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Investigation of the Conservatism Associated With Different Combinations Between Primary and Secondary Piping Responses

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Commission

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Abstract

This report includes the findings of an investigation of the conservatism associated with different combinations between the primary and secondary stress components for piping systems under dynamic loading, such as in an earthquake event. The primary stresses are induced by piping response to its mass inertia effects. The secondary stresses are induced by relative displacements of piping supports. The study involves an independent time history analysis of several typical piping models to predict a best estimate of the actual dynamic and pseudo-static pipe responses to an earthquake. These piping systems are also analyzed using the response spectrum method to obtain the maximum primary stress components. Secondary stresses are next calculated by performing a set of static analyses which provide the worst stress condition. The two components are then combined by both SRSS and absolute sum methods as the results are compared with time history solutions.

It is found that the SRSS combination of the primary and secondary stress components yield acceptable results provided the secondary stress component is calculated in the most unfavorable phasing relationship among displacements of piping supports. The absolute sum combination as recommended in the current Standard Review Plan is found to yield very conservative results when compared to the time history solutions.

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1.0 Introduction

The design of piping systems in nuclear power plants requires the consideration of moment responses caused by postulated earthquake loadings at the structure foundation. The seismic loads are transmitted to the piping through the pipe support connections and structure supporting the system. Thus, potentially each support point excites the piping system with a different time dependent input loading. One way of estimating the pipe response is to perform a time history analysis with a model that includes the piping system together with the structure and all components. The cost of such an analysis is prohibitive. An alternate procedure is to decouple the piping from the structure and to input loading functions for the piping defined from the structure responses at the support points. This requires a time history analysis of the piping system, which predicts the piping response realistically without taking into account the effect of the pipe-structure interactions.

The latter analysis (Ref. 1) yields two components of response if the support point loadings are different. One is due to the inertia effect of pipe mass and the other is due to the differential input motion of the support points. The former component is the dynamic response and is categorized as producing primary stresses whereas the latter component is known as pseudo-static component and produces secondary stresses. In the older versions of the ASME code (Ref. 2), the primary stresses were combined with other stresses caused by sustained loads and pressure to satisfy the code requirements. The secondary stress became a part of the thermal stresses or stresses caused by terminal movements.

However, in the 1980 version of the ASME Section III requirements, the above two kinds of stress can be combined with other dynamic and sustained load responses. In the present requirement of the Standard Review Plan (SRP) (Ref. 3) these two components must be combined by absolute sum if their time dependent magnitudes are not known, which is the case if they are calculated by other than time history methods. This poses a question of the level of conservatism introduced by adopting such a combination method. This report identifies examples of the level of conservatism inherent in various combination procedures.

The combination is carried out between the dynamic responses (i.e., primary) obtained by a response spectrum analysis and the pseudo-static responses (i.e., secondary) derived from the seismic anchor movement (SAM) analysis. Since the abvove two methods predict response in a conservative way, they do not represent the actual responses of a piping system particularly when the peaks are combined by absolute sum. Time history analysis with independent input accelerations is considered to yield the most realistic responses. The percentage of conservatism associated with any combination between the primary and secondary stresses can be estimated by comparison to the time history solution.

2.0 Technical Approach

In present industry practice the dynamic component of piping response is obtained by using the response spectrum method. The input spectra for this kind of analysis represents the envelope of all the support spectra developed from the time history results from the earthquake analysis of the supporting structure or building. The envelope spectra are applied to all support points simultaneously. These spectra are broadened as per the Regulatory Guide 1.122 (Ref. 4) before analysis. The modal and spatial combinations are chosen as recommended in the Regulatory Guide 1.92 (Ref. 5). The predicted moment response thus calculated is supposed to represent the maximum dynamic or inertial response of the piping system.

There exists no standard procedure for calculating the pseudo-static responses of the piping system due to seismic loading. Current standards require that this component be obtained in such a manner that it represents the most severe condition. In order to calculate this, the magnitudes of the maximum support displacements as well as the phasing between these support movements are required. The Standard Review Plan (Ref. 3) suggests the support-displacements can be calculated either from the structure time history analysis or from the support point response spectra. The former method requires a selection of the maximum displacements from the structural analysis. The latter method uses the formula, displacement = $S_a g/\omega^2$, where S_a is the floor response spectra ZPA amplitude representing the floor motion, g is the acceleration due to gravity, and ω is the first fundamental frequency of the structure supporting the piping system. This method is purported to predict the upper bound of the actual displacement of the support point.

Once these components are obtained, the phasing between the support points must be defined. Since there is no established procedure for determining the worst phasing for a piping system with more than two different support movements, a particular method currently available in the existing piping code PSAFE2 (Ref. 6) is being used for the study. It has the capability of considering each spatial direction individually. The analyst specifies the phasing displacements at all the supports, for all supports on input, and then the code combines the spatial direction results in either of three combination methods. They are the algebraic, square root of sum of squares (SRSS) and absolute sum methods.

It should be noted that an intuitive approach is used to predict the worst phasing among support points in any spatial direction. Thus, the prediction of the static responses at any point of the piping system becomes dependent on the choice of the phasing used by the analyst. To illustrate a simple case, when there are two support points (or groups) with two distinct movements, the worse static responses will be produced when they are subjected to out of phase motion. Thus, there exists only one possible choice of phasing in each spatial direction to produce the most unfavorable stress condition. For a system with three distinct support groups three distinct combinations of phasing in each spatial direction must be considered to determine the most severe stress condition at a point in the piping system.

For each case of phase distribution considered in a particular piping system, the same phasing is used in all three spatial directions. Then the results are combined by either the algebraic, SRSS or the absolute sum method. The algebraic method must be used with care since the moment responses at any point can be cancelled if the moment caused by different spatial directional movements have opposite signs. On the other hand the SRSS and absolute sum methods can predict the worst possible cases. In the present study all three combinations between the spatial effects are considered for each phase consideration. Thus, for the case of two support groups there are three possible solutions corresponding to each combination method for the pseudo-static response calculations.

As mentioned earlier, the time history analysis with different support inputs yields the actual dynamic and pseudo-static responses at each point of the piping system. It should be noted that this analysis uses time history inputs at the support points which are consistent with the response spectra used in the response spectrum solutions. In other words, the response spectra used in this study are derived from the time histories predicted in the time dependent solutions. The damping values used are also the same in both analyses. In the present study a critical damping value of 1% was used.

The time history results with independent support movements yields both the dynamic and pseudo-static responses as well as the total responses at each time point for the piping system. Since the phasing is retained between the dynamic and pseudo-static components in this computation the total response should represent the actual response of the piping system. This result is later compared with the different combinations of the individual components (i.e., primary and secondary) obtained from the response spectrum and seismic anchor movement analysis methods.

The moment results at each end of each pipe element are obtained from the separate dynamic and pseudo-static calculations for each problem. Once the three moment components at any point are calculated by any of the combination procedures identified earlier, the resultant moment is determined using vector summation. This moment is used as the parameter to study the conservatism in the combination method between the primary and secondary stress components.

The two combination procedures between two moment resultants considered in this study are the SRSS and absolute sum methods. The results coresponding to each combination method are compared with the total responses as predicted from the time history solution. A percentage of deviation from this actual response is then included for comparison purposes.

3.0 Analysis Procedure

Four piping systems, shown in Figures 1 to 4, were chosen for this study. These represent typical three-dimensional piping problems suitable for nuclear power plants. The entire sampling of piping systems includes one 4-group, one 3-group and two 2-group problems. The 4-group problem has four distinct support groups which are excited with different earthquake motions at the support points. Similarly, the 3-group problem has three distinct inputs and the 2-group problems have two different support movements. Figures 1 and 4 illustrate the 2-group problems whereas Figures 2 and 3 are the 3-group and 4-group problems respectively.

The computer code PSAFE2 was used to perform all the analyses in this study. This code is an all purpose piping analysis code developed at BNL. Independent support motion analysis algorithms (Ref. 1) have been implemented into the code for both the response spectrum and the time history analysis modes. The code has been used in other NRC programs to perform confirmatory analyses of piping systems for plants seeking operating licenses and in the development of Piping Benchmark Problems.

In order to perform an independent time history analysis of a piping problem, the input support movements must include both the acceleration and displacement time histories components. This is because the integration of the acceleration time history to obtain the displacement time history introduces errors associated with numerical integration as well as base-line errors in the original time functions. Since the current version of PSAFE2 does not have the capability to obtain the correct values of displacement from the acceleration, the displacement time history becomes an input along with the acceleration when performing time history analysis. Hence, corresponding displacement and acceleration time histories for the supports are input.

The source for such a data set is found to be the CALTECH earthquake records which includes all components (acceleration, velocity and displacement) for each earthquake record. These records represent ground motion records for different sites rather than the support point time histories for some nuclear structure. Also, each earthquake record has different frequency contents and is uncorrelated with others. For the purpose of this study these records were used as inputs for the support groups, introducing randomness in the study results.

In order to represent realistic systems, this study also included an analysis using floor time history solutions of a nuclear structure. In this case, the building structure filters all the frequencies representing the dynamic characteristic of the building itself. Because of the massiveness and high strength of nuclear power plant structures, each floor is assumed to exhibit in-phase motion and the floor motions contain similar frequency contents. Although results from this analysis are not included in this report, they were used to support the conclusions presented herein.

Spatial Phasing Cases For SAM Analysis

Case 1: +-

GROUP	COMP	TIME HIST.	ENVELOPE
1	X	FIG.5	FIG.13
	Y	2/3 OF FIG.5	2/3 OF FIG.13
	Z	FIG.7	FIG.14
2	X	FIG.6	FIG.13
	Y	2/3 OF FIG.6	2/3 OF FIG.13
	Z	FIG.8	FIG.14

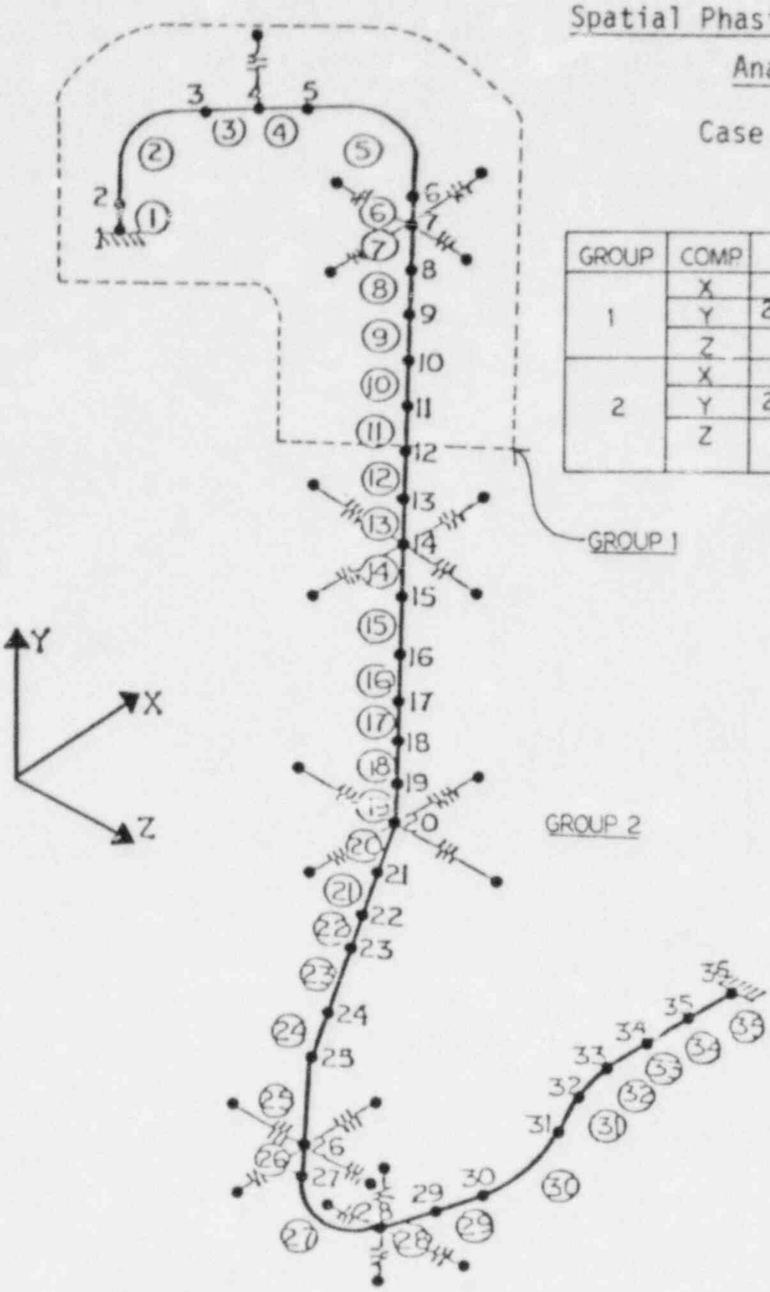


FIG. 1 PIPING PROBLEM Nº 1

GROUP	TIME HIST.	E.R.S.
1 (X,Y,Z)	FIG. 5	FIG. 13
2 (X,Y,Z)	FIG. 6	FIG. 13
3 (X,Y,Z)	FIG. 7	FIG. 13

Spatial Phasing Cases for SAM Analysis

Case 1: +-+
Case 2: ++-
Case 3: +--

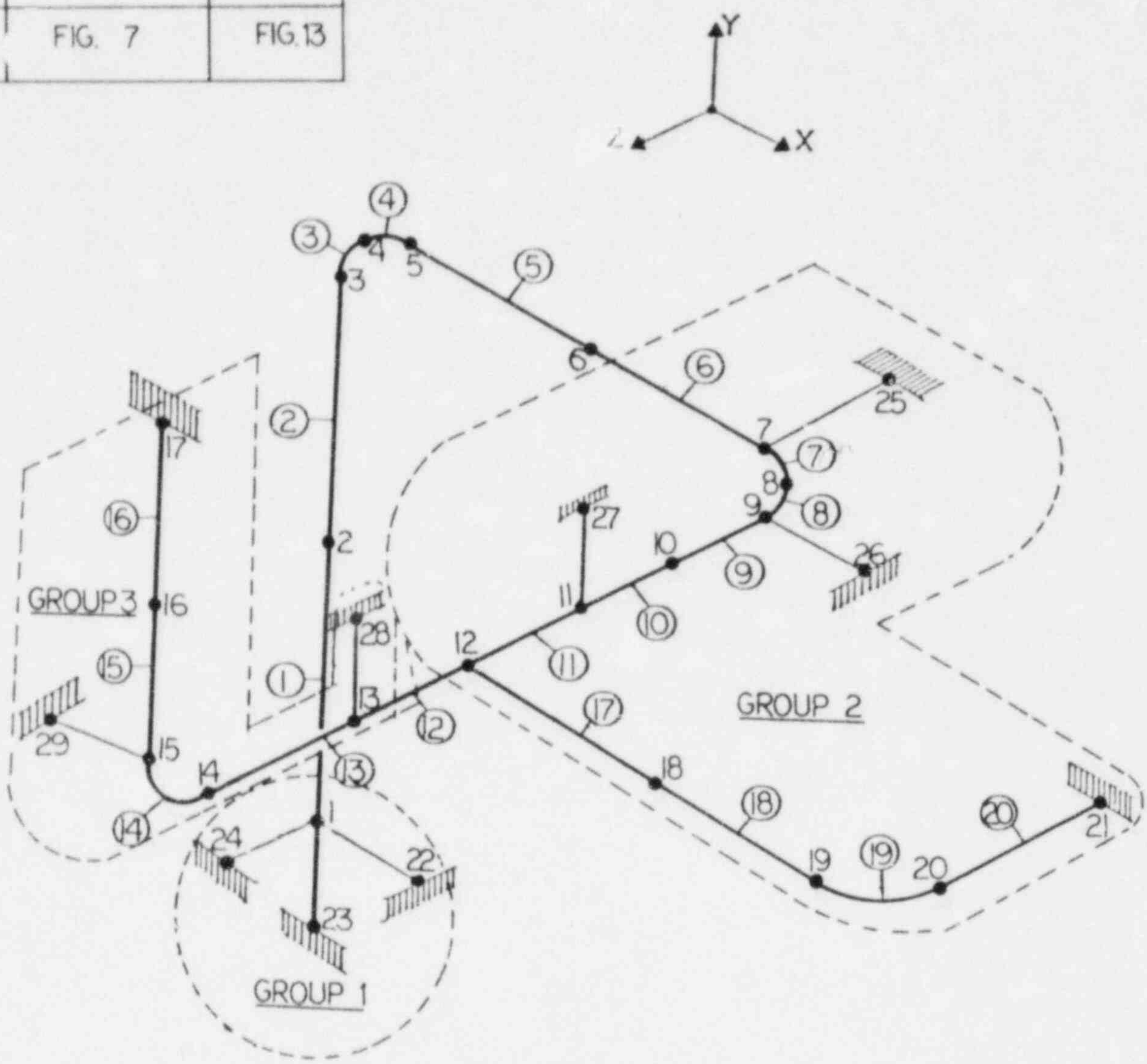
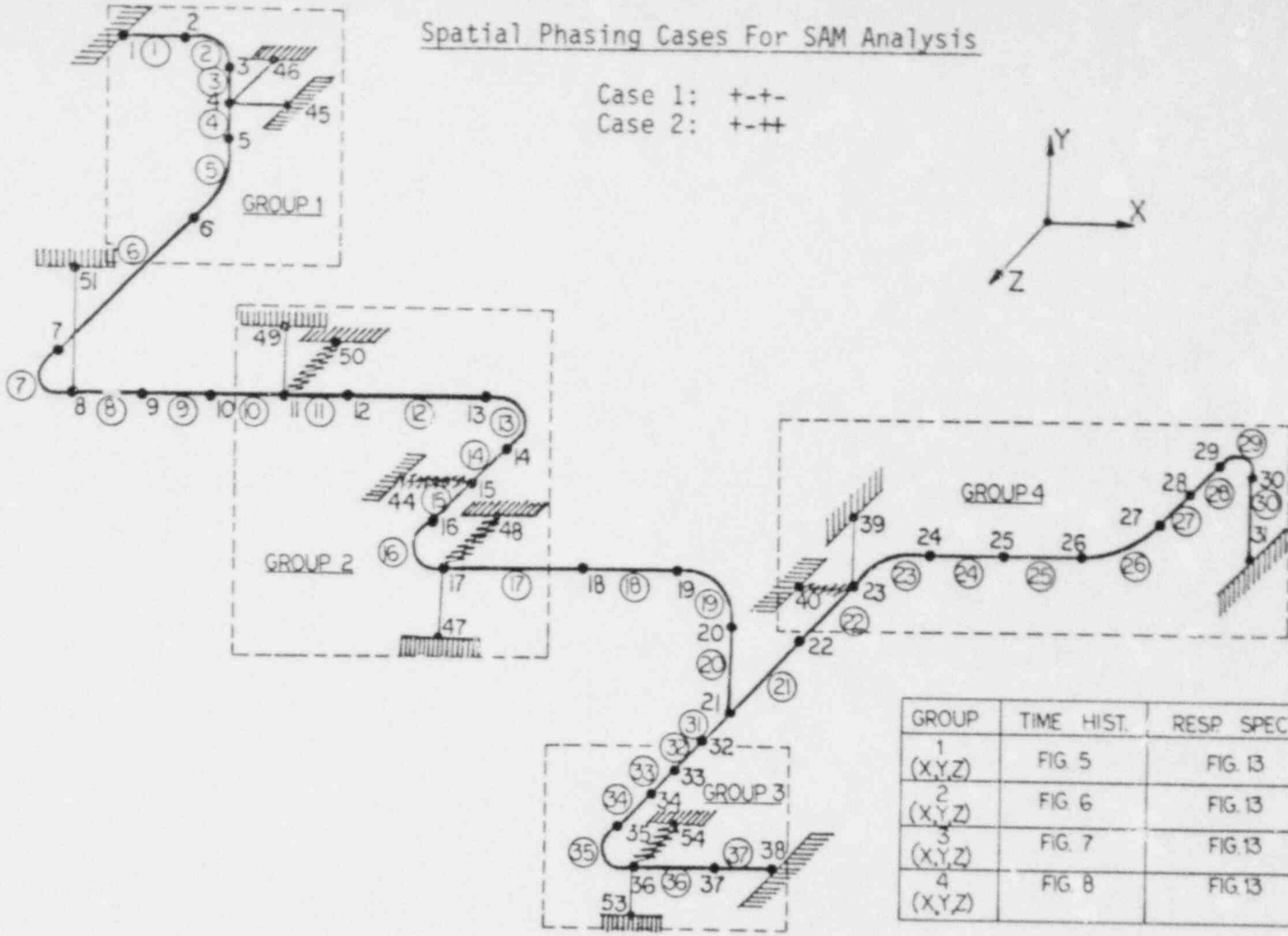


FIG. 2 PIPING PROBLEM Nº 2

Spatial Phasing Cases For SAM Analysis

Case 1: +-+-
Case 2: +-++

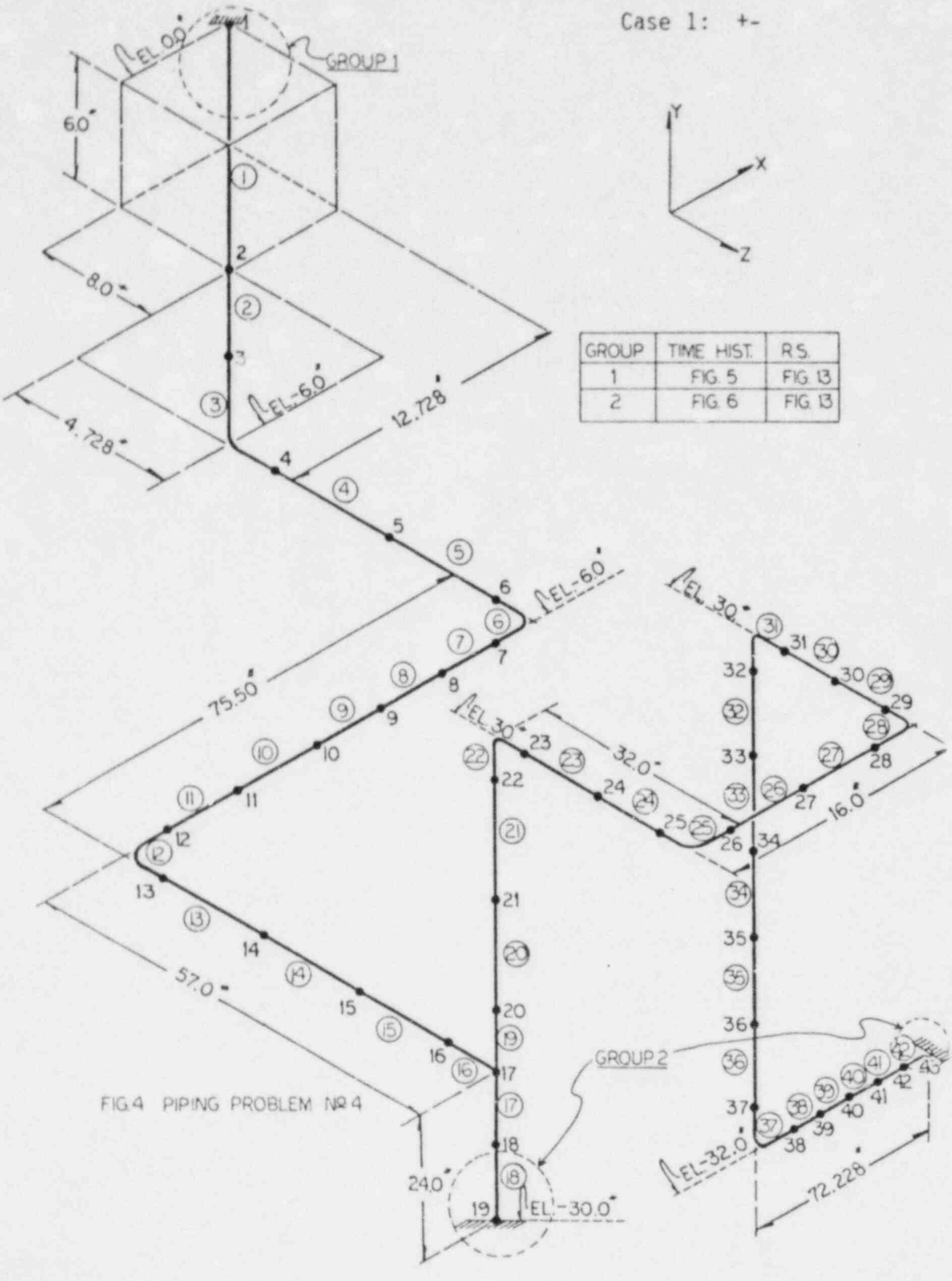


GROUP	TIME HIST.	RESP SPECT.
1 (X,Y,Z)	FIG. 5	FIG. 13
2 (X,Y,Z)	FIG. 6	FIG. 13
3 (X,Y,Z)	FIG. 7	FIG. 13
4 (X,Y,Z)	FIG. 8	FIG. 13

FIG. 3 PIPING PROBLEM Nº 3

Spatial Phasing Cases For SAM Analysis

Case 1: +-



GROUP	TIME HIST.	R.S.
1	FIG. 5	FIG. 13
2	FIG. 6	FIG. 13

FIG.4 PIPING PROBLEM № 4

Figures 5 to 8 represent the four acceleration time histories chosen for this analysis. Figures 9 to 12 illustrate the corresponding response spectra. Figures 13 and 14 show the envelope spectra used for the envelope response spectrum analyses for the piping systems.

The drawings of the piping systems shown in Figures 1 to 4 are self-explanatory for support grouping, input excitation time histories and response spectra. The element numbers in these figures are circled and these numbers correspond to those used in the moment comparison tables. The boundary elements and other relevant data are included in these sketches.

After selecting the piping systems and the loading functions, each piping problem was subjected to a set of analyses as described in the previous section. They include an independent time history analysis, a response spectrum analysis using envelope spectra and a number of static analyses for seismic anchor movement results depending on the number of groups and the intuitive selection of the most unfavorable phasing between these groups.

For comparison purposes, the resultant moment at each end of each element in a piping problem was calculated for all load cases. These results are presented in tabular form for each piping problem for each estimate of seismic anchor movement component in its worst stress condition within each problem.

A typical table includes a comparison of values for the dynamic component from the response spectrum (R.S.) and time history (T.H.) analyses. It also includes a similar comparison for the pseudo-static component from the seismic anchor movement (SAM) and time history (PS.S) analyses. The words 'ALG.', 'SRSS' and 'ABS.' under the SAM title refer to the mode of combination used between the moment components predicted from the three static analyses performed for each spatial displacement input. It should be noted that this combination is done at the moment component level before obtaining the resultant moment as shown in these tables.

Each table also includes a comparison of the total responses obtained from the time history (T.H.) analyses, and the resultant moment produced by combining the R.S. and SAM results by either the SRSS or absolute sum method. The moments listed under the time history analysis only refer to the peak value of the moment for the entire time history. the final column in each table represents the percentage of conservatism (PER. CON.) calculated for each combination method, i.e., SRSS and Absolute Sum (ABS). These numbers are obtained by comparing the results with the time history results listed under the total response column.

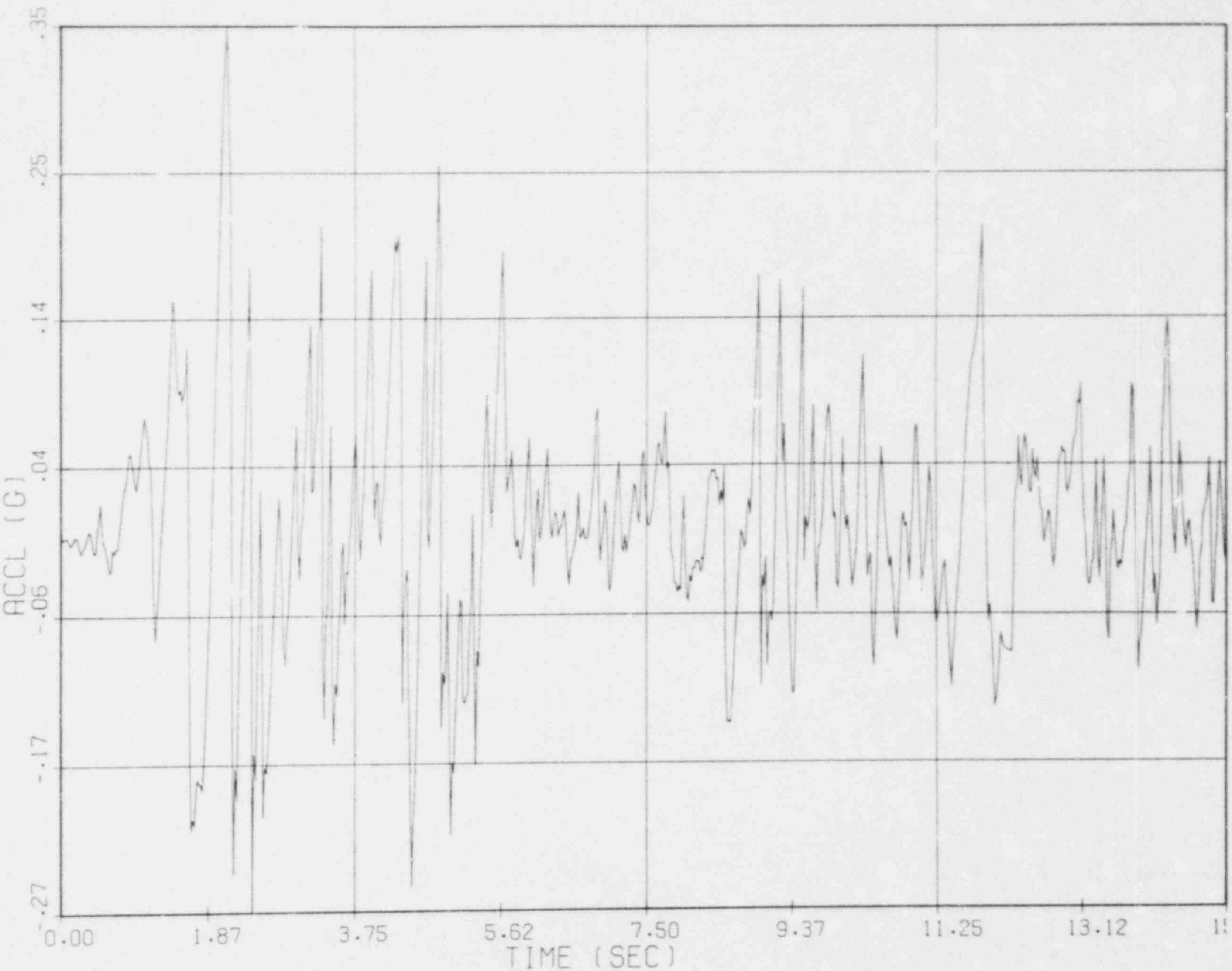


FIG. 5 ACCELERATION TIME HISTORY № 1

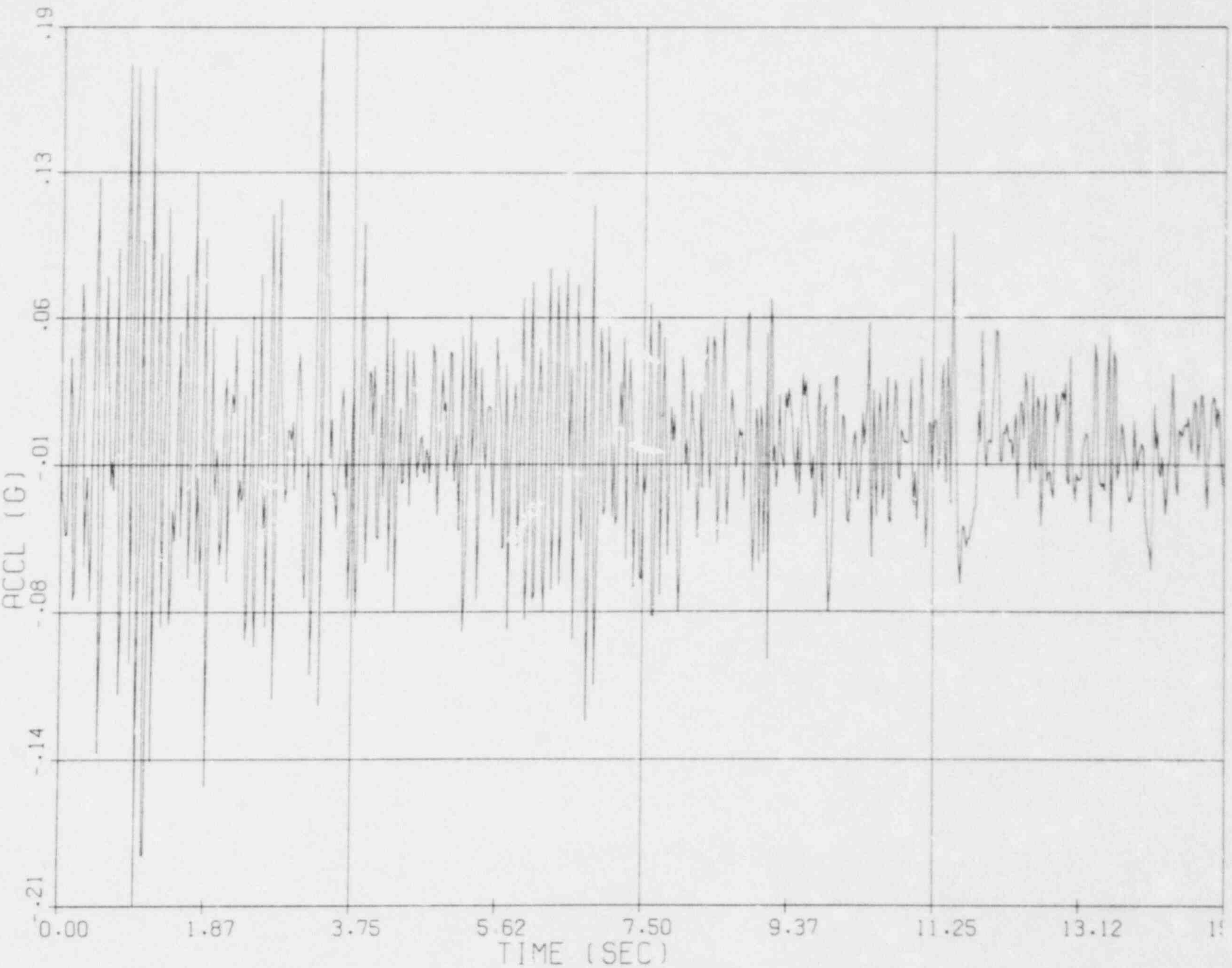


FIG. 6 ACCELERATION TIME HISTORY № 2

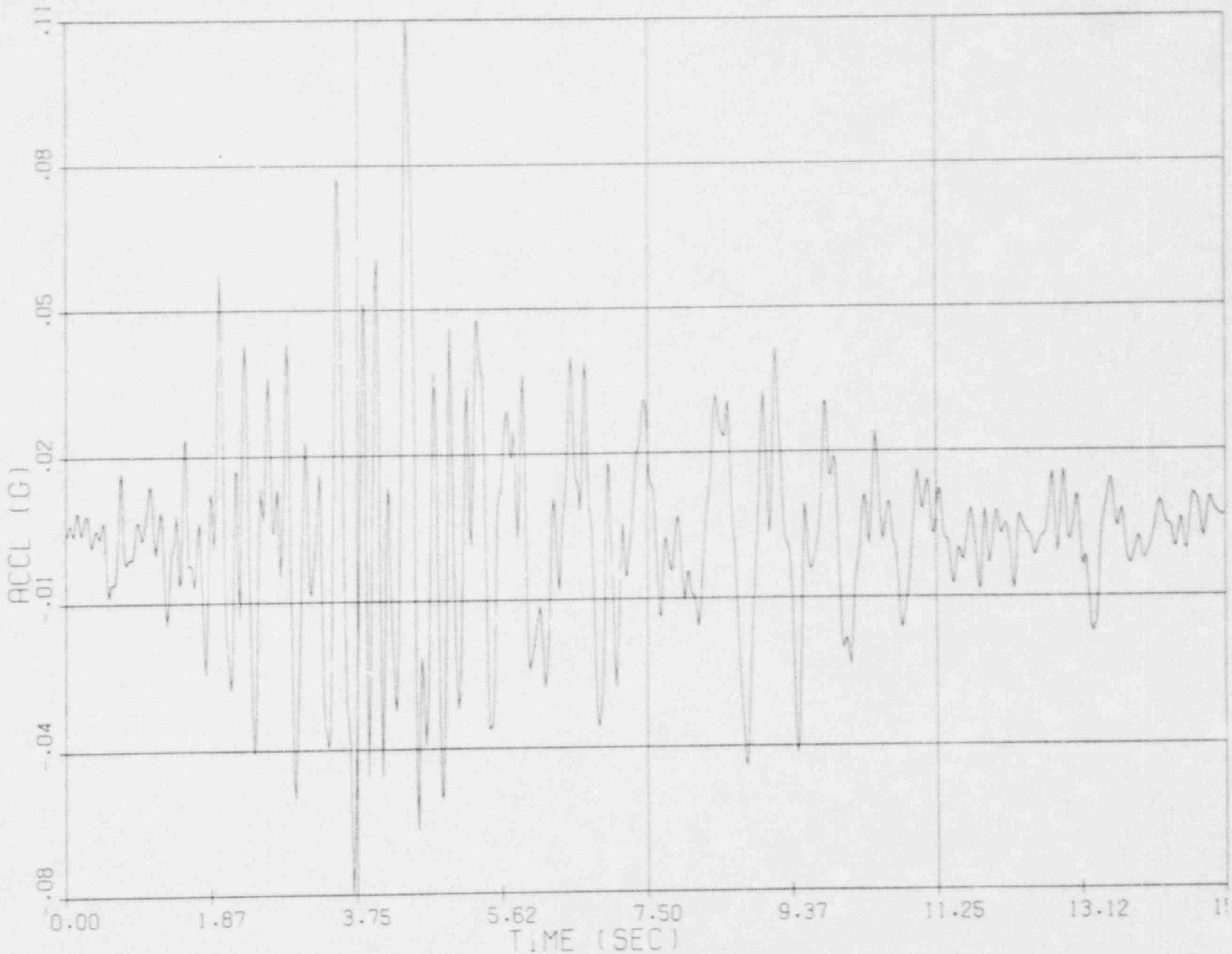


FIG. 7 ACCELERATION TIME HISTORY № 3

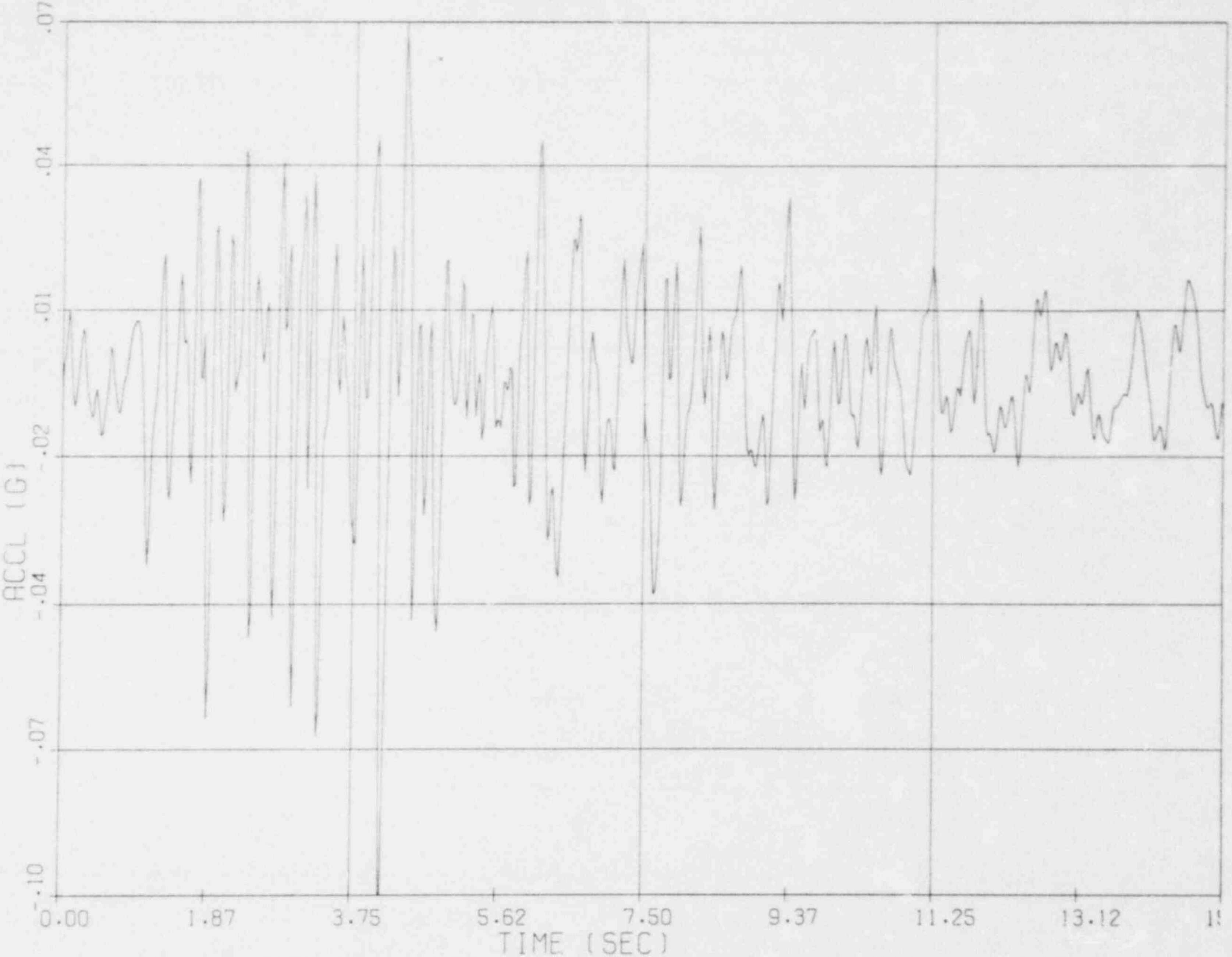


FIG.8 ACCELERATION TIME HISTORY № 4

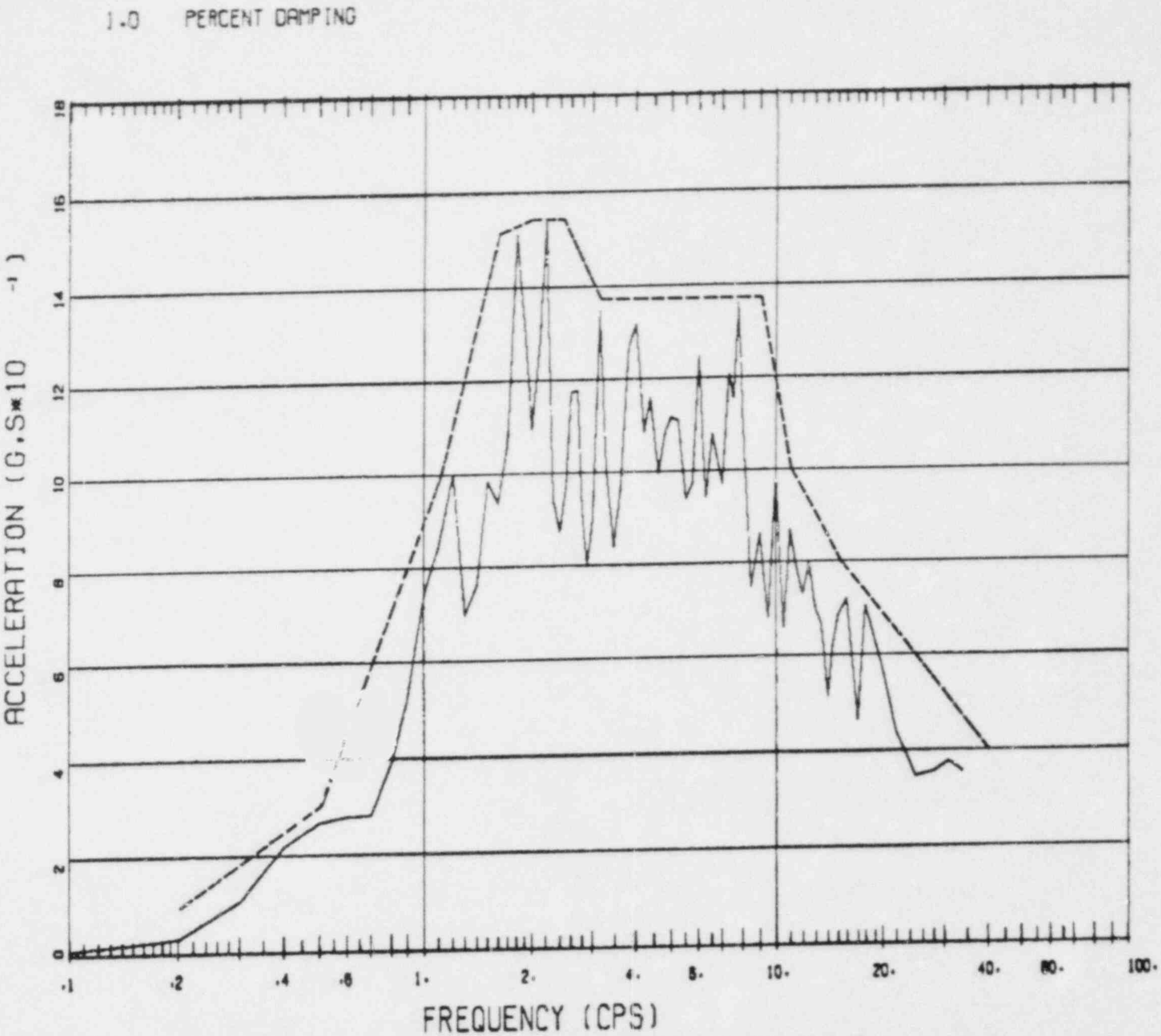


FIG. 9 RESPONSE SPECTRUM OF FIG. 5

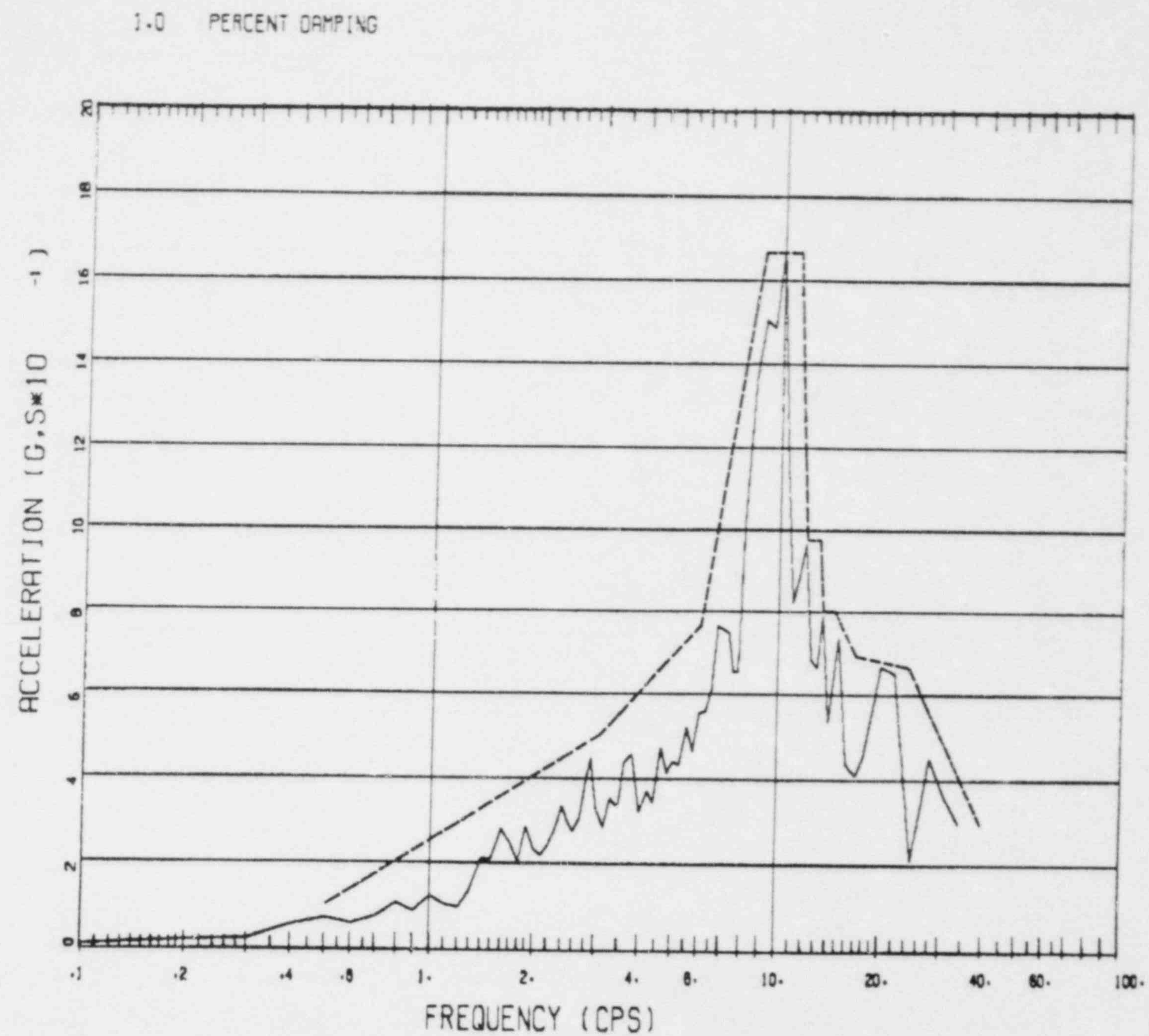


FIG. 10 RESPONSE SPECTRUM OF FIG. 6

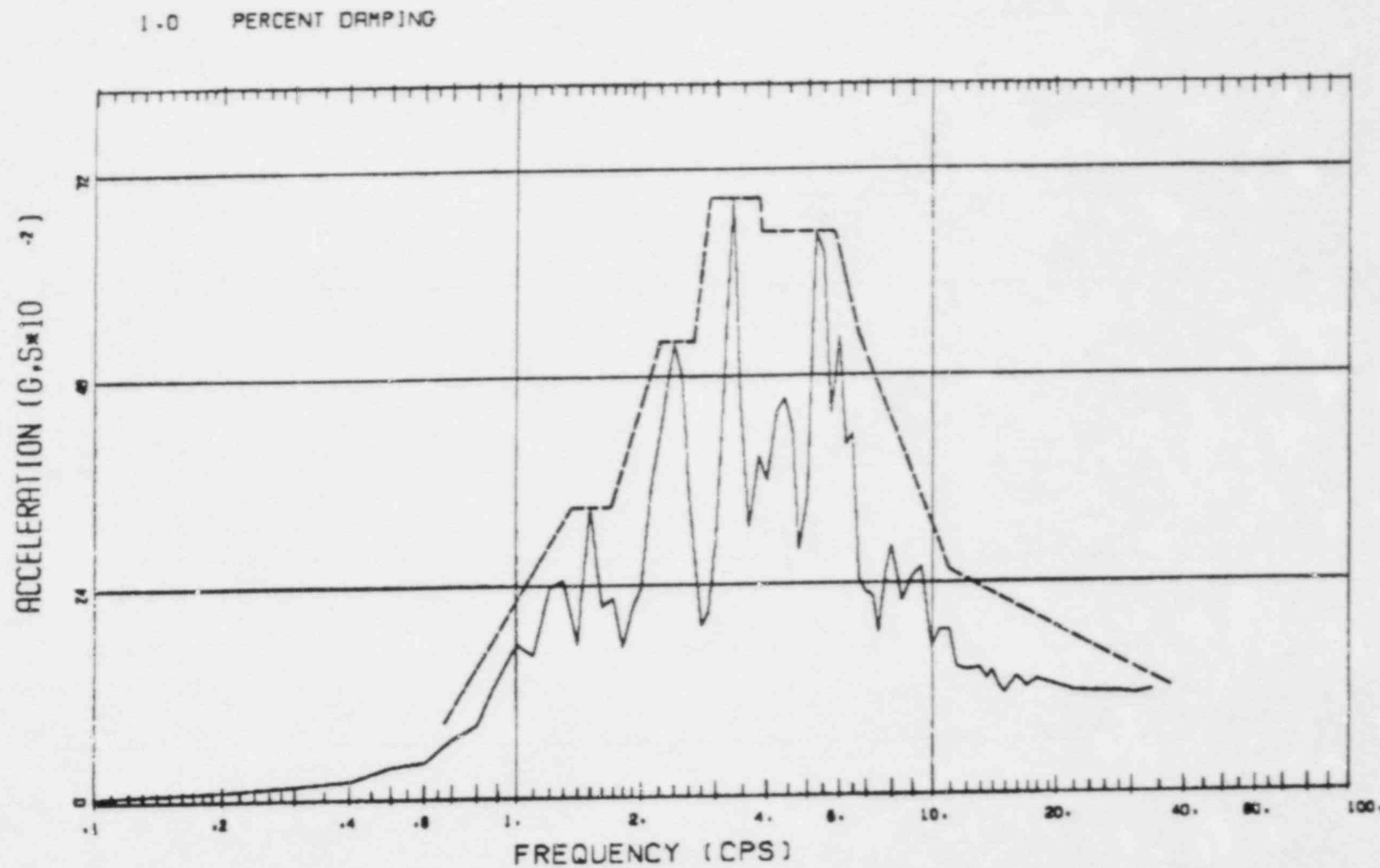


FIG. 11 RESPONSE SPECTRUM OF FIG. 7

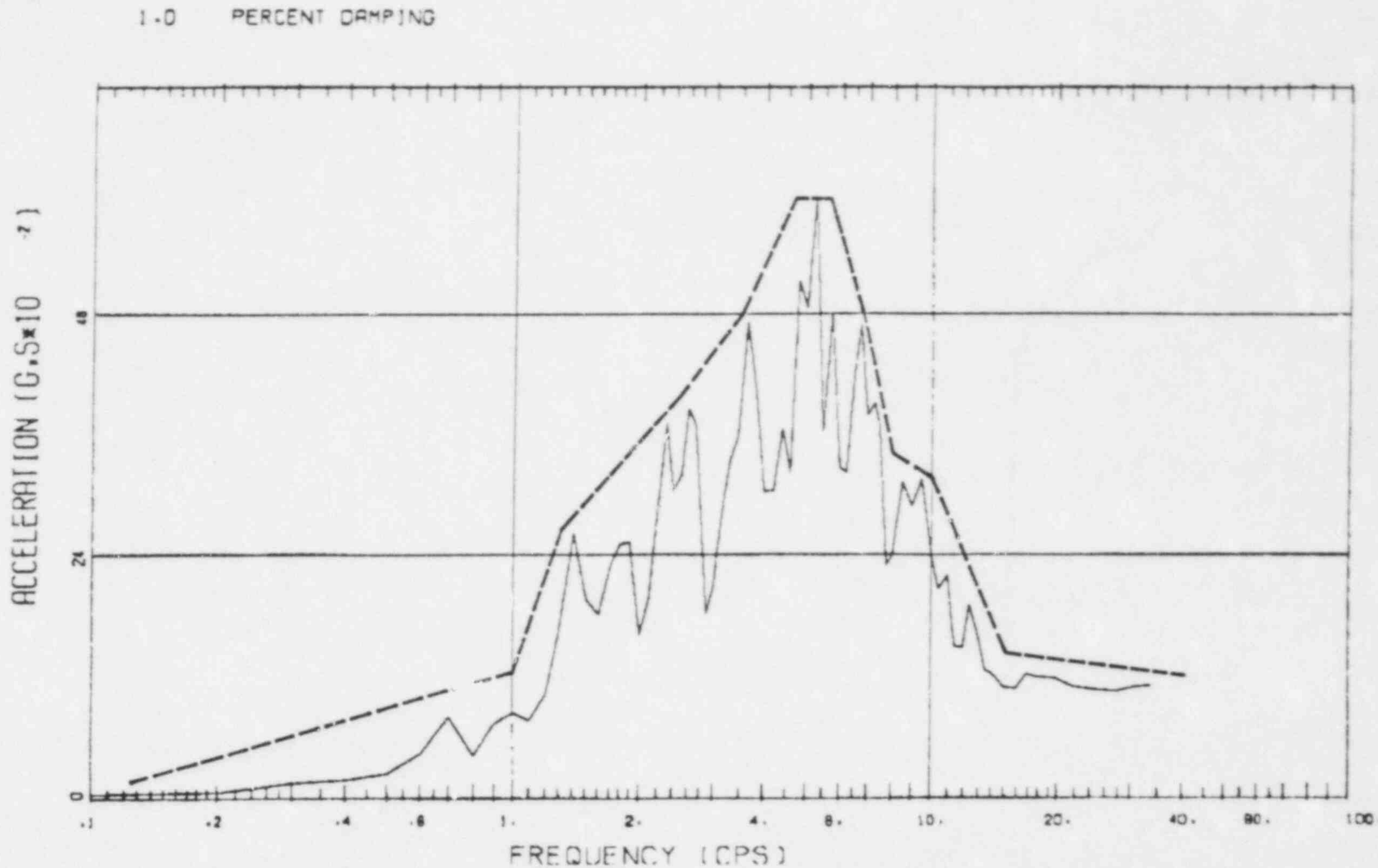


FIG.12 RESPONSE SPECTRUM OF FIG. 8

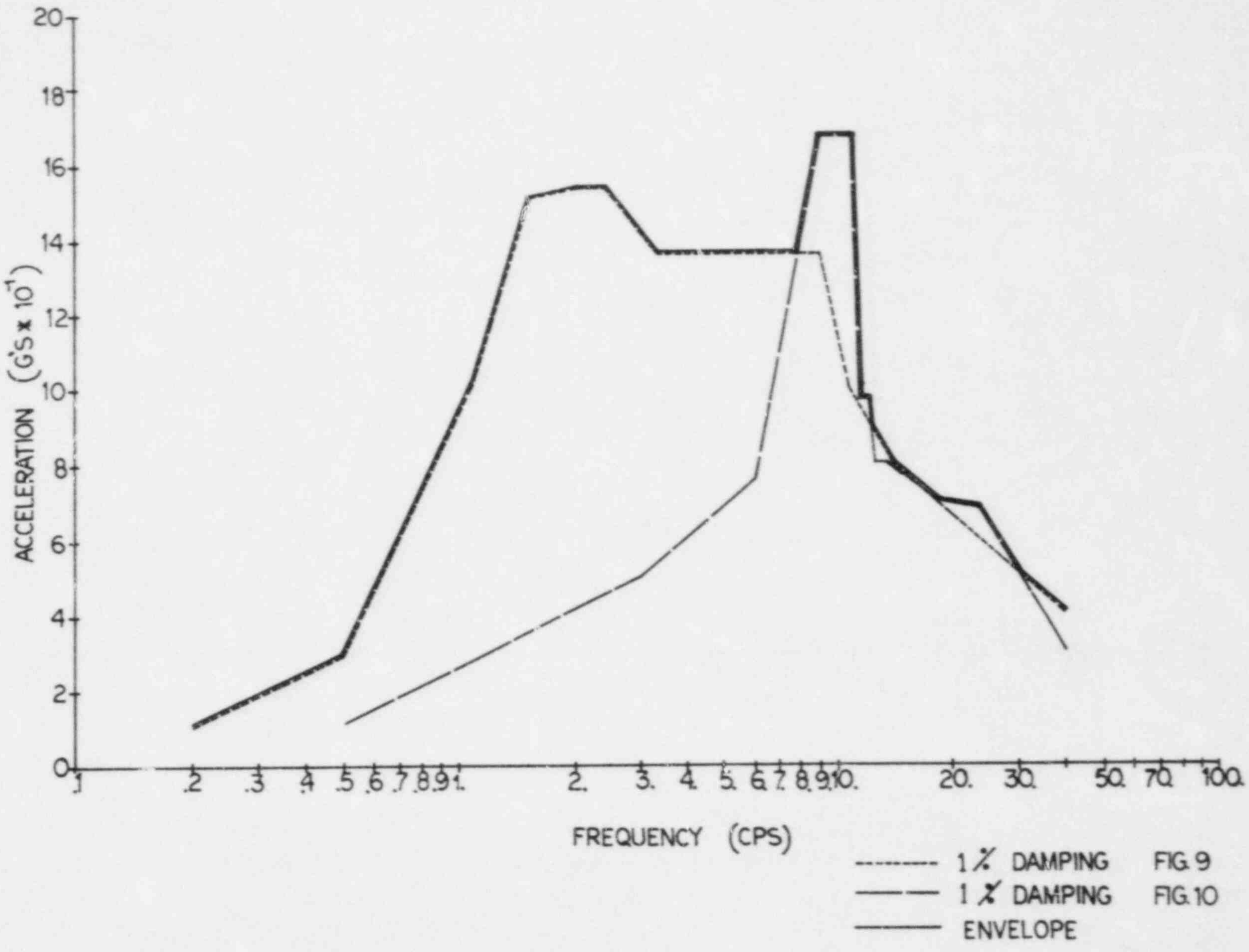


FIG. 13 ENVELOPE SPECTRUM 1

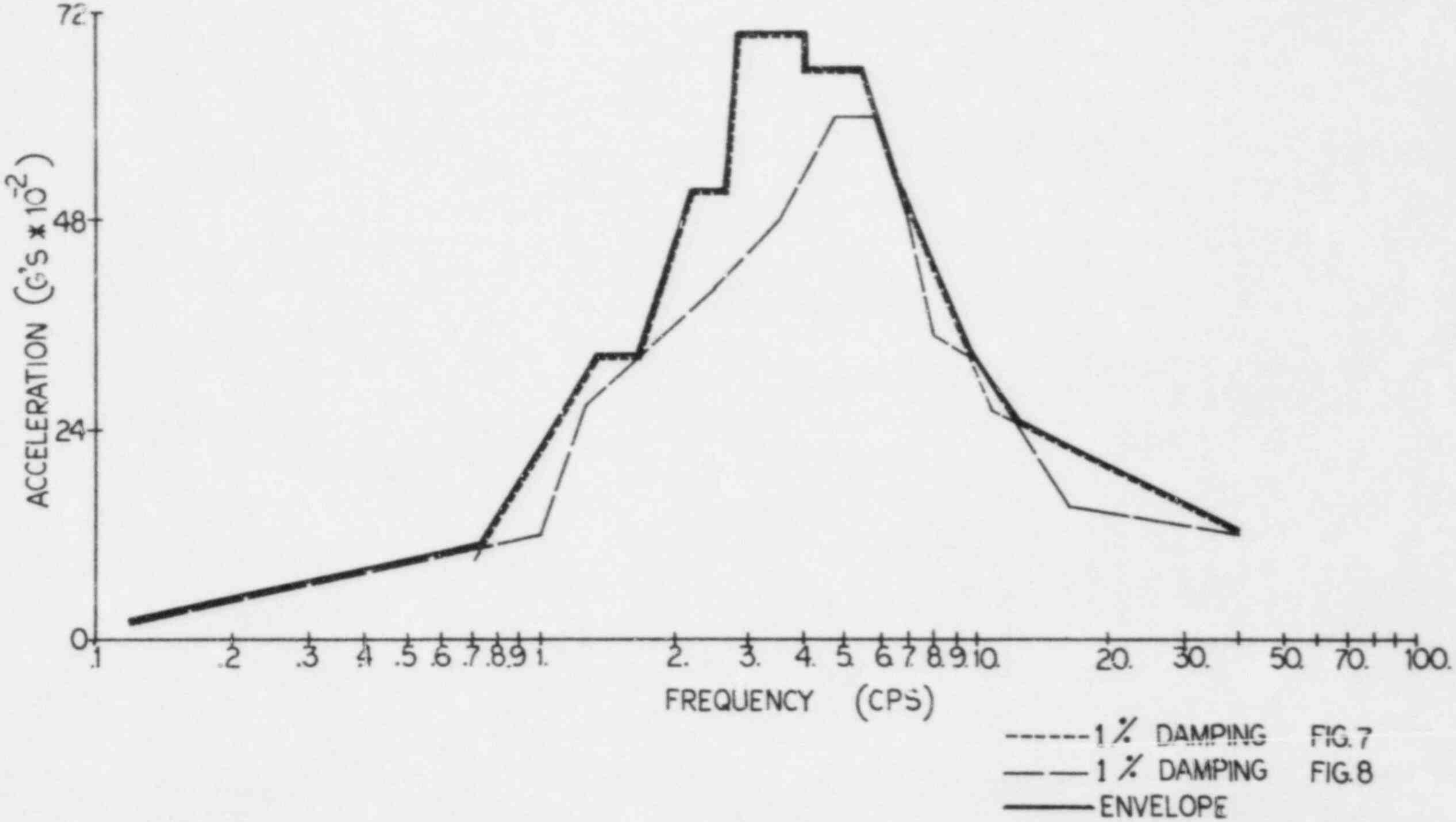


FIG. 14 ENVELOPE SPECTRUM 2

4.0 Results and Conclusions

The results for the four piping systems considered are presented in tabular form in Tables 1A-1 thru 4C-1. Each table is identified by a table I.D. consisting of two numbers and an alphabetical character. The first number refers to the piping problem number (i.e., 2 refers to the results from the piping system shown in Fig. 2). The alphabetical character A, B or C indicates the combination procedure used to combine between spatial directions in the Seismic Anchor Movement Analysis. 'A' stands for algebraic, 'B' for SRSS, and 'C' for the absolute sum method. The last number identifies the assumption for phasing between support group movements used in each problem. The specific meaning varies from problem to problem and is defined on the problem sketches. For problem 2, the symbol ++- indicates that the first two support groups are in phase while the third group is 180° out of phase. This phasing is assigned the number 1 for problem 2.

Tables 1A-1, 1B-1, 1C-1, present the results to the first piping problem. Only out of phase support motions were considered in the study. The second piping system was evaluated for three different cases of phasing and the results are summarized in Tables 2A-1, 2B-1, 2C-1, 2A-2, 2B-2, 2C-2, 2A-3, 2B-3, and 2C-3. The third piping problem has four support groups. Since there are many possible phasing combinations between the groups, it would require many analyses to determine the worst possible seismic anchor movement case. It was decided to consider only two cases either of which may yield the worse stress conditions. The results are summarized in Tables 3A-1, 3B-1, 3C-1, 3A-2, 3B-2 and 3C-2. The last piping problem is a two group system similar to the first problem. Hence, only one case corresponding to the out of phase mode was considered. The results are given is Tables 4A-1, 4B-1 and 4C-1.

All moment values included in the tables are rounded off to the nearest whole number. Positive percentage of conservatism values indicate that the corresponding combination is conservative when compared to the time history solutions. A negative value in this column indicates the combination method is non conservative.

It is understood that for the case of a 2-group problem, the out of phase input support displacement exhibits the worst seismic anchor movement stresses. Also, once this is established, the combination of contributions from three separate spatial directional analyses becomes the defining factor for the most unfavorable combination. An algebraic sum would exhibit concellations of the moments if they have different signs. An absolute sum, on the other hand, would yield the most severe seismic anchor movement stress condition. Hence, since this is a matter of statistics, the SRSS combination should yield a compromise between these two extremes.

Table 1A-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	7	5	107	70	70	107	114	52	62
	J	4	4	50	33	34	50	54	50	61
2	I	4	4	50	33	34	50	54	50	61
	J	3	2	26	19	19	26	29	33	47
3	I	3	2	26	19	19	26	29	33	47
	J	10	4	135	92	92	136	145	47	57
4	I	10	4	135	92	92	136	145	47	57
	J	2	2	13	10	10	14	15	30	46
5	I	2	2	13	10	10	14	15	30	46
	J	3	2	16	10	10	16	18	53	76
6	I	3	2	16	10	10	16	18	55	78
	J	2	2	71	42	42	71	74	70	76
7	I	2	2	71	42	42	71	74	70	76
	J	2	2	54	32	32	54	56	69	75
8	I	2	2	54	32	32	54	56	69	75
	J	2	2	37	22	23	37	39	66	75
9	I	2	2	37	22	23	37	39	66	75
	J	2	2	21	13	13	21	23	57	71
10	I	2	2	21	13	13	21	23	57	71
	J	2	2	6	6	7	6	8	-9	13
11	I	2	2	6	6	7	6	8	-9	13
	J	1	.8	15	11	11	15	16	39	49
12	I	1	.8	15	11	11	15	16	39	49
	J	.8	.4	32	20	20	32	33	58	62
13	I	.8	.4	32	20	20	32	33	58	62
	J	2	1	49	30	30	49	50	63	68
14	I	2	1	49	30	30	49	50	63	68
	J	1	.9	38	24	24	38	39	59	64
15	I	1	.9	38	24	24	38	39	59	64
	J	1	1	27	18	18	27	29	54	62

Table 1A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	1	1	27	18	18	27	29	54	62
	J	2	.9	19	13	13	19	20	47	59
17	I	2	.9	19	13	13	19	20	47	59
	J	1	.7	11	8	8	11	12	33	48
18	I	1	.7	11	8	8	11	12	33	48
	J	1	.4	6	4	4	6	7	29	49
19	I	1	.4	6	4	4	6	7	29	49
	J	1	.9	10	5	5	10	11	97	124
20	I	1	.9	10	5	5	10	11	95	121
	J	.9	.4	9	5	5	9	10	86	105
21	I	.9	.4	9	5	5	9	10	86	105
	J	1	.7	12	8	8	12	13	51	68
22	I	1	.7	12	8	8	12	13	51	68
	J	[illegible]	.9	17	12	12	17	19	43	60
23	I	2	.9	17	12	12	17	19	43	60
	J	3	1	23	16	16	23	26	43	59
24	I	3	1	23	16	16	23	26	43	59
	J	3	1	29	20	20	29	32	44	59
25	I	3	1	29	20	20	29	32	44	59
	J	2	2	30	19	19	30	32	53	64
26	I	2	2	30	19	19	30	32	53	64
	J	3	1	20	14	14	20	23	42	62
27	I	3	1	20	14	14	20	23	42	61
	J	9	3	55	37	37	56	64	49	71
28	I	9	3	55	37	37	56	64	49	71
	J	6	2	40	27	27	41	46	49	70
29	I	6	2	40	27	27	41	46	49	70
	J	6	2	53	36	36	53	59	48	63
30	I	6	2	53	36	36	53	59	48	63
	J	6	2	58	39	40	59	64	48	63

Table 1A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	6	2	58	39	40	59	64	48	63
	J	5	3	19	13	14	20	24	46	77
32	I	5	3	19	13	14	20	24	46	77
	J	7	3	34	23	24	35	41	46	72
33	I	7	3	34	23	24	35	41	46	72
	J	7	3	38	26	27	39	45	47	70
34	I	7	3	38	26	27	39	45	47	70
	J	2	1	12	8	8	12	14	46	72
35	I	2	1	12	8	8	12	14	46	72
	J	11	5	39	27	28	41	51	44	78

Table 1B-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	7	5	83	70	70	83	90	18	27
	J	4	4	38	33	34	38	42	14	25
2	I	4	4	38	33	34	38	42	14	25
	J	3	2	35	19	19	35	38	80	94
3		3	2	35	19	19	35	38	80	94
	J	10	4	130	92	92	130	140	42	52
4	I	10	4	130	92	92	130	140	42	52
	J	2	2	15	10	10	15	17	45	61
5	I	2	2	15	10	10	15	17	45	61
	J	3	2	41	10	10	41	43	294	318
6	I	3	2	41	10	10	41	43	299	323
	J	2	2	47	42	42	47	49	12	18
7	I	2	2	47	42	42	47	49	12	18
	J	2	2	35	32	32	35	37	9	15
8	I	2	2	35	32	32	35	37	9	15
	J	2	2	24	22	23	24	26	5	14
9	I	2	2	24	22	23	24	26	5	14
	J	2	2	14	13	13	14	16	5	19
10	I	2	2	14	13	13	14	16	5	19
	J	2	2	11	6	7	11	13	62	86
11	I	2	2	11	6	7	11	13	62	86
	J	1	.8	19	11	11	19	20	73	84
12	I	1	.8	19	11	11	19	20	73	84
	J	.8	.4	30	20	20	30	31	50	54
13	I	.8	.4	30	20	20	30	31	50	54
	J	2	1	42	30	30	42	43	40	45
14	I	2	1	42	30	30	42	43	40	45
	J	1	.9	32	24	24	32	33	34	38
15	I	1	.9	32	24	24	32	33	34	38
	J	1	1	22	18	18	22	23	25	33

Table 1B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	1	1	22	18	18	22	23	25	33
	J	2	.9	14	13	13	14	16	13	24
17	I	2	.9	14	13	13	14	16	13	24
	J	1	.7	8	8	8	8	9	-1	13
18	I	1	.7	8	8	8	8	9	-1	13
	J	1	.4	7	4	4	7	8	67	88
19	I	1	.4	7	4	4	7	8	67	88
	J	1	.9	13	5	5	13	15	162	190
20	I	1	.9	13	5	5	13	15	160	186
	J	.9	.4	9	5	5	9	9	81	100
21	I	.9	.4	9	5	5	9	9	81	100
	J	1	.7	9	8	8	9	11	17	34
22	I	1	.7	9	8	8	9	11	17	34
	J	2	.9	14	12	12	15	17	22	39
23	I	[illegible]	.9	14	12	12	15	17	22	39
	J	3	1	21	16	16	21	24	33	49
24	I	3	1	21	16	16	21	24	33	49
	J	3	1	28	20	20	29	32	41	56
25	I	3	1	28	20	20	29	32	41	56
	J	2	2	25	19	19	26	28	32	43
26	I	2	2	25	19	19	26	28	32	43
	J	3	1	21	14	14	22	25	53	73
27	I	3	1	21	14	14	22	25	52	72
	J	9	3	52	37	37	53	61	42	64
28	I	9	3	52	37	37	53	61	42	64
	J	6	2	38	27	27	39	45	43	64
29	I	6	2	38	27	27	39	45	43	64
	J	6	2	50	36	36	50	56	41	56
30	I	6	2	50	36	36	50	56	41	56
	J	6	2	55	39	40	55	61	40	55

Table 1B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	6	2	55	39	40	55	61	40	55
	J	5	3	18	13	14	19	23	39	71
32	I	5	3	18	13	14	19	23	40	71
	J	7	3	32	23	24	33	39	37	63
33	I	7	3	32	23	24	33	39	37	63
	J	7	3	36	26	27	37	43	38	61
34	I	7	3	36	26	27	37	43	38	61
	J	2	1	11	8	8	12	14	40	66
35	I	2	1	11	8	8	12	14	40	66
	J	11	5	37	27	28	39	48	36	70

Table 1C-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	7	5	107	70	70	107	114	53	62
	J	4	4	51	33	34	51	55	52	63
2	I	4	4	52	33	34	52	56	55	66
	J	3	2	43	19	19	43	45	120	134
3	I	3	2	43	19	19	43	45	120	134
	J	10	4	136	92	92	136	145	47	58
4	I	10	4	136	92	92	136	145	47	58
	J	2	2	17	10	10	17	18	59	76
5	I	2	2	17	10	10	17	18	59	76
	J	3	2	63	10	10	64	66	517	541
6	I	3	2	62	10	10	63	65	515	539
	J	2	2	71	42	42	71	74	70	76
7	I	2	2	71	42	42	71	74	70	76
	J	2	2	54	32	32	54	56	69	75
8	I	2	2	54	32	32	54	56	69	75
	J	2	2	37	22	23	37	39	66	75
9	I	2	2	37	22	23	37	39	66	75
	J	2	2	21	13	13	21	23	57	72
10	I	2	2	21	13	13	21	23	57	72
	J	2	2	18	6	7	18	19	156	180
11	I	2	2	18	6	7	18	19	156	180
	J	1	.8	23	11	11	23	24	105	115
12	I	1	.8	23	11	11	23	24	105	115
	J	.8	.4	32	20	20	32	33	59	63
13	I	.8	.4	32	20	20	32	33	59	63
	J	2	1	49	30	30	49	50	63	68
14	I	[illegible]	1	49	30	30	49	50	63	68
	J	1	.9	38	24	24	38	39	59	64
15	I	1	.9	38	24	24	38	39	59	64
	J	1	1	27	18	18	27	29	54	62

Table 1C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES *			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	1	1	27	18	18	27	29	54	62
	J	2	.9	19	13	13	19	21	49	60
17	I	2	.9	19	13	13	19	21	49	60
	J	1	.7	12	8	8	12	13	42	57
18	I	1	.7	12	8	8	12	13	42	57
	J	1	.4	10	4	4	10	11	120	141
19	I	1	.4	10	4	4	10	11	120	141
	J	1	.9	19	5	5	19	21	279	307
20	I	1	.9	19	5	5	20	21	276	303
	J	.9	.4	10	5	5	10	11	110	129
21	I	.9	.4	10	5	5	10	11	110	[illegible]
	J	1	.7	13	8	8	13	15	68	86
22	I	[illegible]	.7	13	8	8	13	15	68	86
	J	2	.9	18	12	12	18	20	51	68
23	I	2	.9	18	12	12	18	20	51	68
	J	3	1	23	16	16	24	26	47	62
24	I	3	1	23	16	16	24	26	47	62
	J	3	1	30	20	20	30	33	46	62
25	I	3	1	30	20	20	30	33	48	63
	J	2	2	30	19	19	30	32	53	65
26	I	2	2	30	19	19	30	32	53	65
	J	3	1	24	14	14	[illegible]	27	67	87
27	I	3	1	24	14	14	24	27	68	88
	J	9	3	55	37	37	56	64	49	71
28	I	9	3	55	37	37	56	64	49	71
	J	6	2	40	27	27	41	46	49	70
29	I	6	2	40	27	27	41	46	49	70
	J	6	2	53	36	36	53	59	48	63
30	I	6	2	53	36	36	53	59	48	63
	J	6	2	58	39	40	59	64	48	63

Table 1C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	6	2	58	39	40	59	64	48	63
	J	5	3	19	13	14	20	24	46	77
32	I	5	3	19	13	14	20	24	46	77
	J	7	3	34	23	24	35	41	46	72
33	I	7	3	34	23	24	35	41	46	72
	J	7	3	38	26	27	39	45	47	70
34	I	7	3	38	26	27	39	45	47	70
	J	2	1	12	8	8	12	14	46	73
35	I	2	1	12	8	8	12	14	46	73
	J	11	5	39	27	28	41	51	44	78

Table 2A-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	1847	923	923	1848	1875	100	103
	J	13	10	599	378	378	599	612	58	62
2	I	13	10	599	378	378	599	612	58	62
	J	9	7	819	228	228	819	828	260	264
3	I	9	7	819	228	228	819	828	260	264
	J	10	7	1189	408	408	1189	1199	192	194
4	I	10	7	1189	408	408	1189	1199	192	194
	J	9	7	935	392	392	935	945	139	141
5	I	9	7	935	392	392	935	945	139	141
	J	9	8	640	345	345	641	650	86	88
6	I	9	8	640	345	345	641	650	86	88
	J	10	9	496	347	347	496	506	43	46
7	I	10	9	496	347	347	496	506	43	46
	J	15	13	410	208	209	410	425	97	104
8	I	15	13	410	208	209	410	425	97	104
	J	26	20	869	155	161	870	896	439	455
9	I	26	20	869	155	161	870	896	439	455
	J	18	13	1144	178	179	1144	1163	541	551
10	I	18	13	1144	178	179	1144	1163	541	551
	J	15	10	1492	266	268	1492	1507	456	461
11	I	15	10	1492	266	268	1492	1507	456	461
	J	16	14	766	227	231	767	783	232	239
12	I	13	7	332	284	287	332	345	16	20
	J	9	7	1762	250	253	1762	1771	596	599
13	I	9	7	1762	250	253	1762	1771	596	599
	J	5	4	468	152	153	468	473	206	209
14	I	5	4	468	152	153	468	473	206	209
	J	8	5	236	135	137	236	244	72	77
15	I	8	5	236	135	137	236	244	72	77
	J	6	4	117	67	70	118	123	69	77

Table 2A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. ALG. (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
16	I	6	4	117	67	70	118	123	59	77
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	653	154	158	653	669	314	325
	J	26	11	512	98	102	513	538	404	429
18	I	26	11	512	98	102	513	538	404	429
	J	14	6	419	67	68	420	434	520	540
19	I	14	6	419	67	68	420	434	520	540
	J	11	5	233	72	73	233	244	217	232
20	I	11	5	233	72	73	233	244	217	232
	J	37	18	73	130	138	82	110	-40	-20

Table 2B-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	1350	923	923	1351	1378	46	49
	J	13	10	580	378	378	581	594	54	57
2	I	13	10	580	378	378	581	594	54	57
	J	9	7	658	228	228	658	668	189	193
3	I	9	7	658	228	228	658	668	189	193
	J	10	7	852	408	408	852	862	109	111
4	I	10	7	852	408	408	852	862	109	111
	J	9	7	651	392	392	651	661	66	69
5	I	9	7	651	392	392	651	661	66	69
	J	9	8	452	345	345	453	462	31	34
6	I	9	8	452	345	345	453	462	31	34
	J	10	9	387	347	347	387	397	11	14
7	I	10	9	387	347	347	387	397	11	14
	J	15	13	468	208	209	468	483	124	132
8	I	15	13	468	208	209	468	483	124	132
	J	26	20	846	155	161	846	872	425	441
9	I	26	20	846	155	161	846	872	425	441
	J	18	13	1046	178	179	1047	1065	486	497
10	I	18	13	1046	178	179	1047	1065	486	497
	J	15	10	1293	266	268	1293	1308	382	387
11	I	15	10	1293	266	268	1293	1308	382	387
	J	16	14	808	227	231	808	824	250	257
12	I	13	7	414	284	287	414	426	44	49
	J	9	7	1845	250	253	1845	1854	628	632
13	I	9	7	1845	250	253	1845	1854	628	632
	J	5	4	381	152	153	381	387	149	153
14	I	5	4	381	152	153	381	387	149	153
	J	8	5	397	135	137	397	405	189	195
15	I	8	5	397	135	137	397	405	189	195
	J	6	4	198	67	70	198	204	184	193

Table 2B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2,4	SRSS 1,3	ABS. 1,3	SRSS	ABS.
16	I	6	4	198	67	70	198	204	184	193
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	593	154	158	593	609	276	287
	J	26	11	470	98	102	471	496	363	387
18	I	26	11	470	98	102	471	496	363	387
	J	14	6	401	67	68	402	416	493	514
19	I	14	6	401	67	68	402	416	493	514
	J	11	5	251	72	73	251	262	241	256
20	I	11	5	251	72	73	251	262	241	256
	J	37	18	161	130	138	165	198	20	43

Table 2C-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	1854	923	923	1854	1881	101	104
	J	13	10	677	378	378	677	690	79	83
2	I	13	10	677	378	378	677	690	79	83
	J	9	7	841	228	228	841	851	270	274
3	I	9	7	841	228	228	841	851	270	274
	J	10	7	1206	408	408	1206	1216	196	198
4	I	10	7	1206	408	408	1206	1216	196	198
	J	9	7	961	392	392	961	970	145	147
5	I	9	7	961	392	392	961	970	145	147
	J	9	8	677	345	345	677	686	96	99
6	I	9	8	677	345	345	677	686	96	99
	J	10	9	542	347	347	542	552	56	59
7	I	10	9	542	347	347	542	552	56	59
	J	15	13	629	208	209	629	644	201	208
8	I	15	13	629	208	209	629	644	201	208
	J	26	20	1126	155	161	1127	1153	599	615
9	I	26	20	1126	155	161	1127	1153	599	615
	J	18	13	1366	178	179	1366	1384	665	675
10	I	18	13	1366	178	179	1366	1384	665	675
	J	15	10	1661	266	268	1661	1676	519	525
11	I	15	10	1661	266	268	1661	1676	519	525
	J	16	14	966	227	231	966	983	319	326
12	I	13	7	559	284	287	559	572	95	100
	J	9	7	2039	250	253	2039	2047	705	708
13	I	9	7	2039	250	253	2039	2047	705	708
	J	5	4	501	152	153	501	507	227	231
14	I	5	4	501	152	153	501	507	227	231
	J	8	5	582	135	137	582	590	323	329
15	I	8	5	582	135	137	582	590	323	329
	J	6	4	290	67	70	290	295	317	325

Table 2C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	6	4	290	67	70	290	296	317	325
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	712	154	158	712	728	352	362
	J	26	11	523	98	102	524	549	415	440
18	I	26	11	523	98	102	524	549	415	440
	J	14	6	428	67	68	428	442	533	553
19	I	14	6	428	67	68	428	442	533	553
	J	11	5	273	72	73	273	284	272	287
20	I	11	5	273	72	73	273	284	272	287
	J	37	18	241	130	138	243	277	76	10[illegible]

Table 2A-2

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	159	923	923	161	186	-83	-80
	J	13	10	154	378	378	154	167	-59	-56
2	I	13	10	154	378	378	154	167	-59	-56
	J	9	7	268	228	228	268	278	18	22
3	I	9	7	268	228	228	268	278	18	22
	J	10	7	300	408	408	300	310	-26	-24
4	I	10	7	300	408	408	300	310	-26	-24
	J	9	7	266	392	392	266	275	-32	-30
5	I	9	7	266	392	392	266	275	-32	-30
	J	9	8	246	345	345	246	255	-29	-26
6	I	9	8	246	345	345	246	255	-29	-26
	J	10	9	252	347	347	252	262	-27	-25
7	I	10	9	252	347	347	252	262	-27	-25
	J	15	13	321	208	209	322	337	54	61
8	I	15	13	321	208	209	322	337	54	61
	J	26	20	436	155	161	437	462	171	187
9	I	26	20	436	155	161	437	462	171	187
	J	18	13	505	178	179	505	523	183	193
10	I	18	13	505	178	179	505	523	183	193
	J	15	10	576	266	268	576	591	115	120
11	I	15	10	576	266	268	576	591	115	120
	J	16	14	772	227	231	772	788	235	242
12	I	13	7	504	284	287	504	517	76	80
	J	9	7	1663	250	253	1663	1672	557	560
13	I	9	7	1663	250	253	1663	1672	557	560
	J	5	4	440	152	153	440	446	188	191
14	I	5	4	440	152	153	440	446	188	191
	J	8	5	179	135	137	179	187	31	36
15	I	8	5	179	135	137	179	187	31	36
	J	6	4	89	67	70	89	95	29	37

Table 2A-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	6	4	89	67	70	89	95	29	37
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	400	154	158	401	417	154	164
	J	26	11	361	98	102	362	387	256	281
18	I	26	11	361	98	102	362	387	256	281
	J	14	6	344	67	68	344	358	409	429
19	I	14	6	344	67	68	344	358	409	429
	J	11	5	295	72	73	296	307	302	317
20	I	11	5	295	72	73	296	307	302	317
	J	37	18	267	130	138	270	304	95	120

Table 2B-2

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	320	923	923	321	348	-65	-62
	J	13	10	134	378	378	135	147	-64	-61
2	I	13	10	134	378	378	135	147	-64	-61
	J	9	7	287	228	228	287	297	26	30
3	I	9	7	287	228	228	287	297	26	30
	J	10	7	354	408	408	354	364	-13	-11
4	I	10	7	354	408	408	354	364	-13	-11
	J	9	7	291	392	392	292	301	26	-23
5	I	9	7	291	392	392	292	301	-26	-23
	J	9	8	235	345	345	235	244	-32	-29
6	I	9	8	235	345	345	235	244	-32	-29
	J	10	9	214	347	347	214	224	-38	-36
7	I	10	9	214	347	347	214	224	-38	-36
	J	15	13	290	208	209	290	305	39	46
8	I	15	13	290	208	209	290	305	39	46
	J	26	20	437	155	161	438	464	172	188
9	I	26	20	437	155	161	438	464	172	188
	J	18	13	535	178	179	535	553	200	210
10	I	18	13	535	178	179	535	553	200	210
	J	15	10	639	266	268	639	654	138	144
11	I	15	10	639	266	268	639	654	138	144
	J	16	14	791	227	231	791	807	243	250
12	I	13	7	553	284	287	553	566	93	97
	J	9	7	1779	250	253	1779	1788	602	606
13	I	9	7	1779	250	253	1779	1788	602	606
	J	5	4	362	152	153	362	367	136	140
14	I	5	4	362	152	153	362	367	136	140
	J	8	5	357	135	137	357	365	160	165
15	I	8	5	357	135	137	357	365	160	165
	J	6	4	178	67	70	178	184	156	164

Table 2B-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM. SRSS(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	6	4	178	67	70	178	184	156	164
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	440	154	158	440	456	179	189
	J	26	11	367	98	102	368	393	262	286
18	I	26	11	367	98	102	368	393	262	286
	J	14	6	346	67	68	346	360	411	431
19	I	14	6	346	67	68	346	360	411	431
	J	11	5	297	72	73	297	308	304	319
20	I	11	5	297	72	73	297	308	304	319
	J	37	18	309	130	138	311	346	125	150

Table 2C-2

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	481	923	923	482	509	-48	-45
	J	13	10	191	378	378	191	204	-49	-46
2	I	13	10	191	378	378	191	204	-49	-46
	J	9	7	336	228	228	336	345	48	52
3	I	9	7	336	228	228	336	345	48	52
	J	10	7	445	408	408	445	455	9	12
4	I	10	7	445	408	408	445	455	9	12
	J	9	7	370	392	392	370	379	-6	-3
5	I	9	7	370	392	392	370	379	-6	-3
	J	9	8	294	345	345	295	304	-15	-12
6	I	9	8	294	345	345	295	304	-15	-12
	J	10	9	262	347	347	262	272	-24	-22
7	I	10	9	262	347	347	262	272	-24	-22
	J	15	13	321	208	209	322	337	54	61
8	I	15	13	321	208	209	322	337	54	61
	J	26	20	497	155	161	498	523	209	224
9	I	26	20	497	155	161	498	523	209	224
	J	18	13	606	178	179	606	624	240	250
10	I	18	13	606	178	179	606	624	240	250
	J	15	10	720	266	268	720	735	168	174
11	I	15	10	720	266	268	720	735	168	174
	J	16	14	882	227	231	882	898	282	289
12	I	13	7	644	284	287	644	657	125	129
	J	9	7	1889	250	253	1889	1898	646	649
13	I	9	7	1889	250	253	1889	1898	646	649
	J	5	4	459	152	153	459	464	200	203
14	I	5	4	459	152	153	459	464	200	203
	J	8	5	485	135	137	485	493	253	258
15	I	8	5	485	135	137	485	493	253	258
	J	6	4	241	67	70	241	247	247	256

Table 2C-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM. ABS.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	6	4	241	67	70	241	247	247	256
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	492	154	158	492	508	212	223
	J	26	11	381	98	102	381	407	275	300
18	I	26	11	381	98	102	381	407	275	300
	J	14	6	352	67	68	353	366	421	441
19	I	14	6	352	67	68	353	366	421	441
	J	11	5	301	72	73	302	313	311	326
20	I	11	5	301	72	73	302	313	311	326
	J	37	18	357	130	138	359	393	160	185

Table 2A-3

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	27	21	1730	923	923	1731	1758	88	90
	J	13	10	593	378	378	593	606	57	60
2	I	13	10	593	378	378	593	606	57	60
	J	9	7	656	228	228	666	676	193	197
3	I	9	7	666	228	228	666	676	193	197
	J	10	7	1016	408	408	1016	1026	149	152
4	I	10	7	1016	408	408	1016	1026	149	152
	J	9	7	839	392	392	839	849	114	117
5	I	9	7	839	392	392	839	849	114	117
	J	9	8	625	345	345	625	634	81	84
6	I	9	8	625	345	345	625	634	81	84
	J	10	9	546	347	347	546	556	57	60
7	I	10	9	546	347	347	546	556	57	60
	J	15	13	386	208	209	386	401	85	92
8	I	15	13	386	208	209	386	401	85	92
	J	26	20	618	155	161	619	644	284	300
9	I	26	20	618	155	161	619	644	284	300
	J	18	13	819	178	179	819	838	359	369
10	I	18	13	819	178	179	819	838	359	369
	J	15	10	1100	266	268	1100	1115	310	315
11	I	15	10	1100	266	268	1100	1115	310	315
	J	16	14	482	227	231	483	499	109	116
12	I	13	7	216	284	287	216	229	-25	-20
	J	9	7	836	250	253	836	845	230	234
13	I	9	7	836	250	253	836	845	230	234
	J	5	4	227	152	153	227	232	48	52
14	I	5	4	227	152	153	227	232	48	52
	J	8	5	133	135	137	133	141	-3	3
15	I	8	5	133	135	137	133	141	-3	3
	J	6	4	66	67	70	67	72	-4	4

Table 2A-3 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2,4	SRSS 1,3	ABS. 1,3	SRSS	ABS.
16	I	6	4	66	67	70	67	72	-4	4
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	449	154	158	450	466	185	195
	J	26	11	322	98	102	323	348	218	242
18	I	26	11	322	98	102	323	348	218	242
	J	14	6	230	67	68	231	244	241	261
19	I	14	6	230	67	68	231	244	241	261
	J	11	5	86	72	73	87	97	18	32
20	I	11	5	86	72	73	87	97	18	32
	J	37	18	136	130	138	141	173	2	25

Table 2B-3

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. SRSS (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
1	I	27	21	1302	323	923	1302	1329	41	44
	J	13	10	578	378	378	578	591	53	57
2	I	13	10	578	378	378	578	591	53	57
	J	9	7	506	228	228	507	516	123	127
3	I	9	7	506	228	228	507	516	123	127
	J	10	7	686	408	408	686	697	68	71
4	I	10	7	686	408	408	686	697	68	71
	J	9	7	553	392	392	554	563	41	44
5	I	9	7	553	392	392	554	563	41	44
	J	9	8	413	345	345	413	422	20	22
6	I	9	8	413	345	345	413	422	20	22
	J	10	9	378	347	347	378	388	9	12
7	I	10	9	378	347	347	378	388	9	12
	J	15	13	366	208	209	366	381	75	83
8	I	15	13	366	208	209	366	381	75	83
	J	26	20	610	155	161	611	636	279	295
9	I	26	20	610	155	161	611	636	279	295
	J	18	13	738	178	179	738	756	313	324
10	I	18	13	738	178	179	738	756	313	324
	J	15	10	916	266	268	916	931	241	247
11	I	15	10	916	266	268	916	931	241	247
	J	16	14	460	227	231	460	476	99	106
12	I	13	7	204	284	287	204	217	-29	-24
	J	9	7	861	250	253	861	869	240	243
13	I	9	7	861	250	253	861	869	240	243
	J	5	4	185	152	153	185	190	21	24
14	I	5	4	185	152	153	185	190	21	24
	J	8	5	200	135	137	200	208	46	51
15	I	8	5	200	135	137	200	208	46	51
	J	6	4	100	67	70	100	106	44	52

Table 2B-3 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	6	4	100	67	70	100	106	44	52
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	390	154	158	390	406	148	158
	J	26	11	279	98	102	280	305	175	199
18	I	26	11	279	98	102	280	305	175	199
	J	14	6	215	67	68	216	230	219	239
19	I	14	6	215	67	68	216	230	219	233
	J	11	5	99	72	73	99	110	35	49
20	I	11	5	99	72	73	99	110	35	49
	J	37	18	119	130	138	125	156	-10	13

Table 2C-3

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2,4	SRSS 1,3	ABS. 1,3	SRSS	ABS.
1	I	27	21	1732	923	923	1732	1759	88	91
	J	13	10	641	378	378	641	654	70	73
2	I	13	10	641	378	378	641	654	70	73
	J	9	7	676	228	228	676	685	137	201
3	I	9	7	676	228	228	676	685	197	201
	J	10	7	1016	408	408	1016	1026	149	152
4	I	10	7	1016	408	408	1016	1026	149	152
	J	9	7	839	392	392	839	849	114	117
5	I	9	7	839	392	392	839	849	114	117
	J	9	8	625	345	345	625	634	81	84
6	I	9	8	625	345	345	625	634	81	84
	J	10	9	550	347	347	550	560	58	61
7	I	10	9	550	347	347	550	560	58	61
	J	15	13	525	208	209	525	540	151	159
8	I	15	13	525	208	209	525	540	151	159
	J	26	20	872	155	161	872	898	441	457
9	I	26	20	872	155	161	872	898	441	457
	J	18	13	1037	178	179	1037	1055	481	491
10	I	18	13	1037	178	179	1037	1055	481	491
	J	15	10	1259	266	268	1260	1275	369	375
11	I	15	1[illegible]	1259	266	268	1260	1275	369	375
	J	16	14	589	227	231	589	605	155	162
12	I	13	7	271	284	287	271	283	-6	-1
	J	9	7	993	250	253	993	1002	292	295
13	I	9	7	993	250	253	993	1002	292	295
	J	5	4	248	152	153	248	253	62	65
14	I	5	4	248	152	153	248	253	62	65
	J	8	5	308	135	137	308	316	124	130
15	I	8	5	308	135	137	308	316	124	130
	J	6	4	153	67	70	154	159	1[illegible]	129

Table 2C-3 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	6	4	153	67	70	154	159	121	129
	J	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	I	16	11	477	154	158	477	494	203	213
	J	26	11	328	98	102	329	354	224	248
18	I	26	11	328	98	102	329	354	224	248
	J	14	6	247	67	68	248	261	266	286
19	I	14	6	247	67	68	248	261	266	286
	J	11	5	119	72	73	120	130	63	77
20	I	11	5	119	72	73	120	130	63	77
	J	37	18	191	130	138	195	228	41	65

Table 3A-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	3	2	16	10	10	16	18	60	84
	J	2	.8	15	10	10	15	17	60	78
2	I	2	.8	15	10	10	15	17	60	78
	J	2	.8	15	10	10	15	17	59	75
3	I	2	.8	15	10	10	15	17	59	75
	J	5	3	20	13	13	21	25	53	88
4	I	5	3	20	13	13	21	25	53	88
	J	4	2	15	10	10	16	19	54	86
5	I	4	2	15	10	10	16	19	54	86
	J	5	2	13	9	9	14	18	55	97
6	I	5	2	13	9	9	14	18	55	97
	J	8	4	41	28	28	42	49	52	77
7	I	8	4	41	28	28	42	49	52	77
	J	7	3	42	28	28	43	49	52	74
8	I	7	3	42	28	28	43	49	52	74
	J	14	5	26	17	19	30	40	58	115
9	I	14	5	26	17	19	30	40	58	115
	J	11	4	11	8	10	15	22	48	109
10	I	11	4	11	8	10	15	22	48	109
	J	16	5	28	19	21	32	44	55	111
11	I	16	5	28	19	21	32	44	55	111
	J	8	4	11	10	12	13	18	10	54
12	I	8	4	11	10	12	13	18	10	54
	J	9	5	8	16	19	12	17	-34	-6
13	I	9	5	8	16	19	12	17	-34	-6
	J	8	4	11	17	18	14	19	-27	2
14	I	8	4	11	17	18	14	19	-27	2
	J	16	7	28	23	26	32	44	22	67
15	I	16	7	28	23	26	32	44	22	67
	J	8	4	20	25	26	22	28	-17	9

Table 3A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	8	4	20	25	26	22	28	-17	9
	J	9	4	24	29	30	25	33	-14	11
17	I	9	4	24	29	30	25	33	-14	11
	J	13	5	11	15	18	17	24	-3	37
18	I	13	5	11	15	18	17	24	-3	37
	J	6	3	19	17	18	20	25	14	45
19	I	6	3	19	17	18	20	25	14	45
	J	6	3	17	15	16	18	23	13	45
20	I	6	3	17	15	16	18	23	13	45
	J	19	7	57	54	56	60	76	7	36
21	I	36	10	15	39	44	39	51	-12	15
	J	10	2	14	16	16	18	25	10	54
22	I	10	2	14	16	16	18	25	10	54
	J	10	3	21	17	17	23	31	34	77
23	I	10	3	21	17	17	23	31	34	77
	J	9	2	21	16	17	23	30	38	81
24	I	9	2	21	16	17	23	30	38	81
	J	8	2	14	12	13	16	22	27	72
25	I	8	2	14	12	13	16	22	27	72
	J	6	1	24	16	16	25	31	56	90
26	I	6	1	24	16	16	25	31	56	90
	J	6	1	24	16	16	25	30	57	90
27	I	6	1	24	16	16	25	30	57	90
	J	5	1	19	12	13	20	24	57	92
28	I	5	1	19	12	13	20	24	57	92
	J	5	1	16	10	11	17	21	51	87
29	I	5	1	16	10	11	17	21	51	87
	J	5	1	13	9	10	14	18	46	86
30	I	5	1	13	9	10	14	18	46	86
	J	25	3	38	23	24	46	63	88	160

Table 3A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	40	12	52	61	66	66	92	-.[illegible]	40
	J	46	13	49	59	65	67	95	4	46
32	I	46	13	49	59	65	67	95	4	46
	J	50	14	47	58	64	69	98	8	52
33	I	50	14	47	58	64	69	98	8	52
	J	53	14	49	55	61	72	102	18	67
34	I	53	14	49	55	61	72	102	18	67
	J	13	5	87	68	70	88	100	26	43
35	I	13	5	87	68	70	88	100	26	43
	J	18	7	89	69	71	90	107	27	50
36	I	18	7	89	69	71	90	107	27	50
	J	17	4	45	34	36	48	62	34	73
37	I	17	4	45	34	36	48	62	34	73
	J	21	6	55	43	45	59	76	31	68

Table 3B-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	3	2	15	10	10	15	18	51	76
	J	2	.8	15	10	10	15	17	54	72
2	I	2	.8	15	10	10	15	17	54	72
	J	2	.8	15	10	10	15	16	55	71
3	I	2	.8	15	10	10	15	16	55	71
	J	5	3	17	13	13	18	22	31	65
4	I	5	3	17	13	13	18	22	31	65
	J	4	2	15	10	10	16	19	52	85
5	I	4	2	15	10	10	16	19	52	85
	J	5	2	14	9	9	15	19	64	107
6	I	5	2	14	9	9	15	19	64	107
	J	8	4	32	28	28	33	40	17	42
7	I	8	4	32	28	28	33	40	17	42
	J	7	3	32	28	28	33	39	17	39
8	I	7	3	32	28	28	33	39	17	39
	J	14	5	21	17	19	25	35	34	87
9	I	14	5	21	17	19	25	35	34	87
	J	11	4	10	8	10	15	21	43	102
10	I	11	4	10	8	10	15	21	43	102
	J	16	5	22	19	21	27	37	28	79
11	I	16	5	22	19	21	27	37	28	79
	J	8	4	11	10	12	13	18	10	54
12	I	8	4	11	10	12	13	18	10	54
	J	9	5	11	16	19	14	20	-24	7
13	I	9	5	11	16	19	14	20	-24	7
	J	8	4	13	17	18	15	20	-20	10
14	I	8	4	13	17	18	15	20	-20	10
	J	16	7	25	23	26	30	41	14	57
15	I	16	7	25	23	26	30	41	14	57
	J	8	4	17	25	26	19	26	-26	-1

Table 3B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	8	4	17	25	26	19	26	-26	-1
	J	9	4	20	29	30	22	30	-24	.4
17	I	9	4	20	29	30	22	30	-24	.4
	J	13	5	10	15	18	16	22	-10	26
18	I	13	5	10	15	18	16	22	-10	26
	J	6	3	19	17	18	20	26	15	46
19	I	6	3	19	17	18	20	26	15	46
	J	6	3	17	15	16	18	23	12	43
20	I	6	3	17	15	16	18	23	12	43
	J	19	7	44	54	56	48	63	-14	13
21	I	36	10	27	39	44	45	63	.9	41
	J	10	2	27	16	16	29	37	80	132
22	I	10	2	27	16	16	29	37	80	132
	J	10	3	30	17	17	32	40	83	129
23	I	10	3	30	17	17	32	40	83	129
	J	9	2	29	16	17	31	39	83	130
24	I	9	2	29	16	17	31	39	83	130
	J	8	2	21	12	13	23	29	77	127
25	I	8	2	21	12	13	23	29	77	127
	J	6	1	22	16	16	23	29	45	79
26	I	6	1	22	16	16	23	29	45	79
	J	6	1	23	16	16	24	29	48	81
27	I	6	1	23	16	16	24	29	48	81
	J	5	1	18	12	13	19	23	46	81
28	I	5	1	18	12	13	19	23	46	81
	J	5	1	14	10	11	15	19	35	70
29	I	5	1	14	10	11	15	19	35	70
	J	5	1	11	9	10	12	16	28	66
30	I	5	1	11	9	10	12	16	28	66
	J	25	3	41	23	24	48	66	98	172

Table 3B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

• ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS(3)	[illegible] S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	40	12	46	61	66	61	87	-7	32
	J	46	13	41	59	65	62	87	-5	34
32	I	46	13	41	59	65	62	87	-5	34
	J	50	14	37	58	64	63	88	-2	37
33	I	50	14	37	58	64	63	88	-2	37
	J	53	14	38	55	61	66	91	7	50
34	I	53	14	38	55	61	66	91	7	50
	J	13	5	91	68	70	91	103	31	48
35	I	13	5	91	68	70	91	103	31	48
	J	18	7	98	69	71	99	116	39	62
36	I	18	7	98	69	71	99	116	39	62
	J	17	4	49	34	36	52	66	44	85
37	I	17	4	49	34	36	52	66	44	85
	J	21	6	66	43	45	69	87	52	91

Table 3C-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. ABS. (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2,4	TOTAL RESPONSES SRSS 1,3	TOTAL RESPONSES ABS. 1,3	PER.CON SRSS	PER.CON ABS.
1	I	3	2	17	10	10	18	20	75	100
	J	2	.8	17	10	10	17	18	73	91
2	I	2	.8	17	10	10	17	18	73	91
	J	2	.8	16	10	10	16	18	71	87
3	I	2	.8	16	10	10	16	18	71	87
	J	5	3	21	13	13	22	27	62	97
4	I	5	3	21	13	13	22	27	62	97
	J	4	2	16	10	10	17	20	64	97
5	I	4	2	16	10	10	17	20	64	97
	J	5	2	15	9	9	16	20	78	121
6	I	5	2	15	9	9	16	20	78	121
	J	8	4	43	28	28	44	51	57	83
7	I	8	4	43	28	28	44	51	57	83
	J	7	3	44	28	28	44	51	57	80
8	I	7	3	44	28	28	44	51	57	80
	J	14	5	27	17	19	30	41	62	120
9	I	14	5	27	17	19	30	41	62	120
	J	11	4	11	8	10	16	22	54	117
10	I	11	4	11	8	10	16	22	54	117
	J	16	5	30	19	21	34	46	61	118
11	I	16	5	30	19	21	34	46	61	118
	J	8	4	12	10	12	15	20	22	69
12	I	8	4	12	10	12	15	20	22	69
	J	9	5	13	16	19	16	22	-14	19
13	I	9	5	13	16	19	16	22	-14	19
	J	8	4	14	17	18	16	22	-12	19
14	I	8	4	14	17	18	16	22	-12	19
	J	16	7	31	23	26	35	47	33	79
15	I	16	7	31	23	26	35	47	33	79
	J	8	4	26	25	26	28	35	7	34

Table 3C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER. CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	8	4	26	25	26	28	35	7	34
	J	9	4	31	29	30	32	40	9	36
17	I	9	4	31	29	30	32	40	9	36
	J	13	5	14	15	18	19	27	7	51
18	I	13	5	14	15	18	19	27	7	51
	J	6	3	30	17	18	30	36	74	106
19	I	6	3	30	17	18	30	36	74	106
	J	6	3	27	15	16	27	33	70	103
20	I	6	3	27	16	16	27	33	70	103
	J	19	7	58	54	56	61	77	10	38
21	I	36	10	39	30	44	53	75	19	68
	J	10	2	39	16	16	41	50	154	210
22	I	10	2	39	16	16	41	50	154	210
	J	10	3	40	17	17	41	50	140	188
23	I	10	3	40	17	17	41	50	140	188
	J	9	2	39	16	17	40	48	137	185
24	I	9	2	39	16	17	40	48	137	185
	J	8	2	29	12	13	30	37	134	187
25	I	8	2	29	12	13	30	37	134	187
	J	6	1	27	16	16	28	34	74	109
26	I	6	1	27	16	16	28	34	74	109
	J	6	1	27	16	16	28	33	76	109
27	I	6	1	27	16	16	28	33	76	109
	J	5	1	22	12	13	23	27	79	114
28	I	5	1	22	12	13	23	27	79	114
	J	5	1	20	10	11	21	25	84	121
29	I	5	1	20	10	11	21	25	84	121
	J	5	1	17	9	10	18	22	84	125
30	I	5	1	17	9	10	18	22	84	125
	J	25	3	52	23	24	58	77	138	217

Table 3C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	40	12	58	61	66	71	98	7	49
	J	46	13	53	59	65	70	99	9	53
32	I	46	13	53	59	65	70	99	9	53
	J	50	14	50	58	64	71	100	11	57
33	I	50	14	50	58	64	71	100	11	57
	J	53	14	50	55	61	73	103	20	69
34	I	53	14	50	55	61	73	103	20	69
	J	13	5	102	68	70	103	114	47	64
35	I	13	5	102	68	70	103	114	47	64
	J	18	7	115	69	71	116	133	62	86
36	I	18	7	115	69	71	116	133	62	86
	J	17	4	56	34	36	59	73	63	104
37	I	17	4	56	34	36	59	73	63	104
	J	21	6	84	43	45	87	105	92	132

Table 3A-2

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	3	2	17	10	10	17	20	71	96
	J	2	.8	16	10	10	17	18	71	89
2	I	2	8	16	10	10	17	18	71	89
	J	2	.8	16	10	10	16	18	70	86
3	I	2	.8	16	10	10	16	18	70	86
	J	5	3	21	13	13	22	27	62	97
4	I	5	3	21	13	13	22	27	62	97
	J	4	2	16	10	10	17	20	64	96
5	I	4	2	16	10	10	17	20	64	96
	J	5	2	14	9	9	15	19	65	108
6	I	5	2	14	9	9	15	19	65	108
	J	8	4	44	28	28	45	52	61	87
7	I	8	4	44	28	28	45	52	61	87
	J	7	3	45	28	28	45	52	61	84
8	I	7	3	45	28	28	45	52	61	84
	J	14	5	27	17	19	31	42	65	123
9	I	14	5	27	17	19	31	42	65	123
	J	11	4	12	8	10	16	23	60	126
10	I	11	4	12	8	10	16	23	60	126
	J	16	5	32	19	21	35	47	68	126
11	I	16	5	32	19	21	35	47	68	126
	J	8	4	8	10	12	11	16	-8	31
12	I	8	4	8	10	12	11	16	-8	31
	J	9	5	19	16	19	21	28	12	49
13	I	9	5	19	16	19	21	28	12	49
	J	8	4	22	17	18	23	30	27	62
14	I	8	4	22	17	18	23	30	27	62
	J	16	7	40	23	26	43	56	65	114
15	I	16	7	40	23	26	43	56	65	114
	J	8	4	31	25	26	32	39	24	52

Table 3A-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

PAGE 2 OF 3

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	8	4	31	25	26	32	39	24	52
	J	9	4	37	29	30	38	46	28	56
17	I	9	4	37	29	30	38	46	28	56
	J	13	5	20	15	18	24	33	34	86
18	I	13	5	20	15	18	24	33	34	86
	J	6	3	21	17	18	22	28	27	58
19	I	6	3	21	17	18	22	28	27	58
	J	6	3	18	15	16	19	24	16	47
20	I	6	3	18	15	16	19	24	16	47
	J	19	7	84	54	56	86	103	55	85
21	I	36	10	49	39	44	61	85	37	92
	J	10	2	17	16	16	20	28	25	72
22	I	10	2	17	16	16	20	28	25	72
	J	10	3	23	17	17	25	32	42	86
23	I	10	3	23	17	17	25	32	42	86
	J	9	2	21	16	17	23	31	39	82
24	I	9	2	21	16	17	23	31	39	82
	J	8	2	17	12	13	19	25	48	96
25	I	8	2	17	12	13	19	25	48	96
	J	6	1	2	[illegible]	16	7	9	-58	-46
26	I	6	1	2	16	16	[illegible]	9	-58	-46
	J	5	1	3	16	16	7	9	-57	-42
27	I	6	1	3	16	16	7	9	-57	-42
	J	5	1	5	12	13	7	10	-46	-24
28	I	5	1	5	12	13	7	10	-46	-24
	J	5	1	7	10	11	8	11	-27	1
29	I	5	1	7	10	11	8	11	-27	1
	J	5	1	7	9	10	8	11	-16	17
30	I	5	1	7	9	10	8	11	-16	17
	J	25	3	7	23	24	26	32	6	32

Table 3A-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. ALG.(3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
31	I	40	12	90	61	66	99	130	50	98
	J	46	13	86	59	65	97	132	50	103
32	I	46	13	86	59	65	97	132	50	103
	J	50	14	82	58	64	96	132	50	107
33	I	50	14	82	58	64	96	132	50	107
	J	53	14	74	55	61	91	127	49	108
34	I	53	14	74	55	61	91	127	49	108
	J	13	5	66	68	70	67	78	-4	12
35	I	13	5	66	68	70	67	78	-4	12
	J	18	7	65	69	71	67	83	-6	16
36	I	18	7	65	69	71	67	83	-6	16
	J	17	4	14	34	36	22	31	-38	-13
37	I	17	4	14	34	36	22	31	-38	-13
	J	21	6	46	43	45	50	66	11	47

Table 3B-2

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	3	2	16	10	10	16	19	64	89
	J	2	.8	16	10	10	16	18	67	85
2	I	2	.8	16	10	10	16	18	67	85
	J	2	.8	16	10	10	16	18	68	84
3	I	2	.8	16	10	10	16	18	68	84
	J	5	3	18	13	13	19	23	41	75
4	I	5	3	18	13	13	19	23	41	75
	J	4	2	16	10	10	17	20	64	97
5	I	4	2	16	10	10	17	20	64	97
	J	5	2	15	9	9	16	20	77	120
6	I	5	2	15	9	9	16	20	77	120
	J	8	4	34	28	28	35	42	27	52
7	I	8	4	34	28	28	35	42	27	52
	J	7	3	35	28	28	36	42	27	49
8	I	7	3	35	28	28	36	42	27	49
	J	14	5	22	17	19	26	37	41	35
9	I	14	5	22	17	19	26	37	41	95
	J	11	4	11	8	10	15	22	48	110
10	I	11	4	11	8	10	15	22	48	110
	J	16	5	24	19	21	29	40	37	90
11	I	16	5	24	19	21	29	40	37	90
	J	8	4	13	10	12	15	20	24	70
12	I	8	4	13	10	12	15	20	24	70
	J	9	5	23	16	19	25	32	33	72
13	I	9	5	23	16	19	25	32	33	72
	J	8	4	25	17	18	27	33	44	80
14	I	8	4	25	17	18	27	33	44	80
	J	16	7	40	23	26	43	55	63	111
15	I	16	7	40	23	26	43	55	63	111
	J	8	4	27	25	26	28	35	8	35

Table 3B-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	8	4	27	25	26	28	35	8	35
	J	9	4	32	29	30	33	41	13	40
17	I	9	4	32	29	30	33	41	13	40
	J	13	5	18	15	18	22	31	27	76
18	I	13	5	18	15	18	22	31	27	76
	J	6	3	26	17	18	27	33	53	86
19	I	6	3	26	17	18	27	33	53	86
	J	6	3	22	15	16	22	28	39	71
20	I	6	3	22	15	16	22	28	39	71
	J	19	7	68	54	56	71	87	27	57
21	I	36	10	46	39	44	59	82	32	85
	J	10	2	15	16	16	18	25	13	57
22	I	10	2	15	16	16	18	25	13	57
	J	10	3	18	17	17	20	27	17	58
23	I	10	3	18	17	17	20	27	17	58
	J	9	2	17	16	17	19	26	14	55
24	I	9	2	17	[illegible]	[illegible]	19	26	14	55
	J	8	2	14	[illegible]	[illegible]	16	22	24	70
25	I	8	2	14	12	13	16	22	24	70
	J	6	1	3	16	16	7	9	-56	-41
26	I	6	1	3	16	16	7	9	-56	-41
	J	6	1	3	16	16	7	9	-58	-44
27	I	6	1	3	16	16	7	9	-58	-44
	J	5	1	3	12	13	6	8	-52	-34
28	I	5	[illegible]	3	12	13	6	8	-52	-34
	J	5	1	5	10	11	7	10	-40	-15
29	I	5	1	5	10	11	7	10	-40	-15
	J	5	1	5	9	10	7	9	-31	-2
30	I	5	1	5	9	10	7	9	-31	-2
	J	25	3	7	23	24	26	32	7	33

Table 3B-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. SRSS (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
31	I	40	12	76	61	66	86	116	30	76
	J	46	13	72	59	65	85	118	31	81
32	I	46	13	72	59	65	[illegible]	118	31	81
	J	50	14	68	58	64	85	118	32	85
33	I	50	14	68	58	64	85	118	32	85
	J	53	14	60	55	61	80	113	32	86
34	I	53	14	60	55	61	80	113	32	86
	J	13	5	55	68	70	57	68	-19	-3
35	I	13	5	55	68	70	57	68	-19	-3
	J	18	7	55	69	71	58	73	-19	2
36	I	18	7	55	69	71	58	73	-19	2
	J	17	4	17	34	36	25	35	-31	-3
37	I	17	4	17	34	36	25	35	-31	-3
	J	21	6	35	43	45	41	56	-10	23

Table 3C-2

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	3	2	19	10	10	19	21	88	113
	J	2	.8	18	10	10	18	20	86	104
2	I	2	.8	18	10	10	18	20	86	104
	J	2	.8	17	10	10	17	19	84	100
3	I	2	.8	17	10	10	17	19	84	100
	J	5	3	23	13	13	23	28	73	108
4	I	5	3	23	13	13	23	28	73	108
	J	4	2	18	10	10	18	21	76	109
5	I	4	2	18	10	10	18	21	76	109
	J	5	2	17	9	9	17	21	92	136
6	I	5	2	17	9	9	17	21	92	136
	J	8	4	46	28	28	47	54	68	94
7	I	8	4	46	28	28	47	54	68	94
	J	7	3	47	28	28	47	54	68	91
8	I	7	3	47	28	28	47	54	68	91
	J	14	5	28	17	19	32	43	70	128
9	I	14	5	28	17	19	32	43	70	128
	J	11	4	14	8	10	17	24	69	137
10	I	11	4	14	8	10	17	24	69	137
	J	16	5	34	19	21	37	49	78	136
11	I	16	5	34	19	21	37	49	78	136
	J	8	4	17	10	12	19	25	54	105
12	I	8	4	17	10	12	19	25	54	105
	J	9	5	27	16	19	28	36	52	93
13	I	9	5	27	16	19	28	36	52	93
	J	8	4	28	17	18	30	36	60	97
14	I	8	4	28	17	18	30	36	60	97
	J	16	7	45	23	26	48	61	83	133
15	I	16	7	45	23	26	48	61	83	133
	J	8	4	36	25	26	37	44	42	70

Table 3C-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. ABS. (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
16	I	8	4	36	25	26	37	44	42	70
	J	9	4	42	29	30	43	52	45	74
17	I	9	4	42	29	30	43	52	46	74
	J	13	5	22	15	18	26	35	46	99
18	I	13	5	22	15	18	26	35	46	99
	J	6	3	38	17	18	39	45	121	155
19	I	6	3	38	17	18	39	45	121	155
	J	6	3	32	15	16	33	38	104	138
20	I	6	3	32	15	16	33	38	104	138
	J	19	7	85	54	56	87	104	56	86
21	I	36	10	55	39	44	66	91	48	104
	J	10	2	19	16	16	22	29	34	82
22	I	10	2	19	16	16	22	29	34	82
	J	10	3	23	17	17	25	33	45	89
23	I	10	3	23	17	17	25	33	45	89
	J	9	2	22	16	17	24	31	42	86
24	I	9	2	22	16	17	24	31	42	86
	J	8	2	18	12	13	19	26	51	100
25	I	8	2	18	12	13	19	26	51	100
	J	6	1	4	16	16	8	11	-52	-33
26	I	6	1	4	16	16	8	11	-52	-33
	J	6	1	4	16	16	7	10	-56	-40
27	I	6	1	4	16	16	7	10	-56	-40
	J	[illegible]	1	5	12	13	7	10	-46	-24
28	I	5	1	5	12	13	7	10	-46	-24
	J	5	1	7	10	11	8	12	-26	3
29	I	5	1	7	10	11	8	12	-26	3
	J	5	1	7	9	10	8	11	-15	18
30	I	5	1	7	9	10	8	11	-15	18
	J	25	3	11	23	24	27	36	12	47

Table 3C-2 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS.(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	40	12	96	61	66	104	136	58	107
	J	46	13	90	59	65	102	137	56	110
32	I	46	13	90	59	65	102	137	56	110
	J	50	14	86	58	64	99	136	55	112
33	I	50	14	86	58	64	99	136	55	112
	J	53	14	75	55	61	92	129	51	111
34	I	53	14	75	55	61	92	129	51	111
	J	13	5	68	68	70	69	80	-1	15
35	I	13	5	68	68	70	69	80	-1	15
	J	18	7	63	69	71	70	86	-2	20
36	I	18	7	68	69	71	70	86	-2	20
	J	17	4	25	34	36	31	43	-14	19
37	I	17	4	25	34	36	31	43	-14	19
	J	21	6	52	43	45	56	72	23	60

Table 4A-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

PAGE 1 OF 3

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ALG. (3)	PS. S. (4)	T.H. 2,4	SRSS 1,3	ABS. 1,3	SRSS	ABS.
1	I	68	29	55	38	49	87	123	79	152
	J	69	28	50	34	46	85	118	86	159
2	I	69	28	50	34	46	85	118	86	159
	J	63	26	47	32	43	79	110	85	158
3	I	63	26	47	32	43	79	110	85	158
	J	56	22	47	33	40	73	103	81	155
4	I	56	23	47	33	41	73	103	79	152
	J	54	23	47	33	40	71	100	76	149
5	I	54	23	47	33	40	71	100	76	149
	J	62	27	47	33	45	78	109	75	145
6	I	62	27	47	33	45	78	109	75	145
	J	58	26	42	29	42	72	100	71	139
7	I	58	26	42	29	42	72	100	71	139
	J	38	18	32	22	32	50	71	55	119
8	I	38	18	32	22	32	50	71	55	119
	J	31	15	23	16	25	38	54	51	112
9	I	31	15	23	16	25	38	54	51	112
	J	44	20	16	11	26	47	61	81	133
10	I	44	20	15	11	26	47	61	81	133
	J	65	29	16	11	34	67	81	98	140
11	I	65	29	16	11	34	67	81	98	140
	J	78	35	20	14	40	80	98	102	145
12	I	78	35	20	14	40	80	98	102	145
	J	81	36	22	16	41	85	104	104	151
13	I	81	36	22	16	41	85	104	104	151
	J	71	31	21	15	36	74	92	107	157
14	I	71	31	21	15	36	74	92	107	157
	J	63	28	19	13	31	66	82	112	164
15	I	63	28	19	13	31	66	82	112	164
	J	61	29	18	12	32	64	79	103	152

Table 4A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. ALG.(3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
16	I	61	29	18	12	32	64	79	103	152
	J	63	31	17	12	34	65	80	92	134
17	I	85	36	20	14	38	88	105	129	175
	J	77	30	11	7	31	78	88	151	182
18	I	77	30	11	7	31	78	88	151	182
	J	74	28	4	3	29	74	79	160	175
19	I	55	21	21	15	26	59	76	128	194
	J	42	16	21	14	23	47	63	101	170
20	I	42	16	21	14	23	47	63	101	170
	J	32	13	21	14	21	38	53	79	147
21	I	32	13	21	14	21	38	53	79	147
	J	27	13	20	14	22	34	47	56	119
22	I	27	13	20	14	22	34	47	56	119
	J	26	13	21	14	21	33	46	53	116
23	I	26	13	21	14	21	33	46	53	116
	J	28	13	21	15	20	35	49	75	145
24	I	28	13	21	15	20	35	49	75	145
	J	35	16	22	15	21	41	57	94	167
25	I	35	16	22	15	21	41	57	94	167
	J	41	18	22	15	23	47	63	99	169
26	I	41	18	22	15	23	47	63	99	169
	J	43	19	22	15	25	48	64	92	158
27	I	43	19	22	15	25	48	64	92	158
	J	45	20	21	15	27	50	66	84	144
28	I	45	20	21	15	27	50	66	84	144
	J	38	16	21	15	24	43	59	83	149
29	I	38	16	21	15	24	43	59	83	149
	J	31	15	20	14	23	37	51	62	125
30	I	31	15	20	14	23	37	51	62	125
	J	37	19	19	13	26	42	56	61	117

Table 4A-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. ALG. (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
31	I	37	19	19	13	26	42	56	61	117
	J	42	21	19	13	27	46	61	69	124
32	I	42	21	19	13	27	46	61	69	124
	J	42	20	19	13	26	47	62	78	136
33	I	42	20	19	13	26	47	62	78	136
	J	47	22	20	14	28	51	66	84	140
34	I	47	22	20	14	28	51	66	84	140
	J	54	26	20	14	32	57	73	81	133
35	I	54	26	20	14	32	57	73	81	133
	J	62	32	20	14	36	65	82	80	126
36	I	62	32	20	14	36	65	82	80	126
	J	72	38	20	14	42	75	92	78	120
37	I	72	38	20	14	42	75	92	78	120
	J	73	39	20	14	43	76	94	77	118
38	I	73	39	20	14	43	76	94	77	118
	J	62	33	19	13	37	65	81	78	122
39	I	62	33	19	13	37	65	81	78	122
	J	52	27	19	13	32	55	71	76	125
40	I	52	27	19	13	32	55	71	76	125
	J	45	23	18	13	28	48	63	74	127
41	I	45	23	18	13	28	48	63	74	127
	J	41	21	18	12	26	45	59	73	128
42	I	41	21	18	12	26	45	59	73	128
	J	40	21	18	12	25	44	58	73	128

Table 4B-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

PAGE 1 OF 3

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. SRSS(3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
1	I	68	29	64	38	49	93	132	91	170
	J	69	28	55	34	46	88	124	93	172
2	I	69	28	55	34	46	88	124	93	172
	J	63	26	52	32	43	82	115	93	172
3	I	63	26	52	32	43	82	115	93	172
	J	56	22	53	33	40	77	109	90	168
4	I	56	23	53	33	41	77	109	88	165
	J	54	23	54	33	40	76	107	87	165
5	I	54	23	54	33	40	76	107	87	165
	J	62	27	58	33	45	85	120	91	170
6	I	62	27	58	33	45	85	120	91	170
	J	58	26	53	29	42	79	111	87	165
7	I	58	26	53	29	42	79	111	87	165
	J	38	18	39	22	32	55	77	69	139
8	I	38	18	39	22	32	55	77	69	139
	J	31	15	29	16	25	42	60	67	136
9	I	31	15	29	16	25	42	60	67	136
	J	44	20	30	11	26	54	75	106	186
10	I	44	20	30	11	26	54	75	106	186
	J	65	29	41	11	34	77	106	128	215
11	I	65	29	41	11	34	77	106	128	215
	J	78	35	50	14	40	93	128	133	222
12	I	78	35	50	14	40	93	128	133	222
	J	81	36	53	16	41	97	134	134	224
13	I	81	36	53	16	41	97	134	134	224
	J	71	31	44	15	36	83	115	133	221
14	I	71	31	44	15	36	83	115	133	221
	J	63	28	33	13	31	71	96	128	208
15	I	63	28	33	13	31	71	96	128	208
	J	61	29	28	12	30	68	90	115	185

Table 4B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
NO.		R.S. (1)	T.H. (2)	SAM. SRSS (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	61	29	28	12	32	68	90	115	185
	J	63	31	25	12	34	68	88	100	160
17	I	85	36	35	14	38	92	120	141	214
	J	77	30	21	7	31	80	98	157	217
18	I	77	30	21	7	31	80	98	157	217
	J	74	28	14	3	29	76	88	164	209
19	I	55	21	29	15	26	62	84	140	224
	J	42	16	30	14	23	52	73	122	210
20	I	42	16	30	14	23	52	73	122	210
	J	32	13	34	14	21	47	66	118	209
21	I	32	13	34	14	21	47	66	118	209
	J	27	13	38	14	22	47	65	117	202
22	I	27	13	38	14	22	47	65	117	202
	J	26	13	42	14	21	49	68	131	217
23	I	26	13	42	14	21	49	68	131	217
	J	28	13	44	15	20	52	72	161	260
24	I	28	13	44	15	20	52	72	161	260
	J	35	16	48	15	21	59	83	179	290
25	I	35	16	48	15	21	59	83	179	290
	J	41	18	51	15	23	66	92	180	294
26	I	41	18	51	15	23	66	92	180	294
	J	43	19	51	15	25	67	94	167	277
27	I	43	19	51	15	25	67	94	167	277
	J	45	20	52	15	27	69	97	154	258
28	I	45	20	52	15	27	69	97	154	258
	J	38	16	49	15	24	62	87	162	267
29	I	38	16	49	15	24	62	87	162	267
	J	31	15	44	14	23	54	75	139	233
30	I	31	15	44	14	23	54	75	139	233
	J	37	19	43	13	26	57	80	118	208

Table 4B-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE. NO.	END	DYNAMIC COMP. R.S. (1)	DYNAMIC COMP. T.H. (2)	STATIC COMP. SAM. SRSS (3)	STATIC COMP. PS. S. (4)	TOTAL RESPONSES T.H. 2.4	TOTAL RESPONSES SRSS 1.3	TOTAL RESPONSES ABS. 1.3	PER.CON SRSS	PER.CON ABS.
31	I	37	19	43	13	26	57	80	118	208
	J	42	21	40	13	27	58	81	112	200
[illegible]	I	42	21	40	13	27	58	81	112	200
	J	42	20	34	13	26	55	77	108	193
33	I	42	20	34	13	26	55	77	108	193
	J	47	22	30	14	28	56	77	102	179
34	I	47	22	30	14	28	56	77	102	179
	J	54	26	28	14	32	60	81	92	159
35	I	54	26	28	14	32	60	81	92	159
	J	62	32	28	14	36	68	90	87	147
36	I	62	32	28	14	36	68	90	87	147
	J	72	38	29	14	42	78	101	85	141
37	I	72	38	29	14	42	78	101	85	141
	J	73	39	30	14	43	79	104	85	142
38	I	73	39	30	14	43	79	104	85	142
	J	62	33	27	13	37	68	90	85	145
39	I	62	33	27	13	37	68	90	85	145
	J	52	27	25	13	32	58	77	84	146
40	I	52	27	25	13	32	58	77	84	146
	J	45	23	24	13	28	50	68	82	147
41	I	45	23	24	13	28	50	68	82	147
	J	41	21	23	12	26	47	64	82	147
42	I	41	21	23	12	26	47	64	82	147
	J	40	21	23	12	25	46	63	81	147

Table 4C-1

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS.(3)	PS. S. (4)	T.H. 2,4	SRSS 1,3	ABS. 1,3	SRSS	ABS.
1	I	68	29	103	38	49	124	171	153	251
	J	69	28	90	34	46	113	158	147	246
2	I	69	28	90	34	46	113	158	147	246
	J	63	26	85	32	43	106	149	150	249
3	I	63	26	85	32	43	106	149	150	249
	J	56	22	81	33	40	99	137	144	239
4	I	56	23	81	33	41	99	137	141	235
	J	54	23	76	33	40	93	129	129	219
5	I	54	23	76	33	40	93	129	129	219
	J	62	27	73	33	45	96	135	116	204
6	I	62	27	73	33	45	96	135	116	204
	J	58	26	68	29	42	89	126	112	199
7	I	58	26	68	29	42	89	126	112	199
	J	38	18	54	22	32	66	92	104	134
8	I	38	18	54	22	32	66	92	104	184
	J	31	15	48	16	25	57	79	123	209
9	I	31	15	46	16	25	57	79	123	209
	J	44	20	48	11	26	65	92	151	255
10	I	44	20	48	11	26	65	92	151	255
	J	65	29	66	11	34	92	131	174	288
11	I	65	29	66	11	34	92	131	174	288
	J	78	35	79	14	40	111	156	178	293
12	I	78	35	79	14	40	111	156	178	293
	J	81	36	80	16	41	115	162	176	291
13	I	81	36	80	16	41	115	162	176	291
	J	71	31	65	15	36	96	136	169	280
14	I	71	31	65	15	36	96	136	169	280
	J	63	28	44	13	31	77	107	147	245
15	I	63	28	44	13	31	77	107	147	245
	J	61	29	38	12	32	72	100	130	216

Table 4C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS.(3)	PS. S (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
16	I	61	29	38	12	32	72	100	130	216
	J	63	31	38	12	34	73	100	116	196
17	I	85	36	49	14	38	98	134	157	251
	J	77	30	32	7	31	83	109	169	251
18	I	77	30	32	7	31	83	109	169	251
	J	74	28	24	3	29	78	98	173	243
19	I	55	21	43	15	26	70	99	171	281
	J	42	16	49	14	23	65	92	178	292
20	I	42	16	49	14	23	65	92	178	292
	J	32	13	56	14	21	65	88	204	314
21	I	32	13	56	14	21	65	88	204	314
	J	27	13	64	14	22	69	91	220	319
22	I	27	13	64	14	22	69	91	220	319
	J	26	13	70	14	21	75	96	249	347
23	I	26	13	70	14	21	75	96	249	347
	J	28	13	73	15	20	78	101	291	405
24	I	28	13	73	15	20	78	101	291	405
	J	35	16	77	15	21	85	112	298	428
25	I	35	16	77	15	21	85	112	298	428
	J	41	18	82	15	23	92	123	290	425
26	I	41	18	82	15	23	92	123	290	425
	J	43	19	82	15	25	92	124	268	397
27	I	43	19	82	15	25	92	124	268	397
	J	45	20	81	15	27	93	126	243	367
28	I	45	20	81	15	27	93	126	243	367
	J	38	16	77	15	24	86	115	263	385
29	I	38	16	77	15	24	86	115	263	385
	J	31	15	72	14	23	78	102	245	353
30	I	31	15	72	14	23	78	102	245	353
	J	37	19	67	13	26	77	104	196	302

Table 4C-1 (Cont'd)

COMPARISON OF RESULTANT MOMENT RESPONSES (KIP-IN)

PAGE 3 OF 3

ELE NO.	END	DYNAMIC COMP.		STATIC COMP.		TOTAL RESPONSES			PER.CON	
		R.S. (1)	T.H. (2)	SAM. ABS. (3)	PS. S. (4)	T.H. 2.4	SRSS 1.3	ABS. 1.3	SRSS	ABS.
31	I	37	19	67	13	26	77	104	196	302
	J	42	21	61	13	27	74	103	173	279
32	I	42	21	61	13	27	74	103	173	279
	J	42	20	54	13	26	68	96	160	266
33	I	42	20	54	13	26	68	96	160	266
	J	47	22	46	14	28	65	93	139	237
34	I	47	22	46	14	28	66	93	139	237
	J	54	26	40	14	32	67	94	112	197
35	I	54	26	40	14	32	67	94	112	197
	J	62	32	37	14	36	73	100	100	174
36	I	62	32	37	14	36	73	100	100	174
	J	72	38	41	14	42	83	113	97	168
37	I	72	38	41	14	42	83	113	97	168
	J	73	39	44	14	43	86	117	99	173
38	I	73	39	44	14	43	86	117	99	173
	J	62	33	39	13	37	73	101	101	177
39	I	62	33	39	13	37	73	101	101	177
	J	52	27	35	13	32	63	88	100	178
40	I	52	27	35	13	32	63	88	100	178
	J	45	23	33	13	28	55	77	100	179
41	I	45	23	33	13	28	55	77	100	179
	J	41	21	31	12	26	52	73	100	180
42	I	41	21	31	12	26	52	73	100	180
	J	40	21	31	12	25	51	71	99	180

The results for the two piping systems with two support groups support the above conclusion. The results for the fourth problem are very conservative regardless of which combination is used in the spatial directions. For the first problem, however, a non-conservative stress condition exists at the node between elements 10 and 11 when the primary and secondary components are combined by SRSS. All other elements for this problem remain conservative for either the SRSS or ABS summing procedures. In summary non-conservative results were obtained for only one point in the two problems when the SRSS procedure was applied.

It can be concluded that the absolute sum combination between the primary and secondary stresses will always yield the worse possible stress condition for a given choice of support phasing. The use of SRSS combination also provides reasonably conservative results. However, the most important parameter affecting conservatism is, in fact, the choice of phasing between the support groups. This aspect is discussed in detail below.

The results for a piping system with three support groups are given in Tables 2A-1 to 2C-3. There exists four possible combinations one could use to apply the phasing between these supports. When all supports are in phase, the stress condition is least severe, and hence, is not considered for analysis. Any of the other three phasing conditions can yield the worse stress at certain locations in the piping system. That is, one choice of phasing that does not necessarily result in the worse SAM stress condition at all points in the system as is the case for a system with two support groups. However, if all the three combinations are considered together, one could form the envelop of these three which would then represent the worse SAM stress at every point in the piping system.

To illustrate the above conclusion, comparing results for the first three elements, the second phasing choice yields a non-conservative stress irrespective of which combination was used between the spatial directions. However, when the results for the other phasing choices are surveyed, a condition is apparent which represents the worse stress at each of these points. This condition is conservative as compared to the time history results. A similar observation can be drawn from the results for the 4-group problem presented in Tables 3A-1 to 3C-2. It should be noted that for this problem only two cases of phasing were considered which were assumed to yield the worse SAM stress condition.

Several other studies using more realistic input loadings were made which are not included in this report. As mentioned earlier, the earthquake input for the presented studies were chosen from the real ground motion earthquake records available in the CALTECH publications. A number of analyses were performed with a set of real floor time history and response spectra records from an actual nuclear structure. The results from these studies are not yet final as the correctness of the input time history functions are still under investigation. A general trend observed in this extended study is described below.

Most Category I nuclear structures are designed on the basis of radiation shielding which governs the concrete wall thickness. These structures are consequently very rigid. Such structures when subjected to an earthquake excitation exhibit floor responses which are both in phase and highly correlated. For a piping system supported within this type of structure all support excitations would be in phase. If the simplified SAM analysis considered them out of phase, then the computed SAM stress component would be overly conservative as compared to the independent time history solutions. This observation is also true, for a significant portion of piping systems supported from more than one building. Only the intermediate section between the buildings would experience larger SAM stresses than would be predicted for in-phase response. With this in mind, it should be obvious that the level of conservatism inherent in real nuclear plant designs will usually be large regardless of which combination procedure is used between the primary and secondary stress components.

In summary, the SRSS combination between the primary and secondary stress components of a piping system subjected to seismic loading provides a reasonable level of conservatism in estimating the stress condition. It is not as conservative as that provided by the absolute sum procedure. It should however be noted that the estimation of the static component (i.e., secondary stress) should be made in a proper and conservative way as it has a significant effect on the results.

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This report includes the findings of an investigation of the conservatism associated with different combinations between the primary and secondary stress components for piping systems under dynamic loading, such as in an earthquake event. The primary stresses are induced by piping response to its mass inertia effects. The secondary stresses are induced by relative displacements of piping supports.

It is found that the SRSS combination of the primary and secondary stress components yield acceptable results provided the secondary stress components calculated in the most unfavorable phasing relationship among displacements of piping supports. The absolute sum combination as recommended in the current Standard Review Plan is found to yield very conservative results when compared to the time history solutions.

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COMBINATIONS BETWEEN PRIMARY AND SECONDARY PIPING RESPONSES