.3	ACCEL. NO.4	ACCEL. NO.5	ACCEL. NO.6
1	.13	.10	.19	.11	.20	.02
2	.13	.11	.24	.17	.21	.02
3	.15	.12	.17	.22	.22	.02
4	.14	.13	.21	.22	.22	.02
5	.15	.13	.22	.26	.25	.02
6	.15	.15	.22	.24	.24	.04
7	.15	.15	.21	.24	.25	.07
8	.14	.15	.22	.25	.29	.08
9	.15	.15	.22	.20	.35	.08
10	.16	.23	.22	.35	.46 ✓	.11
11	.15	.20	.22	.39	.54 ✓	.14
12	.15	.26	.21	.71 ✓	1.08 ✓	.19
13	.20	.23	.22	.72 ✓	1.05 ✓	.71 ✓
14	.22	.16	.24	.39	.68 ✓	.21
15	.22	.16	.23	.20	.43 ✓	.18
16	.24	.19	.23	.10	.25	.07
17	.24	.20	.22	.04	.22	.08
18	.21	.18	.23	.04	.19	.09
19	.22	.21	.24	.06	.15	.08
20	.24	.23	.23	.08	.12	.07
21	.24	.24	.23	.11	.12	.08
22	.25	.30	.23	.14	.10	.15
23	.19	.18	.22	.10	.13	.05
24	.18	.19	.22	.11	.12	.05
25	.20	.23	.22	.12	.11	.04

ACCEL. NO. 1 - Z - VERT. IN
ACCEL. NO. 2 - Z - VERT. OUT
ACCEL. NO. 3 - X - HORZ. IN
ACCEL. NO. 4 - X - HORZ. OUT H1
ACCEL. NO. 5 - X - HORZ. OUT H2
ACCEL. NO. 6 - Y - HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO 186455
SYSTEMS CONTROL CORP. PROJECT NO. 13874

Calc. No: EMD - 030469
Rev: 00 Date: 09/24/[illegible]
Proj. No: 4266-00
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TABLE NO.6

TYPE OF TEST - RESONANT SEARCH

PER FIG.3

FREQ.	ACCELERATION IN G'S					
	ACCEL. NO.1	ACCEL. NO. 2	ACCEL. NO. 3	ACCEL. NO. 4	ACCEL. NO. 5	ACCEL. NO. 6
26	.23	.26	.22	.15	.10	.03
27	.25	.34	.23	.14	.11	.04
28	.24	.27	.22	.14	.17	.05
29	.26	.29	.24	.16	.18	.08
30	.20	.18	.23	.11	.19	.12
31	.21	.20	.24	.11	.20	.13
32	.26	.33	.23	.19	.16	.14
33	.26	.36	.23	.20	.14	.15
34	.21	.32	.23	.20	.10	.14
35	.20	.25	.22	.20	.05	.11
36	.20	.22	.23	.14	.05	.11
37	.21	.24	.23	.16	.05	.15
38	.20	.19	.22	.15	.05	.15
39	.17	.15	.22	.14	.10	.13
40	.19	.13	.22	.14	.09	.12
41	.18	.13	.24	.14	.12	.14
42	.21	.11	.23	.13	.12	.14
43	.23	.08	.22	.13	.11	.16
44	.38	.05	.24	.16	.22	.17
45	.35	.21	.24	.15	.14	.17
46	.44	.24	.24	.19	.22	.19
47	.55	.25	.22	.35	.48	.32
48	.68	.39	.18	.50	.71	.34
49	.59	.21	.24	.49	.71	.32
50	.72	.23	.21	.51	.90	.34

ACCEL. NO. 1 - Z - VERT. IN
ACCEL. NO. 2 - Z - VERT. OUT
ACCEL. NO. 3 - X - HORZ. IN
ACCEL. NO. 4 - X - HORZ. OUT H1
ACCEL. NO. 5 - X - HORZ. OUT H2
ACCEL. NO. 6 - Y - HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY PO. NO 188455
SYSTEMS CONTROL CORP. PROJECT NO. 13374

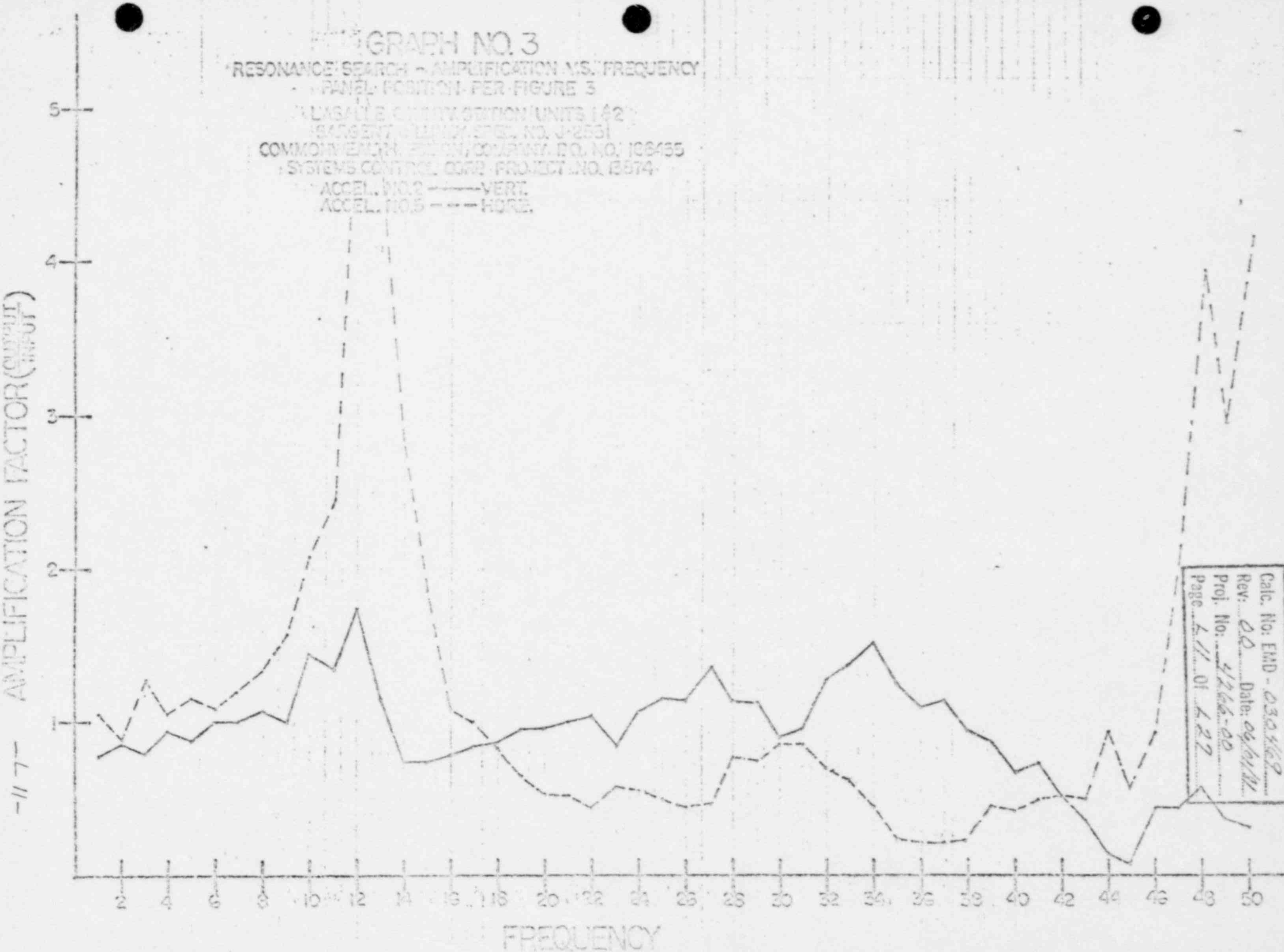

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TABLE NO.7

TYPE OF TEST - RESONANT SEARCH

PER FIG. 4

FREQ.	ACCELERATION IN G'S					
	ACCEL. NO. 1	ACCEL. NO. 2	ACCEL. NO. 3	ACCEL. NO. 4	ACCEL. NO. 5	ACCEL. NO. 6
1	.10	.08	.17	.19	.22	.02
2	.13	.10	.20	.23	.23	.02
3	.13	.10	.21	.24	.26	.02
4	.14	.13	.21	.26	.34	.02
5	.14	.13	.20	.30	.37	.03
6	.14	.12	.20	.61	1.07	.18
7	.15	.12	.20	.41	.91	.11
8	.15	.13	.20	.22	.55	.08
9	.16	.14	.20	.11	.42	.07
10	.20	.15	.25	.08	.35	.07
11	.17	.15	.24	.06	.29	.05
12	.16	.14	.23	.05	.24	.04
13	.15	.14	.25	.04	.20	.04
14	.15	.13	.24	.04	.17	.04
15	.18	.15	.25	.06	.14	.05
16	.15	.14	.21	.06	.13	.07
17	.19	.14	.23	.07	.10	.09
18	.20	.15	.23	.09	.08	.08
19	.19	.14	.21	.10	.05	.12
20	.19	.15	.22	.11	.08	.08
21	.21	.16	.22	.13	.11	.08
22	.21	.17	.23	.12	.14	.06
23	.22	.17	.22	.15	.13	.05
24	.21	.16	.21	.16	.14	.07
25	.25	.20	.24	.16	.15	.12

ACCEL. NO. 1 - Z - VERT. IN
ACCEL. NO. 2 - Z - VERT. OUT
ACCEL. NO. 3 - Y - HORZ. IN
ACCEL. NO. 4 - Y - HORZ. OUT H1
ACCEL. NO. 5 - Y - HORZ. OUT H2
ACCEL. NO. 6 - X - HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY PO. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 13974

TABLE NO. 8

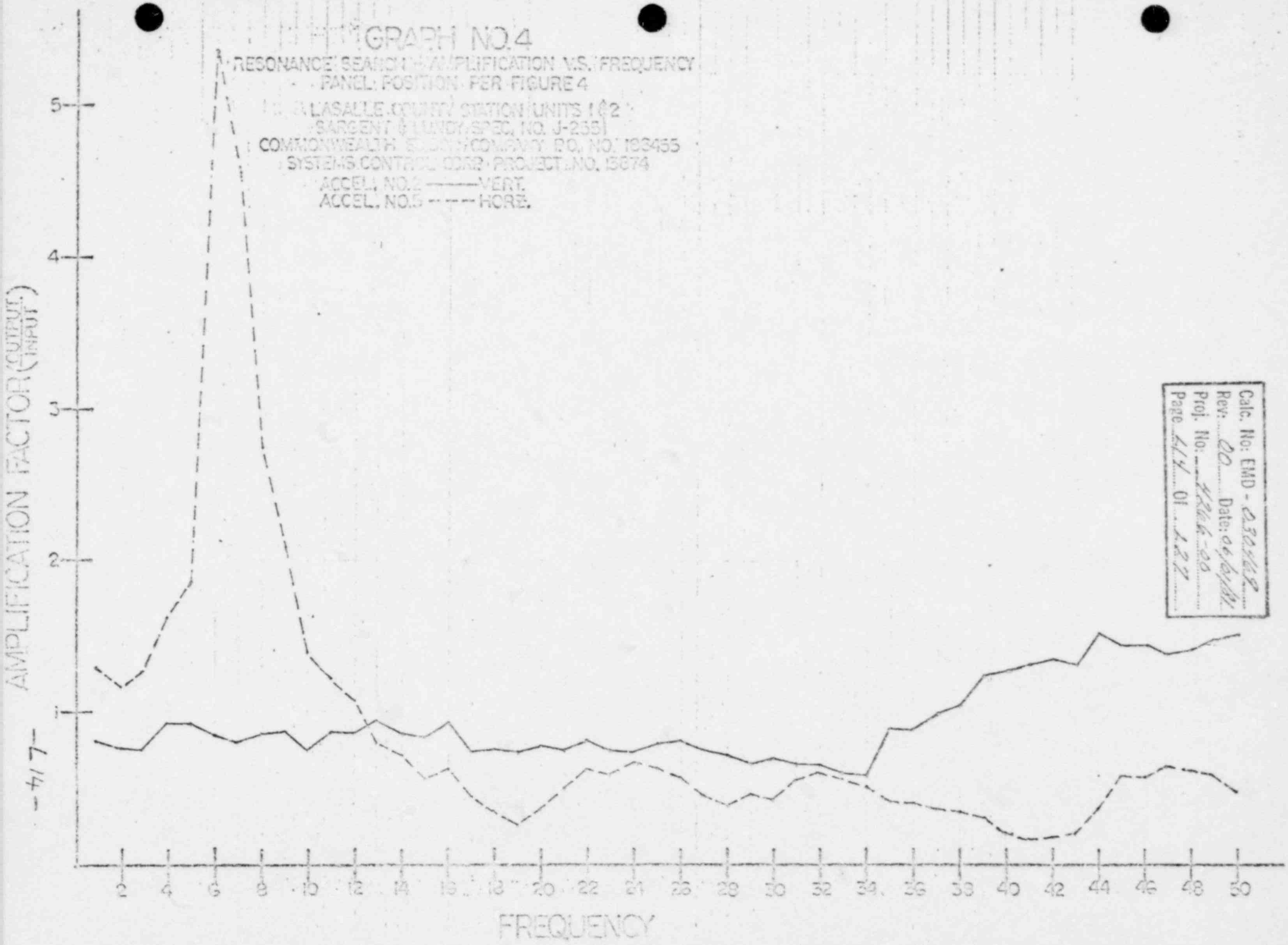
TYPE OF TEST - RESONANT SEARCH

PER FIG. 4

FREQ.	ACCELERATION IN G'S					
	ACCEL. NO. 1	ACCEL. NO. 2	ACCEL. NO. 3	ACCEL. NO. 4	ACCEL. NO. 5	ACCEL. NO. 6
26	.16	.13	.21	.11	.12	.09
27	.20	.15	.24	.16	.11	.07
28	.22	.16	.23	.19	.09	.08
29	.19	.13	.24	.17	.11	.08
30	.20	.14	.24	.20	.10	.10
31	.22	.15	.22	.21	.12	.15
32	.24	.18	.22	.21	.15	.18
33	.21	.17	.22	.21	.14	.19
34	.23	.16	.23	.22	.12	.18
35	.21	.19	.24	.23	.11	.15
36	.20	.18	.22	.20	.10	.19
37	.20	.20	.23	.19	.09	.18
38	.20	.21	.23	.18	.08	.11
39	.21	.26	.22	.16	.07	.11
40	.26	.33	.24	.17	.05	.16
41	.35	.46	.25	.18	.04	.19
42	.40	.54	.23	.20	.04	.25
43	.57	.75	.25	.24	.05	.29
44	.46	.70	.19	.24	.07	.24
45	.50	.73	.22	.38	.13	.26
46	.45	.66	.22	.37	.13	.32
47	.43	.61	.23	.39	.15	.39
48	.39	.56	.24	.33	.15	.46
49	.36	.54	.25	.33	.15	.43
50	.31	.47	.24	.30	.12	.51

ACCEL. NO. 1 - Z-VERT. IN
ACCEL. NO. 2 - Z-VERT. OUT
ACCEL. NO. 3 - Y-HORZ. IN
ACCEL. NO. 4 - Y-HORZ. OUT H1
ACCEL. NO. 5 - Y-HORZ. OUT H2
ACCEL. NO. 6 - X-HORZ. OUT H3

LASALLE COUNTY STATION UNITS 1 & 2
SARGENT & LUNDY SPEC. NO. J-2551
COMMONWEALTH EDISON COMPANY P.O. NO. 186455
SYSTEMS CONTROL CORP. PROJECT NO. 15874



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```
S RECORDS IN USE
REC 1:      11.150 HZ
REC 2:      13.740 HZ
REC 3:      18.130 HZ
REC 4:      30.790 HZ
REC 5:      36.930 HZ
REC 6:      41.130 HZ
REC 7:      47.450 HZ
REC 11:      11.150 HZ   SHAPE 1 MODIFIED
REC 12:      13.740 HZ   SHAPE 2 MODIFIED
REC 13:      18.130 HZ   SHAPE 3 MODIFIED
REC 14:      30.790 HZ   SHAPE 4 MODIFIED
REC 15:      36.930 HZ   SHAPE 5 MODIFIED
REC 16:      41.130 HZ   SHAPE 6 MODIFIED
REC 17:      47.450 HZ   SHAPE 7 MODIFIED
$
```

- L15 -

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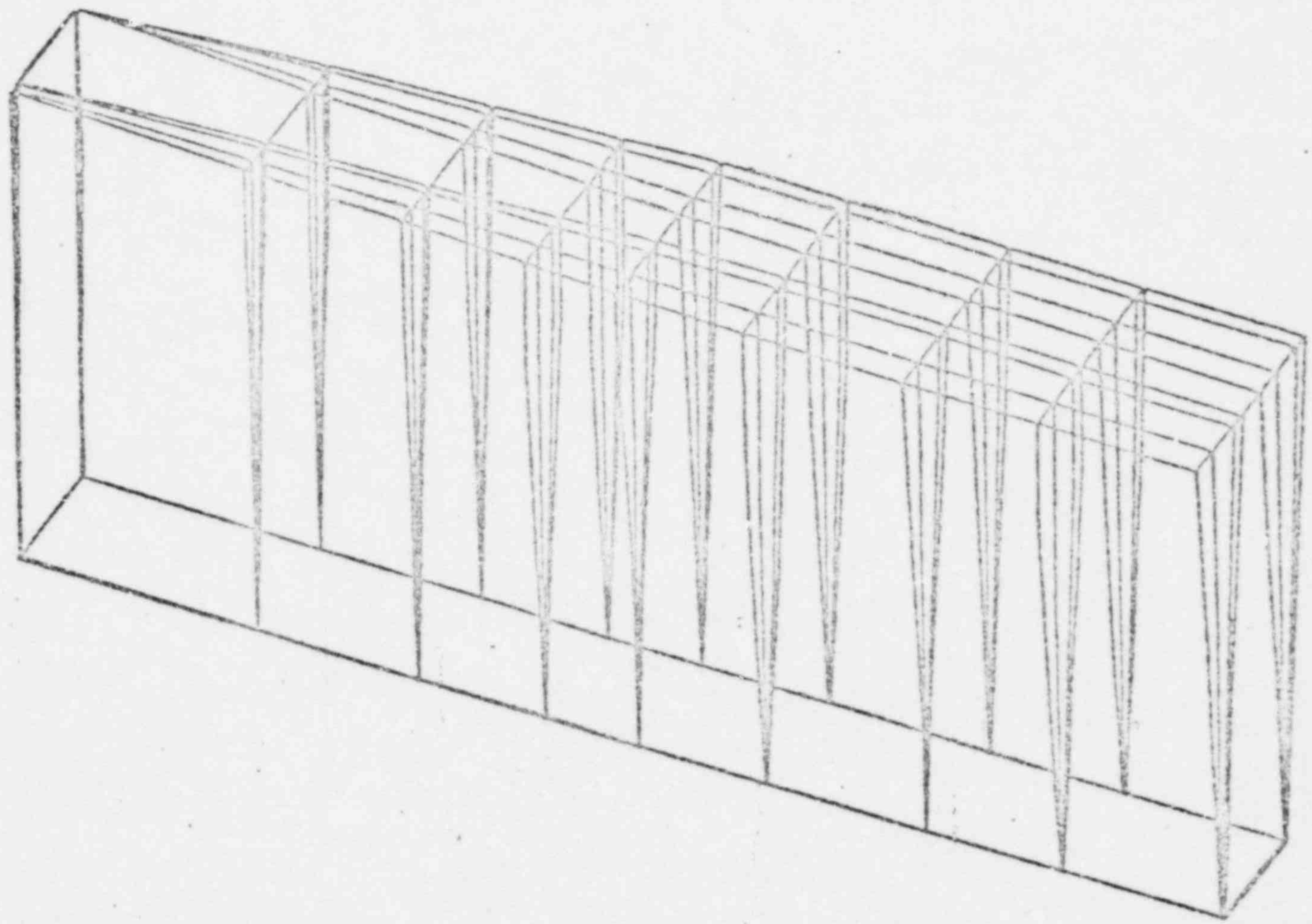

SHAPE 1 MODIFIED
11: S2Z+ COMP,F= 11.150 HZ (0.5, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030469
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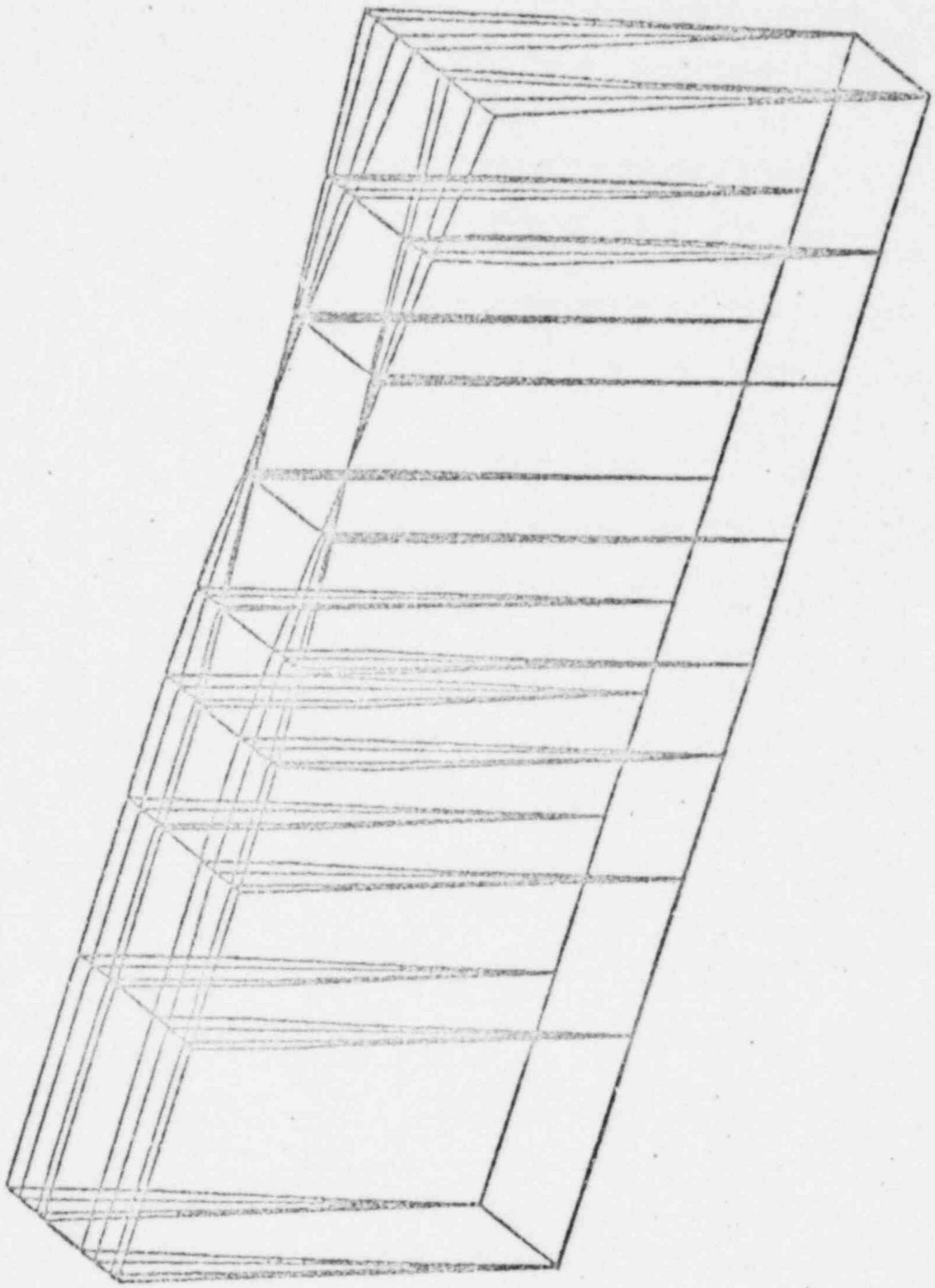
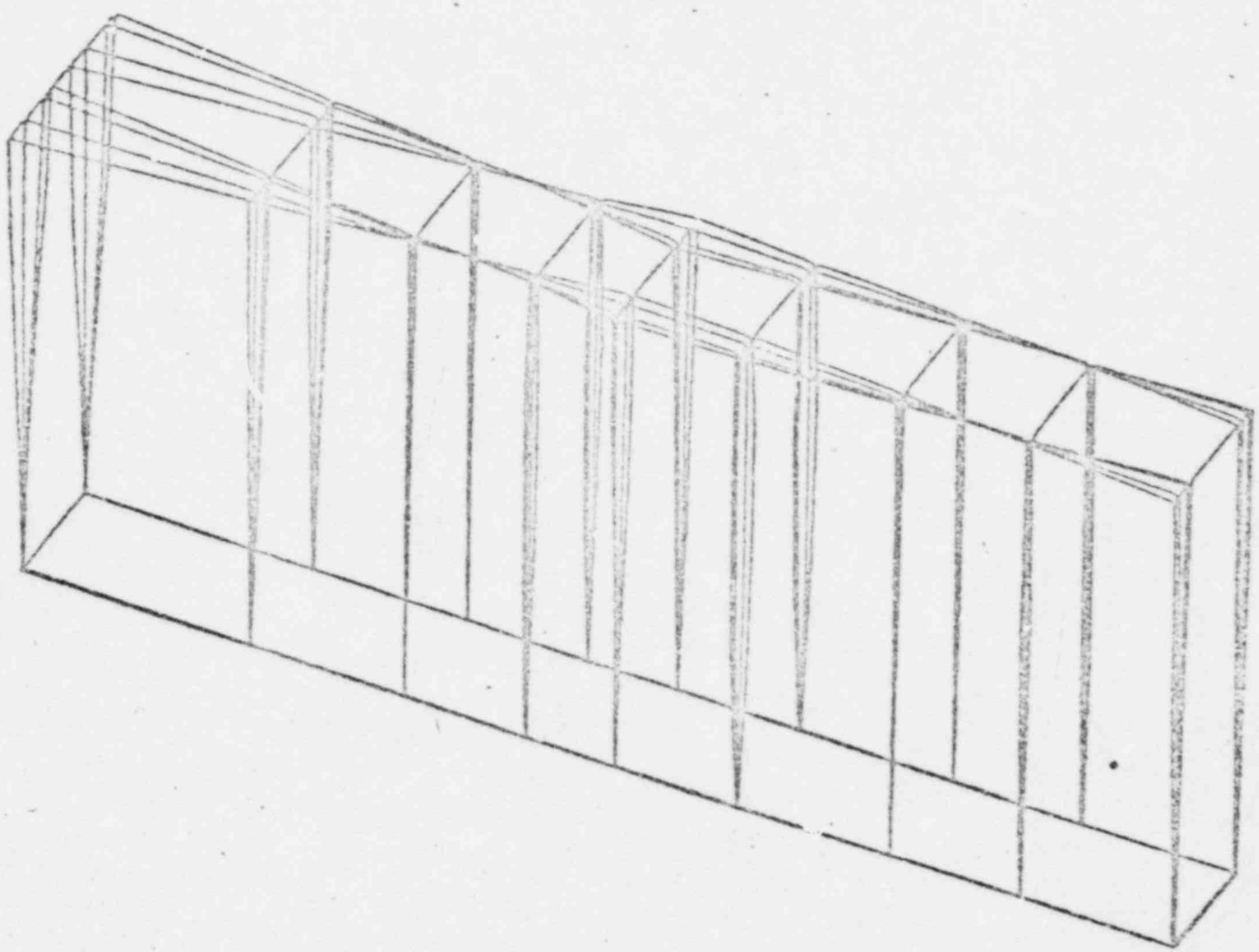


SHAPE 2 MODIFIED
12: 522+ COMP,F= 13.740 HZ (0.5, 1.0, 1.0, 0.0)=VIEW

127



SHAPE 3 MODIFIED
13: 52Z+ COMP,F= 18.130 HZ (0.5, 1.0, 1.0, 0.0)-VIEW

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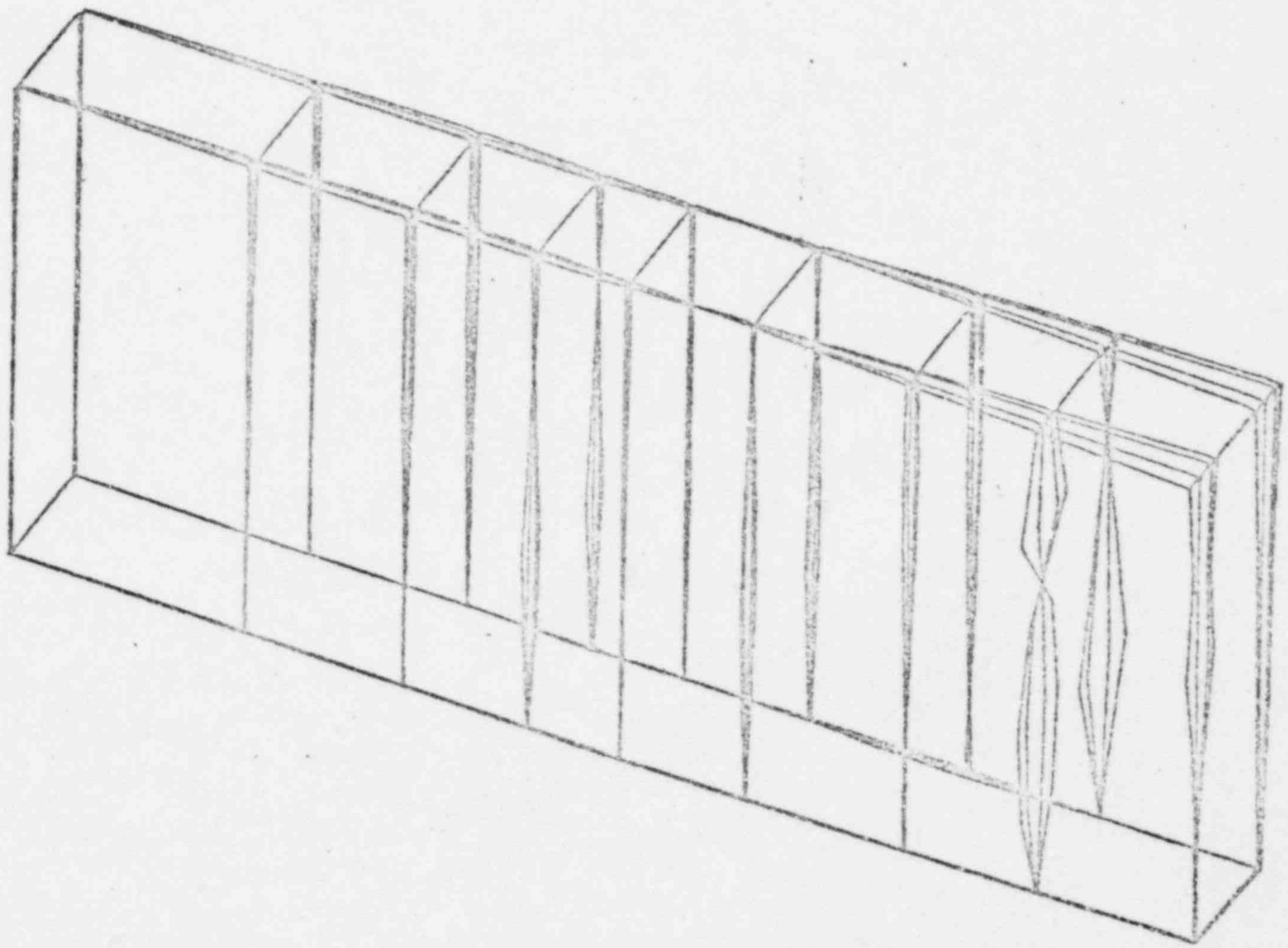

SHAPE 4 MODIFIED
14: 522+ COMP,F= 30.790 HZ (0.5, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030469
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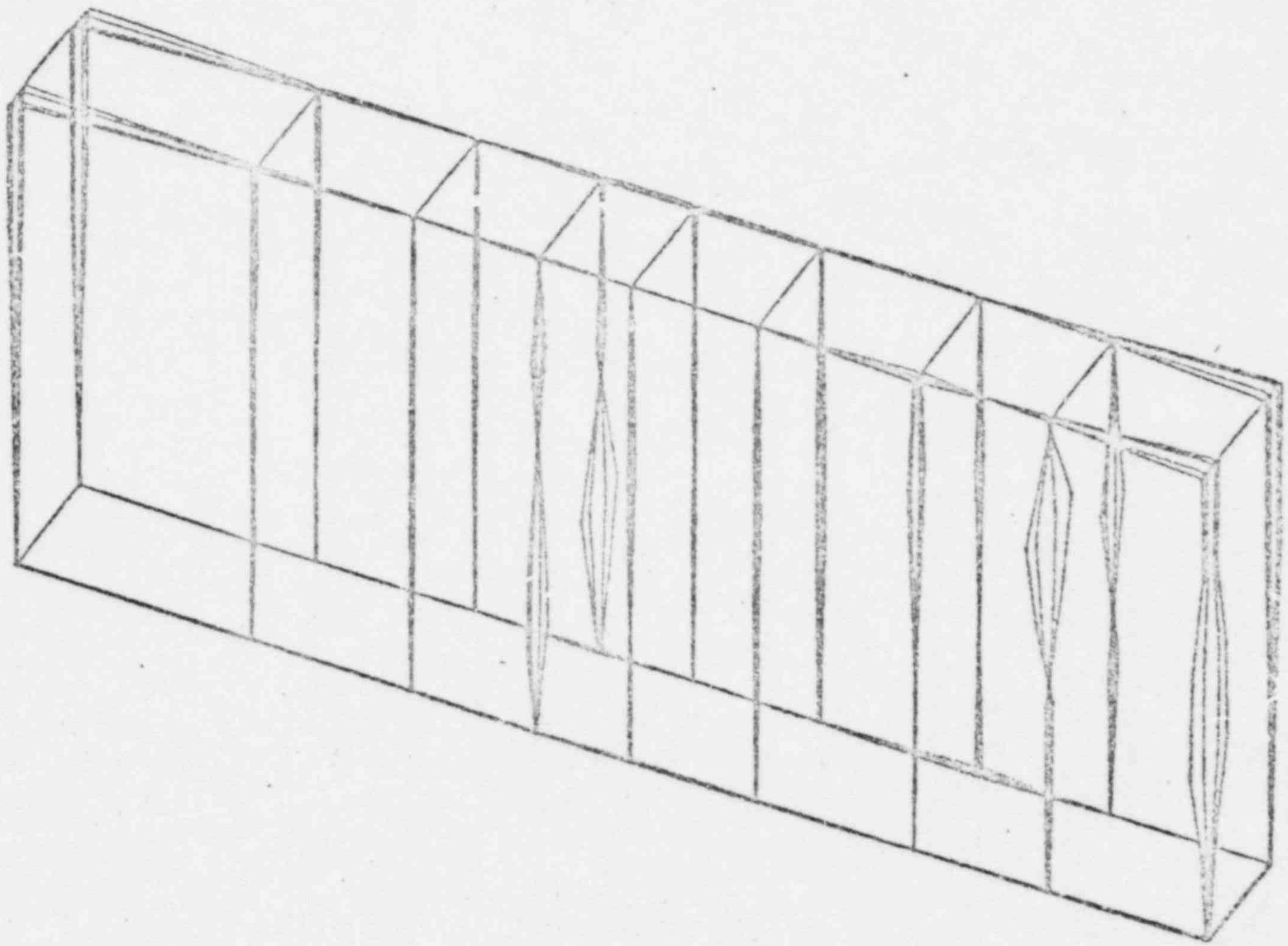

SHAPE 5 MODIFIED
15: 52Z+ COMP.F= 36.930 HZ (0.5, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD-030469
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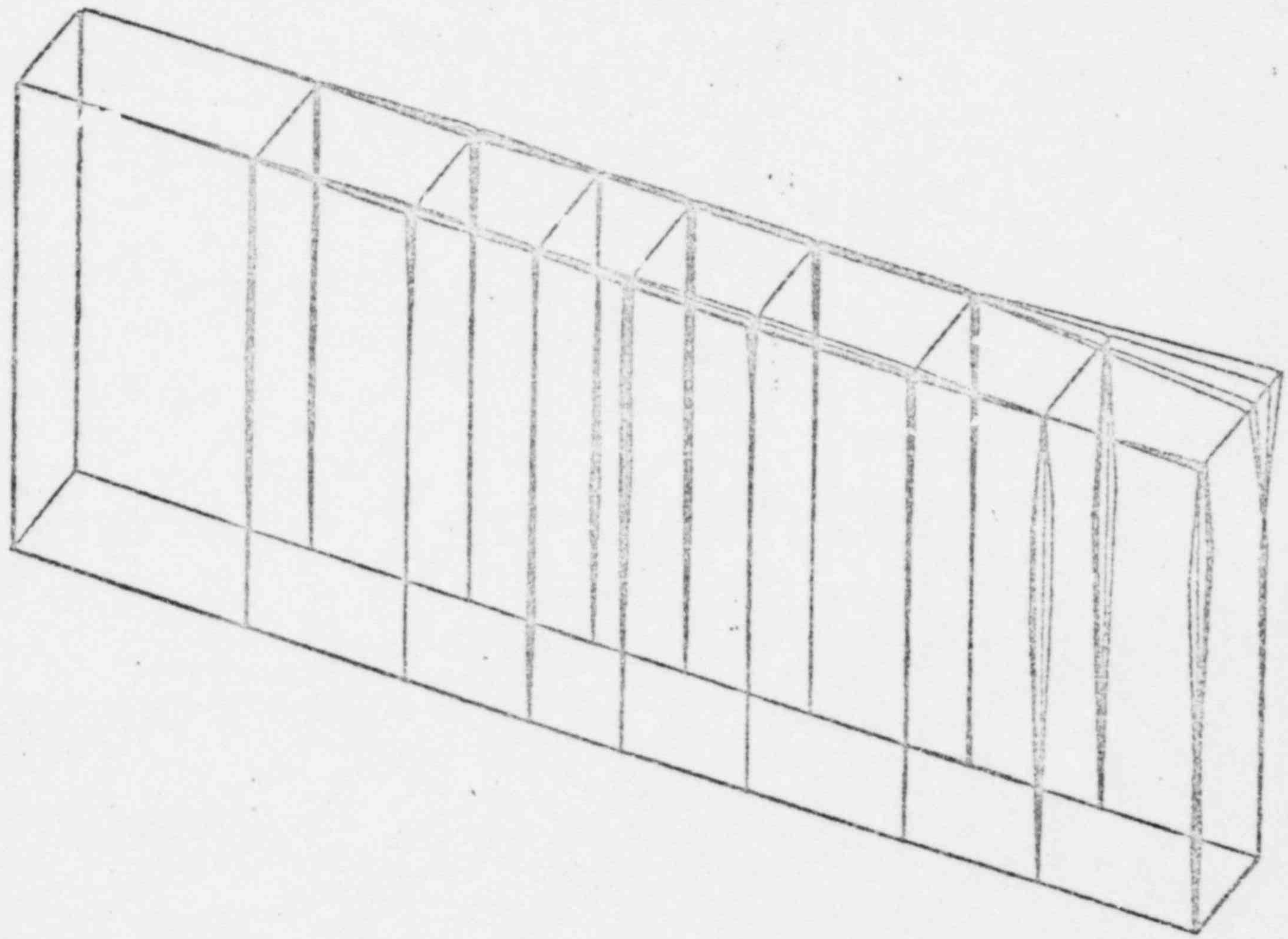

SHAPE 6 MODIFIED
16: 52Z+ COMP,F= 41.130 HZ (0.5, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030469
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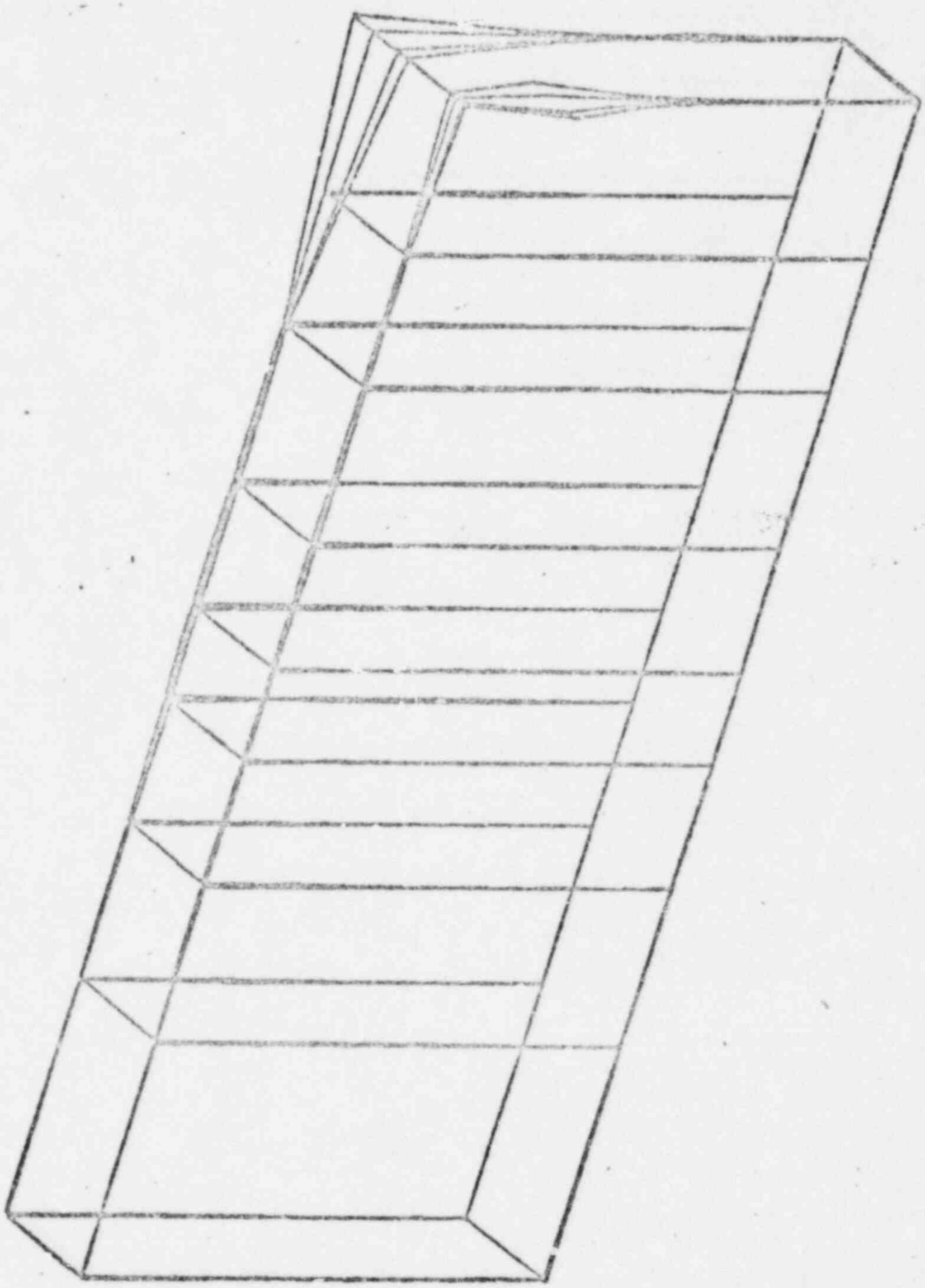


SHAPE 7 MODIFIED
17: 52Z+ COMP,F= 47.450 HZ (0.5, 1.0, 1.0, 0.0)=VIEW

133

^$

.1.00E-02

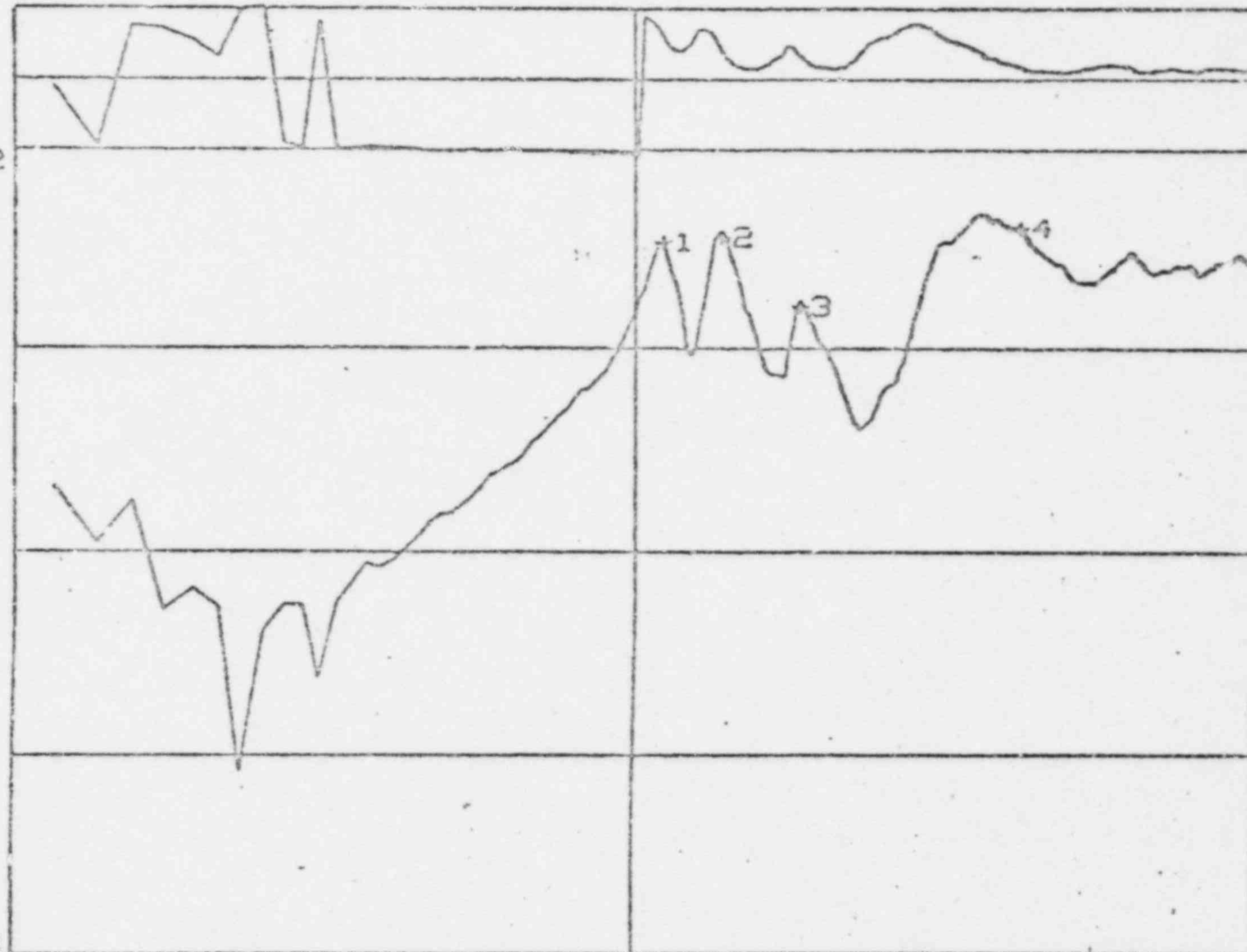
1F= 1.096E 01
1M= 3.607E-03

2F= 1.365E 01
2M= 3.789E-03

3F= 1.820E 01
3M= 1.693E-03

4F= 4.121E 01
4M= 4.252E-03
^$

1.00E-06



1.00E 00 1.00E 0

A1:LA SAL 250V DC CNTL $

072580-000000 FREQRESP-BODE
030581-000000 52Z÷ 52Z÷ 80:

REQUIRED RESPONSE SPECTRUM CURVE

(EMERGENCY CONDITION)

FOR

1 DC06E

250 V DC DIST. EQUIPMENT

LOCATED IN

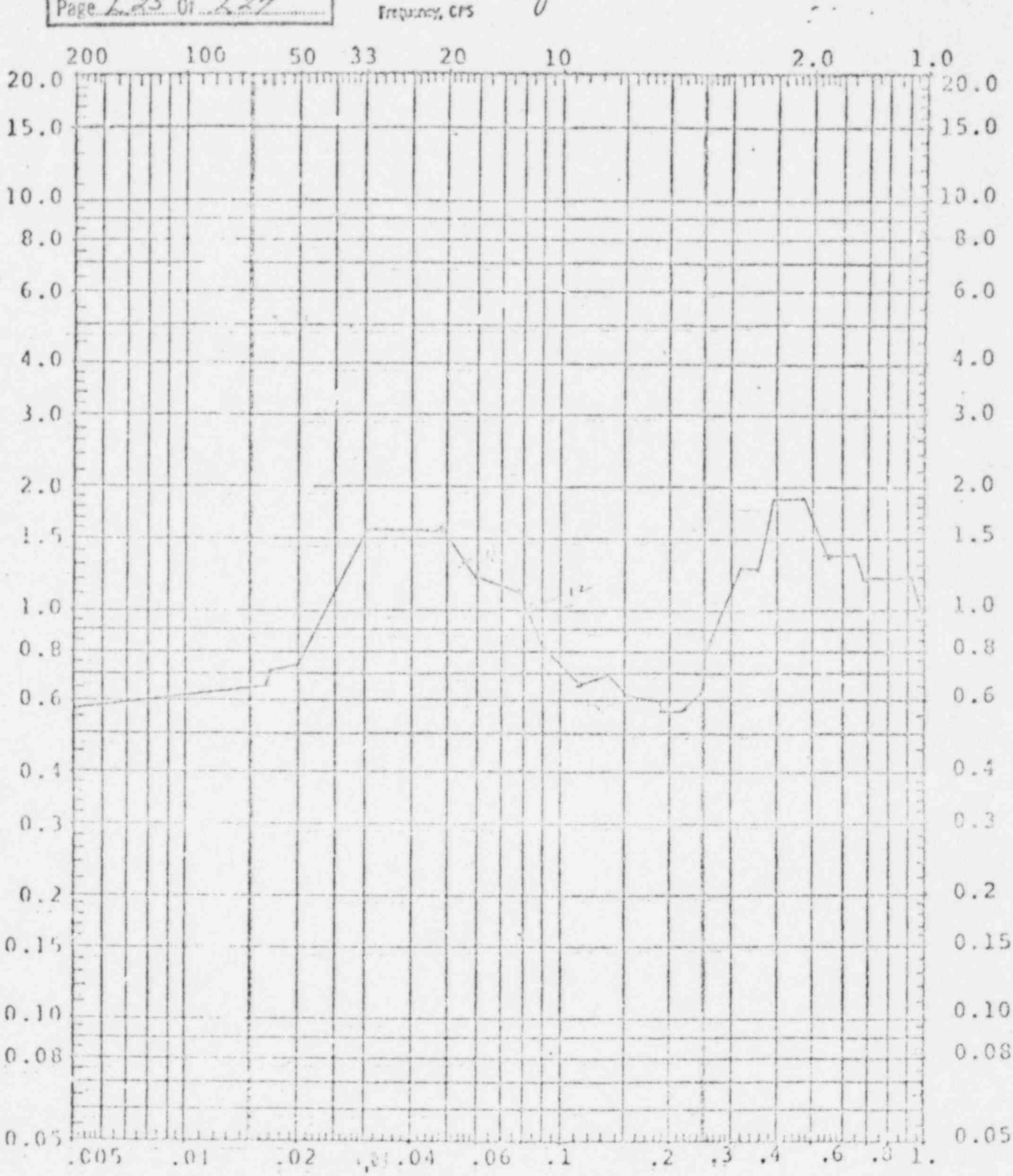
REACTOR BUILDING El. 694'0"

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 3289-18
DESIGN BY [illegible] DATE 1-22-80
CHECKED BY [illegible] DATE 1-22-80 SHEET 4 OF 27

SARGENT & LUNDY ENGINEERS

Calc. No: EMD-030469
Rev: 00 Date: 04/11/81
Proj. No: 4266-00
Page L25 Of L27

REV. NO.	0						
DATE	1-22-80						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 694'6" 2% Damping Horizontal Slab NS-EW

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

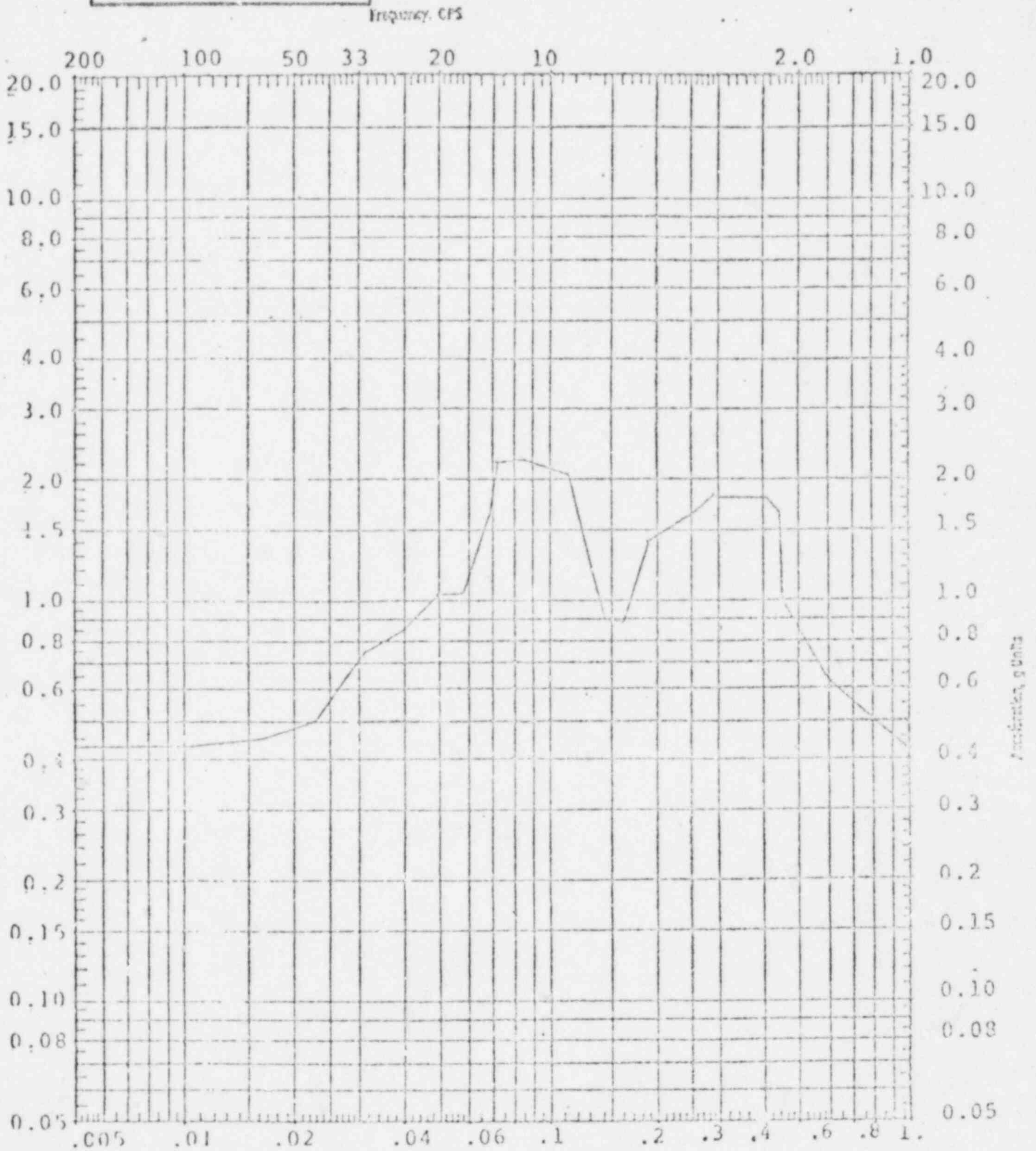
c) SSE + CHUG + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4389-18
DESIGN BY Salonen DATE 1/22/80
CHECKED BY [illegible] DATE 1-22-80 SHEET 6 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
Page L26 Of L27

REV. NO.	0						
DATE	1-22-80						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 694'6" 2% Damping Vertical Wall

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

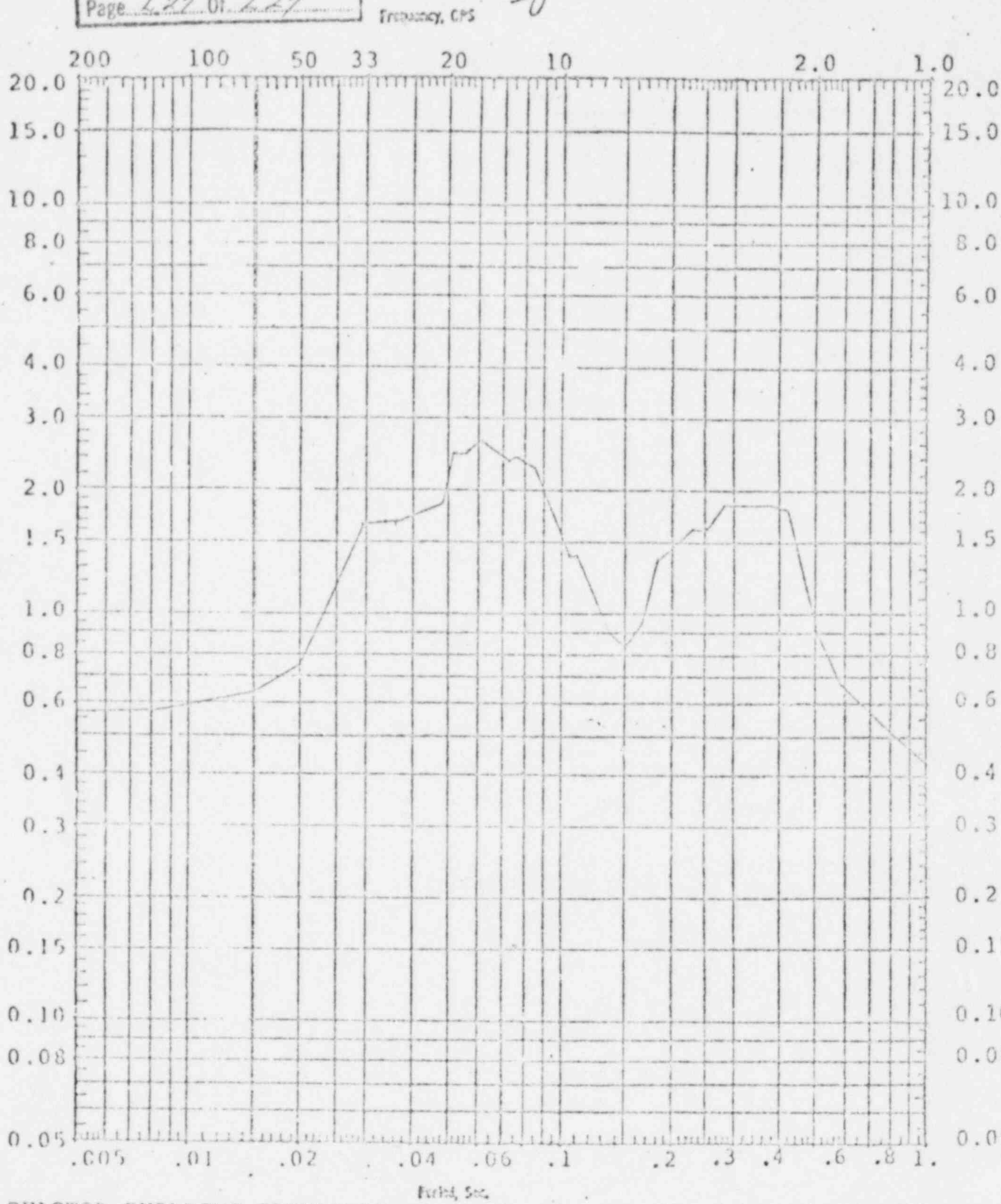
—L26—

SARGENT & LUNDY
ENGINEERS

PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 3287-48
DESIGN BY S. Young DATE 1-22-80
CHECKED BY C.S. DATE 1-22-80 SHEET 5 OF 27

Calc. No: EMD-030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
Page L27 Of L27

REV. NO.	0						
DATE	1-22-80						
INITIALS							



REACTOR BUILDING-ELEVATION: 694'6" 2% Damping Vertical Slab

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

I. OBJECTIVES

The objectives of this study are:

(i) To compare and draw conclusions on equipment adequacy based on the impedance test result and the existing qualification report.

(ii) To determine equipment adequacy for the additional hydrodynamic loads. This is of additional concern in view of the high frequency resonances reported in the impedance tests.

II. ANALYTICAL MODEL [2]

The finite element model of the panel consists of 138 beam elements and 65 plate elements. Maximum values of acceleration found along the X, Y, Z axes are respectively 0.79 g, 1.09 g and 0.46 g. The maximum deflection of 0.0379" was found along the X axis. A total of twenty frequencies ranging from 13.89 Hz to 60.26 Hz are identified. [2]

In the finite element modeling of the structure portions of the structure that do not substantially contribute to structure strength or rigidity are ignored and the mass lumped at the closest nodal points. The structure mode-shape is determined by monitoring structure response at selected representative points. The following representative points indicated on the panel below are selected. Nodal numbering is as in the original qualification report.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For		Calc. No.	
	Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
			Page M2	of M20

Client Commonwealth Edison Company		Prepared by	Date
Project LaSalle County, Units I & II		Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No.	Approved by	Date

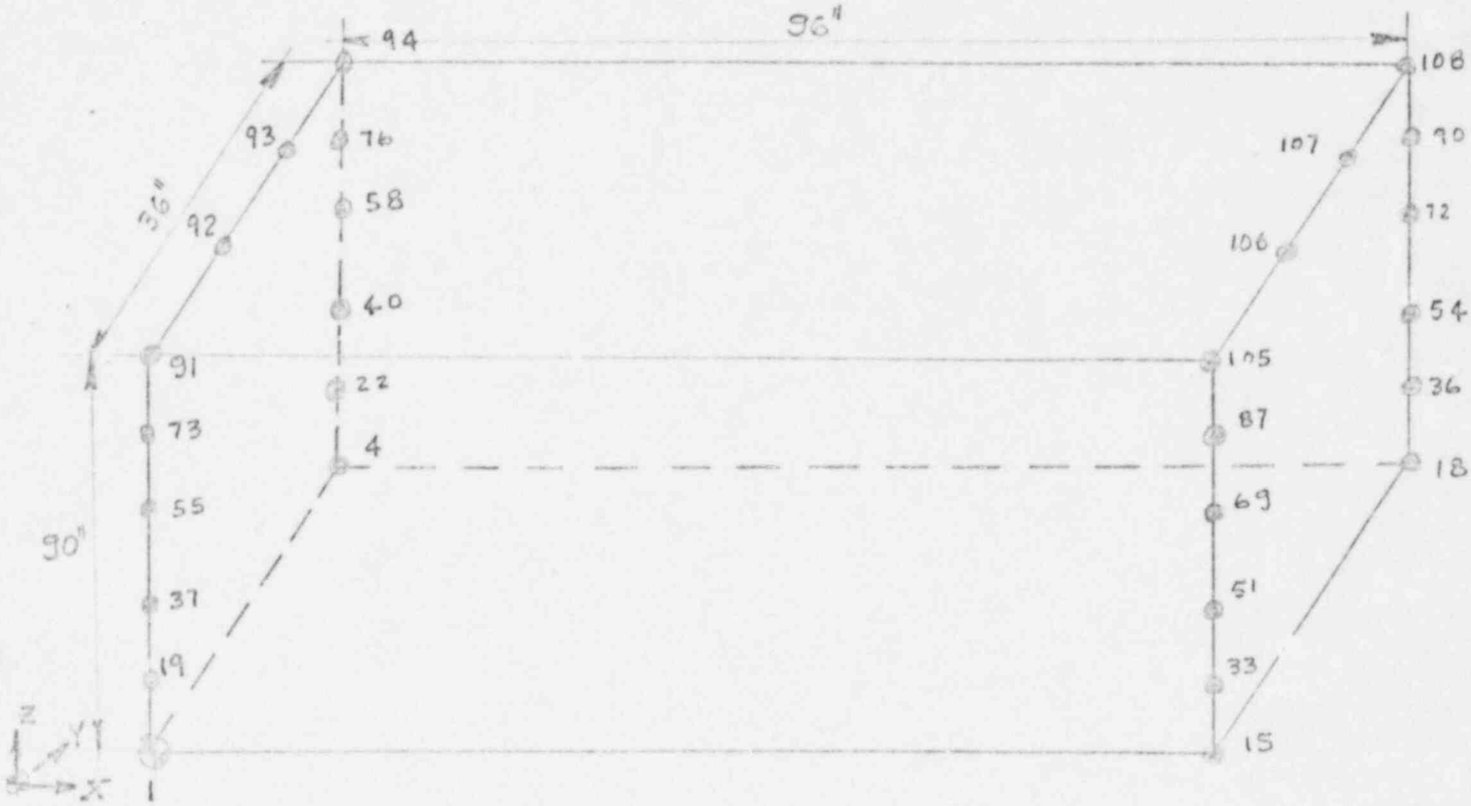


FIGURE - 1 .

III. LIST OF EXPERIMENTAL & ANALYTICALLY OBTAINED FREQUENCIES

Experimentally Obtained Frequencies [1]

Equipment Frequency Hz.	Remarks - (Based on Mode Shape)
19.34	Global Cantilever Mode bending along vertical axis
23.19	Cantilever Mode: Bending along vertical & longer in plane axes
41.12	Local Mode of Panel
44.13	" " " "
48.66	" " " "
57.37	" " " "
68.11	" " " "
70.45	" " " "
82.15	" " " "
91.86	" " " "

Frequencies of Attachments to Panel Board

Frequency (Hz)

17.9
22.87
41.92
53.64
67.384
72.671
17.95
28.58
39.83
42.57
64.63

The above are local frequencies of attachments to the structure. Note the first two frequencies 17.9 Hz & 22.87 Hz are close to the two global modes identified earlier.

LIST OF ANALYTICAL FREQUENCIES

PRINT OF FREQUENCIES

MODE NUMBER	CIRCULAR FREQUENCY (RAD/SEC)	FREQUENCY (CYCLES/SEC)
1	.8791+02	.1399+02
2	.1079+03	.1718+02
3	.1649+03	.2625+02
4	.1687+03	.2685+02
5	.1726+03	.2747+02
6	.2356+03	.3750+02
7	.2371+03	.3773+02
8	.2374+03	.3778+02
9	.2505+03	.3987+02
10	.2521+03	.4012+02
11	.2633+03	.4190+02
12	.2691+03	.4283+02
13	.2725+03	.4338+02
14	.3022+03	.4810+02
15	.3055+03	.4863+02
16	.3218+03	.5122+02
17	.3276+03	.5214+02
18	.3437+03	.5471+02
19	.3763+03	.5990+02
20	.3786+03	.6025+02

DISCUSSION OF EXPERIMENTALLY OBTAINED FREQUENCIES & MODE SHAPES

In the experimental analysis (1) accelerometers are located both on the panel as well as on attachments to the panel. Items attached to the panel exhibit resonant behavior independent of panel resonances. These resonances are of a local nature and do not influence global structure behavior.

A total of ten frequencies are associated with panel vibration ranging from 19.340 Hz to 91.860 Hz. Eleven frequencies ranging from 17.90 Hz to 72.67 Hz are identified for attachments to the panel.

A cantilever mode of vibration is associated with a frequency of 19.34 Hz. This is a global mode affecting the entire structure.

The second mode is also a global mode. However, the left hand portion of the structure undergoes no motion almost simulating a fixity condition on the left hand side. A frequency of 23.19 Hz is associated with this mode.

The remainder of the panel frequencies are strictly local and do not correspond to any global mode of deformation. These frequencies fall in the Z.P.A. range of the response spectrum, and hence will have no significant effect. The mode shapes of the panel attachments are strictly local and do not influence any global modes. Also, it should be noted that these frequencies fall in the Z.P.A. range of the response spectrum (Page M16-20); and again are not significant.

COMPARISON OF EXPERIMENTAL & ANALYTICAL EQUIPMENT FREQUENCIES

Twenty frequencies ranging from 13.89 Hz to 60.25 Hz have been computed. The first mode corresponds to a vibratory mode dominant along the longer of the in plane axis. Since the equipment was not excited along this axis this frequency (13.89 Hz) has not been found in the experimental analysis.

Mode 2 (equipment frequency = 17.18 Hz) corresponds to a cantilever - type of vibration. This frequency compares well with the experimentally determined frequency of 19.34 Hz. This mode shape is schematically shown on page M12.

Mode 3, also a bending mode has a resonant frequency of 26.25 Hz. This frequency compares well with the 23.19 Hz frequency determined from the impedance test.

Frequencies greater than 26.25 Hz - computed and 23.19 Hz - experimentally determined, correspond to panel local modes. Also, on examination of the response spectra charts p. 17-21 indicates that for frequencies greater than 20 Hz Z.P.A. range is reached.

The frequency of vibration of modes 1 & 2 of the attachment to the panel board corresponds closely to the global modes. The remainder of the modes are local and do not affect the panel board since these frequencies fall in the Z.P.A. range. A typical vibratory mode for the panel-attachment is shown on page M15.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For			Calc. No.	
				Rev. 00	Date 06/01/81
	X Safety-Related		Non-Safety-Related	Page M7	of M2C

Client Commonwealth Edison Company	Prepared by	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

QUALIFICATION FOR HYDRODYNAMIC LOADS

This equipment is not subject to hydrodynamic excitation and the combined spectra shown in pages M16 thru M20 is the spectra used for the analytical results. Hence, the equipment is qualified for the required spectra.

CONCLUDING REMARKS

The vertical panel board was excited only along the shorter of the in plane axis. As a result a lower natural frequency associated with motion along the longer axis is not picked up by the Impedance Test. The next two modes obtained from the Impedance Test compare well with the analytically obtained modes. No hydrodynamic loads are involved, and since the original qualification report used identical response spectra curves the equipment is qualified. The equipment local modes consisting of both the vibratory motion of attachments to the panel as well as the local modes of the panel fall in the Z.P.A. range and hence, are not of significance.

REFERENCES

1. Main Control Panel Vertical Board Transitek, Inc. EMD File No. 029473.

2. Qualification Documents for Motor Operated Gate Valve EMD File No. 028900, Dated 3/17/81.

4

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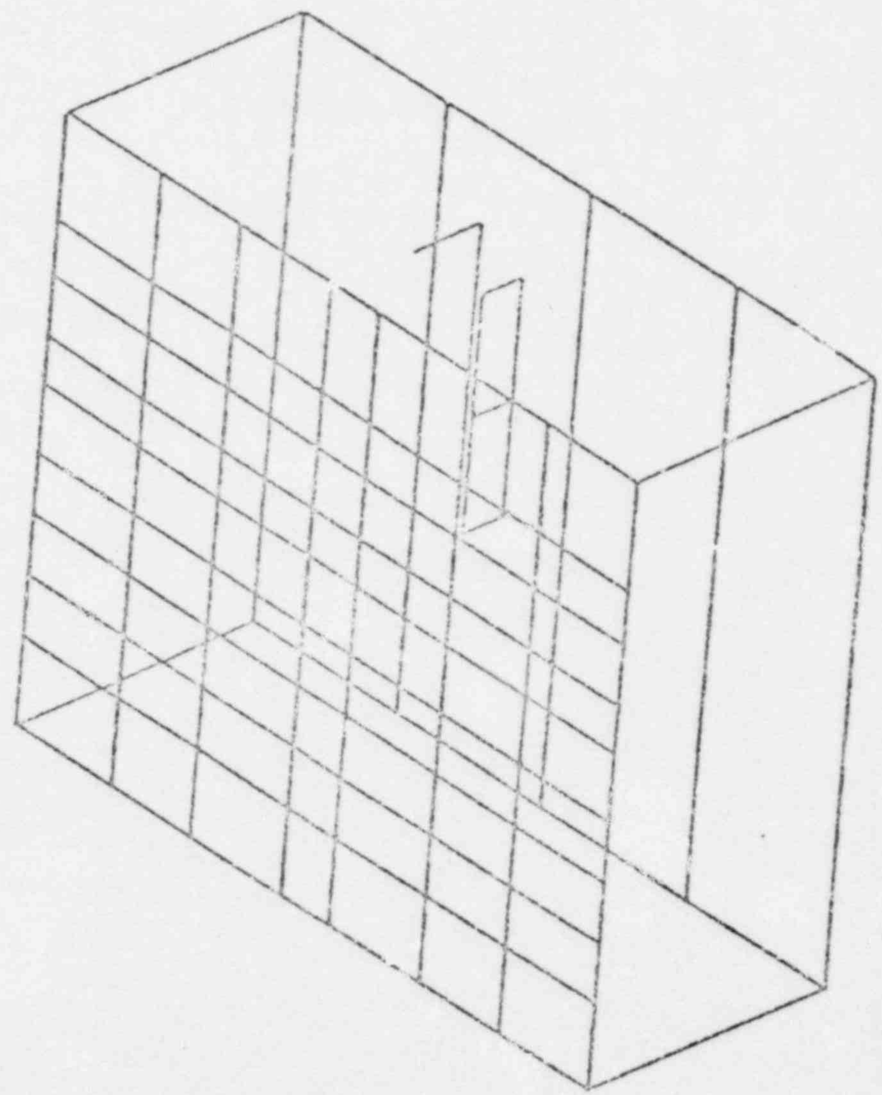

TEST MODEL

0: 0 UND.,F" UNDEFINED (1.0, 1.0, 1.0, 0.0)-VIEW

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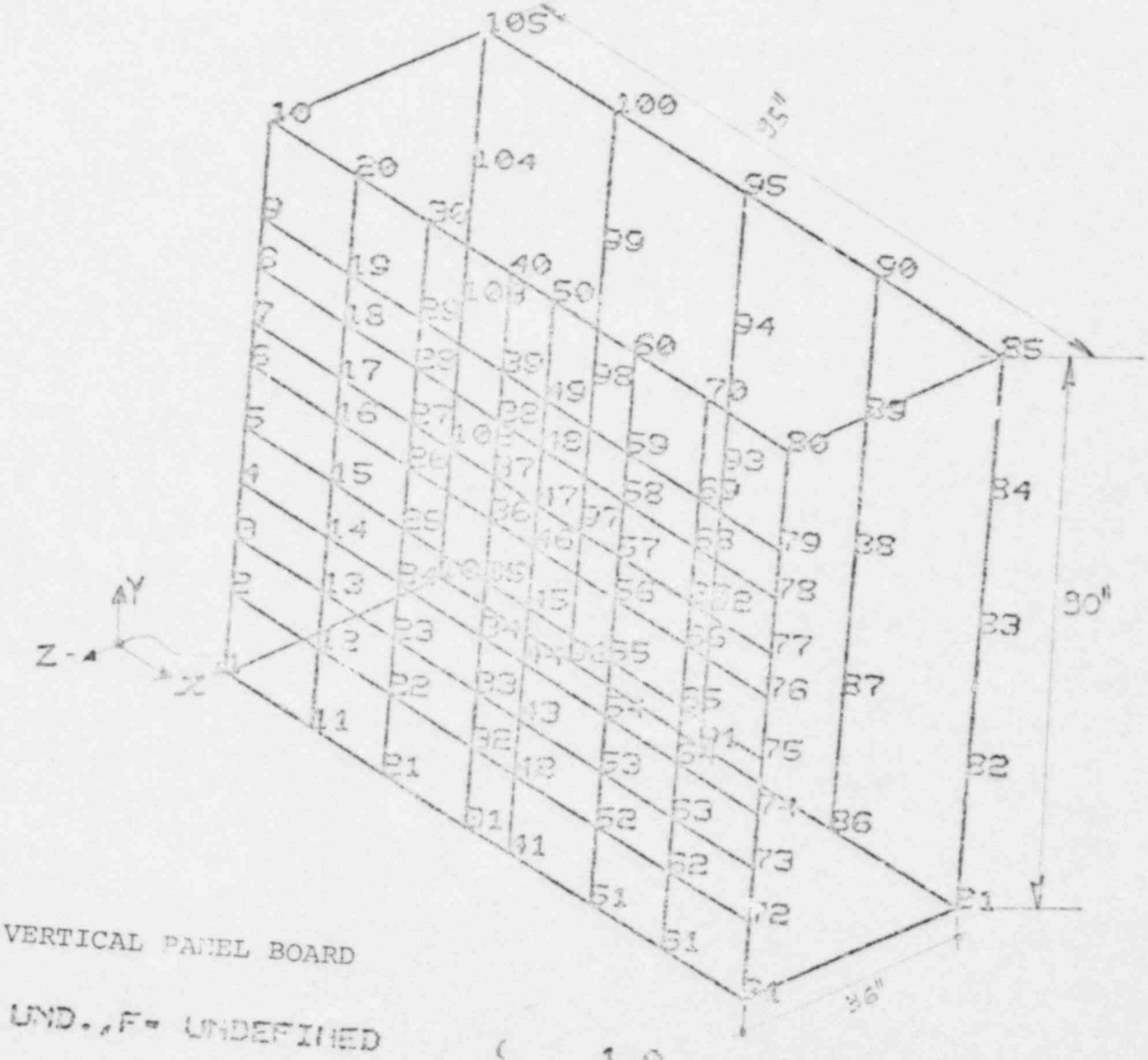

VERTICAL PANEL BOARD

0: 0 UND.,F= UNDEFINED (1.0, 1.0, 1.0, 0.0)=VIEW

10

Calc. No: EMD - 030469
Rev: 0 D Date: 6-1-81
Proj. No: 4266-10
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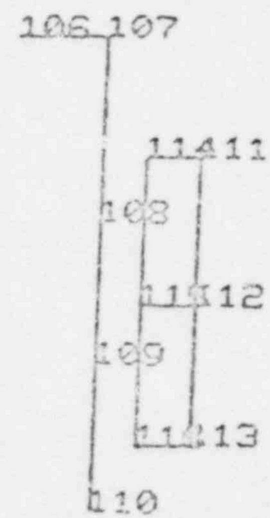

ATTACHMENT TO PANEL BOARD

0:   0   UND.,F= UNDEFINED   (1.0,   0.2,   0.2,   0.0)=VIEW

136

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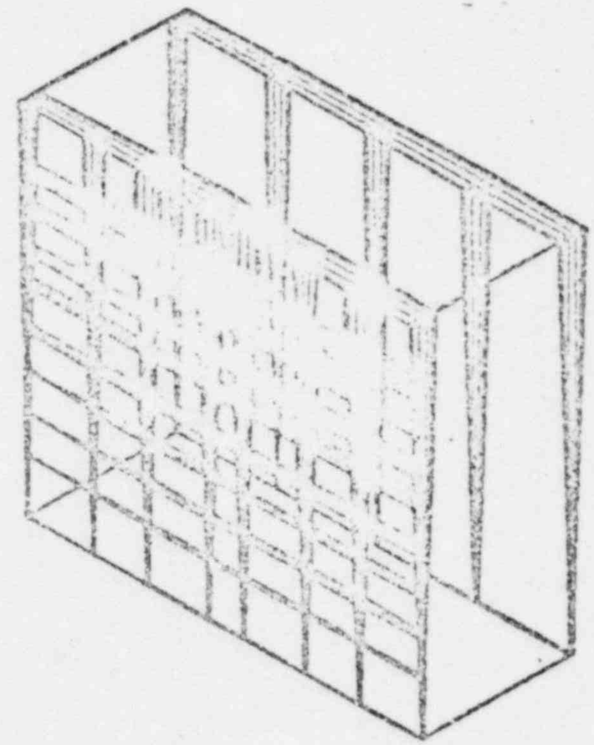

GLOBAL CANTILEVER MODE SHAPE

1: 59Z- REAL,F= 19.340 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

137

Calc. No: EMD - 630469
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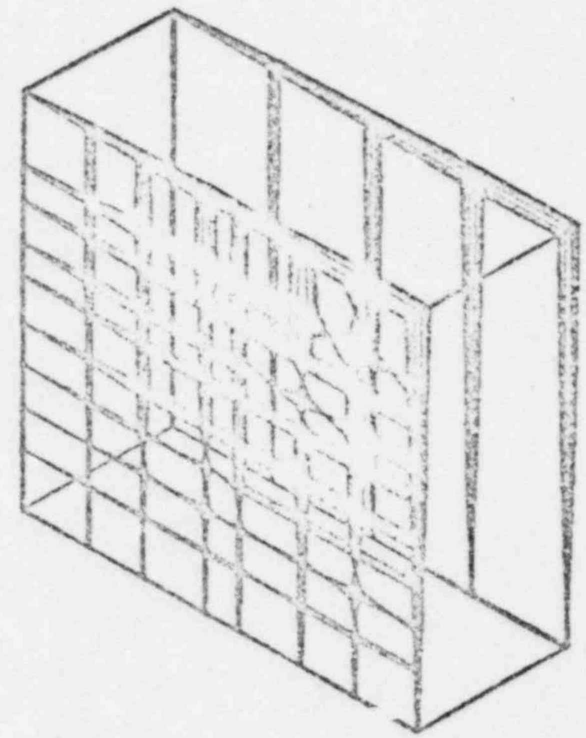

GLOBAL CANTILEVER MODE SHAPE

2: 59Z- REAL,F= 23.190 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030469
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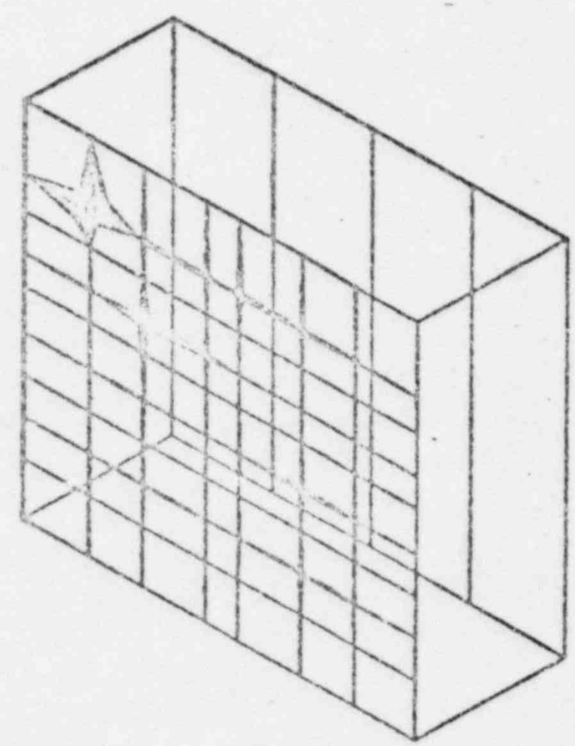
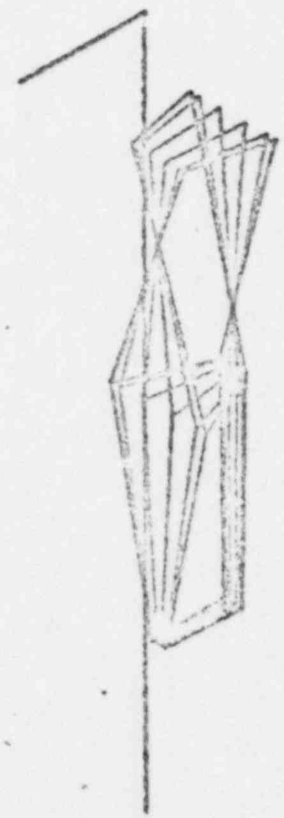


PANEL LOCAL MODE

3: 59Z- REAL,F= 41.120 HZ (1.0, 1.0, 1.0, 0.0)=VIEW



VIBRATORY MOTION OF ATTACHMENT

X-AXIS DATA ONLY

3: 111X+ REAL,F= 41.920 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030464
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Calc. No: EMD-030469
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Proj. No: 4266-00
Page M16 Of M20

REQUIRED RESPONSE SPECTRUM CURVE

(EMERGENCY CONDITION)

FOR

1 H13 - P609

MAIN CONTROL VERTICAL BOARD

LOCATED IN

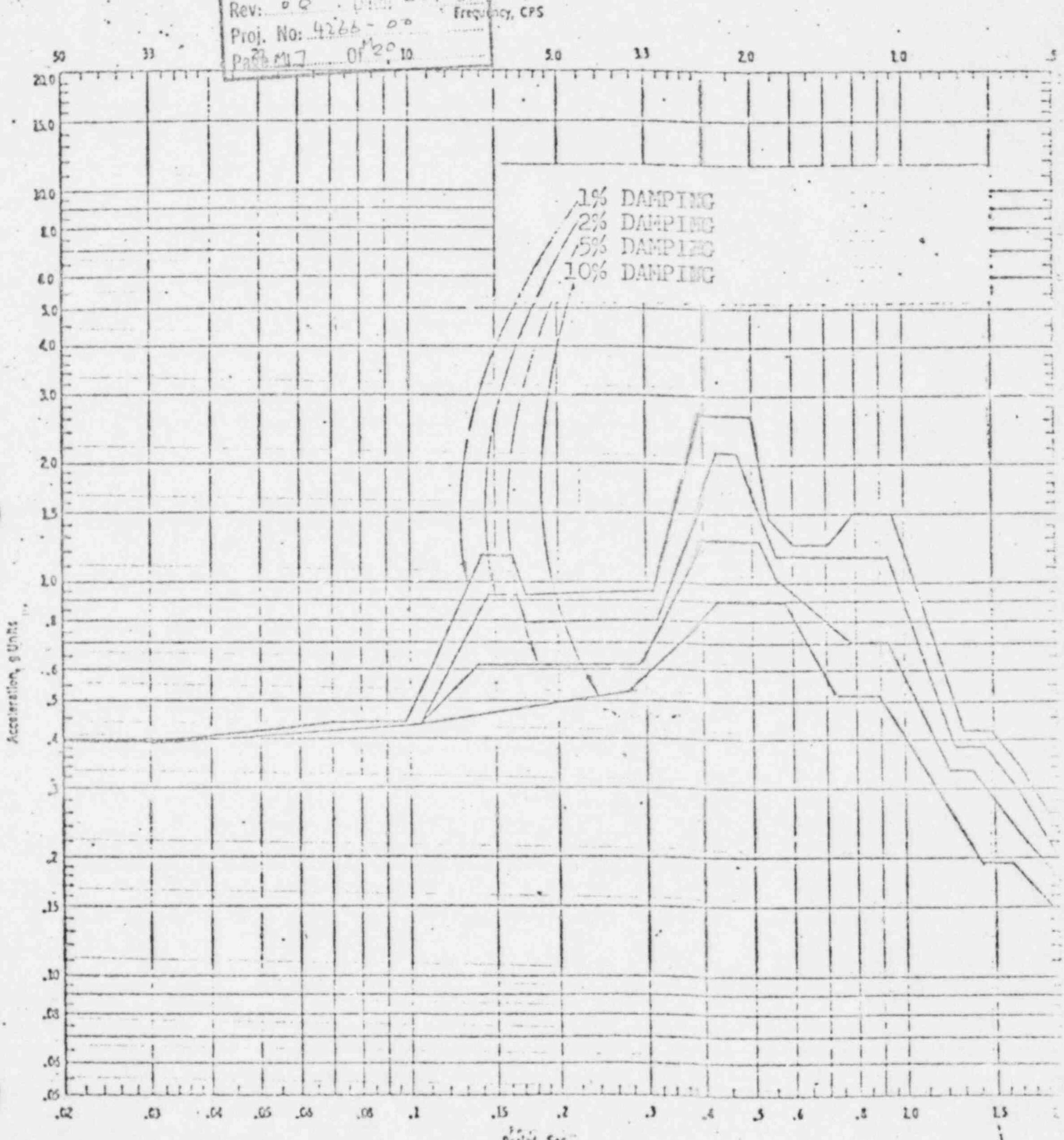
AUXILIARY BUILDING EL. 768'0"

SARGENT & LUNDY ENGINEERS

CLIENT [illegible] CO.
PROJECT LA SALLE COUNTY STATION JOB NO. [illegible]
DESIGN BY A.M. DATE 11-14-72
CHECKED BY B.D. DATE 11-15-72 SHEET [illegible] OF [illegible]

REV. NO.	1
DATE	1-27-73
INITIALS	RS

Calc. No: [illegible]-030469
Rev: 00 Date: 6-1-81
Proj. No: 4266-00
Page M17 Of M20



HORIZONTAL FLOOR RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
NORTH-SOUTH COMPONENT
ELEVATION 786'-0" (SLAB NO. 14)

SPECTRA NO.
120-DB-NS
114-DB-NS

SARGENT & LUNDY ENGINEERS

CLIENT ____

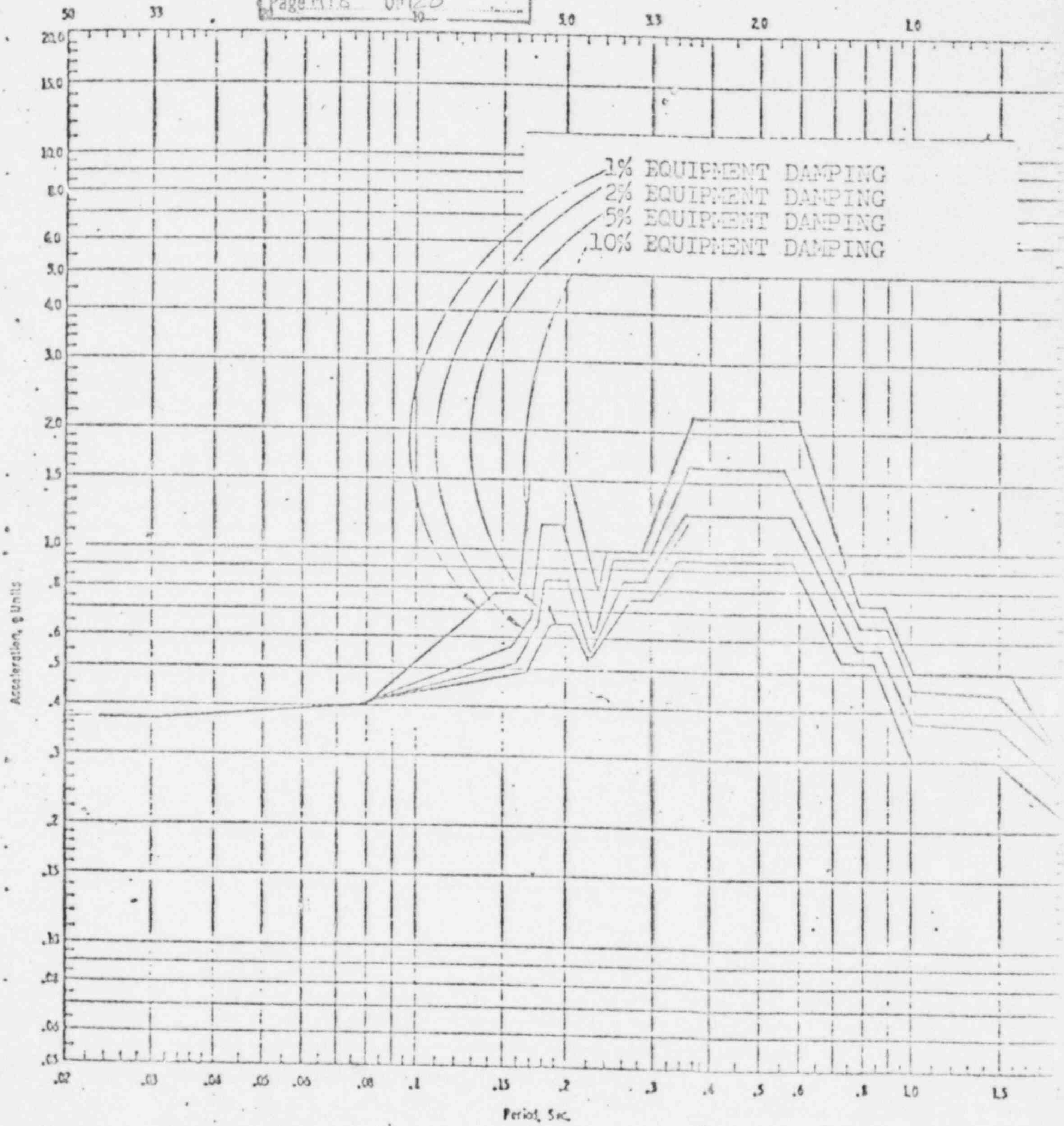
PROJECT LA SALLE COUNTY STATION JOB NO. ____

DESIGN BY A.M. DATE 11-14-72

CHECKED BY B D DATE 11-15-72 SHEET ____ OF ____

REV. NO.	1					
DATE	2-27-73					
INITIALS	RS					

Calc. No. EMD 030469
Rev: 00 Date: 6-1-81
Proj. No: 4266-00
Page M18 0/M20



HORIZONTAL FLOOR RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
EAST-WEST COMPONENT
ELEVATION 768'-0" (SLAB NO. 14)

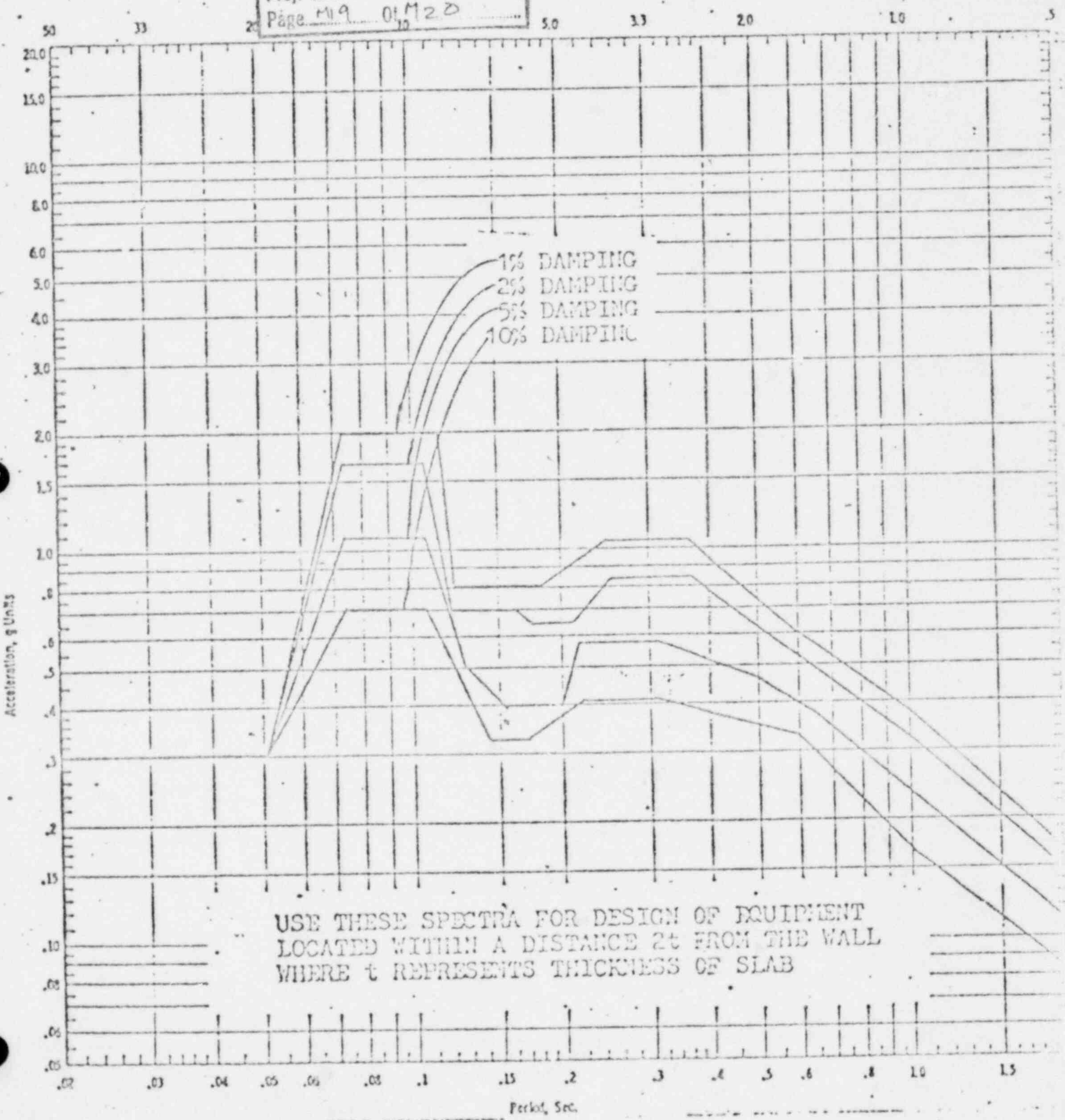
SPECTRA NO.
120-DB-EW
114-DB-EW

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON CO.
PROJECT LASALLE COUNTY STA. JOB NO.
DESIGN BY LUP DATE 7-15-72
CHECKED BY DATE 7-16-72 SHEET OF

REV. NO.	1
DATE	7-24-75
INITIALS	

Calc. No. 30469
Rev:
Proj. No:
Page M19 of M20



VERTICAL RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
AUXILIARY BUILDING WALLS
[illegible]

SPECTRA NO.
114-DB-VW
115-DB-VW
125-DB-VW

SARGENT & LUNDY ENGINEERS

PROJECT LA SALLE COUNTY STA. JOB NO. 4266
DESIGN BY [illegible] DATE 7-15-72
CHECKED BY H.H.S. DATE 7-15-72 SHEET 94 OF [illegible]

Cal. No. EMD 030469
Rev: 00 Date: 6-1-81
Proj. No: 4266-00
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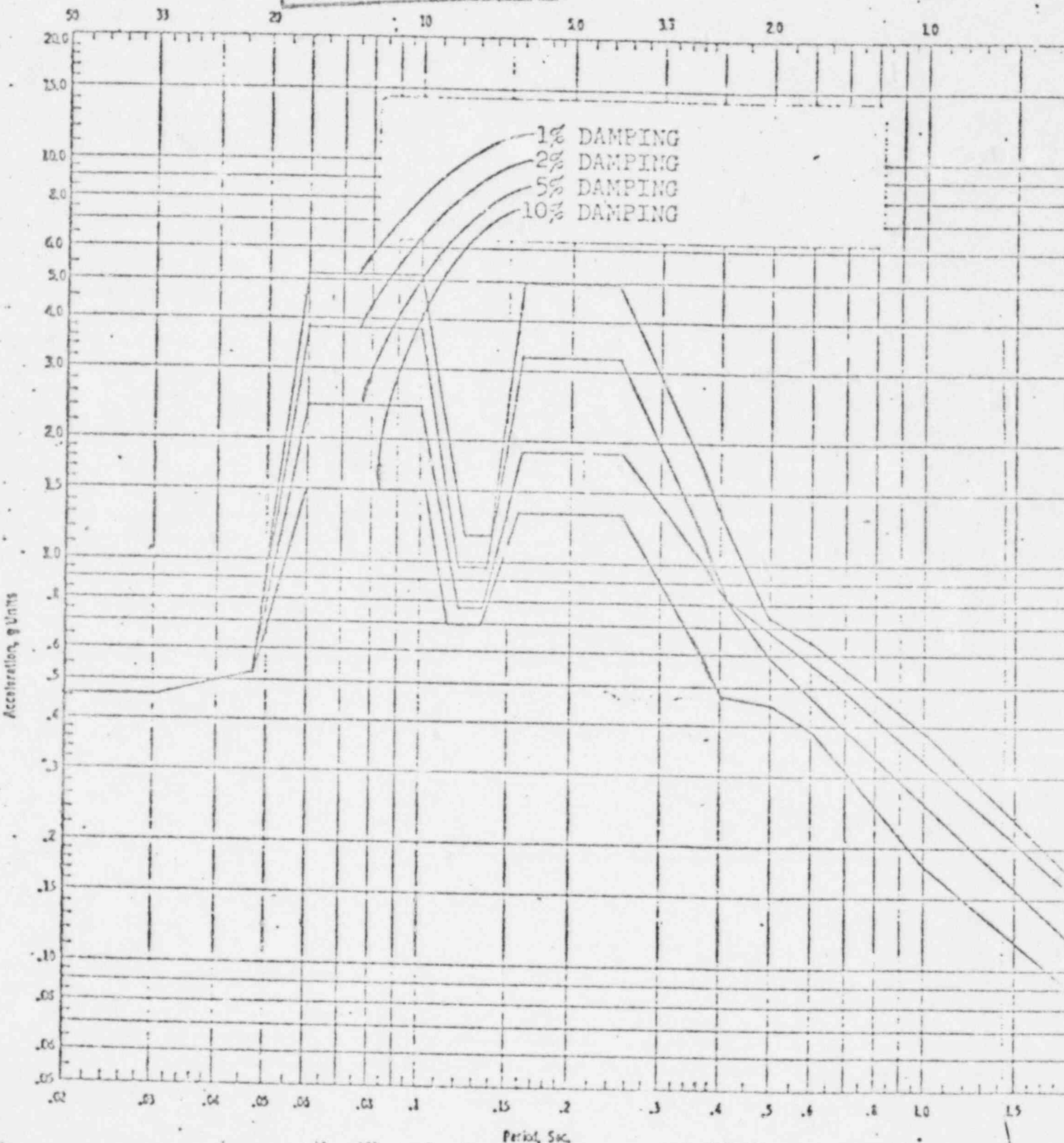
REV. NO.	1						
DATE	7-24-72						
INITIALS	[illegible]						



VERTICAL RESPONSE SPECTRA
DESIGN BASIS EARTHQUAKE
AUXILIARY BUILDING SLAB
EL. 815'-0" TO 768'-0"

SPECTRA NO.
116-DB-VS
115-DB-VS
114-DB-VS

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For SBGTS Primary Fan		Calc. No. EMD-030469	
	X Safety-Related	Non-Safety-Related	Rev. 00	Date 06/01/81
			Page N1	of N13

Client Commonwealth Edison Company	Prepared by N. Munir — Date
Project LaSalle County, Units I & II	Reviewed by — Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by — Date

I. OBJECTIVES

The objectives of this study are:

(i) To compare and draw conclusions on equipment adequacy based on the impedance test result and the existing qualification report.

(ii) To determine equipment adequacy for the additional hydrodynamic loads. This is of additional concern in view of the high frequency resonances reported in the impedance test reports, [1].

II. ANALYTICAL MODEL [Qualification Report Ref. 1].

Simplified frequency estimates are obtained by considering 1 d. o. f and 2 d. o. f modelling of the SBGTS fan. The following frequencies are obtained:

Equipment Component	Frequency, Hz
Fan Shaft	165
Motor Base	85
Power Side Bracing Longitudinally	126
Power Side Bracing Laterally	34

The equipment was considered rigid since equipment frequencies were found to be greater than 33 Hz. The equipment is qualified for ± .5g in the horizontal direction and ± .88g in the vertical direction [1]. The motor can withstand an acceleration of 7.2g [1]. The anchor bolts have a margin of safety of at least 5.0 [1].

III. IMPEDANCE TEST MODEL [2]

The wire grid diagram of the fan showing the locations of the accelerometers is shown on page N5. The fan was tested by the impulse technique. The fan is bolted to the ground through a solid grout pad.

IV. LIST OF EXPERIMENTALLY & ANALYTICALLY OBTAINED FREQUENCIES

Experimentally Obtained Frequencies (2)

The following frequencies were obtained from the impedance test.

	Equipment Frequency Hz.		Axis	Remarks
1.	59.0		X	In ZPA Range*
2.	49.0	Horizontal	X	In ZPA Range*
3.	46.0		X	In ZPA Range*
4.	49.0		Y	In ZPA Range
5.	46.0	Vertical	Y	In ZPA Range
6.	32.5		Y	Vertical Motion of Motor
7.	58.0		Z	In ZPA Range*
8.	36.5		Z	In ZPA Range*
9.	28.0	Horizontal	Z	In ZPA Range*
10.	76.0		Z	In ZPA Range*
11.	95.0		Z	In ZPA Range*

* See pages N10 thru N13

Comparison of Experimental & Analytical Frequencies.

The global equipment modes shown in the impedance test report are not identifiable in the analytical effort. In the analytical effort [1] discrete components of the equipment are analyzed and the associated frequencies computed. In the analytical effort equipment frequencies computed fall in the ZPA range of both the seismic spectra as well as the current spectra that includes hydrodynamic loads. Since in the impedance test frequencies of specific components of the equipment were not determined, the experimentally

obtained frequencies cannot be compared to the analytically determined frequencies.

Frequency #6 p. N6 indicating vertical vibratory motion of the motor base lies in a non ZPA range [p.N10-13]. All other frequencies determined by test, lie in the ZPA range. The importance of this frequency is assessed in the next section.

Discussion of Experimentally Obtained Frequencies & Mode Shapes.

Equipment frequency #6 indicates vertical vibratory motion of the motor base both at the ground (where it is restrained by bolts) as well as at the top of the motor base. The apparent ground motion of the motor base p. N6 is attributed to bending motion of the motor base mounting element. Since only four edge monitoring stations describe the motion of the base of the motor support, this motion is spuriously shown as vertical translational motion. This frequency corresponds to an acceleration of 1.05g. For frequencies greater than 32.5 Hz, the response spectra curve is monotonically decreasing until the ZPA plateau is reached [p.N10-13].

The remainder of the experimentally determined frequencies fall in the ZPA range [p.N10-13] and are not addressed here.

V. QUALIFICATION FOR HYDRODYNAMIC LOADS

In the analytical determination of the equipment-frequencies, the equipment was considered rigid. In the impedance test a 32.5 Hz frequency in the vertical direction was observed. This frequency falls close to the ZPA range, see pages N10-13. All other frequencies are higher and fall in the ZPA range.

An acceleration of 1.05g corresponding to a frequency of 32.5 Hz is shown in the response spectra curves pages N10-13. This corresponds to an effective acceleration of 1.555g. The motor is qualified in the vertical direction to an acceleration of 7.2 g [1]. The equipment therefore is qualified.

VI. CONCLUDING REMARKS

Equipment frequencies obtained thru analysis fall in the ZPA range[p.N10-13]. All but one of the equipment frequencies obtained from the impedance test fall in the ZPA range [p. N10-13]. Based on this frequency the motor is subject to a maximum acceleration of 1.55 g. The motor has been qualified to an acceleration of 7.2g therefore is adequate.

Based on the above observations the equipment is qualified for combined seismic and hydrodynamic loads.

VII. REFERENCES

1. Qualificat on Documents for SBGTS Primary Fan
   EMD File No. 014360

2. SBGTS Primary Fan, Transitek, Inc. EMD File No. 029466

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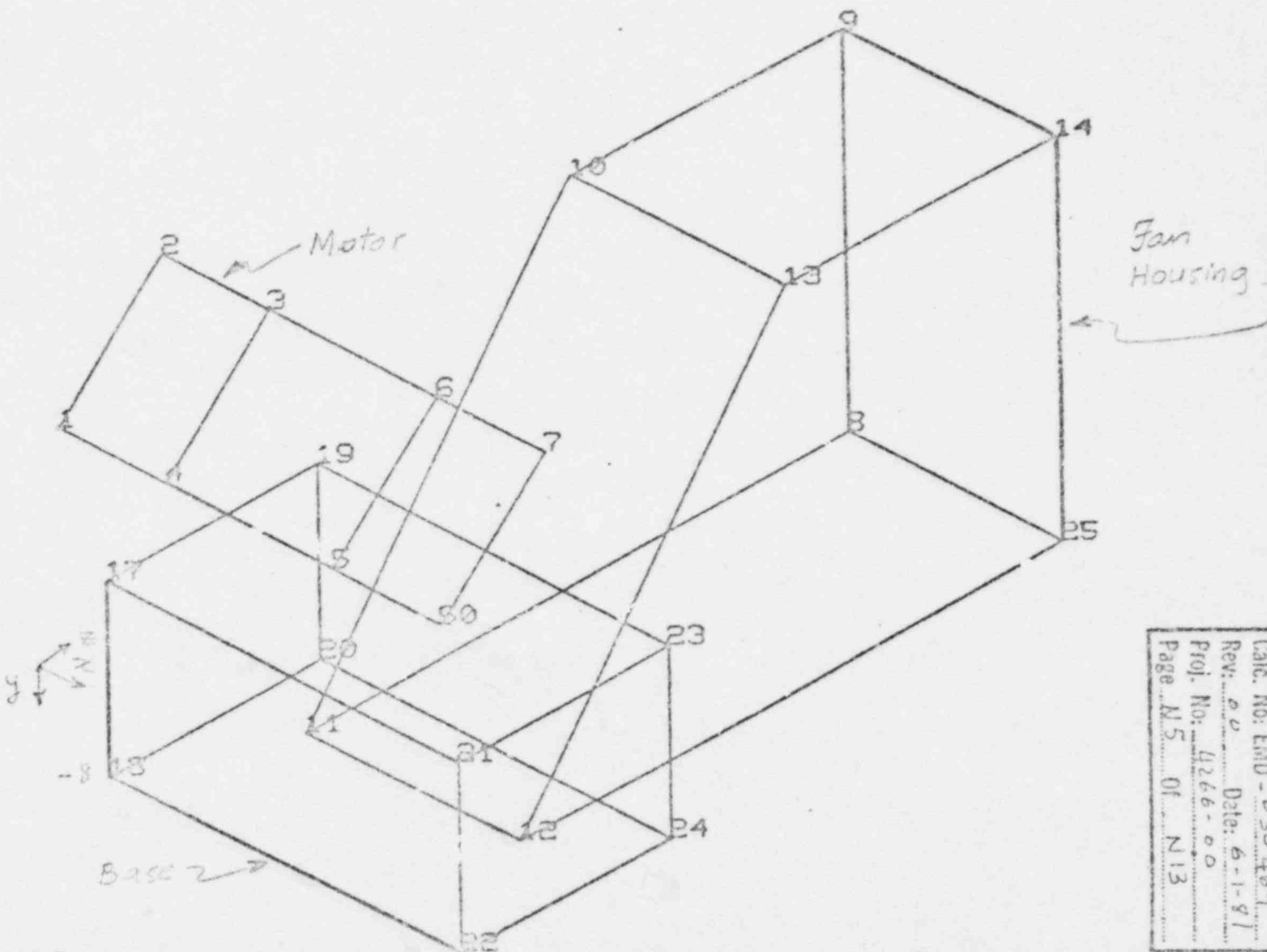
N5



LSBGF FAN Z-AXIS
5: 1Z+ COMP,F= 95.000 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

SBGTS PRIMARY FAN - TEST MODEL - SCHEMATIC REPRESENTATION

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N6

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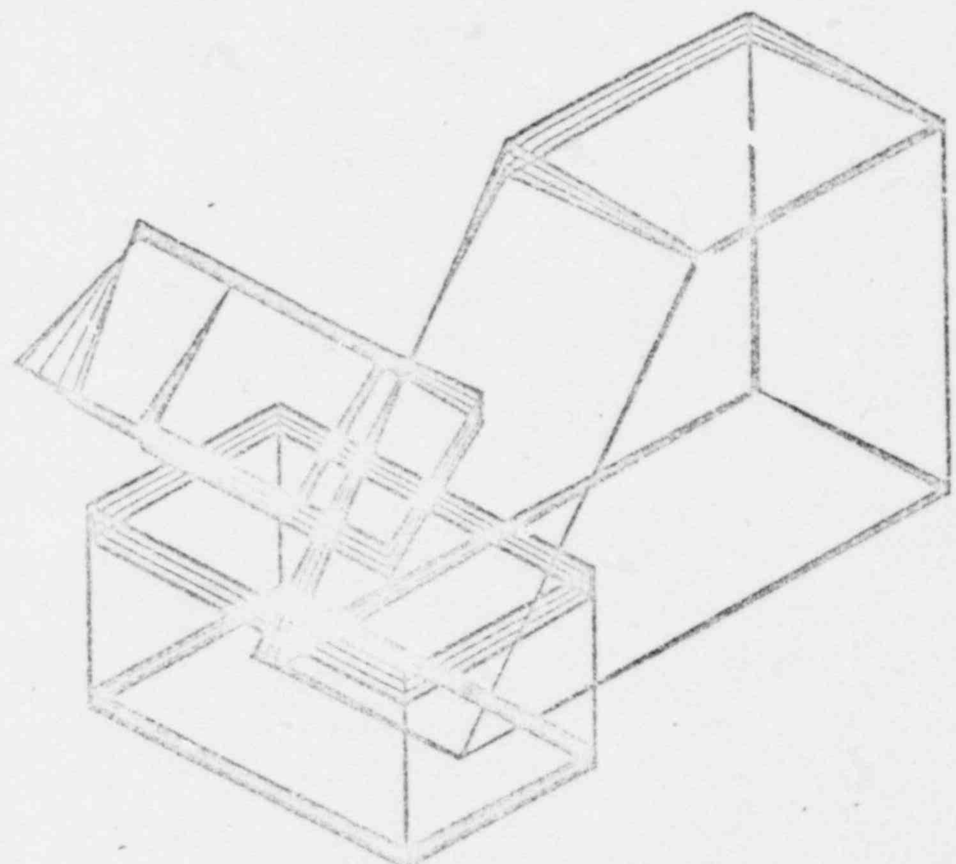

LSBGF FAN Y-AXIS
1: 2Y+ COMP,F= 32.500 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

EQUIPMENT FREQUENCY #6 INDICATING VERTICAL VIBRATORY MOTION OF THE MOTOR BASE.

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N7

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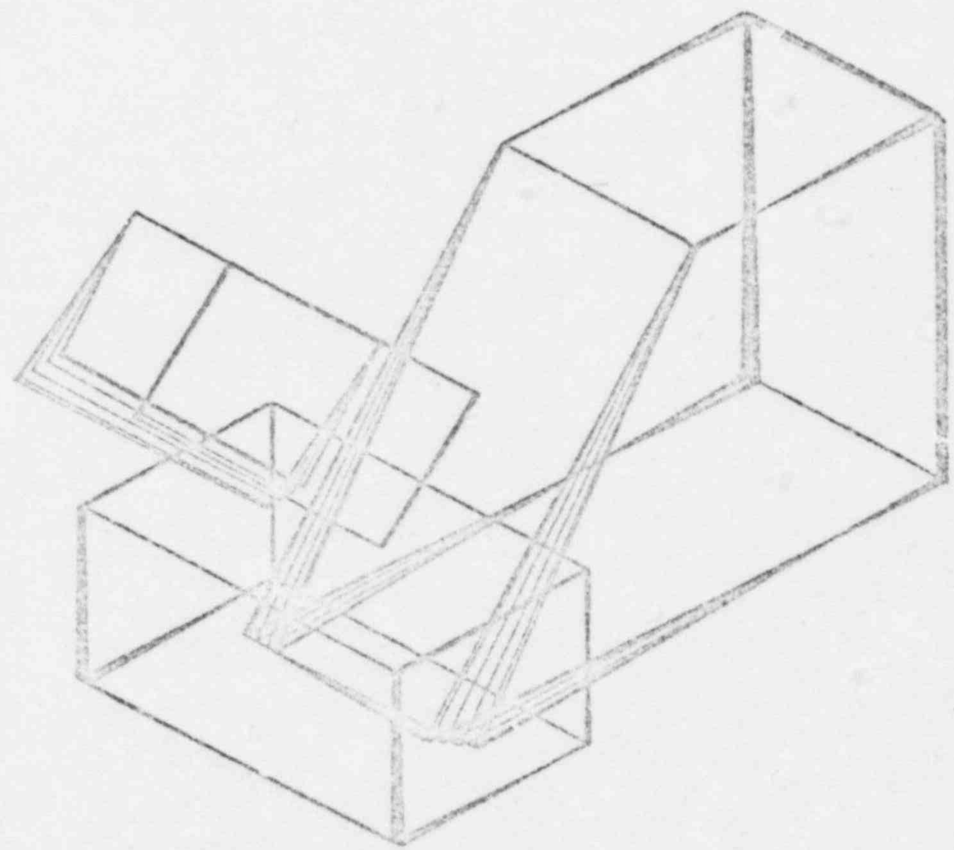

LSBGF FAN X-AXIS
6: 16X- COMP,F= 59.000 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

HIGH FREQUENCY RESONANCE - X AXIS

Calc. No: EMD-030469
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Proj. No: 4266-00
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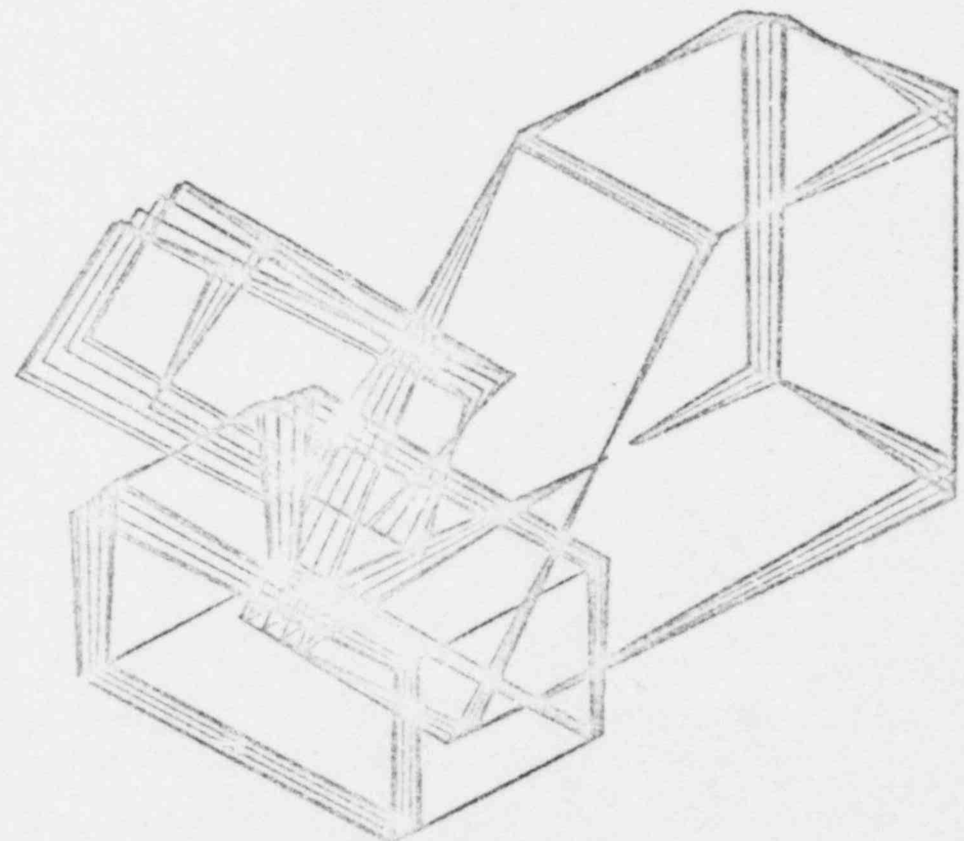
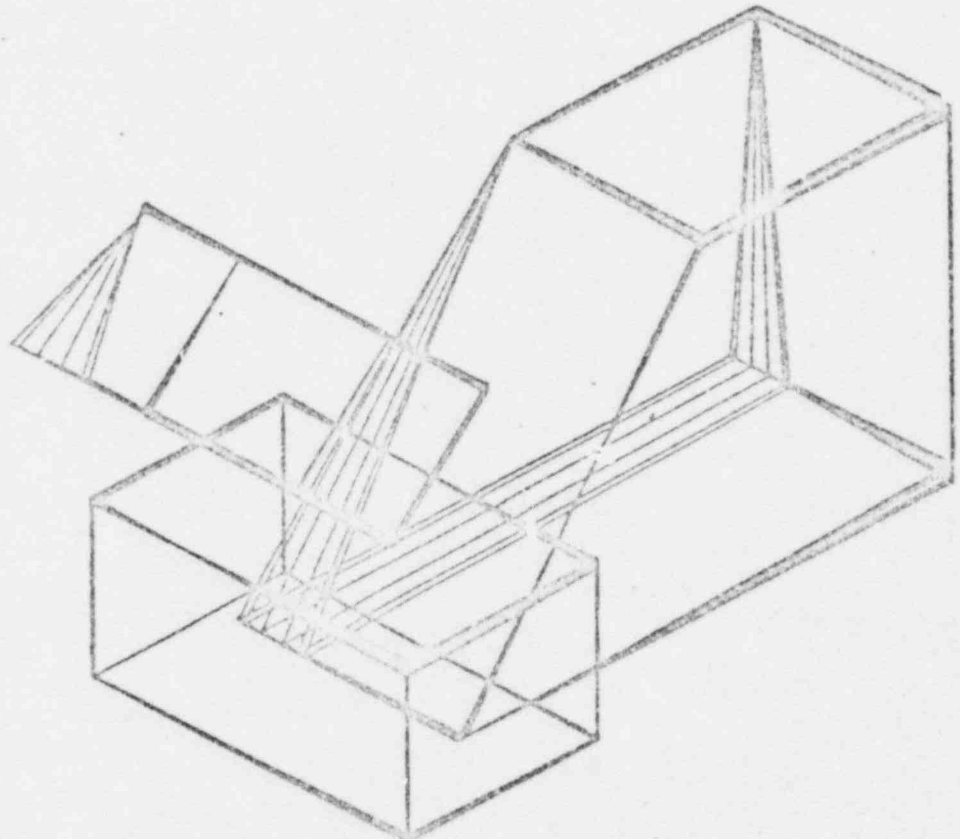


LSBGF FAN Z-AXIS
3: 1Z+ COMP,F= 58.000 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

HIGH FREQUENCY RESONANCE - Z AXIS

47



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LSBGF FAN Y-AXIS

2: 2Y+ COMP,F= 46.000 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

N9

TYPICAL HIGH FREQUENCY RESONANCE - Y AXIS

N10

Calc. No: EMD - 030469
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Proj. No: 4266-00
Page N10 Of N13

REQUIRED RESPONSE SPECTRUM CURVE

(EMERGENCY CONDITION)

FOR

1VG01C

SGTS PRIMARY FAN

LOCATED IN

REACTOR BUILDING El. 820'0"

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-18
DESIGN BY [illegible] DATE 1-22-80
CHECKED BY [illegible] DATE 1-22-80 SHEET 22 OF 27

Calc. No: EMD - 030469
Rev: 0 Date: 6-21-81
Proj. No: 4266-00
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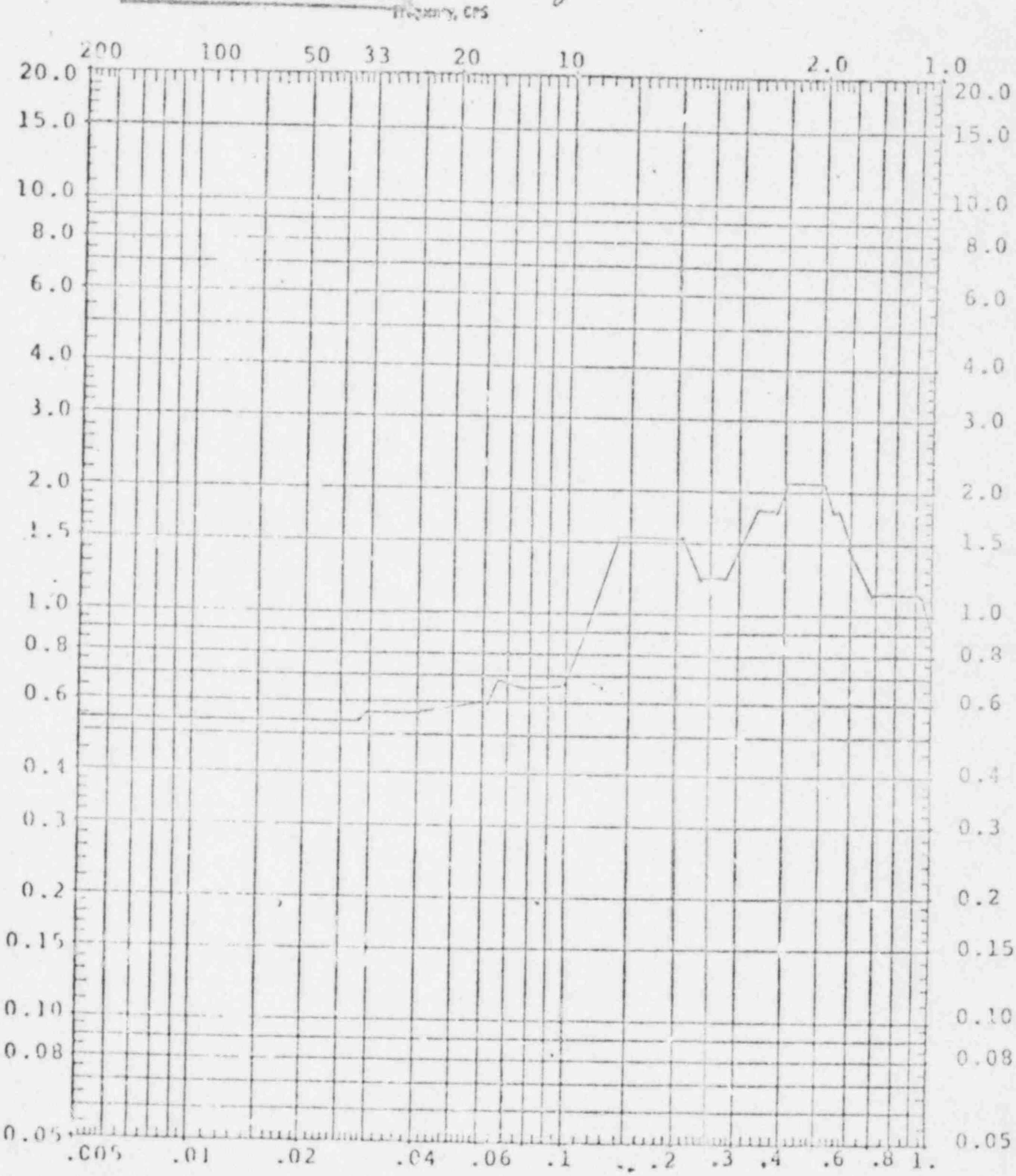
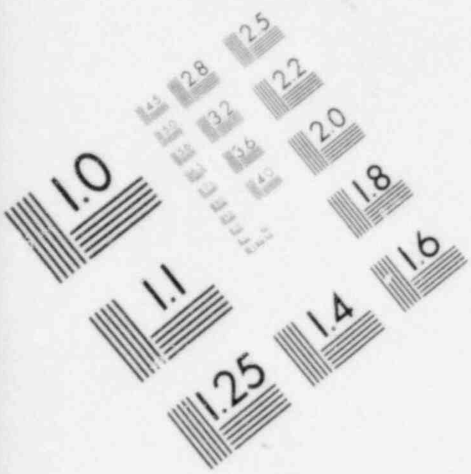
DATE	1-22-80						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Horizontal Slab NS-EW
Envelop of a) SSE + CO_{LEVY-1}
b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})



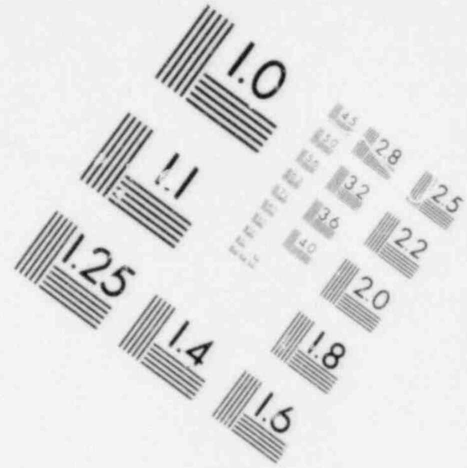
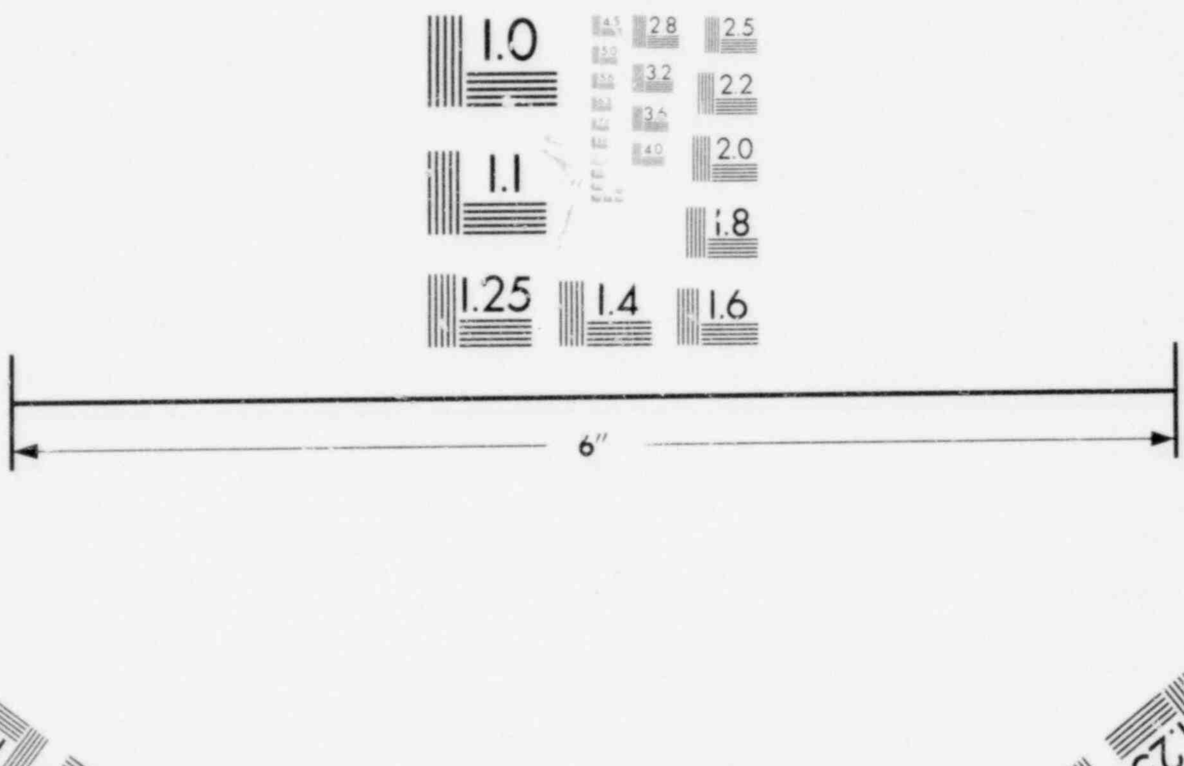
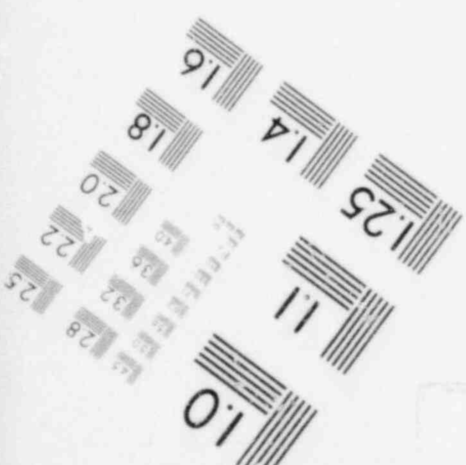


IMAGE EVALUATION TEST TARGET (MT-3)





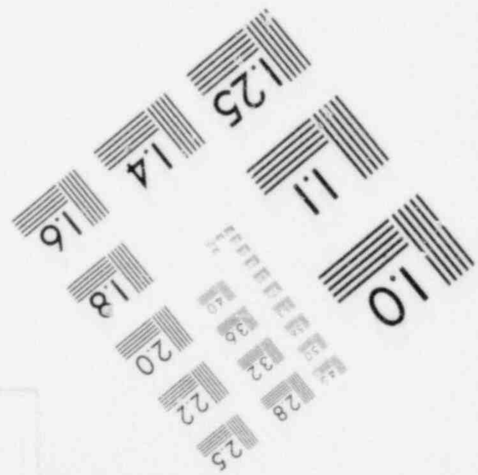


IMAGE EVALUATION TEST TARGET (MT-3)

6″

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY N12

PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-00

DESIGN BY Z. Crowson DATE 1-22-80

CHECKED BY [illegible] DATE 1-22-80 SHEET 24 OF 27

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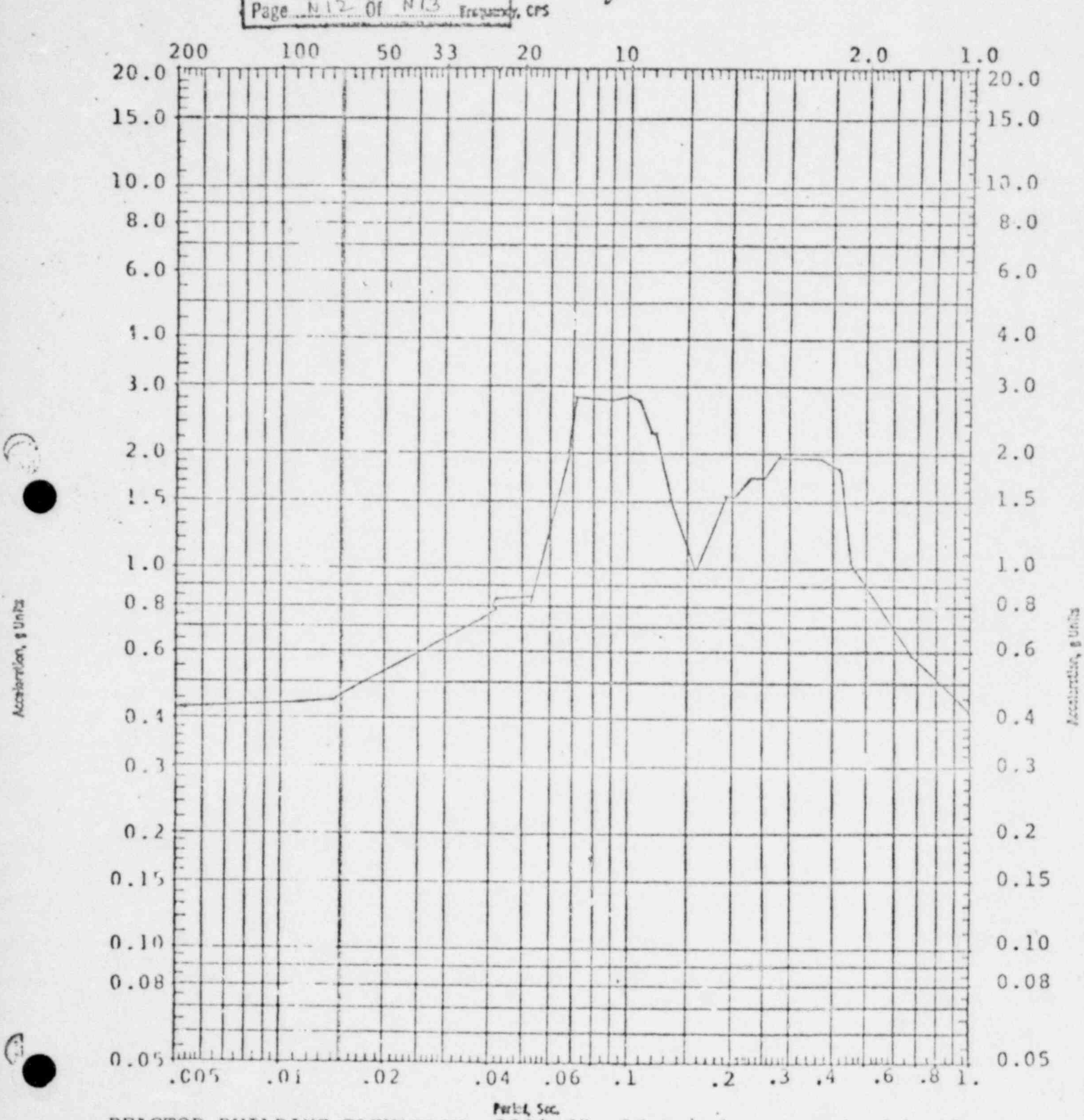
Rev: 00 Date: 6-1-81	DATE	[illegible]						
Proj. No: 4266-00	INITIALS	ZS						
Page N12 Of N13								



REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Wall

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE & CHUG. + Envelop of ($SRV_{...}$ + $SRV_{...}$)

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY N13
PROJECT LA SALLE COUNTY 1 & 2 JOB NO. [illegible]
DESIGN BY [illegible] DATE 1-22-81
CHECKED BY [illegible] DATE [illegible] SHEET 23 OF 27

Calc. No: EMD-030469
Rev: 00 Date: 6-1-81
Proj. No: 4266-00
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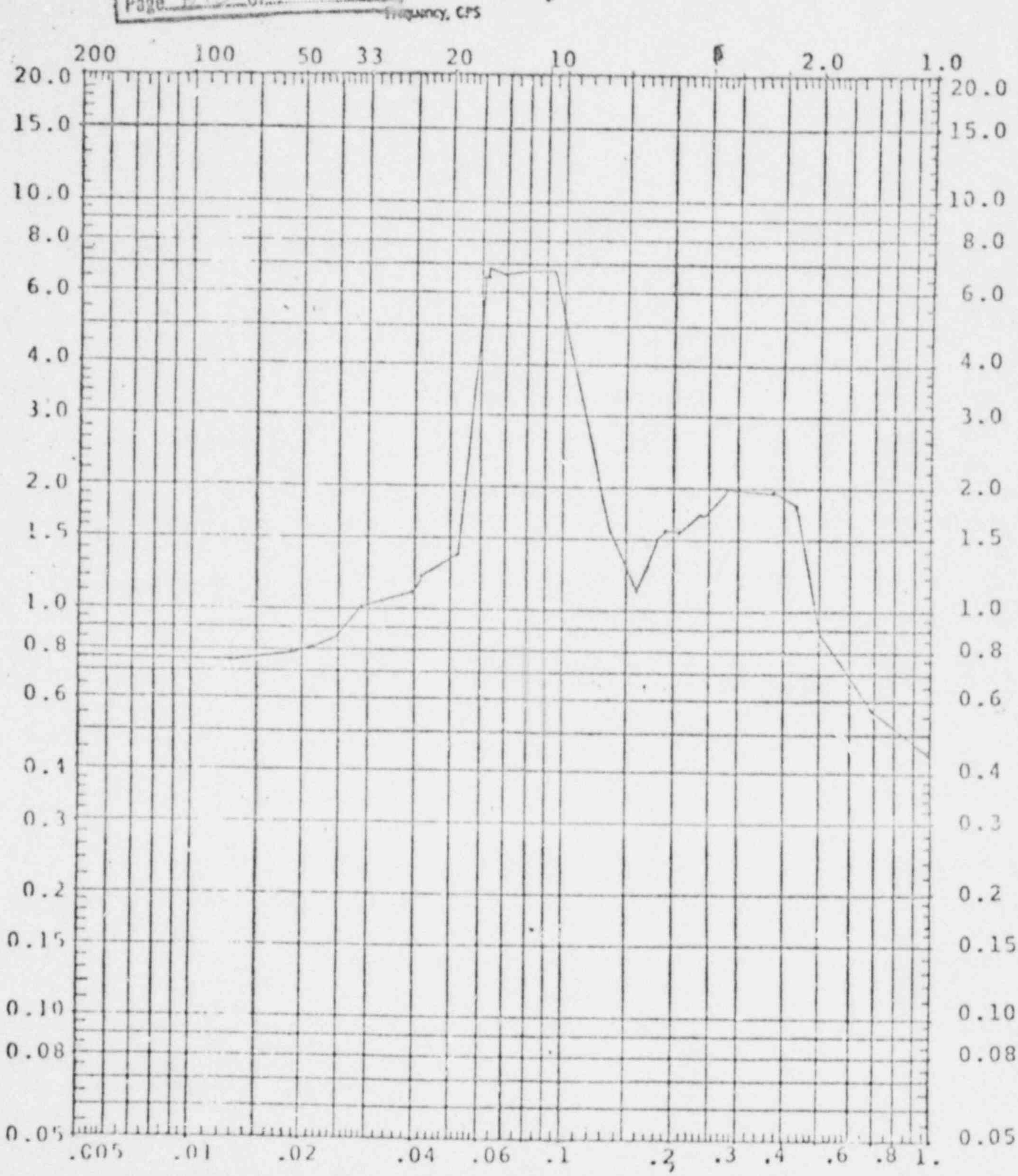
DATE	1-22-81						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 820'-6" 2% Damping Vertical/Slab

Envelope of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

c) SSE + CHUG. + Envelop of (SRV_{ALL} + SRV_{ASY})

I. OBJECTIVES

The objectives of this study are:

(i) To compare and draw conclusions on equipment adequacy based on the Impedance test result and the existing qualification report.

(ii) To determine equipment adequacy for the additional hydrodynamic loads. This is of concern in view of the high frequency resonances reported in the Impedance tests.

ANALYTICAL MODEL (1)

The valve is schematically illustrated on page P9 . The valve is modeled as a 1 D.O.F. system. The major frequencies obtained associated with vibration of various components of the valve are:

(a) The cantilever mode of vibration, length L, considered (p. P9) as the cantilever arm yields a frequency of 32 Hz.

(b) A system torsional frequency of 72.24 Hz has been identified.

(c) A natural frequency of 22.3 Hz based on length L1 (operator to yoke-bonnet connection) has been computed.

Test Model

Geometry (2)

The geometry of the 14" valve as described by the location of the accelerometers is shown on page P10. The equipment (valve and piping) was excited by blows from a large hammer. The equipment was excited along the three mutually orthogonal axes.

Discussion of Experimentally Obtained Frequencies & Mode Shapes

Six resonant frequencies along the X axis were identified ranging from 17.510 Hz to 93.47 Hz.

Pipe motion is associated with the 17.510 Hz frequency as evident from the mode shape page P15. None of the other frequencies exhibit pipe motion. The most common mode shape identifiable is movement of the upper valve body and actuator.

Five resonant frequencies along the Y axis have been identified. The frequencies range from 17.720 Hz to 91.990 Hz. Again the lowest frequency is associated with clearly identifiable pipe motion. As for the case of X-axis frequencies; the most common mode shape identifiable corresponds to motion of the upper valve body and actuator.

Seven resonant frequencies are identified along the Z axis. These frequencies range from 7.42 Hz to 92.77 Hz. The lowest frequencies 7.42 Hz and 9.3 Hz correspond to pipe motion with the valve body moving rigidly. No valve frequencies are excited.

X AXIS (ALONG PIPE AXIS)

The 19.450 Hz and 93.47 Hz frequencies are associated with bending motion of the valve body. However these frequencies are not of significance as evidenced from the Response Spectra pages P25 thru P28 .

The mode shape associated with the 36.790 Hz frequency exhibits translational movement of the upper valve assembly, strongly indicating a localized near-rigid body motion of the motor.

The 30.07 Hz and 25.920 Hz frequencies exhibit lateral motion of the operator. The 17.510 Hz frequency is associated with pipe motion. The rigid body like motion of the operator confirms this.

Y AXIS (VERTICAL)

The 91.9 Hz frequency is associated with movement of the pipe as well as movement of the motor. The mode shape associated the 36.64 Hz frequency combines an up-down rigid body motion with bending in the vicinity of the motor.

The mode shape associated with the 30.710 Hz frequency is a cantilever mode; the motor being 'cantilevered' from the stem. The mode shape associated with the 26.370 Hz, a cantilever mode, cantilevered from the stem of the valve.

The 17.720 Hz frequency is associated with pipe motion. The motor assembly exhibits up and down motion relative to the pipe.

Z AXIS HORIZONTAL PERPENDICULAR TO PIPE AXIS

Seven frequencies are identified:

Lateral movement of the motor is observed for mode shapes corresponding to frequencies 92.773 Hz, 81.2 Hz and 48.61 Hz. These frequencies, however are in the Z.P.A. (p.25-28) range of the response spectrum, pages 27, 28 and hence of reduced significance.

The mode shape associated with 23.48 Hz is a cantilever mode.

Frequencies: 17.530 Hz, 9.296 Hz & 7.416 Hz are pipe modes and do not involve the motor assembly. The 17.530 Hz frequency also appears along the X axis.

Comparison of Experimentally & Analytically Determined Equipment Frequencies

Fundamental modes can be compared. The higher valve modes are not accounted for in the analytical effort and hence are not compared.

Bending Modes

The system cantilever frequency of 32 Hz corresponds well with frequencies 4 & 16, both associated with system bending modes.

Frequencies #5, 10, 17 along the three coordinate axes correspond to a stem valve frequency of 22.3 Hz. The experimental frequencies are greater than the computed frequencies, since the full structure stiffness has not been accounted for in the analytical model used.

The higher frequencies have not been accounted for in the analytical model and hence no basis for comparison exists.

Torsional Mode

A torsional mode $f_n = 72$ Hz has been computed analytically. It appears that this mode has not been excited during the course of the experimental test.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For	Calc. No. EMD-030447
	Safety-Related / Non-Safety-Related	Rev. 00 Date 06/01/81
		Page P6 of P28

Client Commonwealth Edison Company	Prepared by / Date
Project LaSalle County, Units I & II	Reviewed by / Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by / Date

List of Experimentally & Analytically Determined Frequencies

Experimentally Determined Frequencies

#	Equipment Frequency Hz.	Axis	Remarks Based on Mode Shape
1.	93.47	X	Bending Mode
2.	49.45	X	Bending Mode
3.	36.79	X	Bending Mode
4.	30.7	X	Cantilever
5.	25.92	X	Valve Stress Bending
6.	17.51	X	Pipe Frequency - Valve moves with pipe
7.	92.77	Z	Bending Mode
8.	81.21	Z	Bending Mode
9.	48.61	Z	Bending Mode
10.	23.48	Z	Valve Stem Bending
11.	17.53	Z	Pipe Frequency
12.	9.3	Z	Pipe Frequency - Valve moves with pipe
13.	7.42	Z	Pipe Frequency - Valve moves with pipe
14.	91.99	Y	Bending Mode
15.	36.64	Y	Bending Mode
16.	30.71	Y	Cantilever Mode
17.	26.37	Y	Valve Stem Bending
18.	17.72	Y	Pipe Frequency - Valve moves with pipe.

Analytically Determined Frequencies

The valve is analyzed as a 1 D.O.F. system. A bending-cantilever frequency of 32 Hz corresponding to the fundamental cantilever mode is identified. Due to the limitations of the analytical procedure higher modes were not determined. A torsional frequency of 72 24 Hz was also identified.

A valve bending frequency corresponding to the natural frequency of the valve from operator to yoke-bonnet connection is computed. This fundamental mode is associated with a frequency of 22.3 Hz.

Qualification for Hydrodynamic Loads

The analysis (1) was performed using the final required combined seismic & hydrodynamic spectra (p. 25-28). Since the equipment frequencies determined from the test cluster around the analytical frequencies, and the analytical frequencies represent a more severe condition the equipment is qualified for the combined seismic and hydrodynamic loadings.

Concluding Remarks

Fundamental frequencies as determined by the original analytical qualification report correspond with the lower modes determined from the Impedance Test. Pipe frequencies in the Z.P.A. range have been identified, these however do not constitute equipment vibratory motion and are therefore disregarded. Higher

frequencies determined from the test fall either in the Z.P.A. range or yield substantially lower responses to the responses obtained for the primary modes. Based on this and since final combined seismic & hydrodynamic response spectra curves were used in the analysis (1) the equipment is qualified.

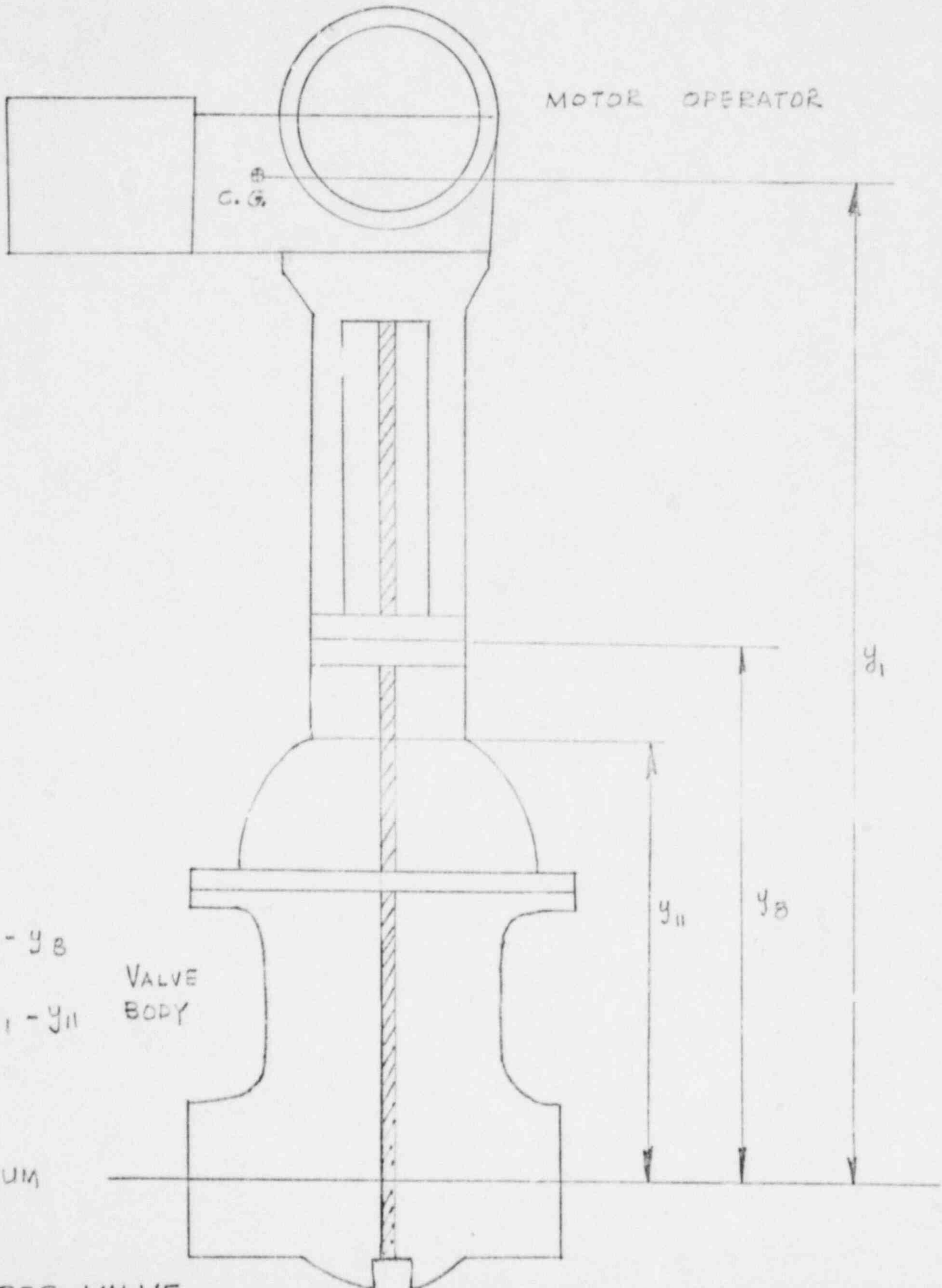
References

1. Qualification Documents for Motor Operated Gate Valve. EMD File #028900

2. 14" HPCS Valve, Transitek Inc. EMD File #029462 3-17-81.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For	Calc. No. EMD-030469
		Rev. 00 Date 06/01/81
	Safety-Related / Non-Safety-Related	Page P9 of P28

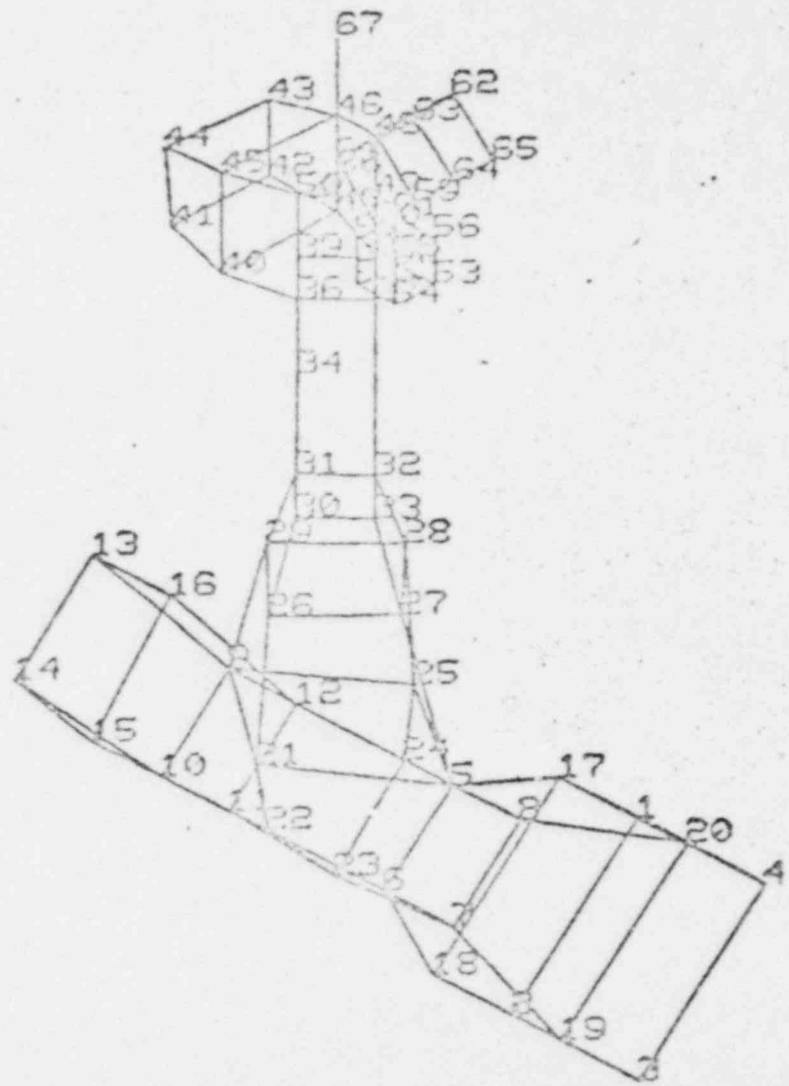
Client	Commonwealth Edison Company	Prepared by	Date
Project	LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No.	Approved by	Date



$L = y_1 - y_B$

$L1 = y_1 - y_{11}$

14" H.P.C.S. VALVE



1: 57Y+ COMP,F= TEST MODEL (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030469
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Rev: 00 Date: 06/01/81
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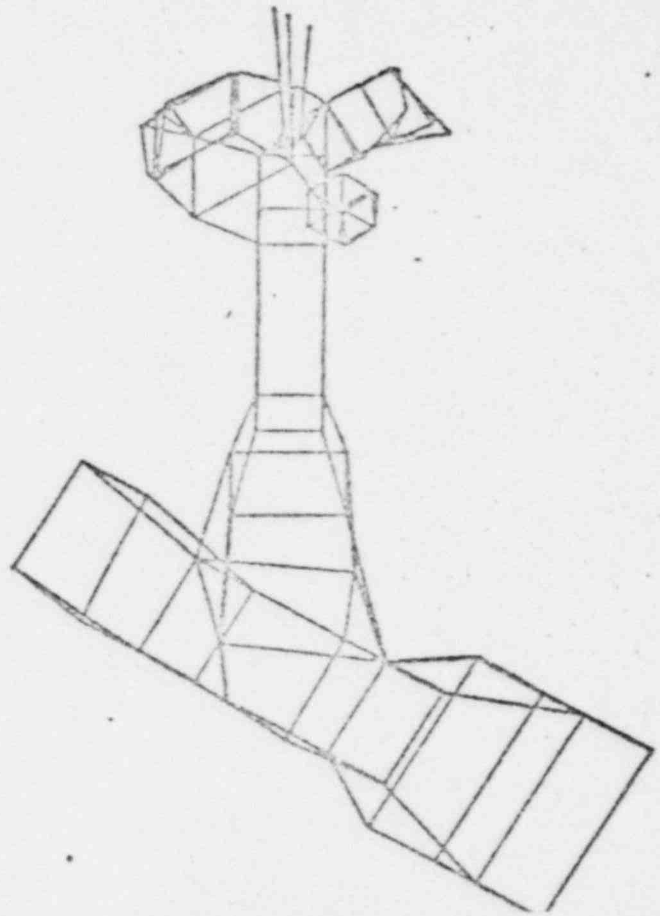
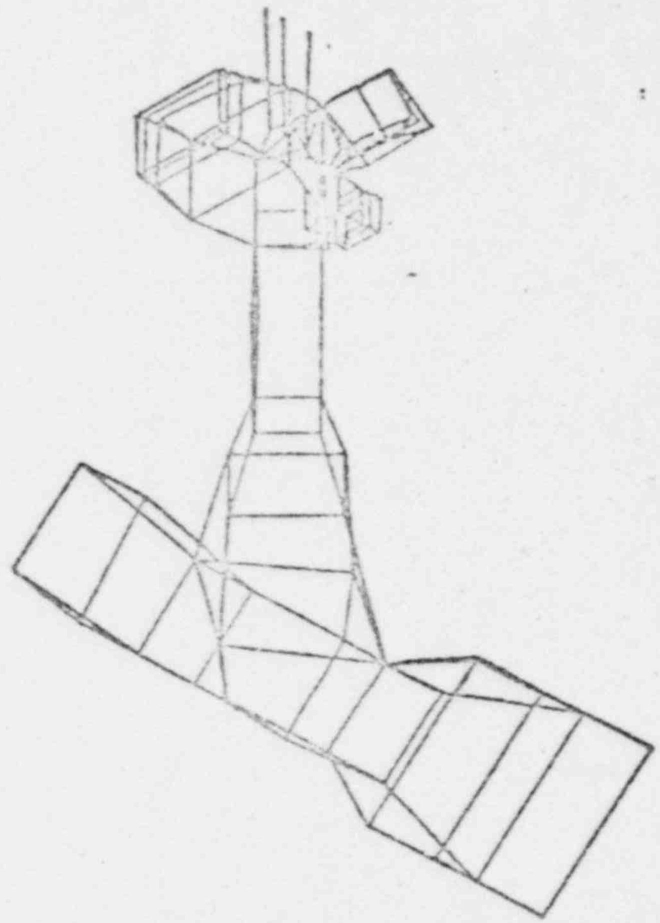


X-AXIS

A TYPICAL HIGH-FREQUENCY MODE SHAPE

6: 55X+ COMP,F= 93.470 HZ (1.0, 1.0, 1.0, 0.0)=VIEW



X-AXIS
4: 55X+ COMP,F= 36.790 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

FREQUENCY CORRESPONDING TO A HIGHER STEM BENDING MODE

NOTE:ALMOST RIGID BODY TYPE OF MOTOR MOTION

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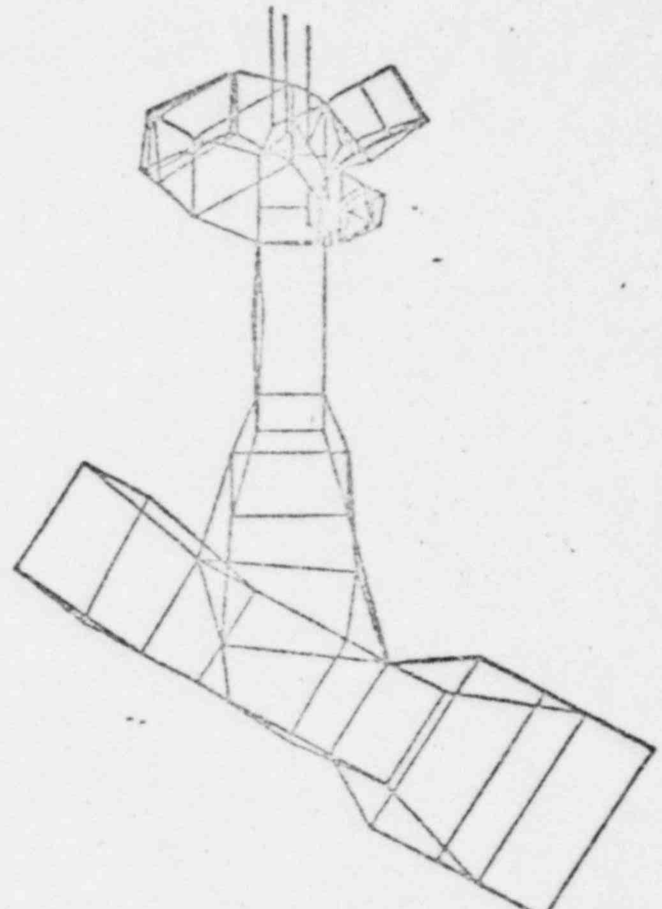

VALVE BENDING MODE

X-AXIS
3: 55X+ COMP,F= 30.700 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

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Rev: 00 Date: 06/01/81
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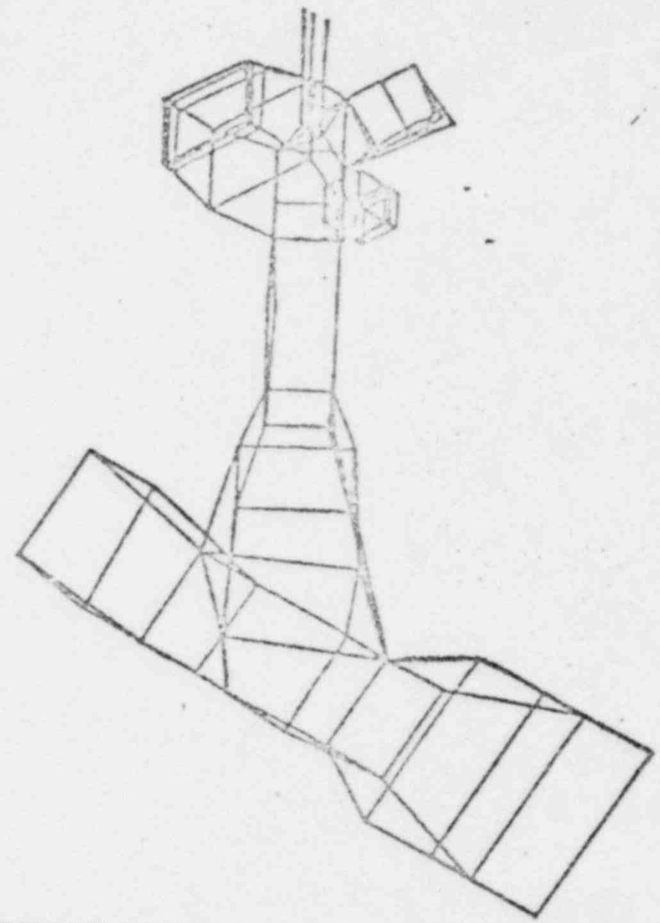

VALVE-STEM BENDING MODE

X-AXIS

2: 55X+ COMP,F= 25.920 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 020??
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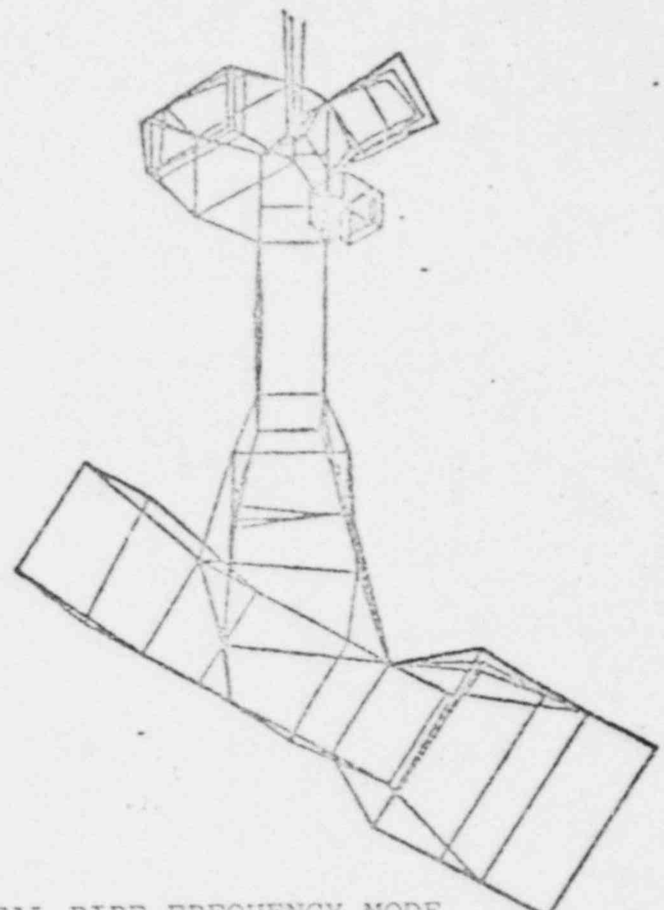
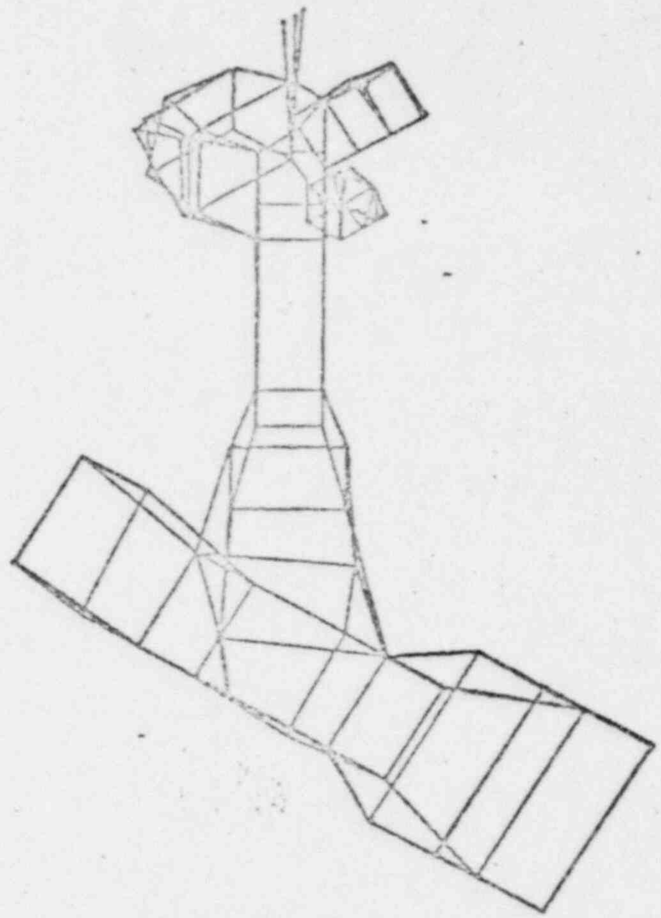


TYPICAL PIPE FREQUENCY MODE

NOTE: PIPE MOTION & ALMOST RIGID BODY OPERATOR MOTION

X-AXIS

1: 55X+ COMP,F= 17.510 HZ (1.0, 1.0, 1.0, 0.0)-VIEW



Calc. No: EMD-032342
Rev: 00 Date: 06/04/91
Proj. No: 4366-00
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TYPICAL HIGH BENDING FREQUENCY

Z-AXIS
7: 55Z+ COMP,F= 92.773 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030262
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
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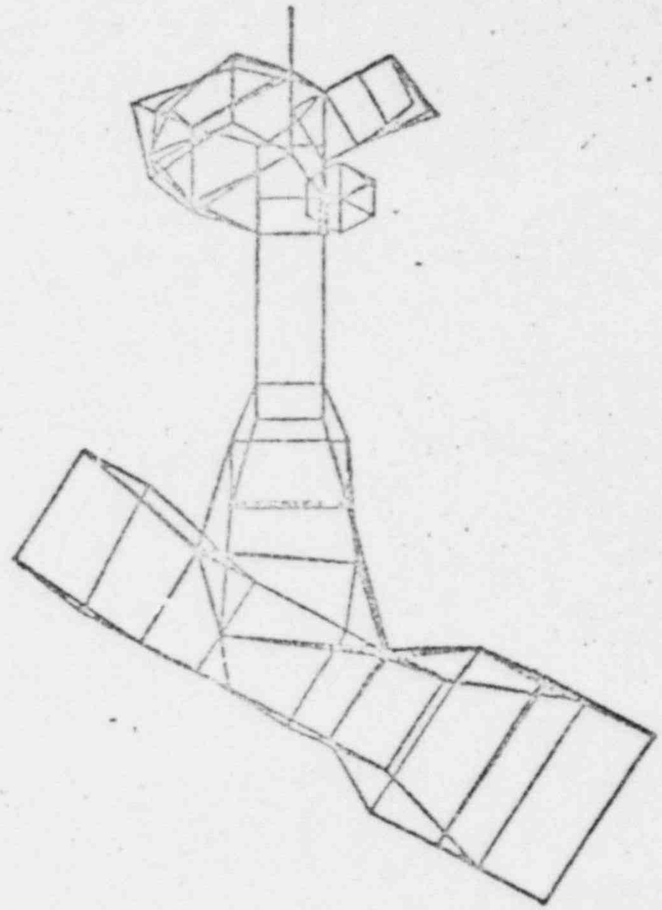

VALVE BENDING MODE

Y-AXIS

3: 57Y+ COMP,F= 30.710 HZ (1.0, 1.0, 1.0, C.0)=VIEW

Calc. No: EMD-030569
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Proj. No: 4266-00
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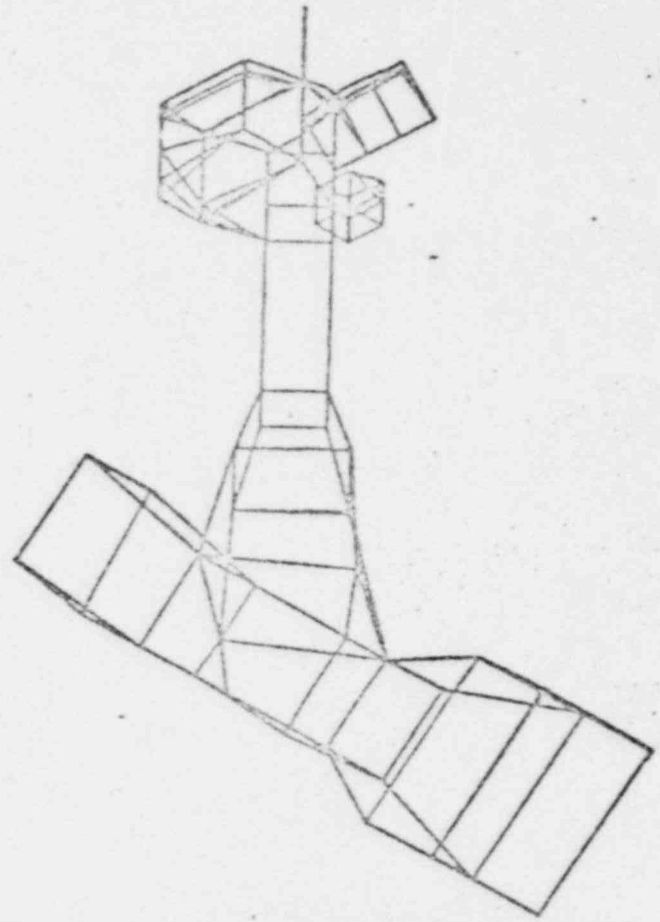

VALVE STEM BENDING

Y-AXIS

2: 57Y+ COMP,F= 26.370 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD - 030469
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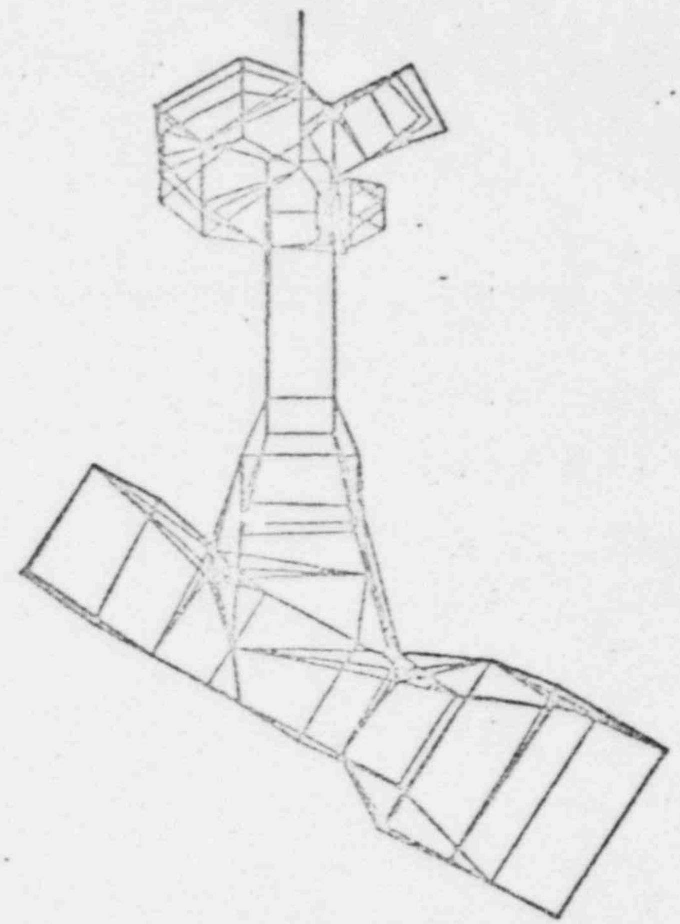
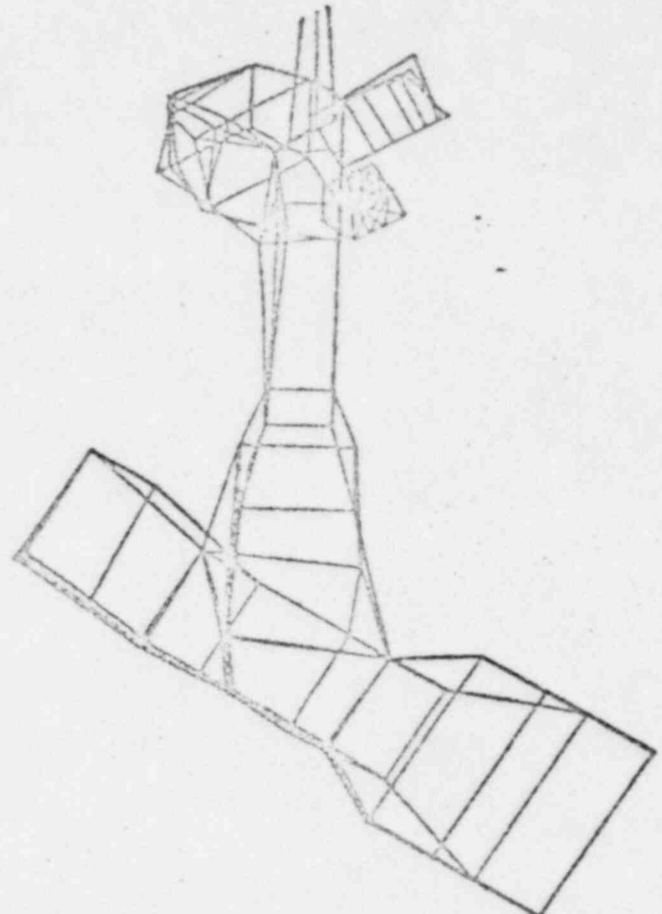


PIPE FREQUENCY MODE

Y-AXIS

1: 57Y+ COMP,F= 17.720 HZ (1.0, 1.0, 1.0, 0.0)=VIEW



HIGH, VALVE BENDING FREQUENCY

Z-AXIS

6: 55Z+ COMP,F= 81.2?4 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: F-D-0307(a2
Rev: 06 Date: 04/10/22
Proj. No: 4266-00
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Calc. No: EAS-030469
Rev: 20 Date: 06/30/21
Proj. No: 4266-00
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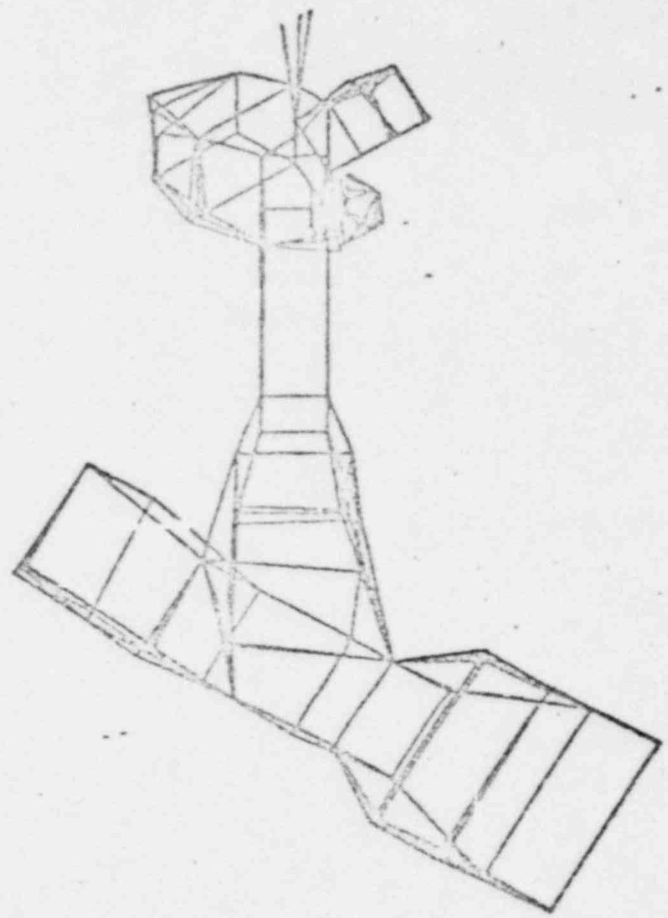

VALVE STEM BENDING FREQUENCY

Z-AXIS
4: 55Z+ COMP,F= 23.481 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD-030469
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Proj. No: 4266-00
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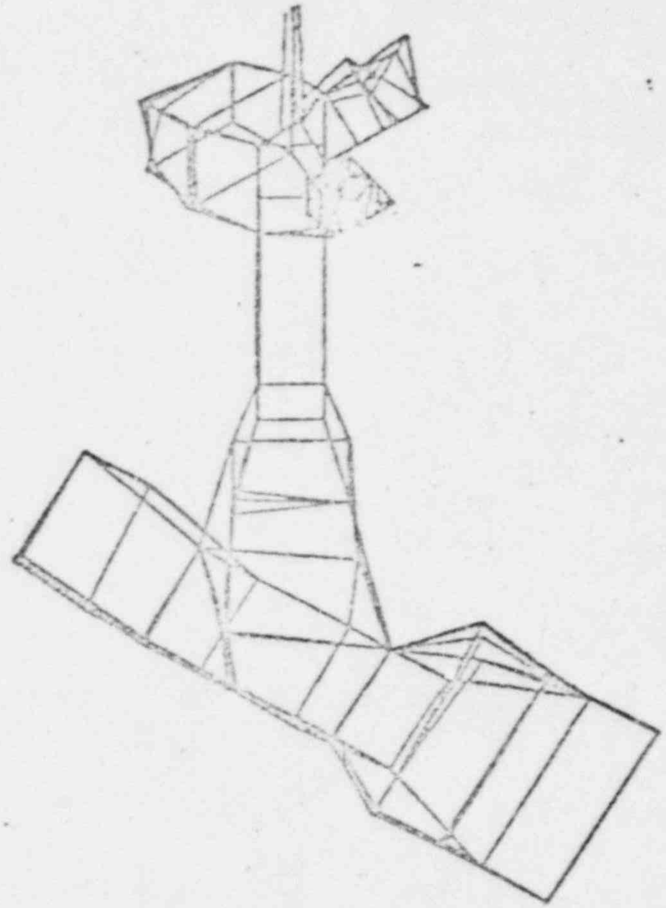

PIPE BENDING FREQUENCY

Z-AXIS

3: 55Z+ COMP,F= 17.530 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

Calc. No: EMD-030469
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Proj. No: 4266-00
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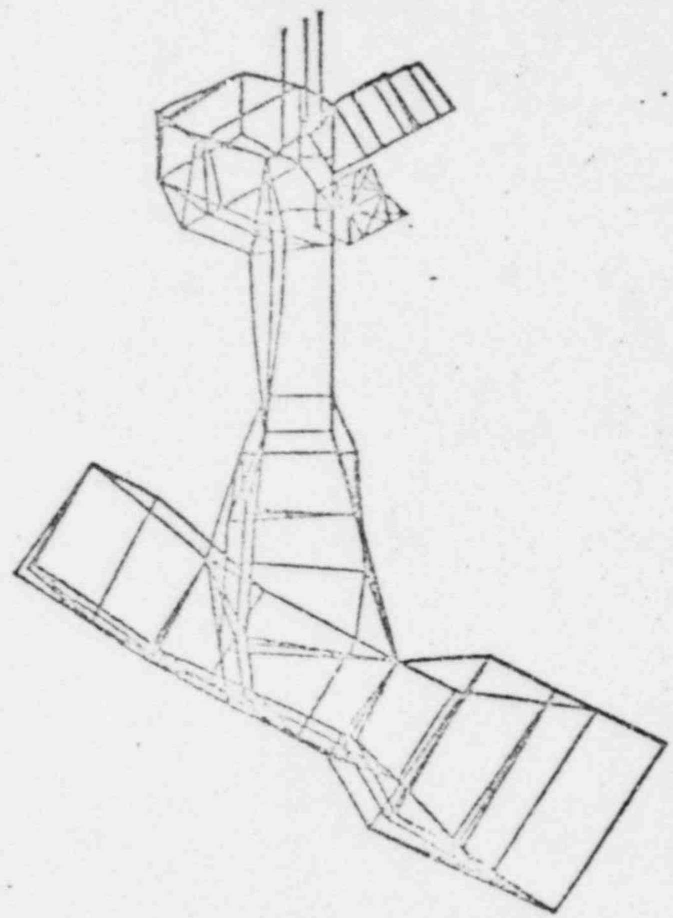

PIPE BENDING FREQUENCY

Z-AXIS

2: SSZ+ COMP,F= 9.296 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

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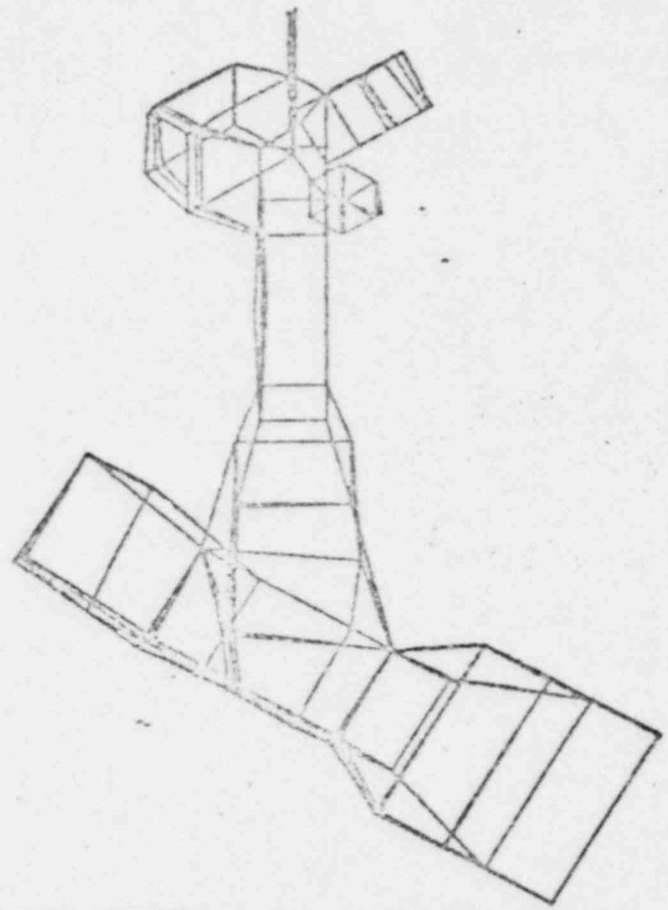

PIPE BENDING FREQUENCY

Z-AXIS

1: 55Z+ COMP,F= 7.416 HZ (1.0, 1.0, 1.0, 0.0)=VIEW

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REQUIRED RESPONSE SPECTRUM CURVE

(EMERGENCY CONDITION)

FOR

1 E22 - F001

14" HPCS VALVE

LOCATED IN

REACTOR BUILDING EL. 674'0"

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. [illegible]
DESIGN BY [illegible] DATE [illegible]
CHECKED BY [illegible] DATE [illegible] SHEET 1 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
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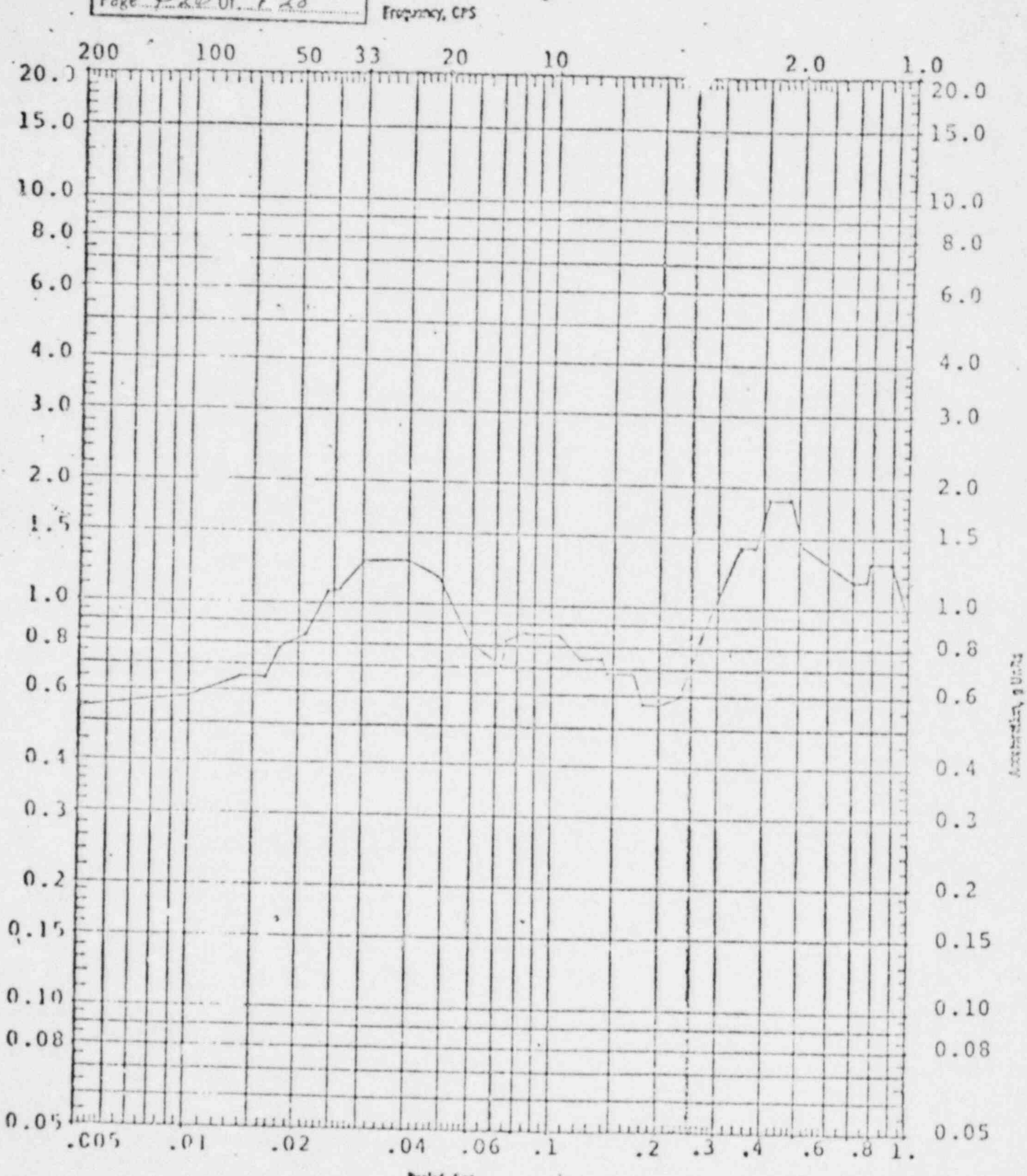
REV. NO.	0						
DATE	4-22-81						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 673'4" 2% Damping Horizontal Slab NS-EW
Envelop of a) SSE + CO_{LEVY-1}
b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})
c) SSE + CHUG ...

SARGENT & LUNDY
ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-00
DESIGN BY S. Joshi DATE 1/22/80
CHECKED BY [illegible] DATE 1-22-80 SHEET 3 OF 27

Calc. No: EMD - 030469
Rev: 00 Date: 06/01/81
Proj. No: 4266-00
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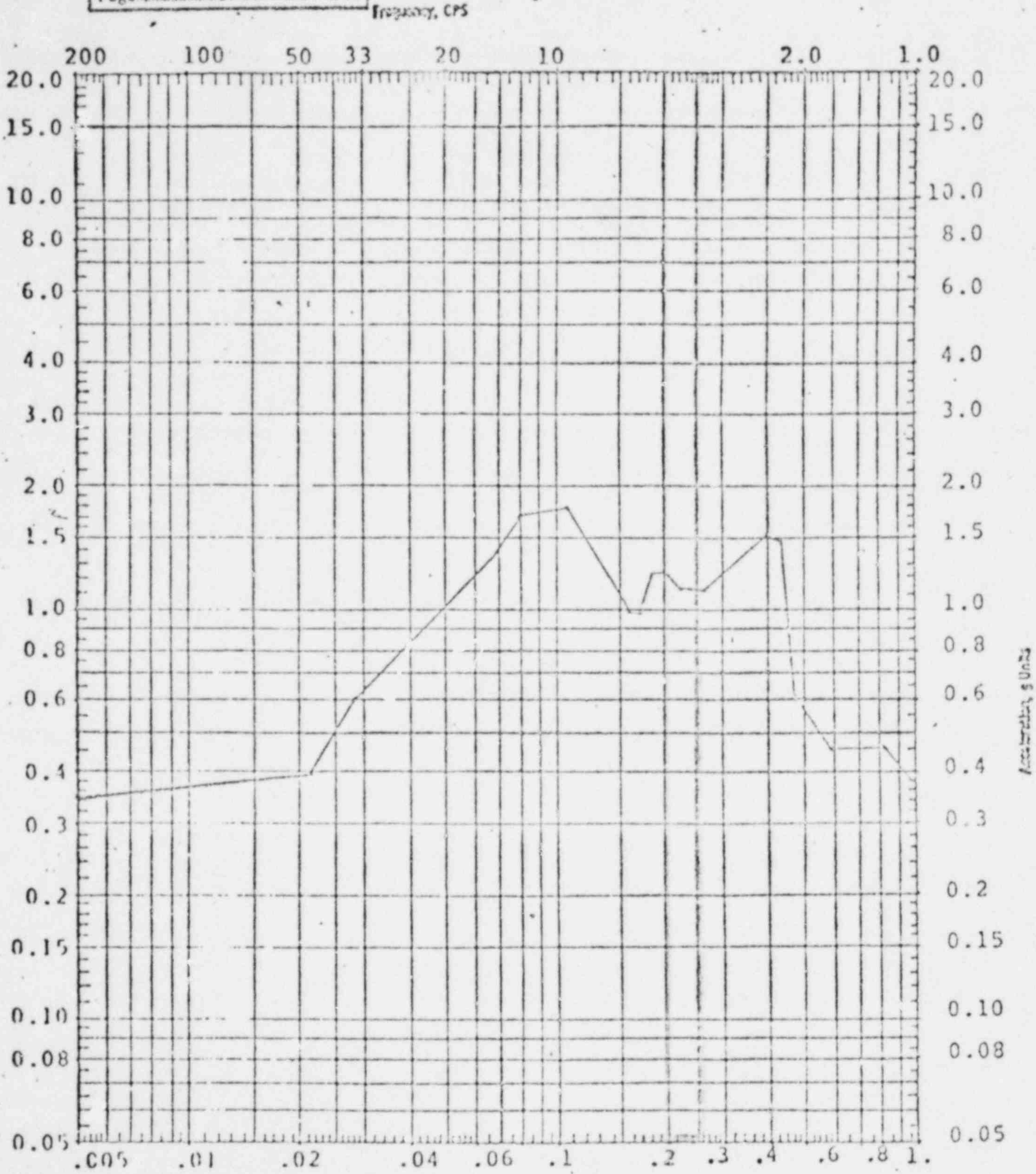
REV. NO.	0						
DATE	1/22/80						
INITIALS	JS						



REACTOR BUILDING-ELEVATION: 673'4" 2% Damping Vertical Wall
Envelop of a) SSE + CO_{LEVY-1}

b) SSE + CO_{LEVY-2} + Envelop of (SRV_{ALL} + SRV_{ASY})

SARGENT & LUNDY ENGINEERS

CLIENT COMMONWEALTH EDISON COMPANY
PROJECT LA SALLE COUNTY - 1 & 2 JOB NO. 4266-18
DESIGN BY [illegible] DATE 11/29/80
CHECKED BY [illegible] DATE 12-22-80 SHEET 2 OF 27

Calc. No: EMD-030469
Rev: 00 Date: 06/04/81
Proj. No: 4266-00
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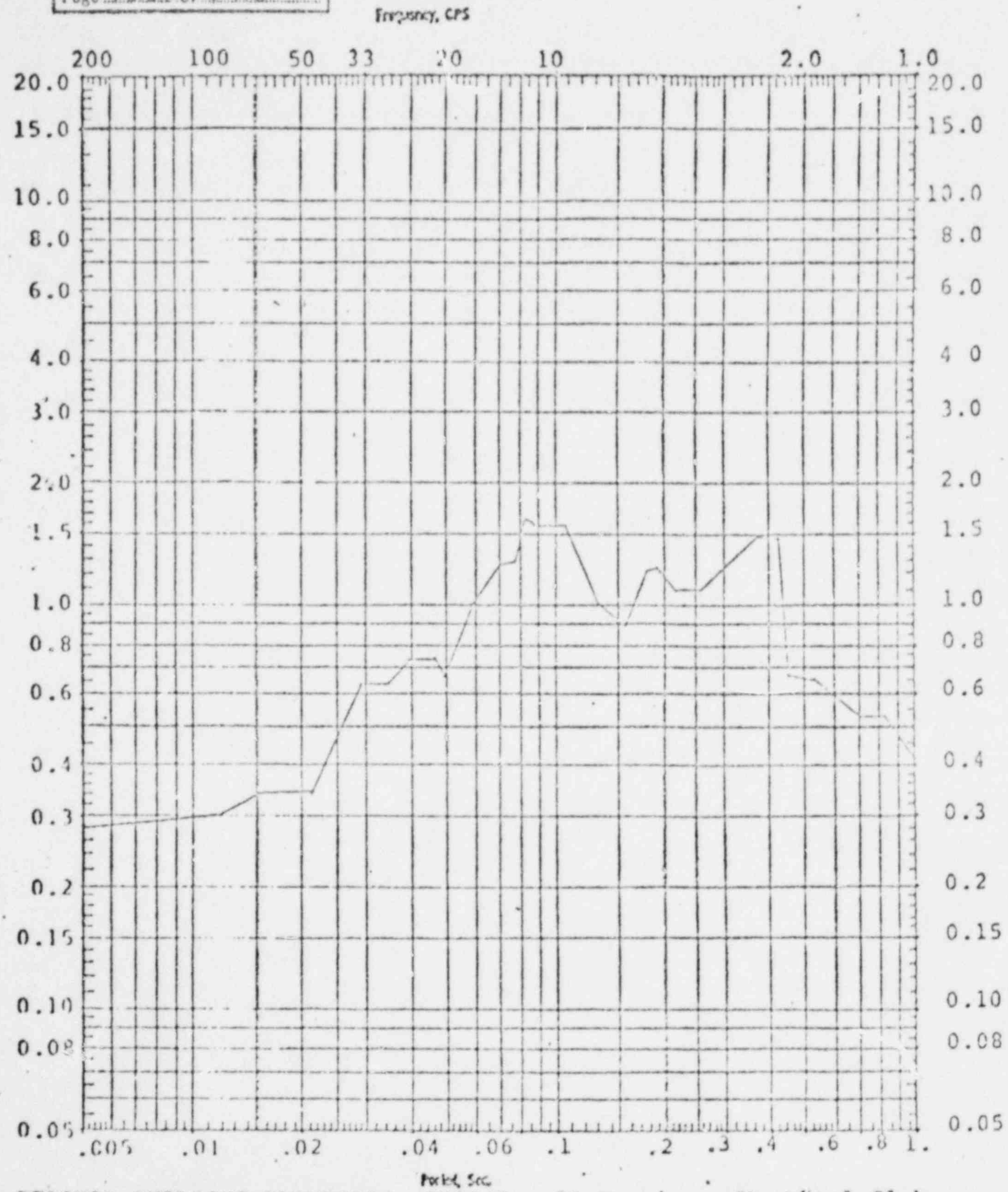
REV. NO.	0						
DATE	12-22-80						
INITIALS	[illegible]						



REACTOR BUILDING-ELEVATION: 673'4" 2% Damping Vertical Slab

Envelop of a) SSE + CO_{LEVY-1}

b) SSE + $CO_{[illegible]}$ + Envelop of ($SRV_{[illegible]}$ + $SRV_{[illegible]}$)

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For Recirculating Flow Control Valve - Comparison of Impedance Test and Analytical Results			Calc. No. EMD-030459	
	X	Safety-Related		Non-Safety-Related	Rev. 00	Date 06/01/81
					Page Q1 of Q26	

Client Commonwealth Edison Company	Prepared by Ismail Kisisel	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No. 1B33-F060B	Approved by	Date

I. OBJECTIVE

The objective of this study can be summarized as follows:

a) To assess the comparison between the impedance test results and the existing qualification report.

b) To re-assess the adequacy of the equip ent for the additonal hydrodynamic loadings, particularly in regard to the high frequency resonances reported as a result of impedance tests conducted in-situ.

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORT

Qualification report presented the results of analytical assessment and design qualification of this recirculating flow control valve (Ref. 1).

In order to assure the functional reliability and operability as well as structural integrity, detailed analysis was performed on various components of the valve in accordance with the rules of Article NB-3000 of "ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components". The results of the evaluation indicated that the valve is adequate under the defined service.

The valve upper works was analyzed to determine its lowest natural frequency. The anlaysis was performed using the SAP IV finite element program. The configuration was modeled with beam

II. SUMMARY OF PERTINENT RESULTS FROM QUALIFICATION REPORT (CONT'D)

elements whose section properties were determined from the thinnest sections in the area of the elements. The mass of the structure was distributed to the nodes by a careful weight analysis using the drawings of all component parts of the assembly.

A schematic drawing of the valve upper works is shown in Figure 1. The nodes utilized in the model are shown by dark circles and the node number is indicated by uncircled integers. The beam element numbers are indicated by circled integers. A Young's modulus of $29. \times 10^6$ psi and a Poisson's ratio of .3 was assumed for all elements.

The final mass distribution for the nodes and the total weight is given on Table 1 below:

TABLE 1

Mass Distribution

Node No.	Mass	Weight
1	1.19	459
2	.792	306
3	1.58	612
4	4.14	1599
5	1.03	396
6	2.12	819
7	1.08	417
8	1.03	398
9	.65	251
10	.16	62

Total Weight = 5319 lb.

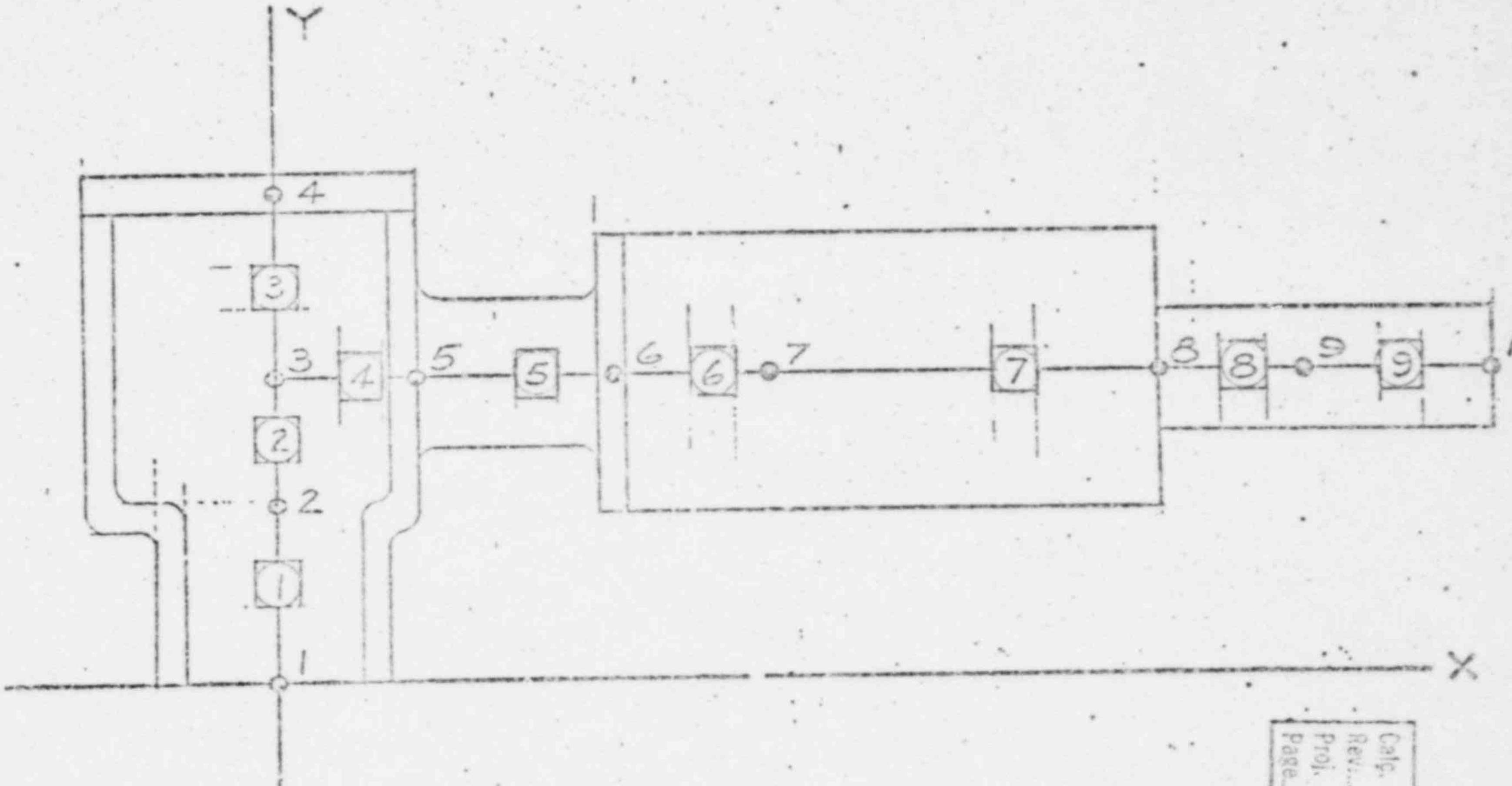


FIGURE 1 MODEL OF UPPER WORKS

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The section properties for the elements are given in Table 2.

TABLE 2. Section Properties

Element #	R_i	R_o	I	J	A
1	6.7	9.75	5515	11030	158
2,3	10.75	13.25	13718	29436	188
4	Rigid	Rigid	10^5	10^5	500
5	4.5	7.5	2163	4326	113
6,7	8.3	9.9	3817	7634	91.5
8,9	0	6.75	1630	3260	143

The two lowest natural frequencies associated with the configuration are 114.5 Hz and 119.1 Hz. The lowest or fundamental is associated with a torsion-bending mode. The long run of the configuration twists about the smallest section of the large casting at the bonnet cover. The next highest frequency which is very close to the lowest is associated with a bending-bending mode.

III. SUMMARY OF PERTINENT RESULTS FROM IMPEDANCE TEST REPORT

The reactor coolant system flow control valve was fully installed and operational at the time of testing. All hydraulic and electrical connections to the valve were complete. The piping system was empty at the time of testing. The line drawing of the valve and the wire frame drawing used in the modal anlaysis is shown in Figures 2 and 3.

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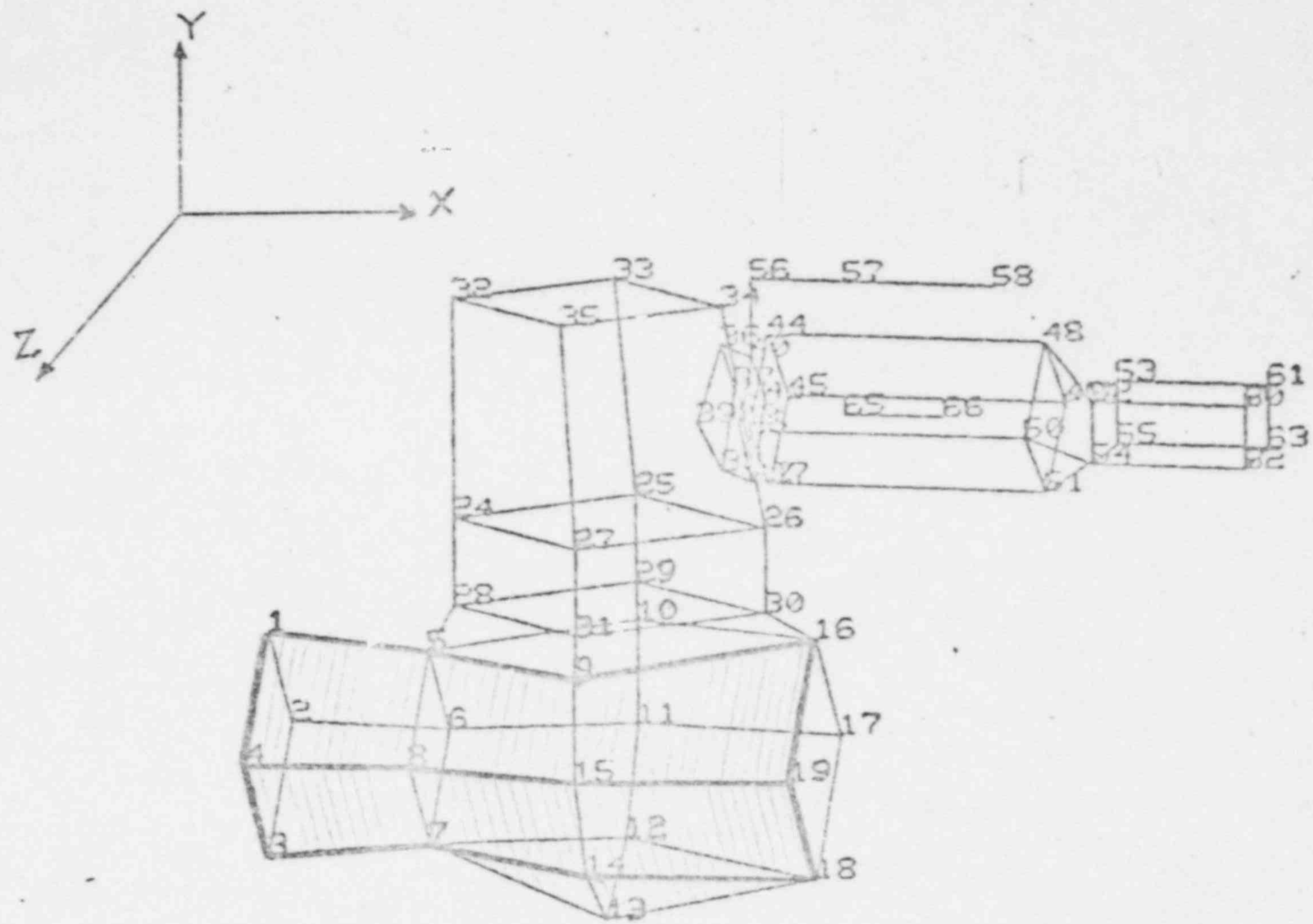

1: 35Z+ COMP,F= 7.400 HZ (0.2, 0.2, 1.0, 0.0)=VIEW

FIGURE 2

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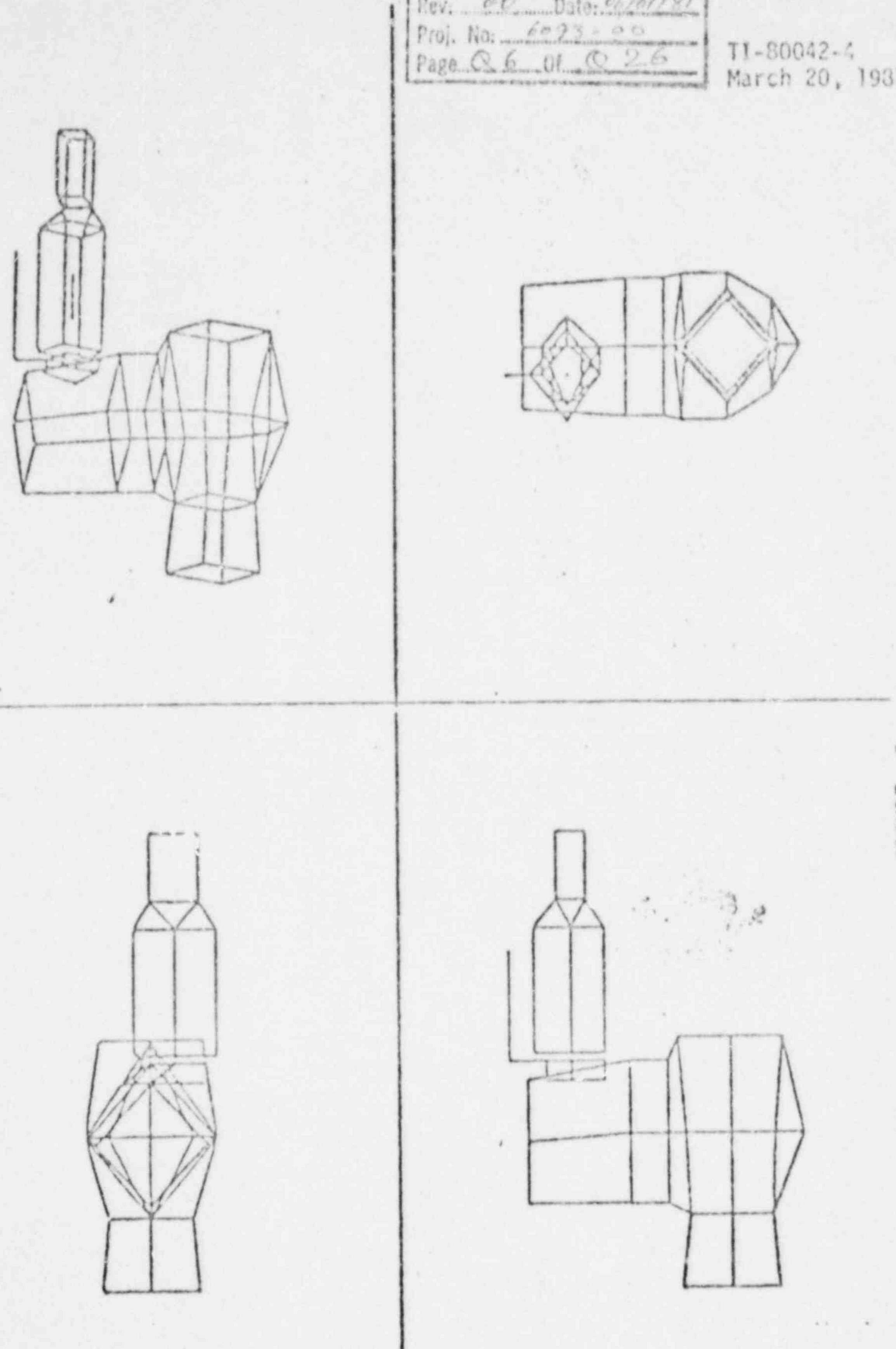

FIGURE 3

ORTHOGONAL VIEWS OF THE REACTOR FLOW CONTROL VALVE WIRE FRAME MODEL

To excite vibration in the reactor flow control valve, the hydraulic shaker was used with the small weight (122 pound). Acceleration levels on the valve were nominally in the .1 to .5 g range. The valve was excited in three directions.

Figures 4 through 6 show representative transfer functions for the X, Y and Z directions, respectively. Tables 3, 4 and 5 list the resonant frequencies and damping values associated with transfer functions shown in Figures 4 through 6. Tables 6, 7 and 8 show the cross coupling coefficients computed for excitation in the X direction, Y direction, and Z direction, respectively.

An inspection of resonant frequencies that are given in Tables 3 to 5 and the corresponding cross-coupling coefficients given in Tables 6 to 8 indicate that the same frequency appears in three directions most of the time with slight differences. Examples are 17.8 cps versus 18.0 and 18.2 cps, or, 29.3 cps versus 28.8 and 29.7 cps. This phenomena was observed by the tester (Ref. 4) also, and the frequencies in the dominant directions were labeled "real". Theoretically, if a mode is participating in more than one direction, individual measurements must indicate the same frequency; yet, considering the approximate nature of the experimental method and evaluation

TABLE 3

MODAL PROPERTIES OF THE REACTOR FLOW CONTROL VALVE MEASURED IN THE X DIRECTION

MODE SHAPE	RESONANT FREQUENCY (HZ)	DAMPING
1	5.4	0.059362
2	9.0	0.063174
3	11.5	0.033636
4	17.8	0.037966
5	21.5	0.021416
6	28.8	0.032197
7	37.7	0.011769
8	49.1	0.035443
9	59.5	0.042132

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For		Calc. No.	
			Rev. 00	Date 06/01/81
	X Safety-Related	Non-Safety-Related	Page Q9	of Q26

Client Commonwealth Edison Company	Prepared by / Date
Project LaSalle County, Units I & II	Reviewed by / Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by / Date

TABLE 4

MODAL PROPERTIES OF THE REACTOR FLOW CONTROL VALVE
MEASURED IN THE Y DIRECTION

MODE SHAPE	RESONANT FREQUENCY (HZ)	DAMPING
1	5.5	0.037823
2	9.7	0.057075
3	18.0	0.044098
4	22.0	0.071703
5	29.7	0.033983
6	58.5	0.024549
7	61.5	0.036330
8	81.3	0.038563

TABLE 5

MODAL PROPERTIES OF THE REACTOR FLOW CONTROL VALVE
MEASURED IN THE Z DIRECTION

MODE SHAPE	RESONANT FREQUENCY (HZ)	DAMPING
1	7.4	0.051854
2	8.6	0.060499
3	12.3	0.063374
4	18.2	0.042194
5	22.5	0.017809
6	29.3	0.027080
7	39.7	0.017744
8	53.4	0.062978
9	[illegible]8.6	0.029086
10	78.2	0.023980

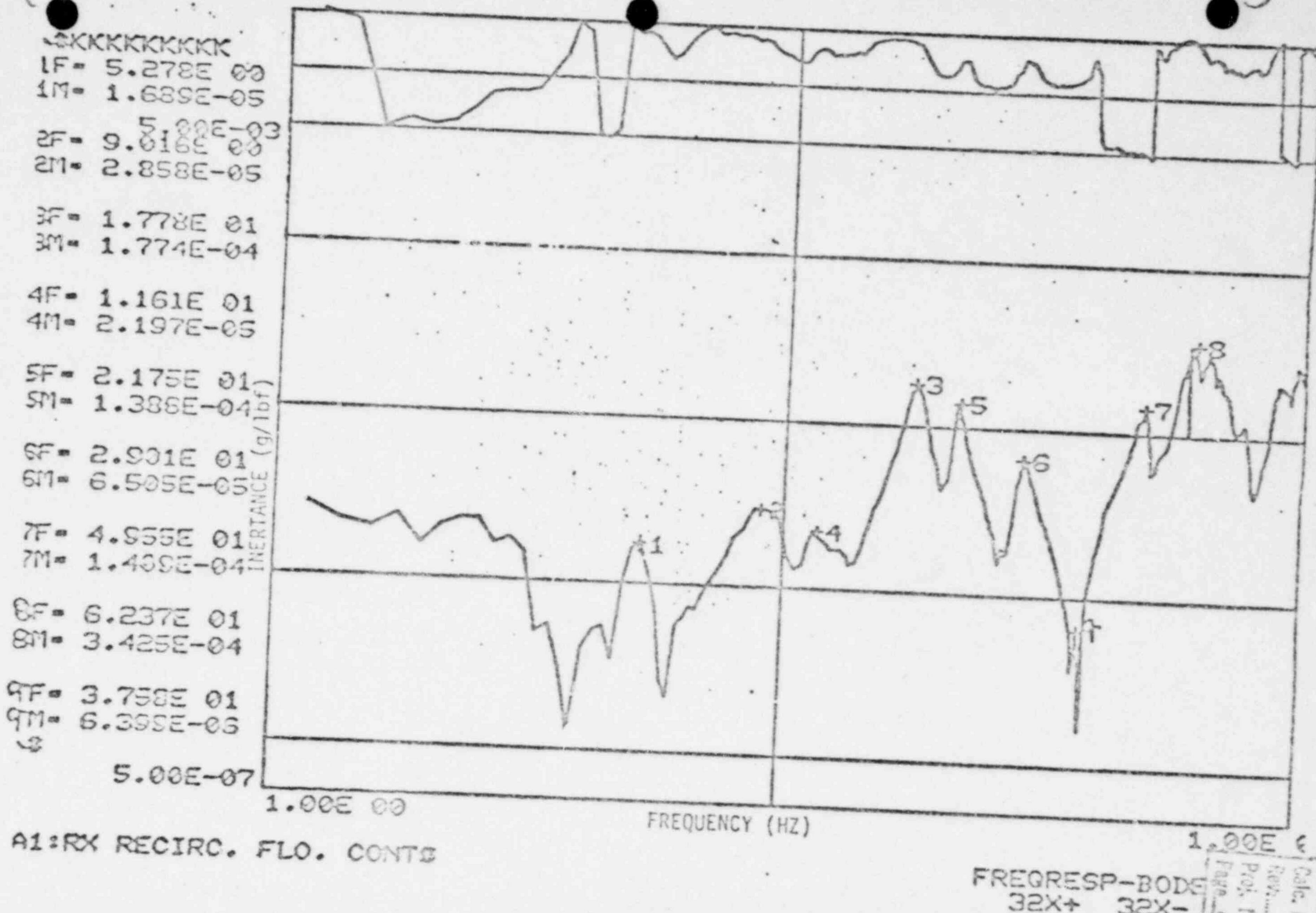

FIGURE 4.

A TYPICAL TRANSFER FUNCTION FOR EXCITATION IN THE X DIRECTION ON THE REACTOR FLOW CONTROL VALVE

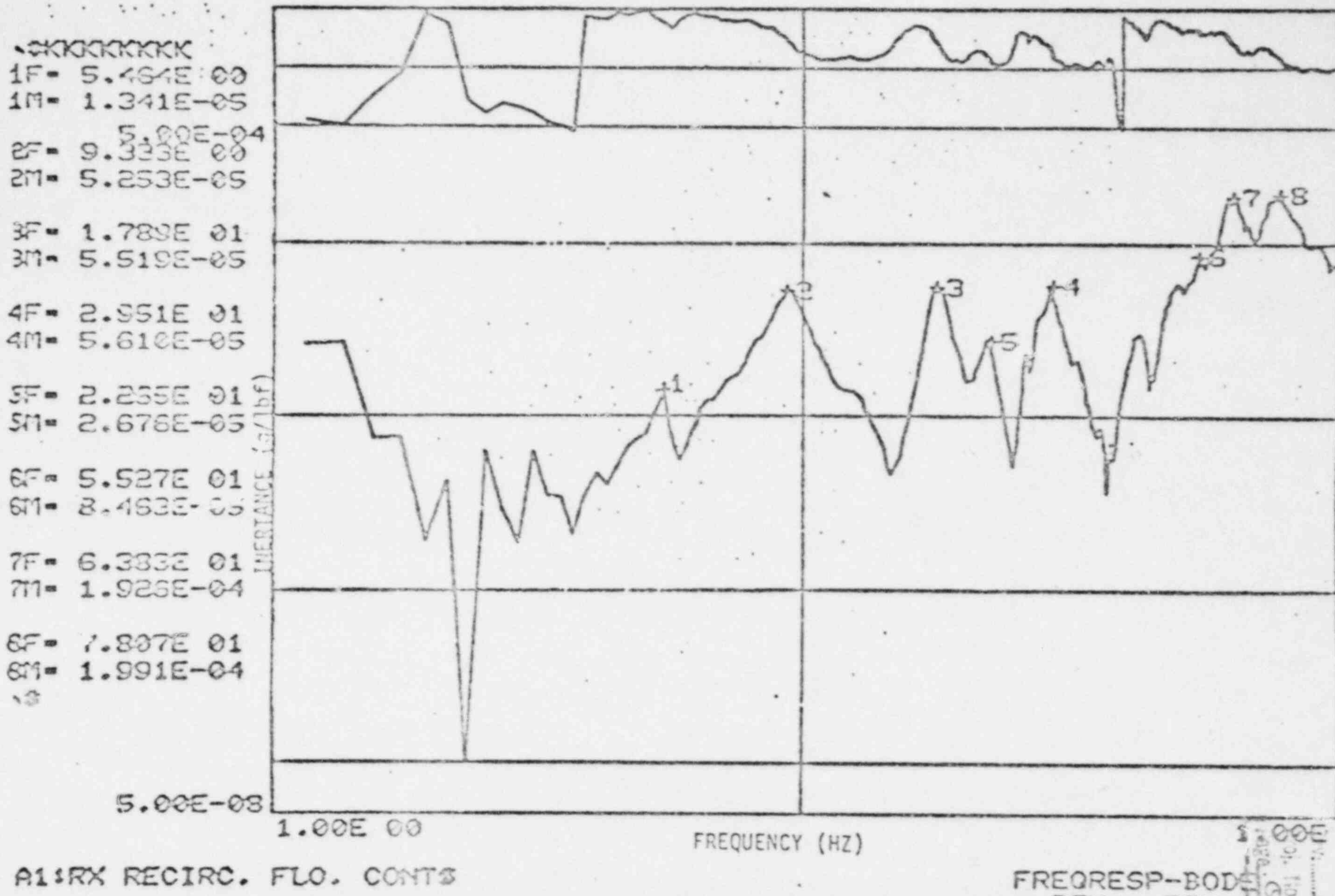

FIGURE 5

A TYPICAL TRANSFER FUNCTION FOR EXCITATION IN THE Y DIRECTION ON THE REACTOR FLOW CONTROL VALVE

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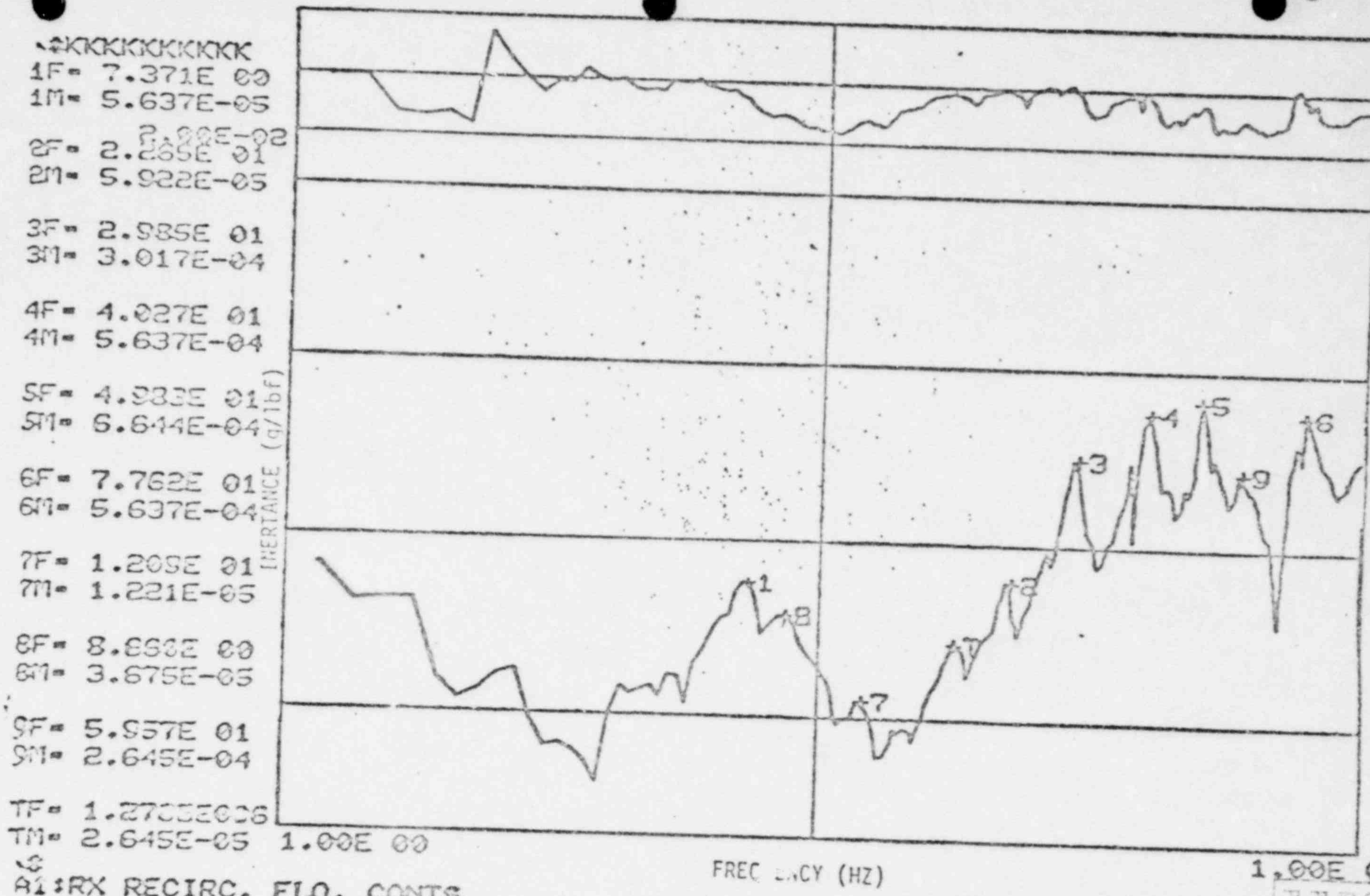

FIGURE 6

A TYPICAL TRANSFER FUNCTION FOR EXCITATION IN THE Z DIRECTION ON THE REACTOR FLOW CONTROL VALVE

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TABLE 6

COEFFICIENTS FOR EXCITATION IN THE X DIRECTION

MODE SHAPE	RESONANT FREQUENCY (HZ)	X→Y(%)	X→Z(%)
1	5.4	61.6	35.0
2	9.0	144.0*	72.5
3	11.5	140.0*	131.0
4	17.8	73.1	32.6
5	21.5	41.0	36.2
6	28.8	137.0	206.0*
7	37.7	167.0	1037.0*
8	49.1	97.5	200.0*
9	59.5	47.8	20.0

*Cross coupling coefficients greater than 100% generally indicate that the mode is dominant in directions other than that in which the excitation was applied.

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TABLE 7

COEFFICIENTS FOR EXCITATION IN THE Y DIRECTION

MODE SHAPE	RESONANT FREQUENCY (HZ)	Y→X(%)	Y→Z(%)
1	5.5	224.0*	60.9
2	9.7	75.5	24.2
3	18.0	293.0*	91.0
4	22.0	287.0*	69.8
5	29.7	99.7	151.0*
6	58.5	52.2	184.0*
7	61.5	68.1	560.0*
8	81.3	46.5	200.0*

*Cross coupling coefficients greater than 100% generally indicate that the mode is dominant in directions other than that in which the excitation was applied.

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TABLE 8

COEFFICIENTS FOR EXCITATION IN THE Z DIRECTION

MODE SHAPE	RESONANT FREQUENCY (HZ)	Z→X(%)	Z→Y(%)
1	7.4	11.8	19.8
2	22.5	235.0*	102.0*
3	29.3	89.0	90.3
4	39.7	13.7	36.0
5	53.4	27.6	39.6
6	78.2	41.5	22.2
7	12.3	422.6*	55.3
8	8.6	49.8	131.0*
9	58.6	56.7	82.7
10	18.2	414.9*	300.0*

*Cross coupling coefficients greater than 100% generally indicate that the mode is dominant in directions other than that in which the excitation was applied.

techniques, mentioned differences are expected and permissible. In the light of this discussion, it can be safely stated that the experimentally determined "real" frequencies are less in number than given in previous tables ; and these frequencies are listed on Table 9.

TABLE 9

EXPERIMENTAL FREQUENCIES (REAL)

FREQUENCY (CPS)	DOMINANT DIRECTION
5.4	X
7.4	Z
9.7	Y
12.3	Z
17.8	X
21.5	X
29.3	Z
39.7	Z
53.4	Z
58.6	Z
78.2	Z

IV. COMPARISON OF RESULTS

Two frequencies, namely 114.5 and 119.1 cps were identified for the valve upper works through analysis and were labeled as lowest natural frequencies. Inspection of the Tables 3, 4, 5 and 9

IV. COMPARISON OF RESULTS (CONT'D)

indicate that the maximum experimentally identified frequency is 78.2 cps, which is substantially smaller than 114.5 cps.

This obvious discrepancy between analysis and test results lead to the investigation of the dynamic characteristics of the piping subsystem on which this valve is mounted. Dynamic analysis of the subsystem 1RH02 was performed using PIPSYS integrated piping analysis program (Ref. 5). Total of 45 modes were considered and the natural frequencies were determined for the piping subsystem. Selected piping frequencies in the range of interest are given on Table 10.

TABLE 10

SELECTED FREQUENCIES FROM PIPING ANALYSIS (REF. 5)

MODE	FREQUENCY (cps)
1	8.48
2	15.00
3	21.20
6	28.80
12	38.11
18	53.91
20	57.97
32	77.76

Considering the simplifying assumptions that are used in piping modelling and the approximate nature of testing procedures, the comparison of Tables 9 and 10 indicate a satsifactory correspondence between the piping frequencies that are analytically determined and the impedance test results. Indeed, inspection of mode shapes indicate that the measured frequencies are pipe frequencies rather than valve frequencies. This observation is demonstrated by Figures 7 thru 10, where mode shape plots for 5.4, 7.4, 12.3 and 17.8 cps are given. As seen, the deflections on various parts of the drawings indicate rigid body translations or rotations for the whole of the valve rather than relative displacements. Similar observations can be done for the rest of the frequencies with the exception of the LVDT bracket-assembly situated on top of the extended portion of the valve, which was not considered in the finite element modelling of the valve. This LVDT bracket assembly experiences its own local natural frequencies of 29.3, 39.7 and 58.6 cps and participation does not persist for higher frequencies.

It is reported in Ref. 2 that the valve experiences a horizontal acceleration of 1.971 g and vertical acceleration of 1.799 g. The allowable values for these accelerations are 8.48 g and 6 g for horizontal and vertical directions respectively. These

values indicate a minimum allowable amplification factor of 3.3, which in turn is regarded as a fairly high safety margin, and leads to a qualitative statement that the LVDT bracket assembly will not experience excessively high stress levels.

V. CONCLUSIONS

a) Actual valve frequencies pertaining to the valve upper works are determined by detailed finite element analysis to be 114.5 and 119.1 cps.

b) Impedance tests did not cover frequency range higher than 100 cps, therefore, it was not possible to compare analytical and experimental results for frequencies higher than 100 cps.

c) Experimentally determined frequencies in the range below 100 cps were shown to be pipe frequencies by comparing piping analysis results and impedance testing results with the exception of LVDT bracket assembly.

d) Considering high margin of safety and non-persistant behavior of excitation, it is concluded that LVDT bracket assembly will not experience high stress levels.

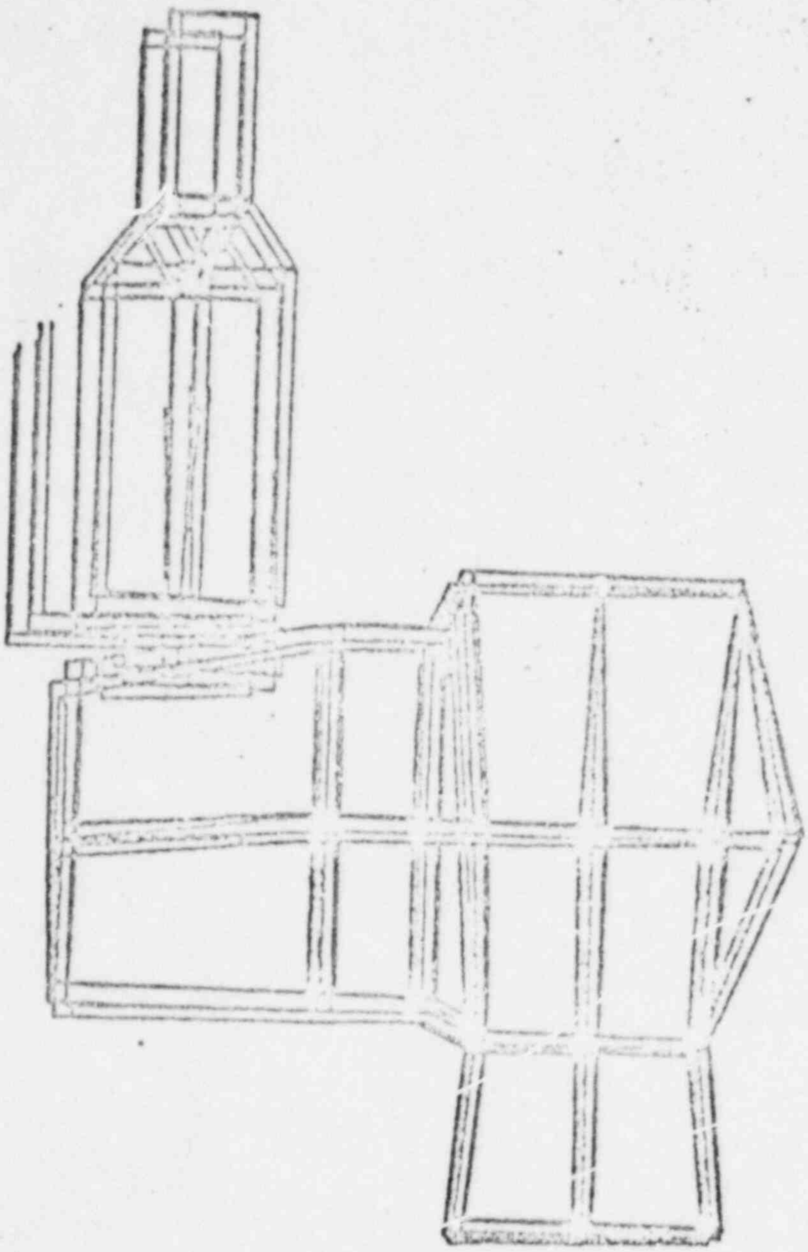

FIGURE 7

MODE SHAPE 1 MEASURED IN THE X DIRECTION ASSOCIATED WITH THE 5.4 HZ MODE
THIS RESONANT FREQUENCY WAS DETERMINED TO BE REAL IN THE X DIRECTION.

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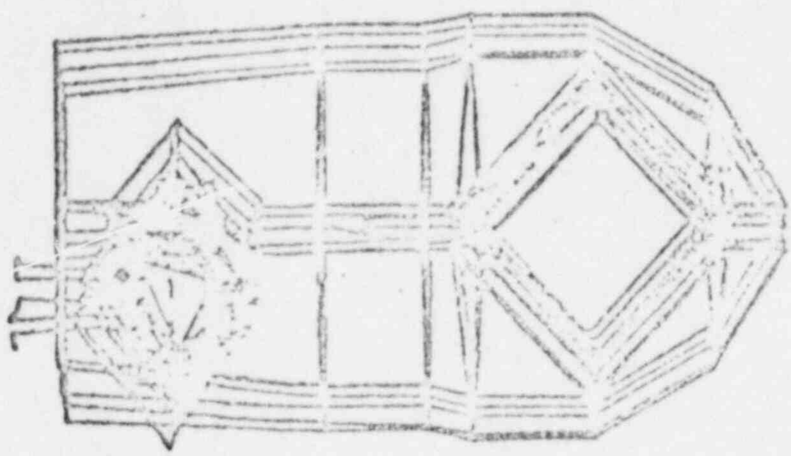

FIGURE 8

MODE SHAPE 1 MEASURED IN THE Z DIRECTION ASSOCIATED WITH THE 7.4 HZ MODE

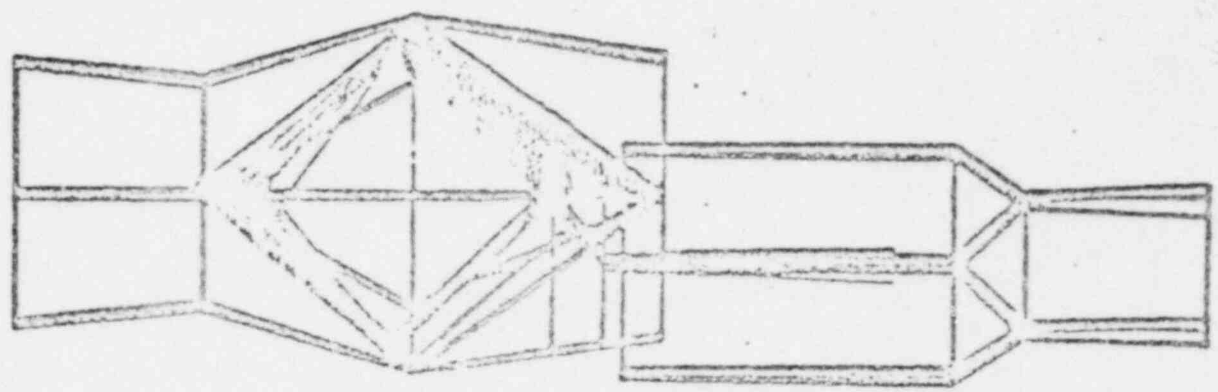

FIGURE 9

MODE SHAPE 3 MEASURED IN THE Z DIRECTION ASSOCIATED WITH THE 12.3 HZ MODE

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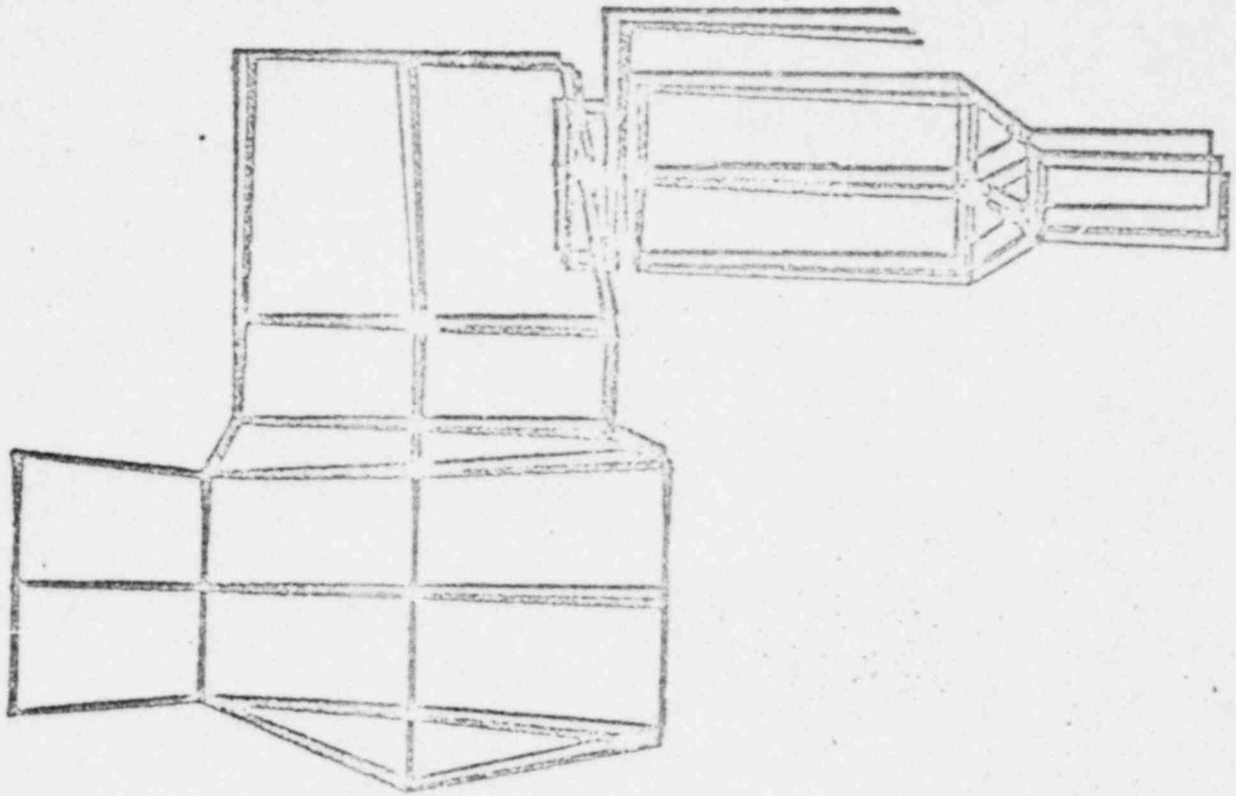

FIGURE 10

MODE SHAPE 4 MEASURED IN THE X DIRECTION ASSOCIATED WITH THE 17.8 HZ MODE
THIS RESONANT FREQUENCY WAS DETERMINED TO BE REAL IN THE X DIRECTION.

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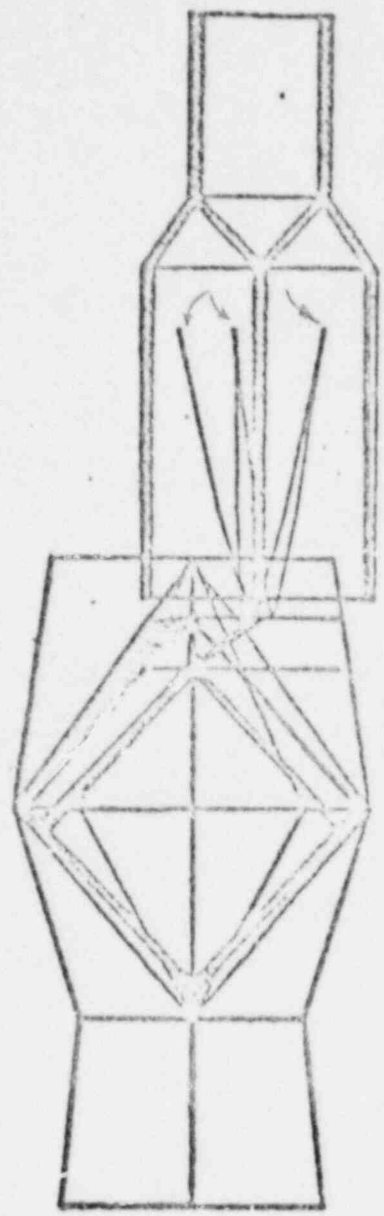

FIGURE 11

MODE SHAPE 7 MEASURED IN THE Z DIRECTION ASSOCIATED WITH THE 39.7 HZ MODE
THIS RESONANT FREQUENCY WAS DETERMINED TO BE REAL IN THE Z DIRECTION.

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REFERENCES

1. "Qualification Documents for Recirculation System Flow Control 24" Gate Valve 1B33-F060 A/B".

2. "G.E. Design Report #22A7428", Rev. 00, March 9, 1981, Sheets 62 thru 72.

3. "Final Test Report SQRT In-Plant Impedance Testing, LaSalle County 1 , Transitek Inc. Job. No. 80042, EMD File No. 029601, Rev. 00, March, 1981.

4. "Impedance Test Results for Reactor Recirculating Flow Control Valve", (Add. to Ref. 3 Above).

5. "S&L Piping Report, 1RH-02", Sargent & Lundy, EMD File No. 025233, 03/07/81.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For HPCS 4" Motor Operate Gate Valve/Impedance Tests		Calc. No.	
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Client Commonwealth Edison Company	Prepared by I. Elgindy	Date
Project LaSalle County, Units I & II	Reviewed by	Date
Proj. No. 4266/4267/6093-00 Equip. No.	Approved by	Date

An assessment of comparison between the Impedance Test Results and the results of the existing qualification report (final) cannot be done for this equipment.

Earlier analysis indicated that the 4" gate valve (E22-F012) was not qualified in the as built condition to resist the existing loads. Therefore it was necessary to implement a design change. This change consisted of building supports between upper yoke flange and the nearby 16" diameter header pipe. The data on this design change was transmitted to NRC thru our transmittal dated 3/10/81 (EMD File #028847).

The impedance tests were conducted in the field for the as built condition of this valve, whereas the implemented design change modifies the fundamental dynamic behavior of the equipment, eliminating the basis of comparison between analytical and experimental results.

SARGENT & LUNDY ENGINEERS CHICAGO	Calcs. For HPCS 12" Globe Valve Comparison of Impedance Test and Analytical Results	Calc. No. EMD-030469
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Client: Commonwealth Edison Company		Prepared by Ismail Kisisel	Date 04/27/81
Project LaSalle County, Units I & II		Reviewed by	Date
Proj. No. 4266/4267/6093-00	Equip. No.	Approved by	Date

An assessment of comparison between the Impedance Test Results and the results of the existing qualification repo: cannot be done for this equipment.

Earlier analysis indicated that E22-F023 globe valve was not qualified in the as built condition to resist the existing loads. Therefore it was necessary to implement a design change. This change consisted of building additional yoke legs between the upper yoke flange and the bonnet flange.*

The impedance tests were conducted in field for the as built condition of this equipment, whereas the implemented design change modifies the fundamental dynamic behavior of the equipment, eliminating the basis of comparison between analytical and experimental results.

*The data on this design change was transmitted to NRC thru our transmittal dated 3-10-81 (EMD File #028847).