RESPONSE TO AEC QUESTIONS

SUBJECT: RGE - Pressurizer Safety Valve Discharge Piping Time History Dynamic Analysis

MAR 15 1973

Question: What is the critical percentage damping used in the analysis?

Answer: The pressurizer safety valve discharge piping system is analyzed by using 0.5 percent critical damping.

Question: How many degrees of freedom are considered in the analysis?

Answer: Each lumped mass is presented by three translatory degrees of freedom.
FIGURE 1 (PCV 435) shows the 25 lumped mass model. The system is analyzed for (25x3) 75 degrees of freedom.
FIGURE 2 (PCV 434) shows the 22 lumped mass model. The system is analyzed for 22x3 66 degrees of freedom.

Question: What method is used for the normal mode solution?

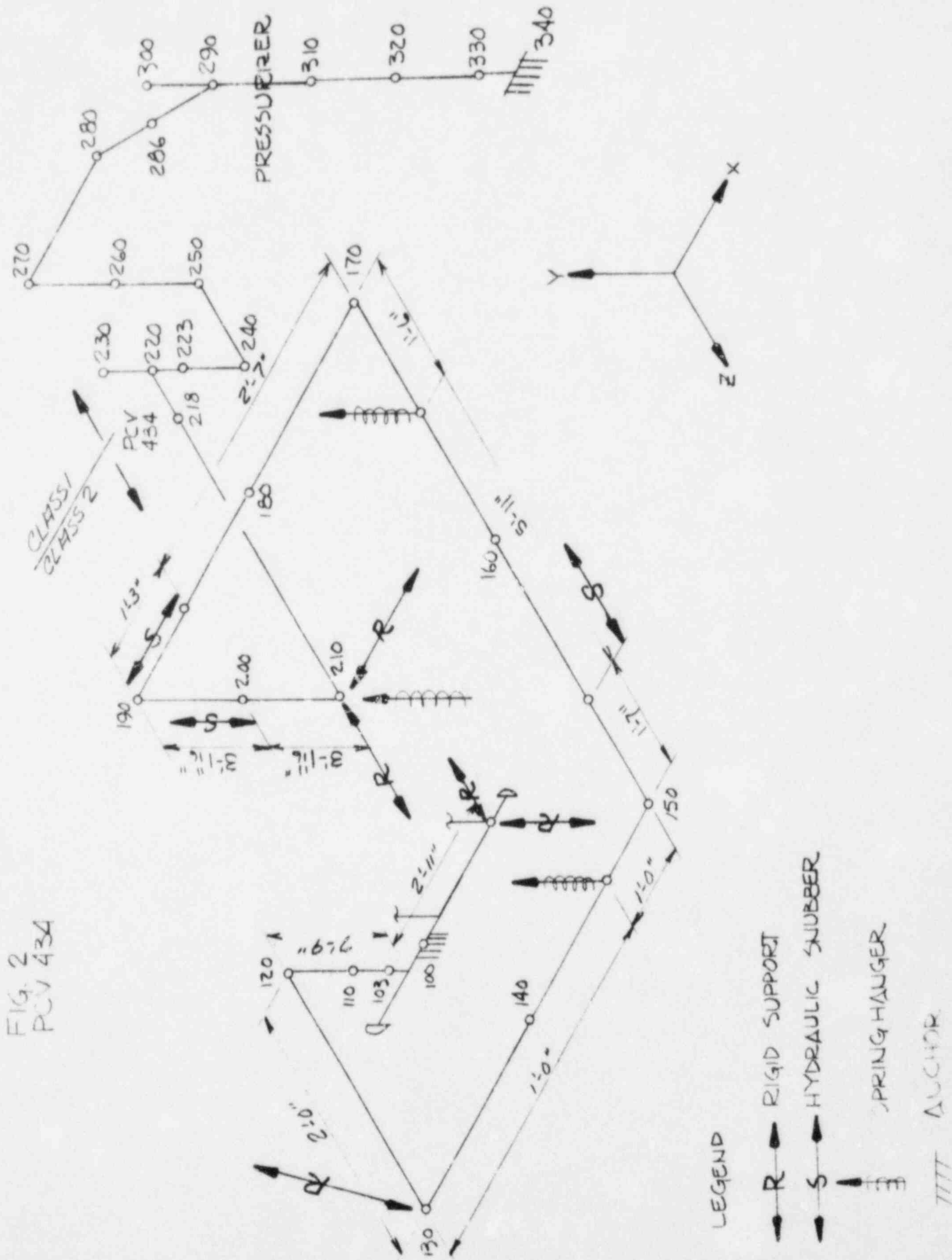
Answer: The modified Jacobi method is used for the normal mode solution, where ω represents the system frequencies and ϕ represents the mode shapes of the system.

Question: Furnish the time history plots of the most highly stressed node point in each system.

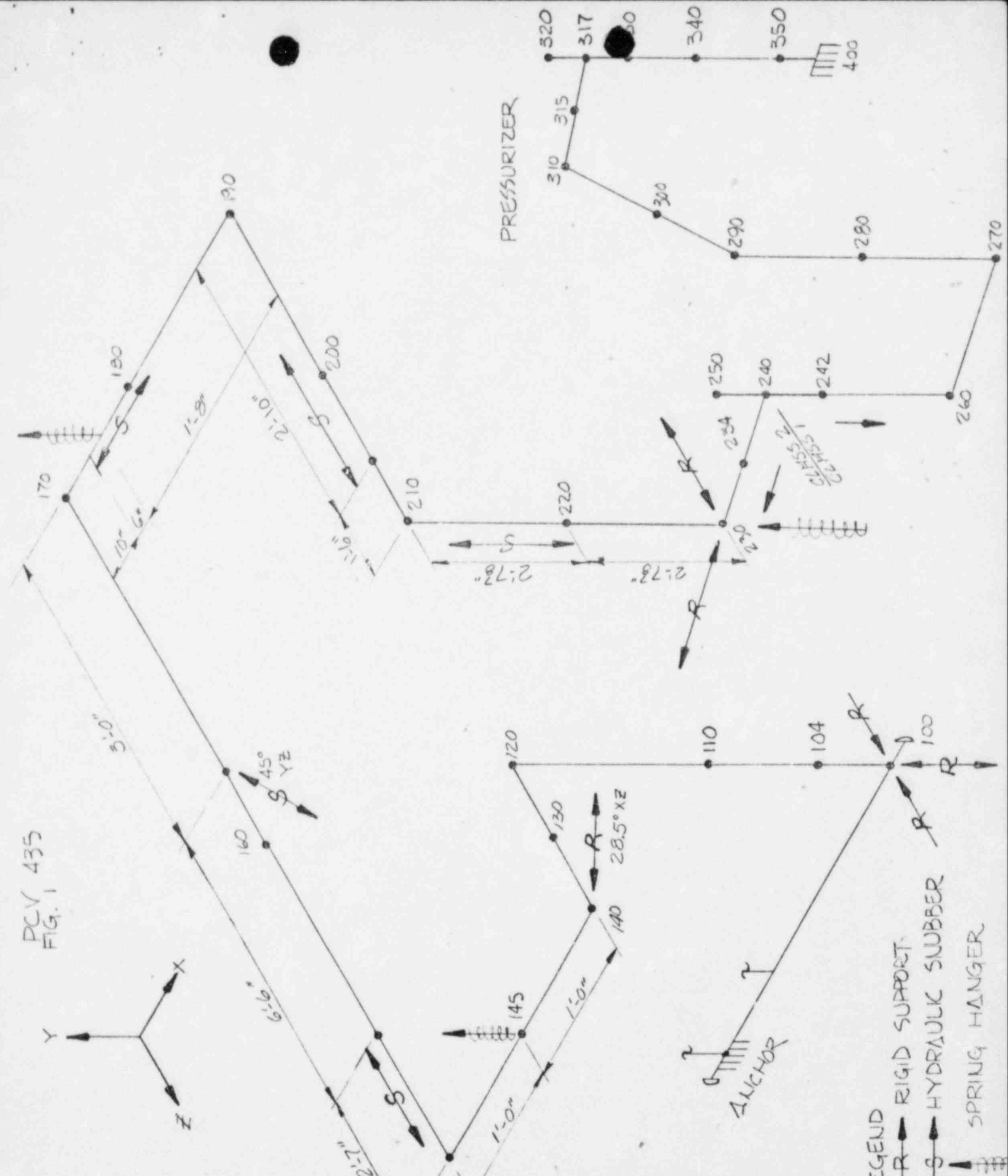
Answer: The Figure 3 shows the maximum stress from the time history analysis for the PCV 435 (FIGURE 1).
The Figure 4 shows the maximum stress from the time history analysis for the PCV 434 (FIGURE 2).

Question: Furnish the plots of the time history displacements for each line at or near the most highly stressed point.

Answer: The figures 5, 6, and 7 show the time history displacements in X, Y, and Z directions for line PCV 435 (FIGURE 1).
The Figures 8, 9, and 10 show the time history displacements in X, Y, and Z directions for line PCV 434 (FIGURE 2).



ROCHESTER GAS & ELECTRIC CORP. ROCHESTER, NEW YORK	GINNA STA. PCV- 434	DRAWN A.V.3	APP'D
		APP'D	
		SCALE	No. 01321-39



ROCHESTER GAS & ELECTRIC CORP. ROCHESTER, NEW YORK	GINNA STATION PCV- 435	DRAWN H.V.	APP'D
		APP'D	
		SCALE	No. 03021-38

Question: How are the stresses combined?

Answer: The stresses due to deadweight, pressure, seismic and time history dynamic analyses are calculated separately. It is conservatively assumed that the maximum stress around the pipe circumference occurs at the same point for all load cases considered. These stresses are added absolutely and compared with the code allowable stress limit of $1.2 \times S_a$, where S_a = stress allowable.

Question: Describe the method used in the time history analysis.

Answer: FIGURES 1 and 2 show the lumped mass mathematical model used in the time history analysis. Support and restraints are represented as springs in the model.
The time history dynamic solution employs the following computer codes. A brief description of the function of each code is also provided.

- WESTDYN: Normal mode solution (ω, Φ)
- FLASH: Calculates the time history transient hydraulic forces in the system.
- FIXFM: Calculates the dynamic time history displacements at each mass point in the system using the time history hydraulic forces.
- WESDYN-2: Time history dynamic displacements are applied as external boundary conditions to evaluate the piping forces and stresses at all node points in the system (not only mass points). Time history forces in supports and piping restraints are also calculated.

Question: Which mode contributes most to the highest stresses point in the system?

Answer: Although the time history analysis employs modal coordinates in solving the equations of motion, the individual modal contributions are not saved but immediately combined to provide the total

response for all modes. We, therefore, cannot ascertain which mode contributes most significantly to the maximum stress.

Question: List a few fundamental frequencies for the dynamic analysis.

Answer: Tables 1 and 2 show the fundamental frequencies and their predominant direction of motion.

TABLE 1

PCV 435 (FIGURE 1)

Frequency cps	Predominant Direction of Motion
23.19	Z
23.22	X
23.51	Y
29.97	Y
30.84	X
36.91	Y
43.75	X
46.75	Z
54.48	Y
61.59	Z

TABLE 2

PCV 434 (FIGURE 2)

16.81	Y
29.72	X
29.78	Z
33.44	X
39.99	Y
41.03	X
51.87	Y
58.17	Z
79.24	Y
81.67	X

Question: Prepare a combined stress summary table including the node points representing elbows and straight runs.

Answer: Tables 3 and 4 show the stress summary for the combined load cases.

S_E = Thermal Expansion Stress, KSI

S_D = Deadweight Stress, KSI

S_P = Pressure Stress, KSI

S_T = Thrust Forces Stress, KSI

S_S = Seismic Stress, KSI

$S = S_D + S_P + S_T + S_S$, KSI

CLASS I MATERIAL - SA 376 Stainless Grade 316

(1) B31.1 Allowable Stress - Sustained Mechanical Load

$S_a = 1.2 \times S_H$

$= 1.2 \times 17.05 = 20.45$ ksi

$S = S_D + S_p + S_T + S_S$

$S_a > S$

(2) B31.1 Allowable Expansion Stress

$S_a = f\ (1.25\ S_c + 0.25\ S_h)$

$= 1\ (1.25 \times 18.75) + (0.25 \times 17.05)$

$= 27.66$ ksi

$S_a > S_E$

f = Stress range reduction factor for cyclic conditions

S_H = Allowable stress of material at maximum hot temperature

S_c = Allowable stress of material at ambient temperature

CLASS II MATERIAL - SA 106B Carbon Steel

(1) B31.1 Allowable Stress - Sustained Mechanical Load

$S_a = 1.2 \times S_H$

$= 1.2\ (15.0)$

$= 18.0$ ksi

$S_a > S$

(2) B31.1 Allowable Expansion Stress

$S_a = F\ (1.25\ S_c + 0.25\ S_h)$

$= (1)\ (1.25\ [15] + 0.25\ [15]\ )$

$= 22.5$ ksi

$S_a > S_E$

TABLE 3

PCV 435 (FIGURE 1)

Node Point	S_E ksi	S_D ksi	S_P ksi	S_T ksi	S_S ksi	S ksi
104	3.65	0.31	3.1	0.27	0.24	3.92
110	2.24	0.41	3.1	0.15	0.17	3.83
120	2.98	1.28	3.1	1.07	0.32	5.77
130	3.32	0.21	3.1	0.17	0.10	3.58
150	7.98	1.77	3.1	0.46	0.38	5.71
160	1.36	0.89	3.1	0.59	0.32	4.90
170	6.61	0.58	3.1	0.46	0.36	4.50
180	4.27	0.17	3.1	0.58	0.18	4.03
190	5.74	1.18	3.1	1.16	0.43	5.87
200	4.02	0.36	3.1	0.32	0.07	3.85
210	6.65	2.05	3.1	1.12	0.30	6.57
220	2.42	1.0	3.1	0.63	0.26	4.99
230	2.75	1.91	3.1	1.84	0.52	7.37
234	2.56	2.5	3.1	2.62	0.77	8.99
242	20.48	0.41	3.1	0.43	0.16	4.10
260	24.10	0.28	3.1	1.24	0.11	4.73
270	22.82	0.26	3.1	1.06	0.06	4.48
280	8.41	0.31	3.1	0.53	0.13	4.07
290	10.39	0.22	3.1	0.74	0.22	4.28
300	10.85	0.32	3.1	0.77	0.07	4.26
310	10.48	0.62	3.1	0.88	0.20	4.80
315	17.69	1.42	3.1	1.89	0.28	6.69

CLASS 2 CARBON STL (nodes 104–234)

CLASS 1 SS316 (nodes 242–315)

TABLE 4

PCV 434 (FIGURE 2)

Node Point	S_E ksi	S_D ksi	S_P ksi	S_T ksi	S_S ksi	S ksi
103	3.87	0.36	3.1	0.18	0.33	3.97
110	2.76	0.56	3.1	0.29	0.23	4.18
120	8.38	1.93	3.1	0.85	0.54	6.42
140	5.60	0.45	3.1	0.63	0.24	4.42
150	7.28	0.57	3.1	0.45	0.34	4.46
160	4.29	0.19	3.1	0.61	0.61	4.51
170	9.73	0.56	3.1	0.92	0.16	4.74
180	6.17	0.51	3.1	0.24	0.32	4.17
190	8.71	1.50	3.1	0.86	0.99	6.45
200	2.63	0.57	3.1	0.58	0.11	4.36
210	3.00	0.61	3.1	0.90	0.26	4.87
223	19.03	0.49	3.1	0.65	0.22	4.46
240	23.42	0.36	3.1	0.50	0.14	4.10
250	24.78	0.26	3.1	0.44	0.11	3.91
260	8.19	0.54	3.1	0.35	0.10	4.09
270	13.36	0.82	3.1	0.35	0.09	4.36
280	14.85	0.61	3.1	0.55	0.17	4.43
286	22.83	0.77	3.1	2.4	0.33	6.60

CLASS 2 CARBON STEEL

CLASS 1 SS316

Figure 3
PVC 435
Point 234

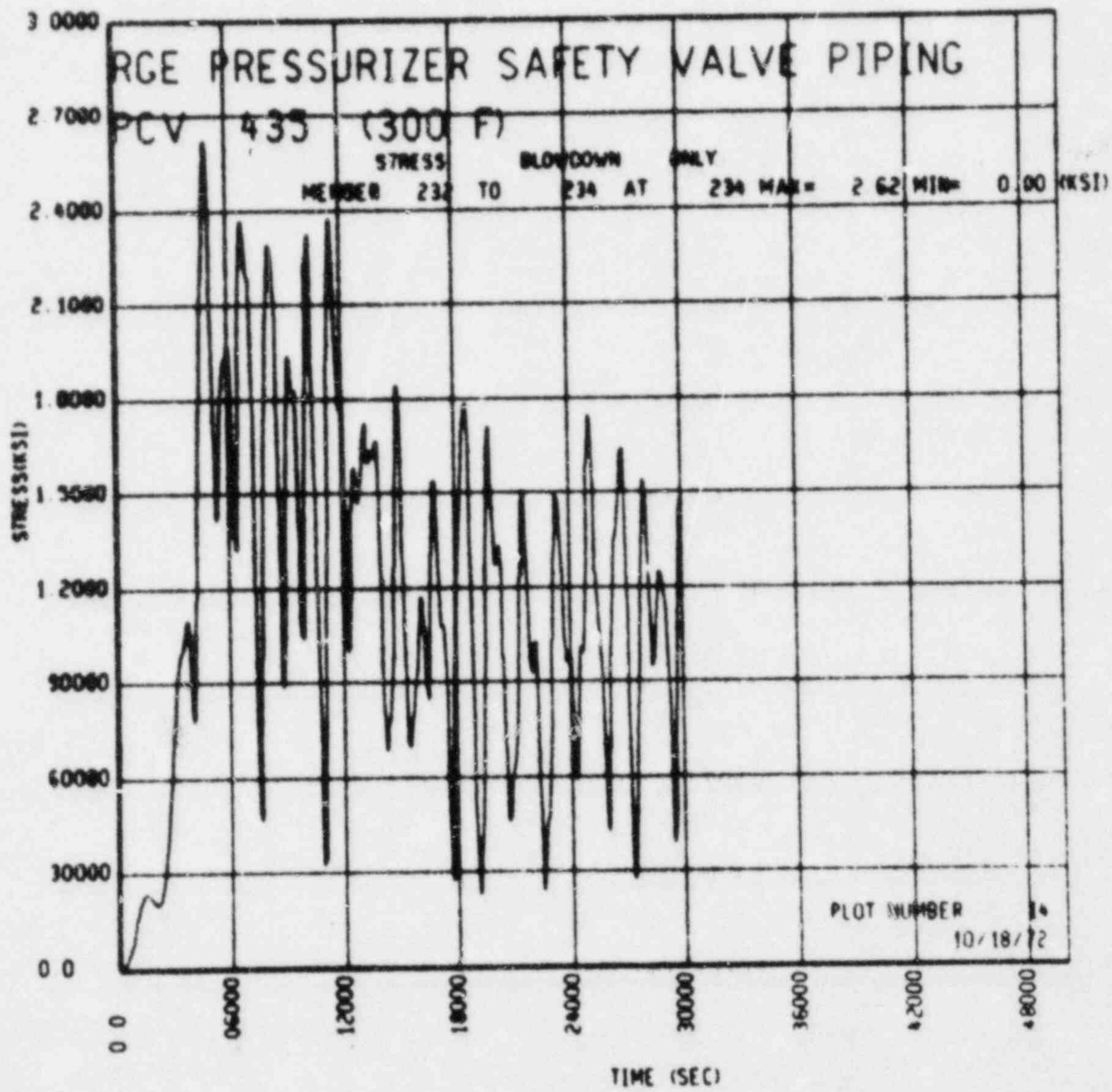


Figure 4
PCV 434
Point 288

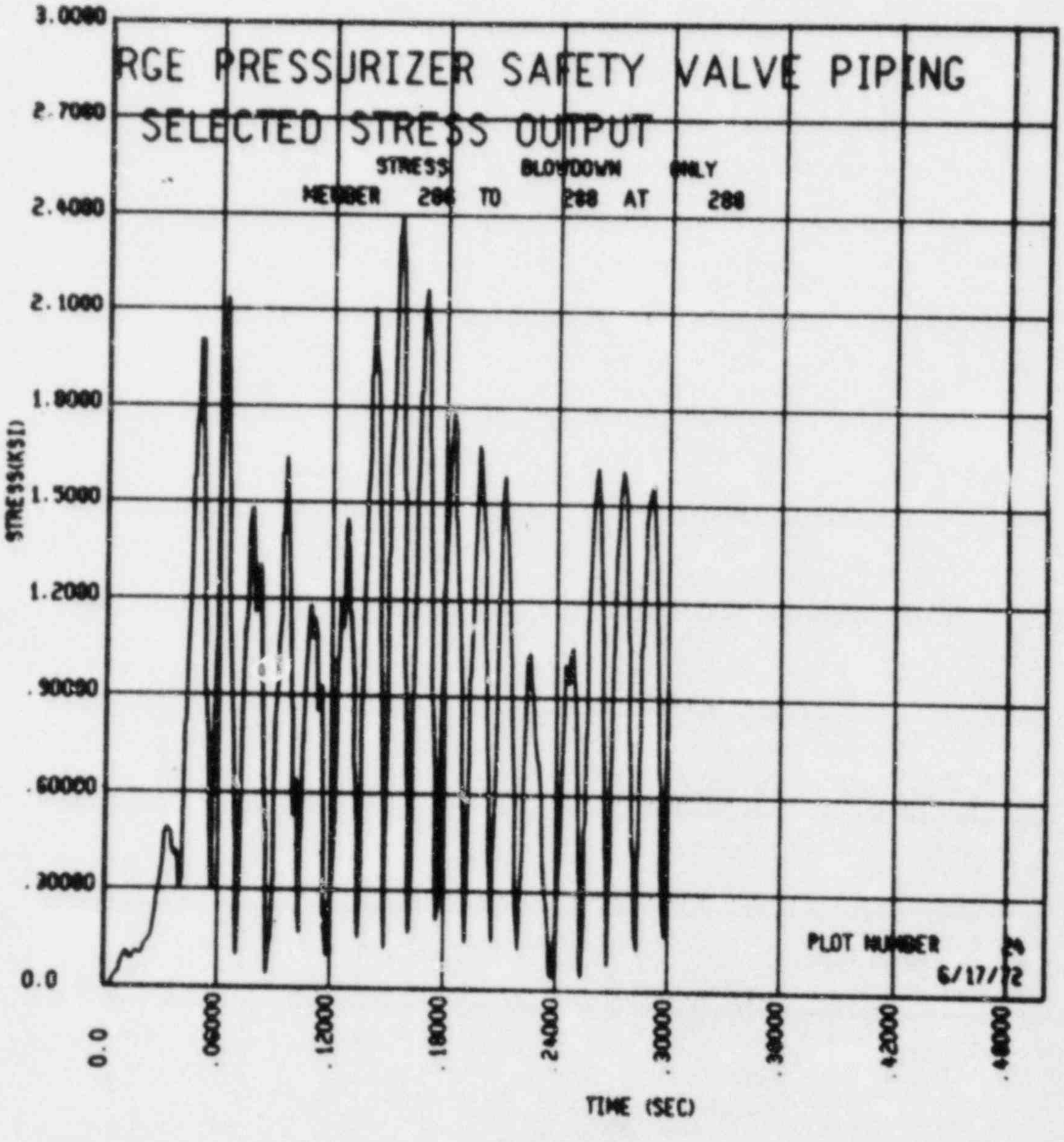


Figure 5
PCV 435
Point 240

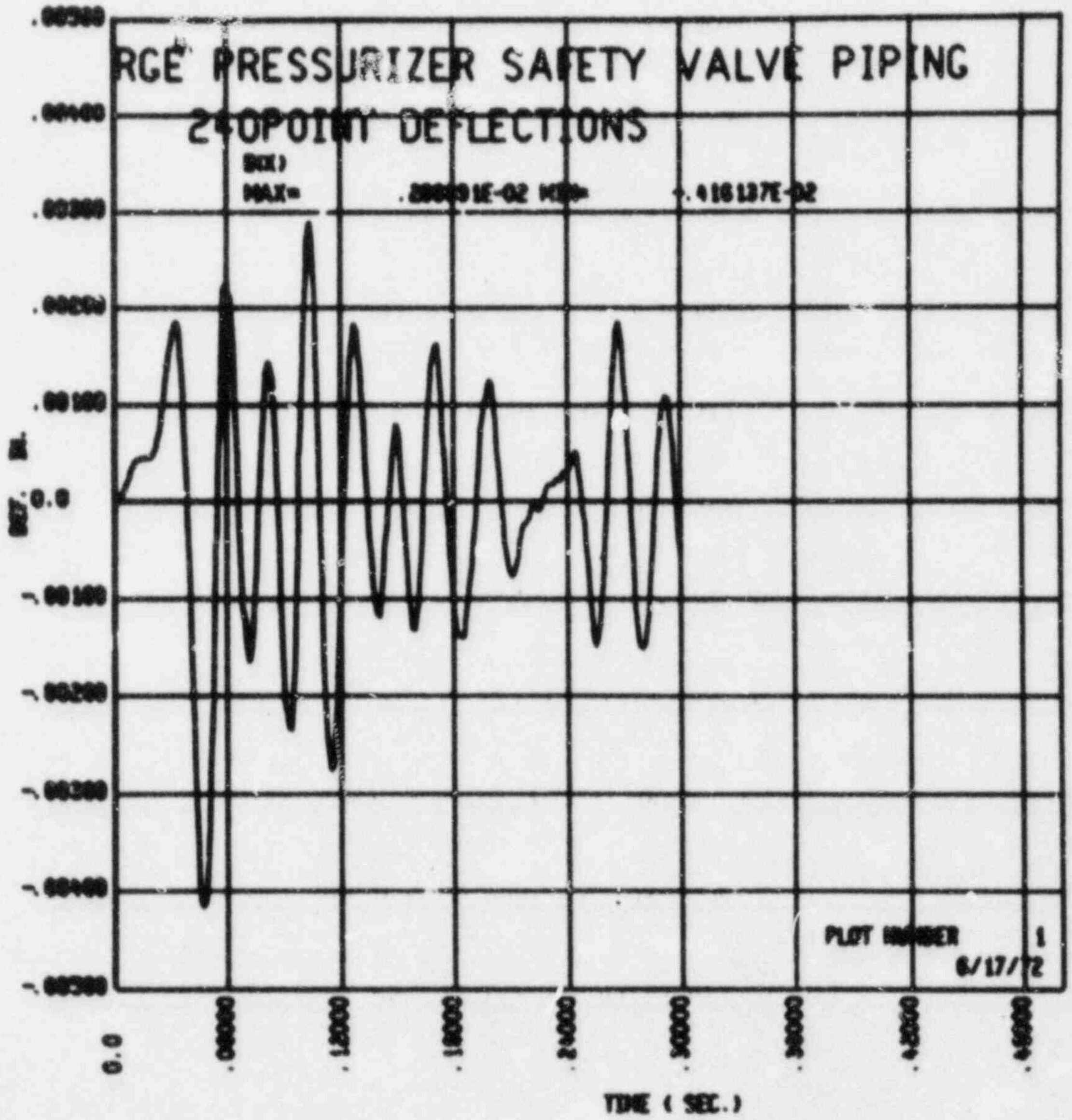


Figure 6
PCV 435
Point 240

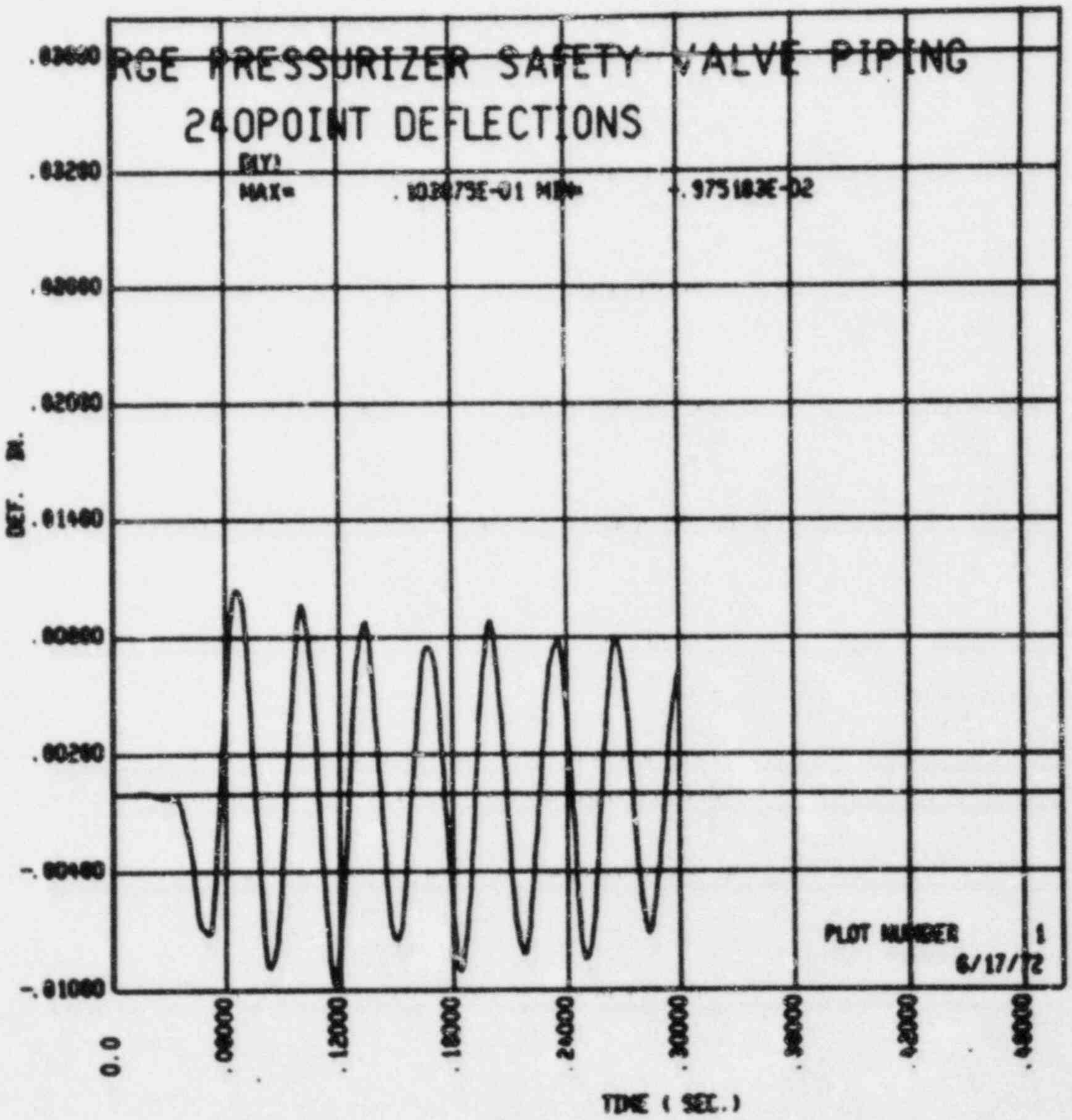


Figure 7
PCV 435
Point 240

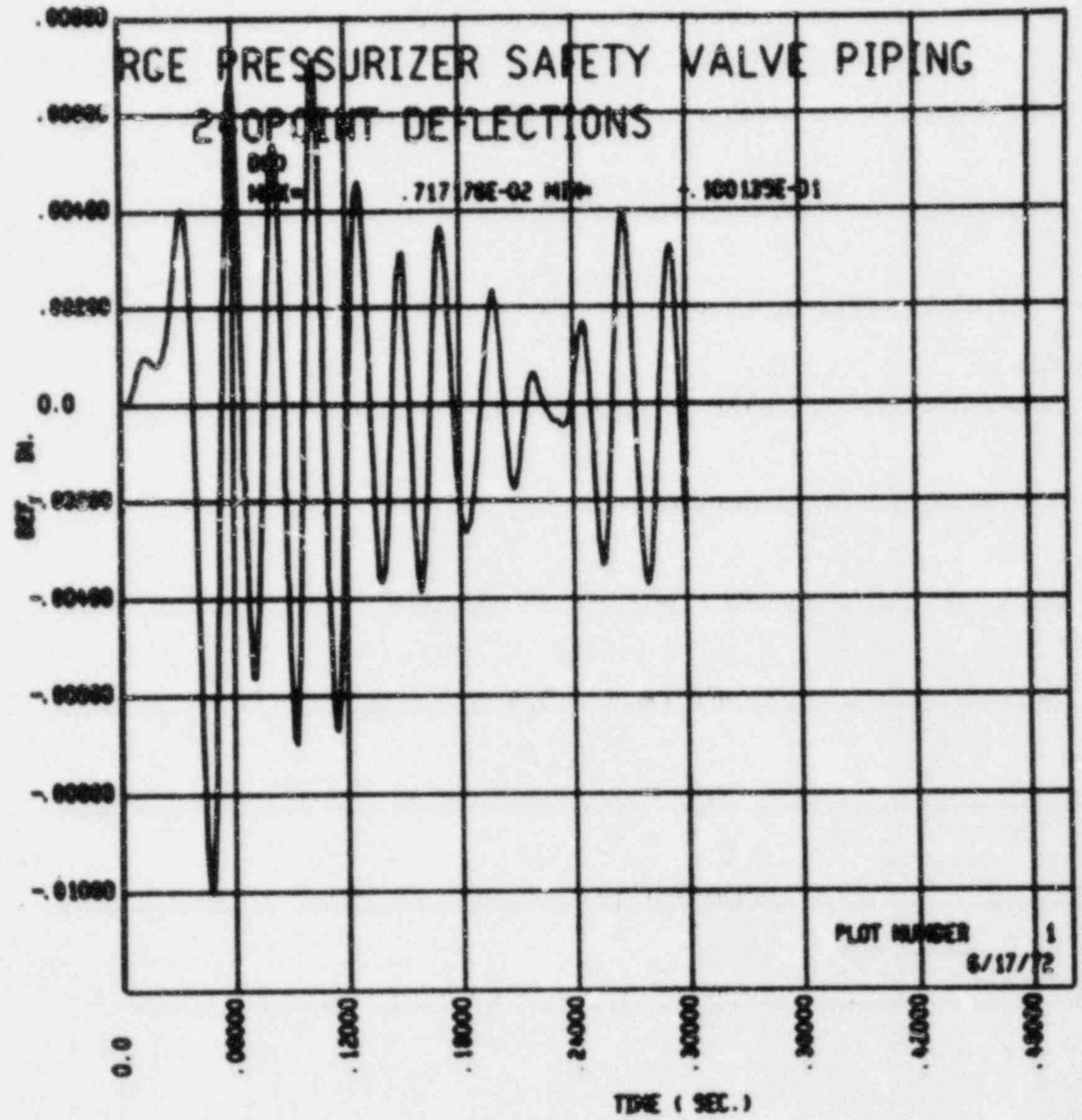


Figure 8
PCV 434
Point 280

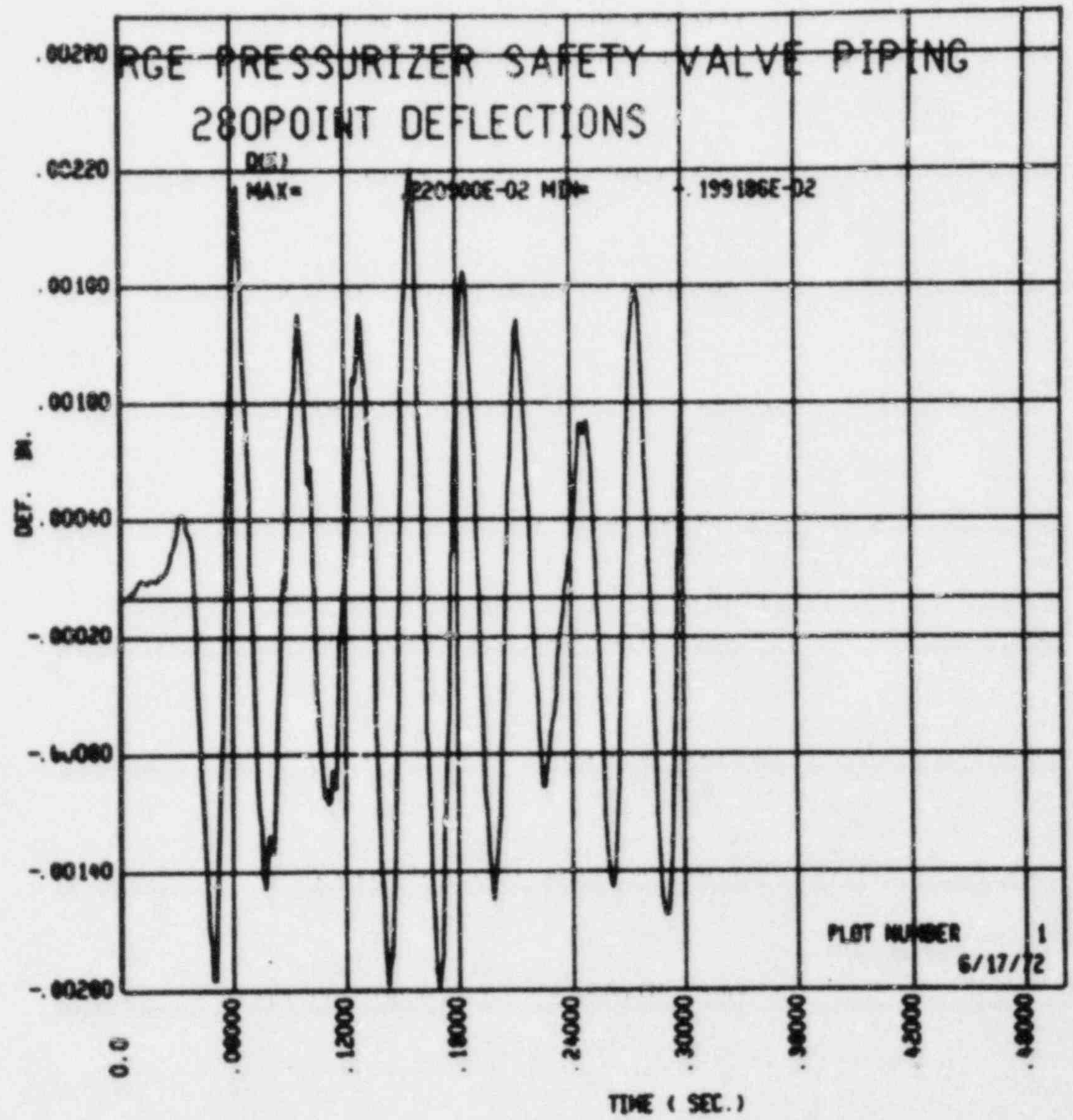


Figure 9
PCV 434
Point 280

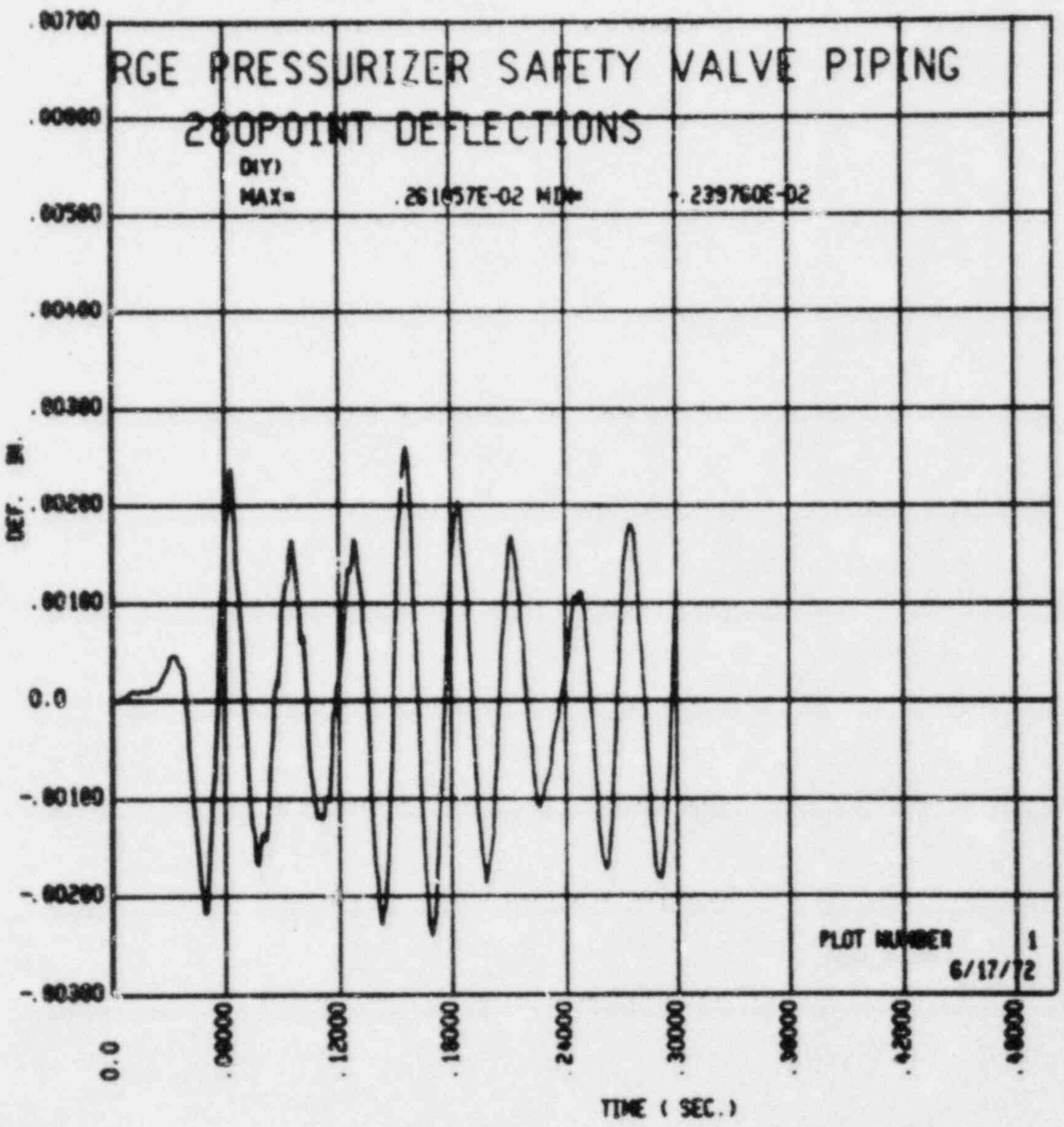


Figure 10
PCV 434
Point 280