MASTER

LOFT TECHNICAL REPORT LTR 115-38
RE & C REPORT NUMBER RE-A-78-015
FEBRUARY 14, 1978

ANALYSIS OF LOFT STEAM GENERATOR MAIN FEED PIPING LOOP SEAL MODIFICATION

M. E. Nitzel

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

IDAHO OPERATIONS OFFICE UNDER CONTRACT EY-76-C-07-1570

FORM EG&G-1916
(Rev. 6-77)

LOFT TECHNICAL REPORT LTR 115-38
RE&C Report # RE-A-78-015
DATE February 14, 1978
WORK REQUEST NO. ______

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE. It has been reproduced from the best available copy to permit the broadest possible availability.

RESEARCH, ENGINEERING AND CONSTRUCTION REPORT
ENGINEERING ANALYSIS DIVISION

APPLIED MECHANICS BRANCH

ANALYSIS OF LOFT STEAM GENERATOR MAIN FEED PIPING LOOP SEAL MODIFICATION

M. E. Nitzel/
AUTHOR

CHECKED BY: J. W. Muffett/ APPROVED BY: C. A. Moore/ 1/23/78

[redacted]

cc: S. M. Gardner (3)
J. G. Arendts
C. A. Moore
J. W. Muffett
M. E. Nitzel
AM Branch (5)

EG&G Idaho, Inc.

LOFT TECHNICAL REPORT
LOFT PROGRAM

FORM EG&G-229
(Rev. 12-76)

TITLE: ANALYSIS OF LOFT STEAM GENERATOR MAIN FEED PIPING LOOP SEAL MODIFICATION	REPORT NO. LTR 115-38
	RE-A-78-015
AUTHOR: M. E. Nitzel	GWA NO.
PERFORMING ORGANIZATION: Applied Mechanics Branch	DATE
LOFT APPROVAL: D H Stevenson; PSB Mgr.; P&CSB Mgr.; RSB Mgr	February 14, 1978

ABSTRACT

This report describes the stress analysis of the proposed loop seal modification to the LOFT Steam Generator Main Feed Piping. The SAP IV finite element computer program was used to analyze normal, upset, emergency, and faulted conditions. Results of the analysis indicate that the modified main feed piping system will satisfy all structural adequacy criteria specified in Subarticle NC-3650 of the ASME Boiler and Pressure Vessel Code. Results also show that the isolation snubber configuration, specified in LTR 115-11, will also be adequate for the piping configuration analyzed in this report.

CONTENTS

TABLES

FIGURES

ANALYSIS OF LOFT STEAM GENERATOR MAIN FEED PIPING LOOP SEAL MODIFICATION

I. INTRODUCTION

The LOFT Steam Generator Main Feed Piping has been previously analyzed as reported in LTR 115-11[1]. Subsequently, it was determined that the possibility for water hammer existed and that some type of seal or trap was necessary to prevent steam from entering the main feed line. The purpose of this report is to describe the analysis of the modification made to the main feed piping to facilitate the steam seal or trap.

The main feed piping was designed as specified in SDD 1.1.5 B[2] and the current configuration is as shown in Aerojet Nuclear Company Drawing 204259, Revision H. The material used in the piping is ASTM A106, Grade B. Design temperature and pressure is 600°F and 1100 psi while operating temperature and pressure is 407°F and 900 psi, respectively.

The seal configuration consists of adding a loop to the six-inch main feed line such that a liquid "seal" would prevent steam entrance into the line. A one-half inch drain line was added at the bottom of the loop. A finite element model of the affected portion of the main feed piping was developed and is shown in Figure 1. The response spectra analysis option of the SAP IV[3] computer program was used to analyze for normal, upset, emergency, and faulted conditions. Stress limits, as specified by Subarticle NC-3650 of the ASME Boiler and Pressure Vessel Code[4] (hereafter referred to as "the Code"), were used throughout this analysis.

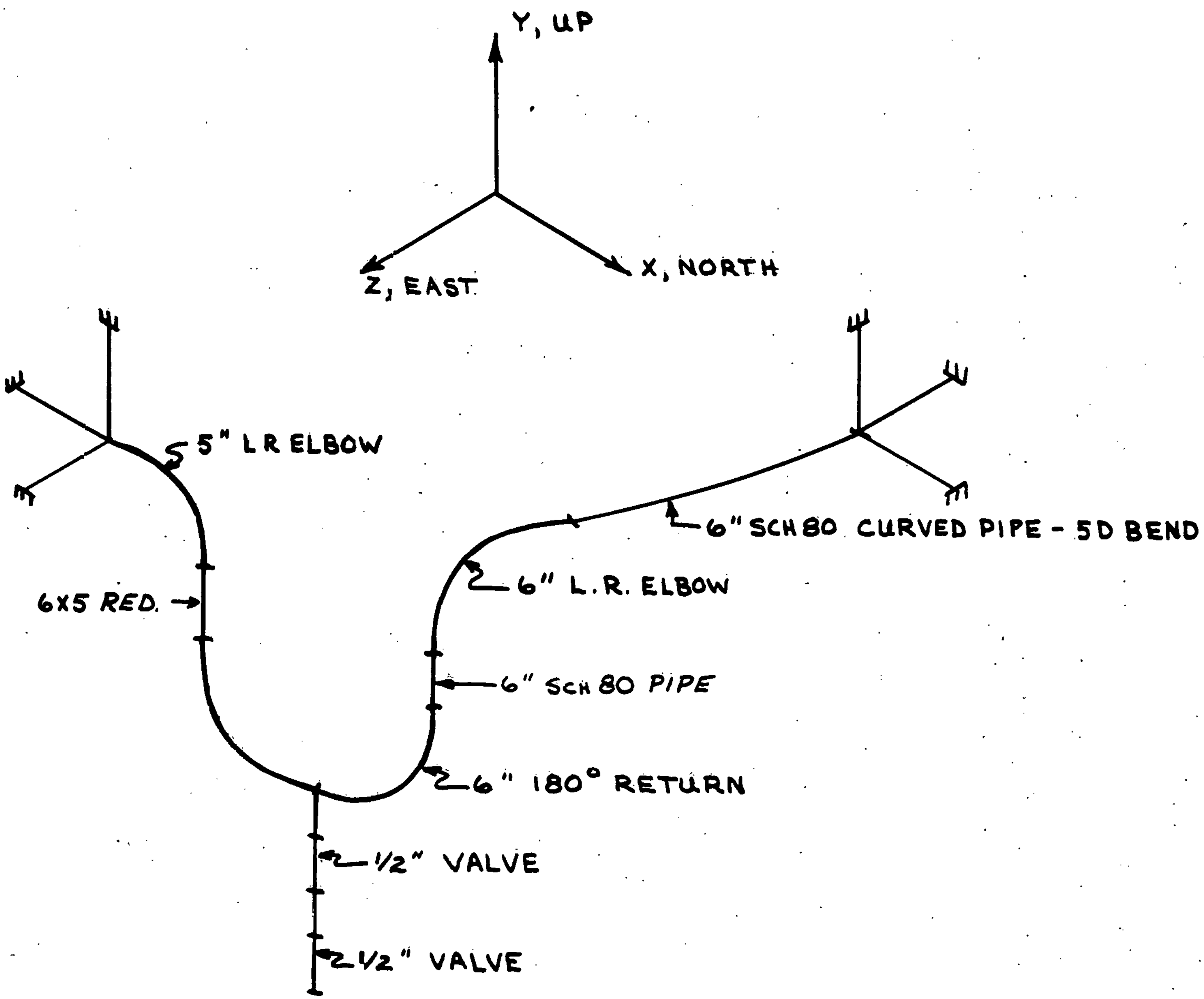


Figure 1

LOFT STEAM GENERATOR MAIN FEED- LOOP SEAL MODIFICATION

II. ANALYSIS

1. STRUCTURAL ADEQUACY CRITERIA

Subarticle NC-3650 of the ASME Code[4] defines allowable stresses to be used in the analysis of Class 2 piping. Stress equations are given for sustained loads, occasional loads, and thermal expansion in Subparagraphs NC-3652.1, NC-3652.2, and NC-3652.3, respectively. The guidelines set forth in these subparagraphs were followed throughout this analysis.

2. MATERIAL PROPERTIES AND ALLOWABLES

The six-inch, Schedule 80 main feed piping is constructed of SA-106, Grade B, carbon steel. The fittings which comprise the seal loop are specified to be constructed of SA-234 carbon steel. The properties of SA-106, Grade B, carbon steel were used for all piping components throughout this analysis. This procedure was used to simplify computer program input and to insure conservatism since the material allowables of SA-106, Grade B, carbon steel are lower than the values of the other specified material. The material properties used were taken from Reference 5 and are shown below:

PROPERTY	TEMPERATURE (^oF)			
	100	200	400	600
E (psi)	27,860,000	27,700,000	27,000,000	25,700,000
α (in./in./^oF)	$6.13(10^{-6})$	$6.38(10^{-6})$	$6.82(10^{-6})$	$7.23(10^{-6})$
ν	.30	.30	.30	.30
S (psi)	15,000	15,000	15,000	15,000

3. ASME CODE ANALYSIS

To complete the analysis of the main feed loop seal piping, the following load cases were considered:

1. Deadweight
2. Thermal Expansion
3. Loss-of-Coolant Experiment (LOCE)
4. Safe Shutdown Earthquake (SSE)
5. Loss-of-Coolant Accident (LOCA)
6. Anchor Movements.

The SAP IV finite element model, described in Figure 1 of the Reference 1 report, was modified to include the seal loop. This model was then used to analyze the deadweight and thermal expansion loading cases. It should be noted that the deadweight and thermal expansion computer runs used in this report were made using a preliminary piping configuration in which the seal loop was constructed using two six-inch elbows and a six-inch 180 degree return instead of the components comprising the final configuration shown in Figure 1 of this report. The deadweight case was not rerun with the final configuration because the weight difference of the components was approximately six pounds - which is negligible in comparison to the overall weight of the system. For the deadweight run, the one-half-inch drain line was taken into account by applying a nodal load, equal to the drain piping weight, at the appropriate node. The thermal expansion load case was not rerun since the preliminary configuration was less flexible than the final configuration. Thus, the preliminary configuration would yield conservative results when compared to the final configuration for the thermal expansion load case and essentially the same results for the deadweight case. A plot of the model used for the deadweight and thermal expansion runs is shown in Figure A1, Appendix A, Page A1.

Figure 1, page 2, shows a simplified version of the SAP IV finite element model used to analyze the LOCE, SSE, LOCA, and anchor movement load cases. A more complete plot of this model showing the node and element numbering scheme may be found in Figure A2, Appendix A, page A2. It should also be noted that Appendix A includes sample input for static and dynamic SAP IV loading cases. The isolated main feed piping model, used for these loading cases, was completed using 11 pipe elements and 12 boundary elements. Boundary elements were used to simulate isolation snubber and steam generator anchor restraints and to input anchor movements. The hand operated valves, located in the one-half-inch drain, were modeled using valve weights of four pounds per valve. The centers of gravity of these valves were assumed to be at the pipe centerline. The response spectra analysis option of the SAP IV program was used with the response spectra shown in Figures 2 thru 4. The anchor movement runs were made using displacements of δx = 0.060 inch and δz = 0.177 inch.

Moment data, resulting from the previously mentioned computer runs, was tabulated and resultant moments were calculated for use in the ASME Code Class 2 piping equations. This data may be found in Appendix B. The complete ASME Code evaluation, per the requirements of Subarticle NC-3650, may be found in Appendix C.

Microfiche copies of all computer output and a source listing of the version of SAP IV used may be found in Appendix D.

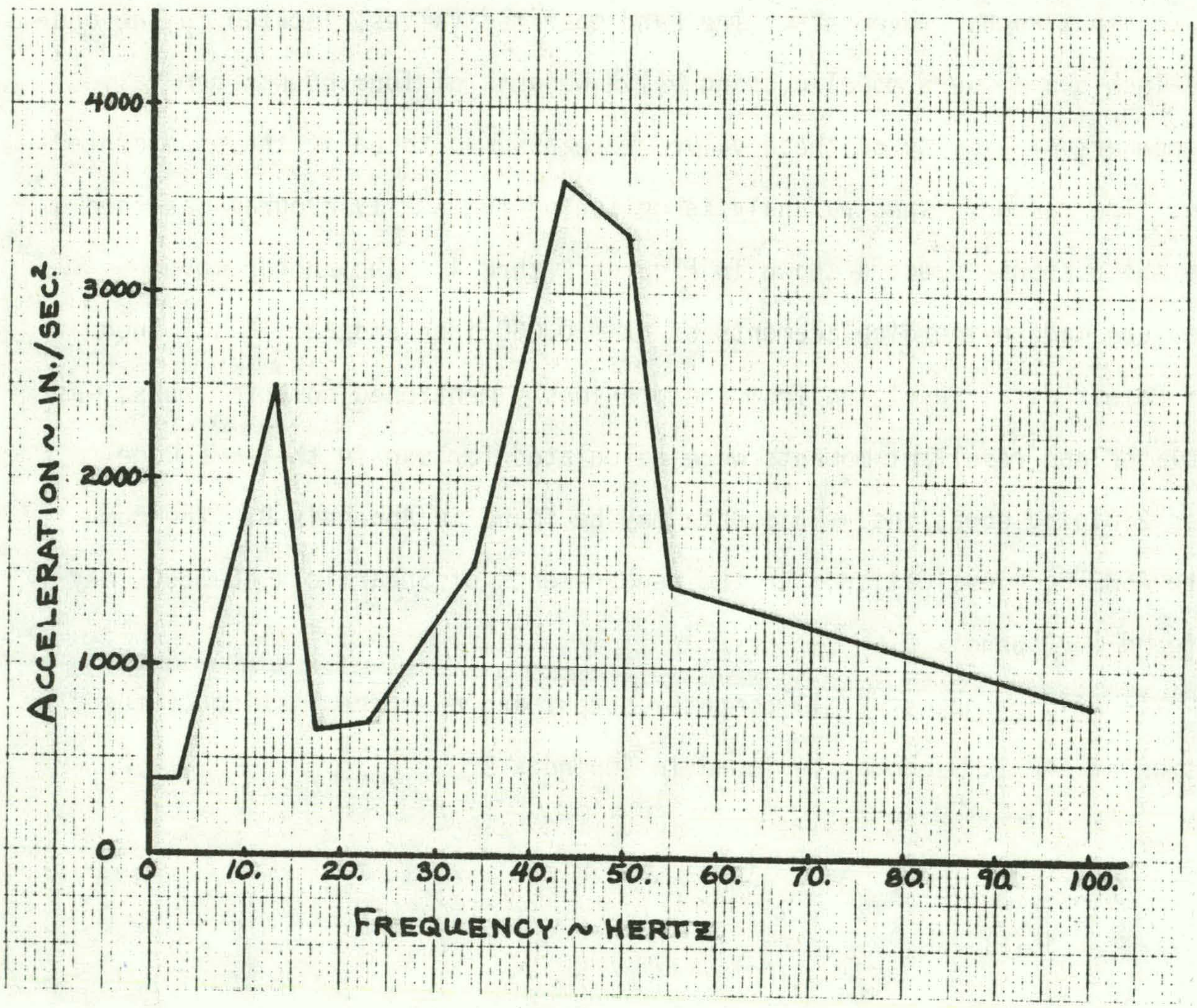


Figure 2

LOCE RESPONSE SPECTRUM ENVELOPE CURVE - 1% DAMPING

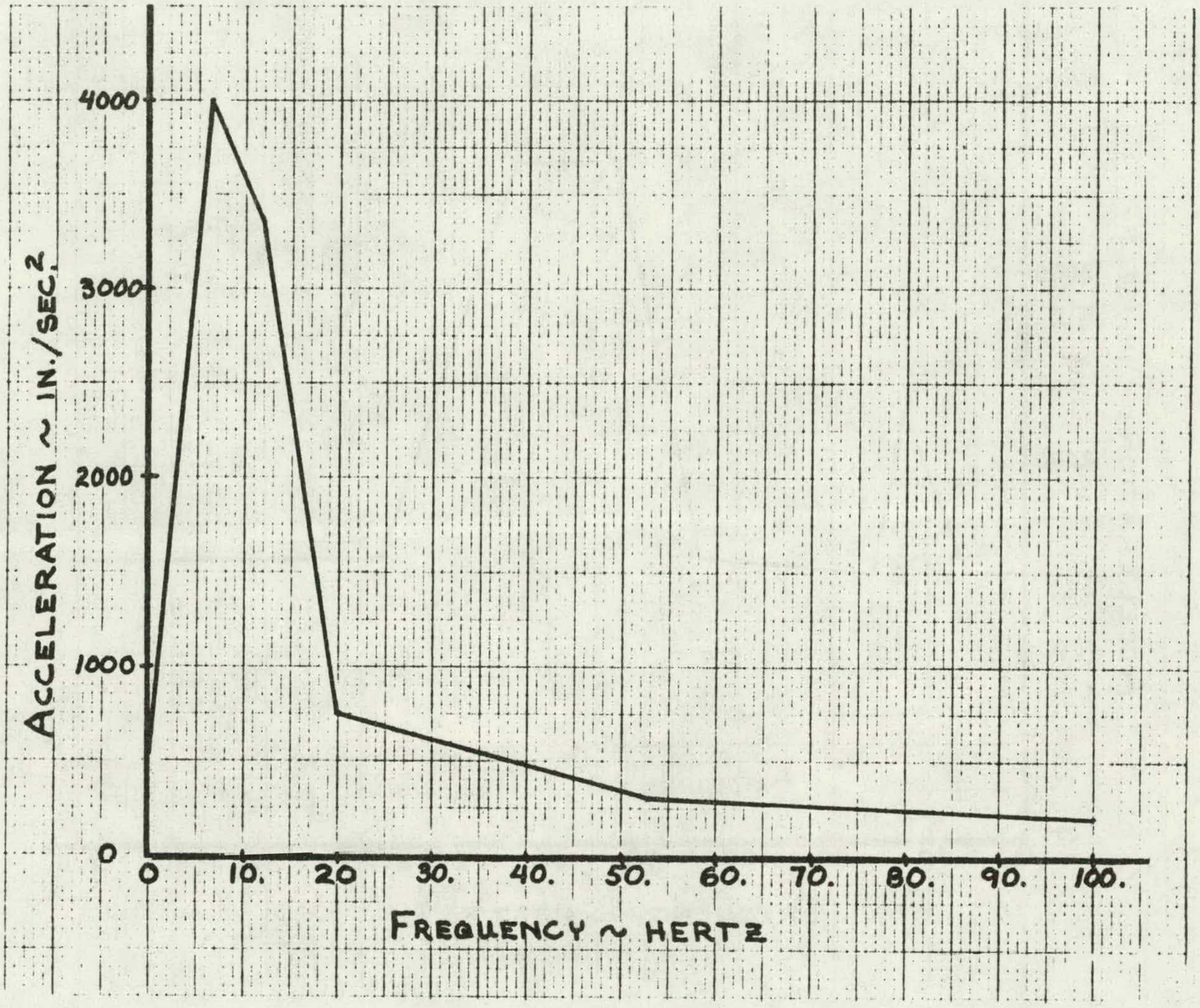


Figure 3

SSE SEISMIC RESPONSE SPECTRUM ENVELOPE CURVE - 1% DAMPING

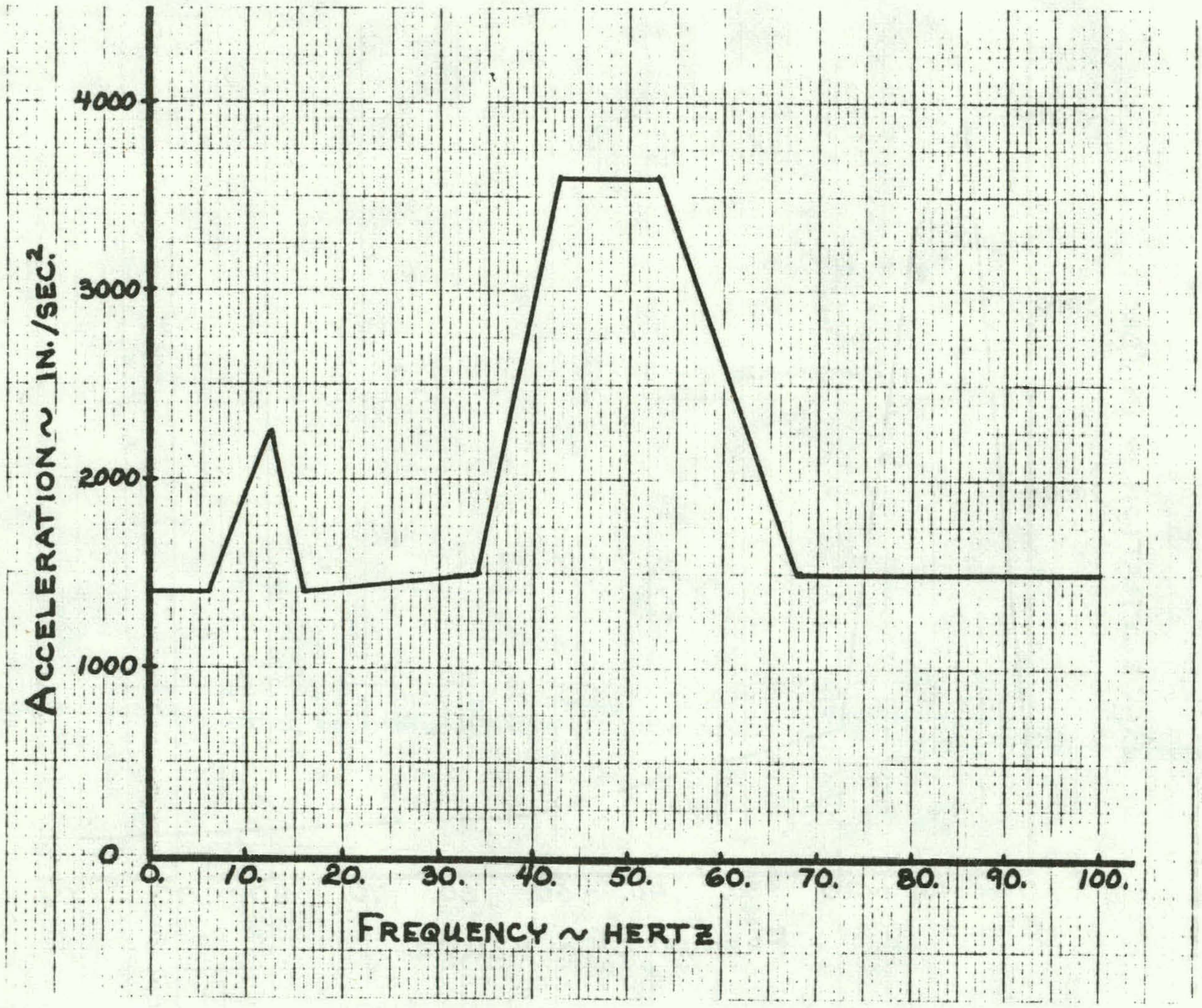


Figure 4

LOCA RESPONSE SPECTRUM ENVELOPE CURVE - 1% DAMPING

III. RESULTS

The maximum allowable moment method was used as described in Appendix C to evaluate the structural adequacy of the loop seal addition to the main feed piping. The results of this analysis are tabulated in Table I.

TABLE I

LOFT STEAM GENERATOR MAIN FEED LOOP SEAL ADDITION PIPING MAXIMUM MOMENTS

PIPE SIZE	LOAD	MAX. ALLOWABLE MOMENT (IN-LB)	MAX. MOMENT (IN-LB)
6" SCH 80	DEADWEIGHT	121497	31055
5" SCH 80	"	74883	32000
½" SCH 80	"	695	0
6" SCH 80	LOCE	121866	7713
5" SCH 80	"	62042	5093
½" SCH 80	"	842	520
6" SCH 80	SSE	216205	2610
5" SCH 80	"	119519	1730
½" SCH 80	"	1283	281
6" SCH 80	LOCA + SSE	310545	12693
5" SCH 80	" "	176996	8384
½" SCH 80	" "	1724	859
6" SCH 80	THERMAL EX.	244745	157217
5" SCH 80	+ Z DIR.	139931	86784
½" SCH 80	ANCHOR DISP.	1348	0
6" SCH 80	T.E. + X DIR.	244745	33372
5" SCH 80	ANCHOR	139931	31108
½" SCH 80	DISPLACEMENT	1348	0

IV. CONCLUSIONS

The results of the analysis described in the preceding pages warrant the following conclusions:

(1) The main feed loop seal piping, as shown in Figure 1 of this report, will meet all structural adequacy requirements as set forth in Subarticle NC-3650 of the ASME Code.

(2) The main feed line isolation snubbers, as specified in Reference 1, will be adequate for the piping configuration considered in this report.

V. REFERENCES

1. D. K. Morton, "LOFT Main Feed Piping System Stress Analysis", LOFT Technical Report LTR 115-11, June 17, 1976.

2. "LOFT Integral Test System Preliminary System Design Description for the Secondary Coolant System", SDD 1.1.5 B, May 1971.

3. K. J. Bathe, et al, "SAP IV, A Structural Analysis Program for Static and Dynamic Response of Linear Systems", Earthquake Engineering Research Center, Berkeley, California, June 1973.

4. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Division 1, "Nuclear Power Plant Components", Subsection NC, 1977 Edition plus Summer 1977 Addenda.

5. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Division 1, "Nuclear Power Plant Components", Subsection NA, 1977 Edition plus Summer 1977 Addenda.

Item No.	Description	Checked	Comment
1.0	Basic Design Data		
1.1	Does the system have a Design Specification? (Include name and number of Design Specification in report.)	✓	SDD 115B
1.2	Includes all branch lines where $I_R/I_B \leq 7.0$?	✓	
1.3	Are all materials specified correctly?	✓	
1.4	Check pipe size, thickness, and uniform weight.	✓	
1.5	Are all valves coded correctly? Are all motor or pneumatic operated valves specified with lumped wts and cgs?	✓	
1.6	Is the system modeled correctly? (Length ratios, etc.)	✓	
1.7	Are all hanger/restraints modeled correctly per the analytical drawing?	✓	
1.8	Are all "node codes" specified correctly?	✓	
1.9	Is the design temperature and pressure listed correct?	✓	
1.10	Is the Quality Group and Safety Category of the system correct?	✓	
1.11	Are elbows explicitly modeled?	✓	
2.0	Weight Analysis		
2.1	Verify uniform pipe wts.	✓	
2.2	Verify valve wts and cgs.	✓	
2.3	Verify all rigid and spring hanger locations and types against drawing.	✓	
2.4	Check stresses against allowables.	✓	
2.5	Check deflections.	✓	
2.6	For Hydro-run verify that all spring hangers were pinned (rigid).	✓	
2.7	Are branch connections correctly reinforced?	✓	

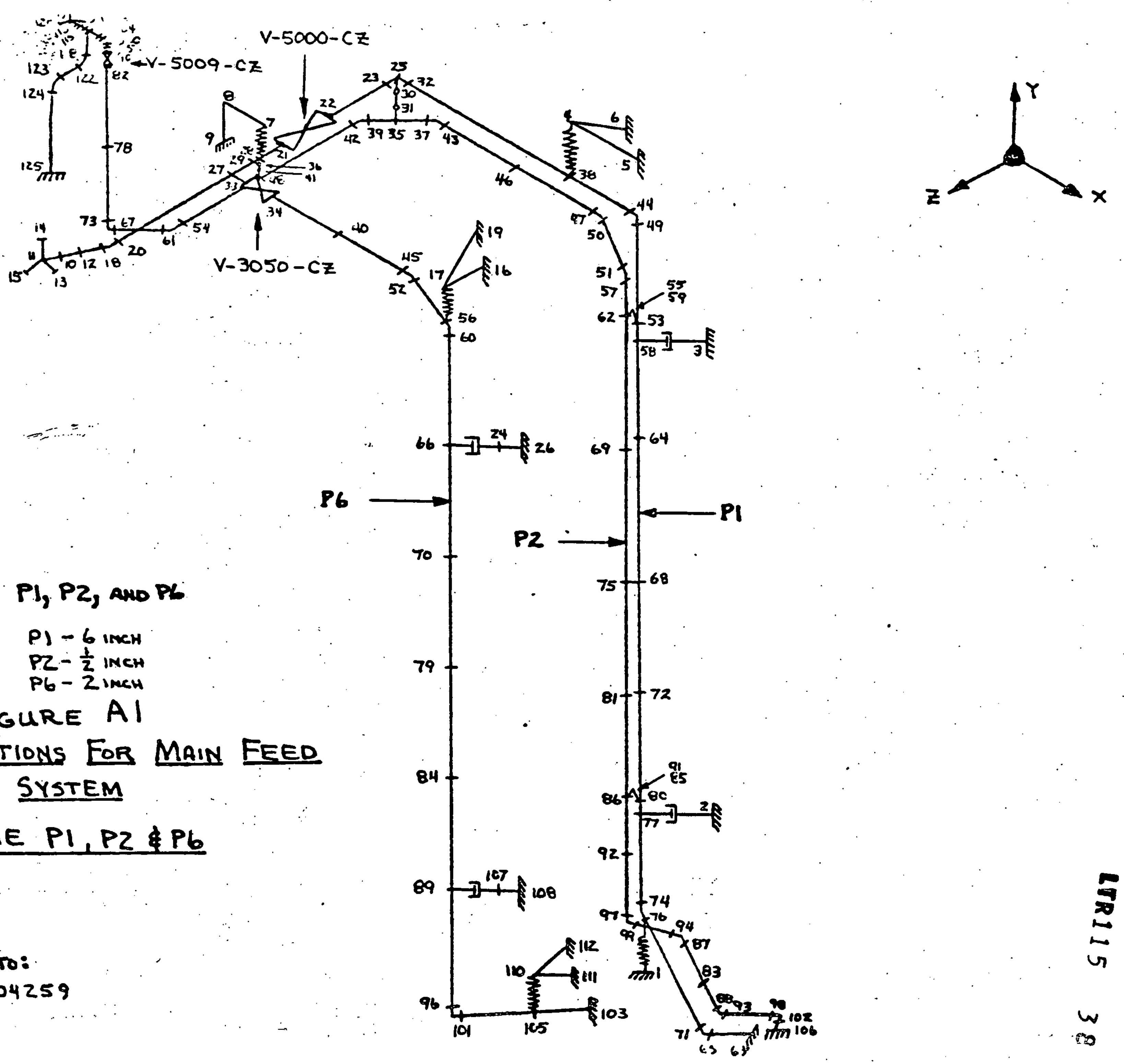
Item No.	Description	Checked	Comment
3.0	Thermal Analysis		
3.1	Do defined thermal modes agree with the analyticals and process flow diagrams?	✓	
3.2	Are the branch and run pipe temperatures specified correctly for all modes?	✓	
3.3	Are the anchor movements specified correctly for all modes?	✓	
3.4	Are all restraints coded correctly?	✓	
3.5	Are the thermal stresses acceptable?	✓	
3.6	Are equipment reactions acceptable?	✓	
4.0	Seismic Analysis		
4.1	Does the system have a seismic requirement?	✓	
4.2	Is the correct response spectra used?	✓	
4.3	Is the response spectra adequately identified?	✓	
4.4	Is the system correctly modeled for seismic analysis?	✓	
4.5	Correct length ratios?	✓	
4.6	Correct valve wts and cgs.	✓	
4.7	Correct snubber locations and directions?	✓	
4.8	Is equipment rigid?		
4.9	If equipment is flexible, is it modeled correctly?	✓	
4.10	Are seismic stresses acceptable?	✓	
4.11	Are equipment loads acceptable?	✓	
4.12	Were the seismic anchor movements acceptable?	✓	

Item No.	Description	Checked	Comment
5.0	Hydraulic Transient Analysis		
5.1	Were all required fluid transient problems considered? a. RV discharge b. Valve closure c. Valve opening d. Water hammer	✓	NONE SPECIFIED TO BE ANALYZED
5.2	Are all necessary design parameters specified in the report? (Opening/closing times, flow rates, etc.)		
5.3	Was the force calculation performed per the appropriate procedure?		
5.4	Was the force calculation submitted to your Group Leader?		
5.5	Was a dynamic or quasi-static analysis performed?		
5.6	Were the forces input correctly in the SAP program?		
5.7	Were the stresses acceptable?		
5.8	Were the equipment reactions included with the correct load set?		
6.0	Combined Stress		
6.1	Is the design pressure correct?	✓	
6.2	Is the material type correct?	✓	
6.3	Is the allowable stress for the correct material at the design temperature?	✓	
6.4	Are the number of earthquake cycles correct?	✓	
6.5	Are all thermal load combinations specified correctly?	✓	
6.6	Are all mechanical loads listed correctly as upset, emergency, or faulted?	✓	

Item No.	Description	Checked	Comment
6.7	Are all transient stresses identified and are the thermal transient runs properly documented?	✓	
6.8	Are all stresses and usage factors within allowables?	✓	
6.9	Were all high-stress/usage factor points run with the detailed output?	✓	
6.10	Were all special fittings (valve ends, branch connections, etc) run separately with the correct transient stresses?	✓	
6.11	Is the piping code used correct?	✓	
6.12	Were there any special considerations?	✓	
6.13	Are testing conditions considered?	✓	
7.0	Documentation		
7.1	Does the stress report define all loading conditions to be considered and explain what loads are considered to be acting concurrently?	✓	
7.2	Does the stress report explain the omission of any transient or the enveloping of transients with less severe conditions?	✓	
7.3	Does the report explain how analysis report can be traced?	✓	
7.4	Does the report explain retention of documentation (computer runs and analyses)?	✓	

APPENDIX A

SAP IV MODELS AND SAMPLE INPUT



LINES P1, P2, AND P6

P1 - 6 INCH
P2 - $\frac{1}{2}$ INCH
P6 - 2 INCH

FIGURE A1
NODE LOCATIONS FOR MAIN FEED SYSTEM

LINE P1, P2 & P6

REFER TO:
DWG. NO. 204259

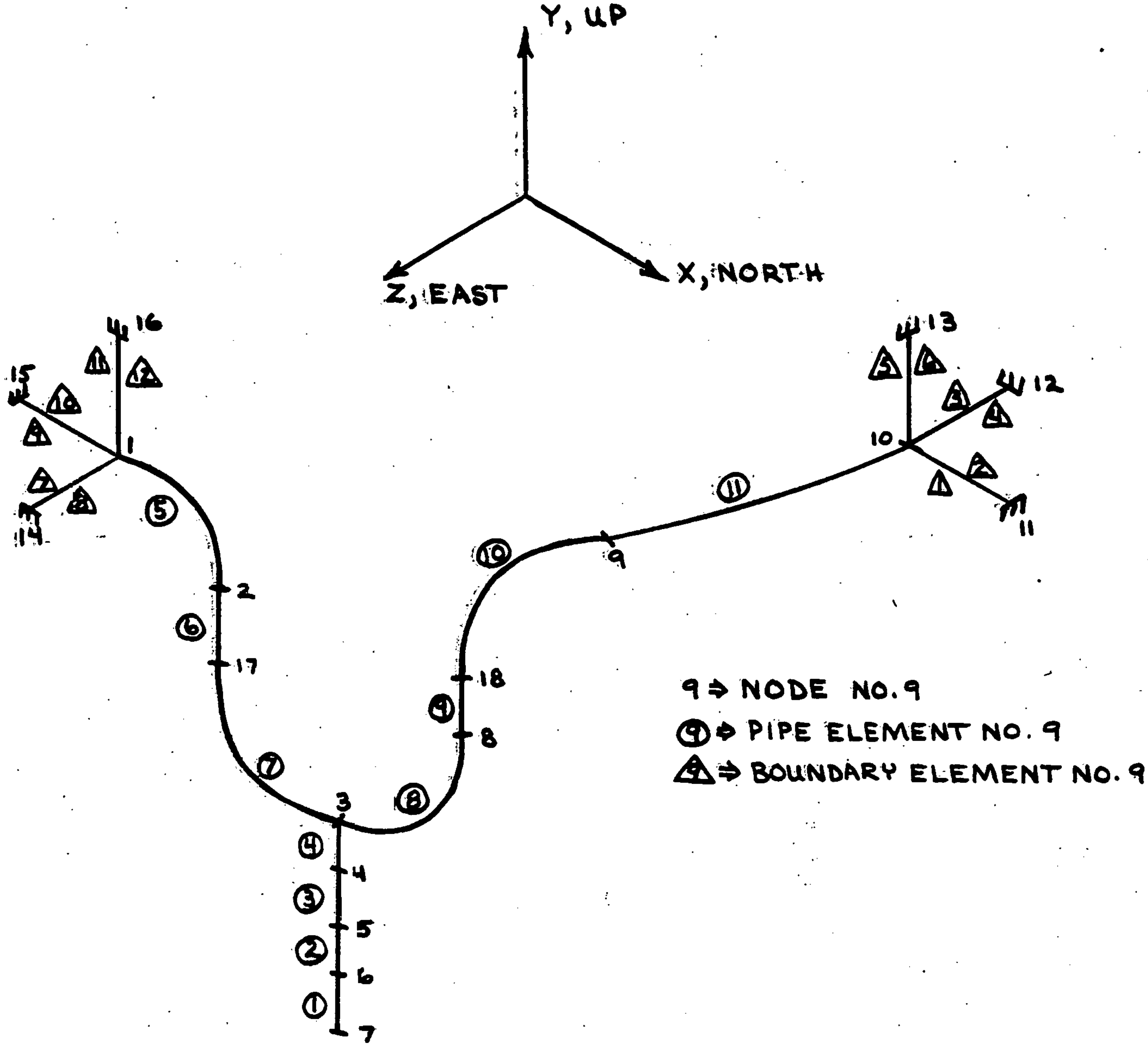


FIGURE A2
LOFT PRESSURIZER MAIN FEED- LOOP SEAL MODIFICATION

MAIN FEED LOOP SEAL MODIFICATION - D.W. AND THERMAL

C O N T R O L   I N F O R M A T I O N

```
NUMBER OF NODAL POINTS     =  153
NUMBER OF ELEMENT TYPES    =    3
NUMBER OF LOAD CASES       =    2
NUMBER OF FREQUENCIES      =    0
ANALYSIS CODE (NDYN)       =    0
  EQ.0,  STATIC
  EQ.1,  MODAL EXTRACTION
  EQ.2,  FORCED RESPONSE
  EQ.3,  RESPONSE SPECTRUM
  EQ.4,  DIRECT INTEGRATION
SOLUTION MODE (MODEX)      =    0
  EQ.0,  EXECUTION
  EQ.1,  DATA CHECK
NUMBER OF SUBSPACE
ITERATION VECTORS (NAD)    =    0
EQUATIONS PER BLOCK        =    0
TAPE10 SAVE FLAG (N10SV)   =    0
```

NODAL POINT INPUT DATA

NODE	BOUNDARY CONDITION CODES						NODAL POINT COORDINATES				
NUMBER	X	Y	Z	XX	YY	ZZ	X	Y	Z		T
1	1	1	1	1	1	1	361.232	-51.000	-107.155	0	70.000
2	1	1	1	1	1	1	389.695	57.000	-147.500	0	70.000
3	1	1	1	1	1	1	389.695	249.000	-147.500	0	70.000
4	1	1	1	1	1	1	321.995	323.800	-136.500	0	70.000
5	1	1	1	1	1	1	399.995	323.800	-136.500	0	70.000
6	1	1	1	1	1	1	411.995	393.300	-90.500	0	70.000
7	1	1	1	1	1	1	241.561	326.800	-64.000	0	70.000
8	1	1	1	1	1	1	228.060	326.800	-64.000	0	70.000
9	1	1	1	1	1	1	228.060	320.300	-64.000	0	70.000
10	0	0	0	0	0	0	214.180	288.300	-16.200	0	407.000
11	0	0	0	0	0	0	205.592	297.300	-13.275	0	407.000
12	0	0	0	0	0	0	222.611	279.300	-19.130	0	407.000
13	1	1	1	1	1	1	199.262	297.300	-10.745	0	70.000
14	1	1	1	1	1	1	198.262	298.300	-10.745	0	70.000
15	1	1	1	1	1	1	198.262	297.300	-9.745	0	70.000
16	1	1	1	1	1	1	402.500	319.300	-42.326	0	70.000
17	1	1	1	1	1	1	350.500	319.300	-42.326	0	70.000
18	0	0	0	0	0	0	231.120	288.300	-22.060	0	407.000
19	1	1	1	1	1	1	402.500	365.300	-42.326	0	70.000
20	0	0	0	0	0	0	236.251	297.300	-29.522	0	407.000
21	0	0	0	0	0	0	241.561	297.300	-74.500	0	407.000
22	0	0	0	0	0	0	241.561	297.300	-98.500	0	407.000
23	0	0	0	0	0	0	241.561	297.300	-106.500	0	407.000
24	0	0	0	0	0	0	390.947	255.000	-45.830	0	70.000
25	0	0	0	0	0	0	249.847	297.300	-127.713	0	407.000
26	1	1	1	1	1	1	407.500	255.000	-49.000	0	70.000
27	0	0	0	0	0	0	241.380	297.300	-49.410	0	407.000
28	0	0	0	0	0	0	241.561	297.300	-64.000	0	407.000
29	0	0	0	0	0	0	241.651	297.300	-57.000	0	407.000
30	0	0	0	0	0	0	249.847	291.450	-127.713	0	407.000
31	0	0	0	0	0	0	249.847	288.450	-127.713	0	407.000
32	0	0	0	0	0	0	271.060	297.300	-136.500	0	407.000
33	0	0	0	0	0	0	242.810	297.300	-50.000	0	250.000
34	0	0	0	0	0	0	257.310	297.300	-50.000	0	250.000
35	0	0	0	0	0	0	249.847	286.250	-127.713	0	407.000
36	0	0	0	0	0	0	241.561	291.650	-57.000	0	407.000

A3

LVR115 38

35	0	0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
36	0	0	0	0	0	0	241.561	291.450	-57.000	0	[illegible]
37	0	0	0	0	0	0	257.401	286.250	-135.768	0	407.000
38	0	0	0	0	0	0	321.995	297.300	-136.500	0	407.000
39	0	0	0	0	0	0	242.293	286.250	-119.658	0	407.000
40	0	0	0	0	0	0	294.405	297.300	-50.000	0	250.000
41	0	0	0	0	0	0	241.561	288.450	-57.000	0	407.000
42	0	0	0	0	0	0	241.561	286.250	-117.891	0	407.000
43	0	0	0	0	0	0	259.168	286.250	-136.500	0	407.000
44	0	0	0	0	0	0	324.995	297.300	-136.500	0	407.000
45	0	0	0	0	0	0	331.500	297.300	-50.000	0	250.000
46	0	0	0	0	0	0	292.817	286.250	-136.500	0	407.000
47	0	0	0	0	0	0	326.465	286.250	-136.500	0	407.000
48	0	0	0	0	0	0	241.561	286.250	-57.000	0	407.000
49	0	0	0	0	0	0	354.995	267.300	-136.500	0	407.000
50	0	0	0	0	0	0	328.232	285.518	-136.500	0	407.000
51	0	0	0	0	0	0	344.768	268.981	-136.500	0	407.000
52	0	0	0	0	0	0	335.638	297.300	-49.104	0	250.000
53	0	0	0	0	0	0	354.995	254.000	-136.500	0	407.000
54	0	0	0	0	0	0	241.561	286.250	-19.855	0	407.000
55	0	0	0	0	0	0	349.743	254.000	-140.743	0	407.000
56	0	0	0	0	0	0	350.500	297.300	-42.326	0	250.000
57	0	0	0	0	0	0	345.500	267.214	-136.500	0	407.000
58	0	0	0	0	0	0	354.995	249.000	-136.500	0	407.000
59	0	0	0	0	0	0	347.621	254.000	-138.621	0	407.000
60	0	0	0	0	0	0	359.604	287.300	-38.188	0	250.000
61	0	0	0	0	0	0	240.829	286.250	-18.088	0	407.000
62	0	0	0	0	0	0	345.500	254.000	-136.500	0	407.000
63	1	1	1	1	1	1	386.560	4.500	-82.160	0	407.000
64	0	0	0	0	0	0	354.995	201.000	-136.500	0	407.000
65	0	0	0	0	0	0	376.213	4.500	-79.961	0	407.000
66	0	0	0	0	0	0	359.604	255.000	-38.188	0	250.000
67	0	0	0	0	0	0	220.379	286.250	2.362	0	407.000
68	0	0	0	0	0	0	354.995	153.000	-136.500	0	407.000
69	0	0	0	0	0	0	345.500	203.500	-136.500	0	407.000
70	0	0	0	0	0	0	359.604	207.000	-38.188	0	250.000
71	0	0	0	0	0	0	365.539	4.500	-86.893	0	407.000
72	0	0	0	0	0	0	354.995	107.500	-136.500	0	407.000
73	0	0	0	0	0	0	218.611	288.750	4.130	0	407.000
74	0	0	0	0	0	0	354.995	34.500	-136.500	0	407.000
75	0	0	0	0	0	0	345.500	153.000	-136.500	0	407.000
76	0	0	0	0	0	0	361.232	4.500	-107.155	0	407.000
77	0	0	0	0	0	0	354.995	57.000	-136.500	0	407.000
78	0	0	0	0	0	0	218.611	323.150	4.130	0	407.000
79	0	0	0	0	0	0	359.604	159.000	-38.188	0	250.000
80	0	0	0	0	0	0	354.995	62.000	-136.500	0	407.000
81	0	0	0	0	0	0	345.500	107.500	-136.500	0	407.000
82	0	0	0	0	0	0	218.611	357.550	4.130	0	407.000
83	0	0	0	0	0	0	372.447	-3.450	-109.533	0	407.000
84	0	0	0	0	0	0	359.604	111.000	-38.188	0	250.000
85	0	0	0	0	0	0	349.743	62.000	-132.257	0	407.000
86	0	0	0	0	0	0	345.500	62.000	-136.500	0	407.000
87	0	0	0	0	0	0	367.137	-3.450	-134.520	0	407.000
88	0	0	0	0	0	0	375.241	-3.450	-96.388	0	407.000
89	0	0	0	0	0	0	359.604	63.000	-38.188	0	250.000
90	0	0	0	0	0	0	218.611	359.550	4.130	0	407.000
91	0	0	0	0	0	0	347.621	62.000	-134.379	0	407.000
92	0	0	0	0	0	0	345.500	30.525	-136.500	0	407.000
93	0	0	0	0	0	0	378.206	-3.450	-94.463	0	407.000
94	0	0	0	0	0	0	364.691	-3.450	-136.500	0	407.000
95	0	0	0	0	0	0	218.611	361.300	4.130	0	407.000
96	0	0	0	0	0	0	359.604	11.310	-38.188	0	250.000
97	0	0	0	0	0	0	345.500	-.950	-136.500	0	407.000
98	0	0	0	0	0	0	401.193	-3.450	-99.348	0	407.000
99	0	0	0	0	0	0	348.000	-3.450	-136.500	0	407.000
100	0	0	0	0	0	0	218.611	363.300	4.130	0	407.000
[illegible]	0	0	0	0	0	0	369.261	1.310	-40.786	0	250.000
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-2.700	-98.389	0	407.000

EYR115 38

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					
102	0	0	0	0	0	0	402.930	-2.700	-96.389	0	407.000
[illegible]	1	1	1	1	1	1	402.500	1.310	-48.000	0	250.000
[illegible]	0	0	0	0	0	0	220.108	364.800	4.039	0	407.000
[illegible]	0	0	0	0	0	0	380.500	1.310	-43.810	0	250.000
106	1	1	1	1	1	1	403.722	-.501	-94.665	0	407.000
107	0	0	0	0	0	0	390.947	63.000	-45.830	0	70.000
108	1	1	1	1	1	1	407.500	63.000	-49.000	0	70.000
109	0	0	0	0	0	0	215.590	364.800	3.826	0	407.000
110	1	1	1	1	1	1	380.500	51.310	-43.810	0	70.000
111	1	1	1	1	1	1	420.500	51.310	-43.810	0	70.000
112	1	1	1	1	1	1	422.500	84.310	-23.810	0	70.000
113	0	0	0	0	0	0	208.590	364.800	3.400	0	407.000
114	0	0	0	0	0	0	212.090	364.800	3.613	0	407.000
115	0	0	0	0	0	0	205.090	364.800	3.187	0	407.000
116	0	0	0	0	0	0	204.435	364.800	3.148	0	407.000
117	0	0	0	0	0	0	199.935	364.800	2.874	0	407.000
118	0	0	0	0	0	0	212.090	361.333	3.613	0	407.000
119	1	1	1	1	1	1	200.935	364.800	2.874	0	70.000
120	1	1	1	1	1	1	199.935	365.800	2.874	0	70.000
121	1	1	1	1	1	1	199.935	364.800	3.874	0	70.000
122	0	0	0	0	0	0	211.054	357.797	4.649	0	407.000
123	0	0	0	0	0	0	203.983	350.727	9.594	0	407.000
124	0	0	0	0	0	0	205.019	347.191	10.630	0	407.000
125	1	1	1	1	1	1	205.019	300.191	10.637	0	407.000
126	1	1	1	1	1	1	246.561	286.250	-19.855	0	70.000
127	1	1	1	1	1	1	241.561	286.250	-14.855	0	70.000
128	1	1	1	1	1	1	223.611	323.150	4.130	0	70.000
129	1	1	1	1	1	1	218.611	323.150	9.130	0	70.000
130	1	1	1	1	1	1	246.561	297.300	-50.000	0	70.000
131	1	1	1	1	1	1	241.561	302.300	-50.000	0	70.000
132	1	1	1	1	1	1	241.561	297.300	-45.000	0	70.000
133	1	1	1	1	1	1	246.561	286.250	-57.000	0	70.000
134	1	1	1	1	1	1	241.561	291.250	-57.000	0	70.000
135	1	1	1	1	1	1	241.561	286.250	-52.000	0	70.000
136	1	1	1	1	1	1	299.405	297.300	-50.000	0	70.000
137	1	1	1	1	1	1	350.500	297.300	-37.326	0	70.000
138	1	1	1	1	1	1	369.261	6.310	-40.766	0	70.000
139	1	1	1	1	1	1	367.137	2.450	-134.520	0	70.000
140	1	1	1	1	1	1	350.500	-.950	-136.500	0	70.000
141	1	1	1	1	1	1	345.500	-.950	-131.500	0	70.000
142	1	1	1	1	1	1	350.500	203.500	-136.500	0	70.000
143	1	1	1	1	1	1	345.500	203.500	-131.500	0	70.000
144	1	1	1	1	1	1	331.465	286.250	-136.500	0	70.000
145	1	1	1	1	1	1	326.465	286.250	-131.500	0	70.000
146	1	1	1	1	1	1	241.561	291.250	-19.855	0	70.000
147	1	1	1	1	1	1	223.611	288.750	4.130	0	70.000
148	1	1	1	1	1	1	218.611	288.750	9.130	0	70.000
149	1	1	1	1	1	1	294.405	302.300	-50.000	0	70.000
150	1	1	1	1	1	1	294.405	297.300	-45.000	0	70.000
151	1	1	1	1	1	1	350.500	107.500	-136.500	0	70.000
152	1	1	1	1	1	1	345.500	107.500	-131.500	0	70.000
153	1	1	1	1	1	1	218.611	293.750	4.130	0	70.000

GENERATED NODAL DATA

NODE NUMBER	BOUNDARY CONDITION CODES X	Y	Z	XX	YY	ZZ	NODAL POINT COORDINATES X	Y	Z	T
1	1	1	1	1	1	1	361.232	-51.000	-107.155	70.000
2	1	1	1	1	1	1	389.695	57.000	-147.500	70.000
3	1	1	1	1	1	1	389.695	249.000	-147.500	70.000
4	1	1	1	1	1	1	321.995	323.800	-136.500	70.000
5	1	1	1	1	1	1	399.995	323.800	-136.500	70.000
6	1	1	1	1	1	1	411.995	393.300	-90.500	70.000
7	1	1	1	1	1	1	241.561	326.800	-64.000	70.000
8	1	1	1	1	1	1	228.060	326.800	-64.000	70.000

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70.000
10	0	0	0	0	0	0	214.180	288.300	-16.200	407.000
11	0	0	0	0	0	0	205.592	297.300	-13.275	407.000
12	0	0	0	0	0	0	222.611	279.300	-19.130	407.000
13	1	1	1	1	1	1	199.262	297.300	-10.745	70.000
14	1	1	1	1	1	1	198.262	298.300	-10.745	70.000
15	1	1	1	1	1	1	198.262	297.300	-9.745	70.000
16	1	1	1	1	1	1	402.500	319.300	-42.326	70.000
17	1	1	1	1	1	1	350.500	319.300	-42.326	70.000
18	0	0	0	0	0	0	231.120	288.300	-22.060	407.000
19	1	1	1	1	1	1	402.500	365.300	-42.326	70.000
20	0	0	0	0	0	0	236.251	297.300	-29.522	407.000
21	0	0	0	0	0	0	241.561	297.300	-74.500	407.000
22	0	0	0	0	0	0	241.561	297.300	-98.500	407.000
23	0	0	0	0	0	0	241.561	297.300	-106.500	407.000
24	0	0	0	0	0	0	390.947	255.000	-45.830	70.000
25	0	0	0	0	0	0	249.847	297.300	-127.713	407.000
26	1	1	1	1	1	1	407.500	255.000	-49.000	70.000
27	0	0	0	0	0	0	241.380	297.300	-49.410	407.000
28	0	0	0	0	0	0	241.561	297.300	-64.000	407.000
29	0	0	0	0	0	0	241.651	297.300	-57.000	407.000
30	0	0	0	0	0	0	249.847	291.450	-127.713	407.000
31	0	0	0	0	0	0	249.847	288.450	-127.713	407.000
32	0	0	0	0	0	0	271.060	297.300	-136.500	407.000
33	0	0	0	0	0	0	242.810	297.300	-50.000	250.000
34	0	0	0	0	0	0	257.310	297.300	-50.000	250.000
35	0	0	0	0	0	0	249.847	286.250	-127.713	407.000
36	0	0	0	0	0	0	241.561	291.450	-57.000	407.000
37	0	0	0	0	0	0	257.401	286.250	-135.768	407.000
38	0	0	0	0	0	0	321.995	297.300	-136.500	407.000
39	0	0	0	0	0	0	242.293	286.250	-119.658	407.000
40	0	0	0	0	0	0	294.405	297.300	-50.000	250.000
41	0	0	0	0	0	0	241.561	288.450	-57.000	407.000
42	0	0	0	0	0	0	241.561	286.250	-117.891	407.000
43	0	0	0	0	0	0	259.168	286.250	-136.500	407.000
44	0	0	0	0	0	0	324.995	297.300	-136.500	407.000
45	0	0	0	0	0	0	331.500	297.300	-50.000	250.000
46	0	0	0	0	0	0	292.817	286.250	-136.500	407.000
47	0	0	0	0	0	0	326.465	286.250	-136.500	407.000
48	0	0	0	0	0	0	241.561	286.250	-57.000	407.000
49	0	0	0	0	0	0	354.995	267.300	-136.500	407.000
50	0	0	0	0	0	0	328.232	285.518	-136.500	407.000
51	0	0	0	0	0	0	344.768	268.981	-136.500	407.000
52	0	0	0	0	0	0	335.638	297.300	-49.104	250.000
53	0	0	0	0	0	0	354.995	254.000	-136.500	407.000
54	0	0	0	0	0	0	241.561	286.250	-19.855	407.000
55	0	0	0	0	0	0	349.743	254.000	-140.743	407.000
56	0	0	0	0	0	0	350.500	297.300	-42.326	250.000
57	0	0	0	0	0	0	345.500	257.214	-136.500	407.000
58	0	0	0	0	0	0	354.995	249.000	-136.500	407.000
59	0	0	0	0	0	0	347.621	254.000	-138.621	407.000
60	0	0	0	0	0	0	359.604	287.300	-38.188	250.000
61	0	0	0	0	0	0	240.829	286.250	-18.088	407.000
62	0	0	0	0	0	0	345.500	254.000	-136.500	407.000
63	1	1	1	1	1	1	386.560	4.500	-82.160	407.000
64	0	0	0	0	0	0	354.995	201.000	-136.500	407.000
65	0	0	0	0	0	0	376.213	4.500	-79.961	407.000
66	0	0	0	0	0	0	359.604	255.000	-38.188	250.000
67	0	0	0	0	0	0	220.379	286.250	2.362	407.000
68	0	0	0	0	0	0	354.995	153.000	-136.500	407.000
69	0	0	0	0	0	0	345.500	203.500	-136.500	407.000
70	0	0	0	0	0	0	359.604	207.000	-38.188	250.000
71	0	0	0	0	0	0	365.539	4.500	-86.893	407.000
7	0	0	0	0	0	0	354.995	107.500	-136.500	407.000
7	0	0	0	0	0	0	218.611	283.750	4.130	407.000
7	0	0	0	0	0	0	354.995	34.500	-136.500	407.000
75	0	0	0	0	0	0	345.500	153.000	[illegible]	[illegible]

A6

LTR115 38

75	0	0	0	0	0	0	345.500	153.000	-136.500	407.000
76		0	0	0	0	0	361.232	4.500	-107.155	407.000
77		0	0	0	0	0	354.995	57.000	-136.500	407.000
78		0	0	0	0	0	218.611	323.150	4.130	407.000
79	0	0	0	0	0	0	359.604	159.000	-38.188	250.000
80	0	0	0	0	0	0	354.995	62.000	-136.500	407.000
81	0	0	0	0	0	0	345.500	107.500	-136.500	407.000
82	0	0	0	0	0	0	218.611	357.550	4.130	407.000
83	0	0	0	0	0	0	372.447	-3.450	-109.533	407.000
84	0	0	0	0	0	0	359.604	111.000	-38.188	250.000
85	0	0	0	0	0	0	349.743	62.000	-132.257	407.000
86	0	0	0	0	0	0	345.500	62.000	-136.500	407.000
87	0	0	0	0	0	0	367.137	-3.450	-134.520	407.000
88	0	0	0	0	0	0	375.241	-3.450	-96.388	407.000
89	0	0	0	0	0	0	359.604	63.000	-38.188	250.000
90	0	0	0	0	0	0	218.611	359.550	4.130	407.000
91	0	0	0	0	0	0	347.621	62.000	-134.379	407.000
92	0	0	0	0	0	0	345.500	30.525	-136.500	407.000
93	0	0	0	0	0	0	378.206	-3.450	-94.463	407.000
94	0	0	0	0	0	0	364.691	-3.450	-136.500	407.000
95	0	0	0	0	0	0	218.611	361.300	4.130	407.000
96	0	0	0	0	0	0	359.604	11.310	-38.188	250.000
97	0	0	0	0	0	0	345.500	-.950	-136.500	407.000
98	0	0	0	0	0	0	401.193	-3.450	-99.348	407.000
99	0	0	0	0	0	0	348.000	-3.450	-136.500	407.000
100	0	0	0	0	0	0	218.611	363.300	4.130	407.000
101	0	0	0	0	0	0	369.261	1.310	-40.786	250.000
102	0	0	0	0	0	0	402.930	-2.700	-98.389	407.000
103	1	1	1	1	1	1	402.500	1.310	-48.000	250.000
104	0	0	0	0	0	0	220.108	364.800	4.039	407.000
105	0	0	0	0	0	0	380.500	1.310	-43.810	250.000
106	1	1	1	1	1	1	403.722	-.501	-94.665	407.000
107	0	0	0	0	0	0	390.947	63.000	-45.830	70.000
108	1	1	1	1	1	1	407.500	63.000	-49.000	70.000
109	0	0	0	0	0	0	215.590	364.800	3.826	407.000
110	1	1	1	1	1	1	380.500	51.310	-43.810	70.000
111	1	1	1	1	1	1	420.500	51.310	-43.810	70.000
112	1	1	1	1	1	1	422.500	84.310	-23.810	70.000
113	0	0	0	0	0	0	208.590	364.800	3.400	407.000
114	0	0	0	0	0	0	212.090	364.800	3.613	407.000
115	0	0	0	0	0	0	205.090	364.800	3.187	407.000
116	0	0	0	0	0	0	204.435	364.800	3.148	407.000
117	0	0	0	0	0	0	199.935	364.800	2.874	407.000
118	0	0	0	0	0	0	212.090	361.333	3.613	407.000
119	1	1	1	1	1	1	200.935	364.800	2.874	70.000
120	1	1	1	1	1	1	199.935	365.800	2.874	70.000
121	1	1	1	1	1	1	199.935	364.800	3.874	70.000
122	0	0	0	0	0	0	211.054	357.797	4.649	407.000
123	0	0	0	0	0	0	203.983	350.727	9.594	407.000
124	0	0	0	0	0	0	205.019	347.191	10.630	407.000
125	1	1	1	1	1	1	205.019	300.191	10.637	407.000
126	1	1	1	1	1	1	246.561	286.250	-19.855	70.000
127	1	1	1	1	1	1	241.561	286.250	-14.855	70.000
128	1	1	1	1	1	1	223.611	323.150	4.130	70.000
129	1	1	1	1	1	1	218.611	323.150	9.130	70.000
130	1	1	1	1	1	1	246.561	297.300	-50.000	70.000
131	1	1	1	1	1	1	241.561	302.300	-50.000	70.000
132	1	1	1	1	1	1	241.561	297.300	-45.000	70.000
133	1	1	1	1	1	1	246.561	286.250	-57.000	70.000
134	1	1	1	1	1	1	241.561	291.250	-57.000	70.000
135	1	1	1	1	1	1	241.561	286.250	-52.000	70.000
136	1	1	1	1	1	1	299.405	297.300	-50.000	70.000
137	1	1	1	1	1	1	350.500	297.300	-37.326	70.000
138	1	1	1	1	1	1	369.261	6.310	-40.786	70.000
139	1	1	1	1	1	1	367.137	2.450	-134.520	70.000
140	1	1	1	1	1	1	350.500	-.950	-136.500	70.000
141	1	1	1	1	1	1	345.500	-.950	-131.600	70.000

A7

LTR115 38

141	1	1	1	1	1	1	345.500	-.950	-131.500	70.000
142	1	1	1	1	1	1	350.500	203.500	-136.500	70.000
143	1	1	1	1	1	1	345.500	203.500	-131.500	70.000
144	1	1	1	1	1	1	331.465	286.250	-136.500	70.000
145	1	1	1	1	1	1	326.465	286.250	-131.500	70.000
146	1	1	1	1	1	1	241.561	291.250	-19.855	70.000
147	1	1	1	1	1	1	223.611	288.750	4.130	70.000
148	1	1	1	1	1	1	218.611	288.750	9.130	70.000
149	1	1	1	1	1	1	294.405	302.300	-50.000	70.000
150	1	1	1	1	1	1	294.405	297.300	-45.000	70.000
151	1	1	1	1	1	1	350.500	107.500	-136.500	70.000
152	1	1	1	1	1	1	345.500	107.500	-131.500	70.000
153	1	1	1	1	1	1	218.611	293.750	4.130	70.000

EQUATION NUMBERS

N	X	Y	Z	XX	YY	ZZ
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	1	2	3	4	5	6
11	7	8	9	10	11	12
12	13	14	15	16	17	18
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	19	20	21	22	23	24
19	0	0	0	0	0	0
20	25	26	27	28	29	30
21	31	32	33	34	35	36
22	37	38	39	40	41	42
23	43	44	45	46	47	48
24	49	50	51	52	53	54
25	55	56	57	58	59	60
26	0	0	0	0	0	0
27	61	62	63	64	65	66
28	67	68	69	70	71	72
29	73	74	75	76	77	78
30	79	80	81	82	83	84
31	85	86	87	88	89	90
32	91	92	93	94	95	96
33	97	98	99	100	101	102
34	103	104	105	106	107	108
35	109	110	111	112	113	114
36	115	116	117	118	119	120
37	121	122	123	124	125	126
38	127	128	129	130	131	132
39	133	134	135	136	137	138
40	139	140	141	142	143	144
41	145	146	147	148	149	150
42	151	152	153	154	155	156
43	157	158	159	160	161	162
44	163	164	165	166	167	168
45	169	170	171	172	173	174
46	175	176	177	178	179	180
47	181	182	183	184	185	186
48		188	169	190	191	192
49		194	195	196	197	198

A8

LTR115 38

5	5	206	207	208	209	210
5	1	212	213	214	215	216
53	217	218	219	220	221	222
54	223	224	225	226	227	228
55	229	230	231	232	233	234
56	235	236	237	238	239	240
57	241	242	243	244	245	246
58	247	248	249	250	251	252
59	253	254	255	256	257	258
60	259	260	261	262	263	264
61	265	266	267	268	269	270
62	271	272	273	274	275	276
63	0	0	0	0	0	0
64	277	278	279	280	281	282
65	283	284	285	286	287	288
66	289	290	291	292	293	294
67	295	296	297	298	299	300
68	301	302	303	304	305	306
69	307	308	309	310	311	312
70	313	314	315	316	317	318
71	319	320	321	322	323	324
72	325	326	327	328	329	330
73	331	332	333	334	335	336
74	337	338	339	340	341	342
75	343	344	345	346	347	348
76	349	350	351	352	353	354
77	355	356	357	358	359	360
78	361	362	363	364	365	366
79	367	368	369	370	371	372
80	373	374	375	376	377	378
81	379	380	381	382	383	384
82	385	386	387	388	389	390
83	391	392	393	394	395	396
84	397	398	399	400	401	402
85	403	404	405	406	407	408
86	409	410	411	412	413	414
87	415	416	417	418	419	420
88	421	422	423	424	425	426
89	427	428	429	430	431	432
90	433	434	435	436	437	438
91	439	440	441	442	443	444
92	445	446	447	448	449	450
93	451	452	453	454	455	456
94	457	458	459	460	461	462
95	463	464	465	466	467	468
96	469	470	471	472	473	474
97	475	476	477	478	479	480
98	481	482	483	484	485	486
99	487	488	489	490	491	492
100	493	494	495	496	497	498
101	499	500	501	502	503	504
102	505	506	507	508	509	510
103	0	0	0	0	0	0
104	511	512	513	514	515	516
105	517	518	519	520	521	522
106	0	0	0	0	0	0
107	523	524	525	526	527	528
108	0	0	0	0	0	0
109	529	530	531	532	533	534
110	0	0	0	0	0	0
111	0	0	0	0	0	0
112	0	0	0	0	0	0
113	535	536	537	538	539	540
114	541	542	543	544	545	546
115	547	548	549	550	551	552
116	553	554	555	556	557	558

A9

LTR115 38

116	553	554	555	556	557	558
117	559	560	561	562	563	564
118	565	566	567	568	569	570
119	0	0	0	0	0	0
120	0	0	0	0	0	0
121	0	0	0	0	0	0
122	571	572	573	574	575	576
123	577	578	579	580	581	582
124	583	584	585	586	587	588
125	0	0	0	0	0	0
126	0	0	0	0	0	0
127	0	0	0	0	0	0
128	0	0	0	0	0	0
129	0	0	0	0	0	0
130	0	0	0	0	0	0
131	0	0	0	0	0	0
132	0	0	0	0	0	0
133	0	0	0	0	0	0
134	0	0	0	0	0	0
135	0	0	0	0	0	0
136	0	0	0	0	0	0
137	0	0	0	0	0	0
138	0	0	0	0	0	0
139	0	0	0	0	0	0
140	0	0	0	0	0	0
141	0	0	0	0	0	0
142	0	0	0	0	0	0
143	0	0	0	0	0	0
144	0	0	0	0	0	0
145	0	0	0	0	0	0
146	0	0	0	0	0	0
147	0	0	0	0	0	0
148	0	0	0	0	0	0
149	0	0	0	0	0	0
150	0	0	0	0	0	0
151	0	0	0	0	0	0
152	0	0	0	0	0	0
153	0	0	0	0	0	0

A10

LTR115 38

3/D BEAM ELEMENTS

NUMBER OF BEAMS = 23
NUMBER OF GEOMETRIC PROPERTY SETS= 7
NUMBER OF FIXED END FORCE SETS = 0
NUMBER OF MATERIALS = 2

MATERIAL PROPERTIES

MATERIAL NUMBER	YOUNG*S MODULUS	POISSON*S RATIO	MASS DENSITY	WEIGHT DENSITY
1	.2790E+08	.3000	.7330E-03	.2833E+00
2	.2700E+08	.3000	.7330E-03	.2833E+00

BEAM GEOMETRIC PROPERTIES

SECTION NUMBER	AXIAL AREA A(1)	SHEAR AREA A(2)	SHEAR AREA A(3)	TORSION J(1)	INERTIA I(2)	INERTIA I(3)
1	.3820E+01	0.	0.	.1540E+00	.3760E+01	.1130E+02
2	.2110E+01	0.	0.	.8000E-01	.1760E+01	.1760E+01
3	.4560E+01	0.	0.	.1110E+00	.9670E+01	.3010E+02
4	.1500E+01	0.	0.	.1120E+00	.3000E-01	.1130E+01
5	.9380E+00	0.	0.	.3000E-01	.3480E+00	.3480E+00
6	.2500E+00	0.	0.	.4000E-02	.2100E-01	.1000E-02
7	.4420E+00	0.	0.	.3100E-01	.1600E-01	.1600E-01

A11

ELEMENT LOAD MULTIPLIERS

	A	B	C	D
X-DIR	0.	0.	0.	0.
Y-DIR	.100000E+01	0.	.100000E+01	0.
Z-DIR	0.	0.	0.	0.

LTR 1 15

3/D BEAM ELEMENT DATA

BEAM NUMBER	NODE -I	NODE -J	NODE -K	MATERIAL NUMBER	SECTION NUMBER	ELEMENT END LOADS A	B	C	D	END CODES -I	-J
1	4	5	38	1	1	0	0	0	0	0	0
2	7	8	9	1	2	0	0	0	0	0	0
3	8	9	7	1	2	0	0	0	0	0	0
4	17	16	56	1	3	0	0	0	0	0	0
5	17	19	56	1	4	0	0	0	0	0	0
6	24	26	89	1	1	0	0	0	0	0	0
7	107	108	64	1	1	0	0	0	0	0	0
8	110	111	105	1	5	0	0	0	0	0	0
9	110	112	105	1	4	0	0	0	0	0	0
10	76	83	88	2	6	0	0	0	0	0	0
11	86	91	97	2	7	0	0	0	0	0	0
12	91	85	97	2	7	0	0	0	0	1	10
13	80	85	53	2	7	0	0	0	0	0	0
14	68	75	86	2	6	0	0	0	0	0	0
15	62	59	75	2	7	0	0	0	0	0	0
16	59	55	75	2	7	0	0	0	0	1	10
17	53	55	80	2	7	0	0	0	0	0	0
18	35	31	37	2	7	0	0	0	0	0	0
19	31	30	37	2	7	0	0	0	0	1	1
20	25	30	37	2	7	0	0	0	0	0	0
21	48	41	42	2	7	0	0	0	0	0	0
22	41	36	42	2	7	0	0	0	0	1	1
23	29	36	42	2	7	0	0	0	0	0	0

B O U N D A R Y   E L E M E N T S

ELEMENT TYPE = 7
NUMBER OF ELEMENTS = 23

ELEMENT LOAD CASE MULTIPLIERS

CASE(A)	CASE(B)	CASE(C)	CASE(D)
1.0000	1.0000	0.0000	0.0000

ELEMENT NUMBER	NODE (N)	NODES DEFINING CONSTRAINT DIRECTION (NI)	(NJ)	(NK)	(NL)	CODE KD	CODE KR	GENERATION CODE (KN)	SPECIFIED DISPLACEMENT	SPECIFIED ROTATION	SPRING RATE
1	11	13	0	0	0	1	1	0	0.	0.	.1000E+11
2	11	14	0	0	0	1	1	0	0.	0.	.1000E+11
3	11	15	0	0	0	1	1	0	0.	0.	.1000E+11
4	40	149	0	0	0	1	0	0	0.	0.	.1000E+11
5	40	150	0	0	0	1	0	0	0.	0.	.1000E+11
6	56	137	0	0	0	1	0	0	0.	0.	.1000E+11
7	58	3	0	0	0	1	0	0	0.	0.	.1500E+03
8	66	24	0	0	0	1	0	0	0.	0.	.5000E+02
9	69	142	0	0	0	1	0	0	0.	0.	.1000E+11
10	69	143	0	0	0	1	0	0	0.	0.	.1000E+11
11	73	147	0	0	0	1	0	0	0.	0.	.1000E+11
12	73	148	0	0	0	1	0	0	0.	0.	.1000E+11
13	77	2	0	0	0	1	0	0	0.	0.	.1500E+03
14	81	151	0	0	0	1	0	0	0.	0.	.1000E+11
15	81	152	0	0	0	1	0	0	0.	0.	.1000E+11
16	87	139	0	0	0	1	0	0	0.	0.	.1000E+11
17	89	107	0	0	0	1	0	0	0.	0.	.5000E+02
18	97	140	0	0	0	1	0	0	0.	0.	.1000E+11
19	97	141	0	0	0	1	0	0	0.	0.	.1000E+11
20	101	138	0	0	0	1	0	0	0.	0.	.1000E+11
21	117	119	0	0	0	1	1	0	0.	0.	.1000E+11
22	117	120	0	0	0	1	1	0	0.	0.	.1000E+11
23	117	121	0	0	0	1	1	0	0.	0.	.1000E+11

A13

PIPE ELEMENT INPUT DATA

CONTROL INFORMATION

```
NUMBER OF PIPE ELEMENTS          =   91

NUMBER OF MATERIAL SETS          =    1

MAXIMUM NUMBER OF MATERIAL
TEMPERATURE INPUT POINTS         =    6

NUMBER OF SECTION PROPER-Y SETS =   11

NUMBER OF BRANCH POINT NODES     =    2

MAXIMUM NUMBER OF TANGENTS
COMMON TO A BRANCH POINT         =    3

FLAG FOR NEGLECTING AXIAL
DEFORMATIONS IN BEND ELEMENTS    =    0
(EQ.1, NEGLECT)
```

MATERIAL PROPERTY TABLES

A14

```
MATERIAL NUMBER     = (    1)
NUMBER OF
TEMPERATURE POINTS = (    6)
IDENTIFICATION      = (           CARBON STEEL             )
```

POINT NUMBER	TEMPERATURE	YOUNG*S MODULUS	POISSON*S RATIO	THERMAL EXPANSION
1	70.00	27900000.0	.300	.607E-05
2	200.00	27700000.0	.300	.638E-05
3	300.00	27400000.0	.300	.660E-05
4	400.00	27000000.0	.300	.682E-05
5	500.00	26400000.0	.300	.702E-05
6	600.00	25700000.0	.300	.723E-05

S E C T I O N   P R O P E R T Y   T A B L E

SECTION NUMBER	OUTSIDE DIAMETER	WALL THICKNESS	SHAPE FACTOR FOR SHEAR	WEIGHT/ UNIT LENGTH	MASS/ UNIT LENGTH	D E S C R I P T I O N
1	6.625	.4320	0.0000	.3040E+01	.7867E-02	6 INCH MAIN FEED
2	2.375	.2180	0.0000	.6970E+00	.1804E-02	2 INCH AUXL FEED
3	.840	.1470	0.0000	.2210E+00	.5719E-03	1/2 INCH SUPLY LEV
4	1.315	.1790	0.0000	.3320E+00	.8592E-03	1 INCH MISC PIPE
5	8.146	1.1920	0.0000	.2656E+02	.6874E-01	VALVE V-5000-CZ
6	1.518	.5480	0.0000	.1255E+02	.3248E-01	VALVE V-3050-CZ
7	1.150	.3000	0.0000	.1758E+01	.4550E-02	VALVE V-5009-CZ
8	5.563	.3750	0.0000	.2387E+01	.6178E-02	6X4 IN RED CONC
9	1.050	.1540	0.0000	.2100E+00	.5435E-03	1X1/2 RED CONC
10	3.500	.3000	0.0000	.9560E+00	.2474E-02	3X3 IN TEE
11	2.375	.3430	0.0000	.1175E+01	.3041E-02	PC-11 BOSS

A15

B R A N C H   P O I N T   N O D E   L I S T

BRANCH POINT	NODE NUMBER
1	27
2	114

E L E M E N T   L O A D   C A S E   M U L T I P L I E R S

	CASE A	CASE B	CASE C	CASE D
X-DIRECTION GRAVITY	0.000	0.000	0.000	0.000
Y-DIRECTION GRAVITY	-1.000	0.000	0.000	0.000
Z-DIRECTION GRAVITY	0.000	0.000	0.000	0.000
THERMAL DISTORTION	0.000	1.000	0.000	0.000
PRESSURE DISTORTION	0.000	0.000	0.000	0.000

A16

LTR115 38

PIPE ELEMENT INPUT DATA

ELEMENT NUMBER	ELEMENT TYPE	NODE -I	NODE -J	MATL. NUMBER	SECTION NUMBER	REFERENCE TEMPERATURE (BEND RADIUS)	INTERNAL PRESSURE (THIRD POINT)	DIRECTION COSINES A(YX) (X3-ORDINATE)	A(YY) (Y3-ORDINATE)	A(YZ) (Z3-ORDINATE)	NODE INCREMENT (WALL FRACTION)	INPUT TAG
1	TANGENT	63	65	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
2	BEND	65	71	1	1	70.00	900.00					IC
						(30.000)	( )	(367.410)	(4.500)	(-78.090)	(.1000)	
3	TANGENT	71	76	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
4	BEND	76	74	1	1	70.00	900.00					IC
						(30.000)	( )	(354.995)	(4.500)	(-136.500)	(.1000)	
5	TANGENT	74	77	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
6	TANGENT	77	80	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
7	TANGENT	80	72	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
8	TANGENT	72	68	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
9	TANGENT	68	64	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
10	TANGENT	64	58	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
11	TANGENT	58	53	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
12	TANGENT	53	49	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
13	BEND	49	44	1	1	70.00	900.00					IC
						(30.000)	( )	(354.995)	(297.300)	(-136.500)	(.1000)	
14	TANGENT	44	38	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
15	TANGENT	4	6	1	2	70.00	0.00	0.0000	0.0000	0.0000	1	II
16	TANGENT	38	32	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
17	BEND	32	25	1	1	70.00	900.00					IC
						(30.000)	( )	(258.634)	(297.300)	(-136.500)	(.1000)	
18	BEND	25	23	1	1	70.00	900.00					IC
						(30.000)	( )	(241.060)	(297.300)	(-118.926)	(.1000)	
19	TANGENT	23	22	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
20	TANGENT	22	21	1	5	70.00	900.00	0.0000	0.0000	0.0000	1	II
21	TANGENT	21	28	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
22	TANGENT	28	29	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
23	TANGENT	29	27	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
24	BEND	27	20	1	1	70.00	900.00					IC
						(30.000)	(CC)	(211.650)	(297.300)	(-46.700)	(.4000)	
25	BEND	20	18	1	1	70.00	900.00					IC
						(9.000)	(CC)	(236.250)	(288.300)	(-29.520)	(.2500)	
26	BEND	18	12	1	1	70.00	900.00					IC
						(9.000)	(CC)	(222.610)	(288.300)	(-19.130)	(.2500)	
27	BEND	12	10	1	8	70.00	900.00					IC
						(9.000)	(CC)	(222.610)	(288.300)	(-19.130)	(.2500)	
28	BEND	10	11	1	1	70.00	900.00					IC
						(9.000)	(CC)	(205.590)	(288.300)	(-13.270)	(.2500)	
29	TANGENT	27	33	1	11	70.00	950.00	0.0000	0.0000	0.0000	1	II
30	TANGENT	33	34	1	6	70.00	950.00	0.0000	0.0000	0.0000	1	II

A17

LTR115 38

PIPE ELEMENT INPUT DATA

ELEMENT NUMBER	ELEMENT TYPE	NODE -I	NODE -J	MATL. NUMBER	SECTION NUMBER	REFERENCE TEMPERATURE (BEND RADIUS)	INTERNAL PRESSURE (THIRD POINT)	DIRECTION COSINES A(YX) (X3-ORDINATE)	A(YY) (Y3-ORDINATE)	A(YZ) (Z3-ORDINATE)	NODE INCREMENT (WALL FRACTION)	INPUT TAG
31	TANGENT	34	40	1	6	70.00	950.00	0.0000	0.0000	0.0000	1	II
32	TANGENT	40	45	1	6	70.00	950.00	0.0000	0.0000	0.0000	1	II
33	BEND	45	52	1	2	70.00	950.00					IC
						(10.000)	( )	(333.666)	(297.300)	(-50.000)	(.1000)	
34	TANGENT	52	56	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
35	BEND	56	60	1	2	70.00	950.00					IC
						(10.000)	( )	(359.604)	(297.300)	(-38.188)	(.1000)	
36	TANGENT	60	66	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
37	TANGENT	66	70	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
38	TANGENT	70	79	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
39	TANGENT	79	84	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
40	TANGENT	84	89	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
41	TANGENT	89	96	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
42	BEND	96	101	1	2	70.00	950.00					IC
						(10.000)	( )	(359.604)	(1.310)	(-38.188)	(.1000)	
43	TANGENT	101	105	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
44	TANGENT	105	103	1	2	70.00	950.00	0.0000	0.0000	0.0000	1	II
45	TANGENT	106	102	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
46	BEND	102	98	1	3	70.00	270.00					IC
						(2.500)	( )	(402.660)	(-3.450)	(-99.660)	(.1000)	
47	TANGENT	98	93	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
48	BEND	93	88	1	3	70.00	270.00					IC
						(2.500)	( )	(375.761)	(-3.450)	(-93.943)	(.1000)	
49	TANGENT	88	83	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
50	TANGENT	83	87	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
51	BEND	87	94	1	3	70.00	270.00					IC
						(2.500)	( )	(366.716)	(-3.450)	(-136.500)	(.1000)	
52	TANGENT	94	99	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
53	BEND	99	97	1	3	70.00	270.00					IC
						(2.500)	( )	(345.500)	(-3.450)	(-136.500)	(.1000)	
54	TANGENT	97	92	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
55	TANGENT	92	86	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
56	TANGENT	86	81	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
57	TANGENT	81	75	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
58	TANGENT	75	69	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
59	TANGENT	69	62	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
60	TANGENT	62	57	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
61	BEND	57	51	1	3	70.00	270.00					IC
						(2.500)	( )	(345.500)	(268.249)	(-136.500)	(.1000)	
62	TANGENT	51	50	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
63	BEND	50	47	1	3	70.00	270.00					IC
						(2.500)	( )	(327.500)	(286.250)	(-136.500)	(.1000)	

A/8

P I P E   E L E M E N T   I N P U T   D A T A

ELEMENT NUMBER	ELEMENT TYPE	NODE -I	NODE -J	MATL. NUMBER	SECTION NUMBER	REFERENCE TEMPERATURE (BEND RADIUS)	INTERNAL PRESSURE (THIRD POINT)	DIRECTION COSINES A(YX) (X3-ORDINATE)	A(YY) (Y3-ORDINATE)	A(YZ) (Z3-ORDINATE)	NODE INCREMENT (WALL FRACTION)	INPUT TAG
64	TANGENT	47	46	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
65	TANGENT	46	43	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
66	BEND	43	37	1	3	70.00	270.00					IC
						(2.500)	( )	(258.133)	(286.250)	(-136.500)	(.1000)	
67	TANGENT	37	35	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
68	TANGENT	35	39	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
69	BEND	39	42	1	3	70.00	270.00					IC
						(2.500)	( )	(241.561)	(286.250)	(-116.926)	(.1000)	
70	TANGENT	42	48	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
71	TANGENT	48	54	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
72	BEND	54	61	1	3	70.00	270.00					IC
						(2.500)	( )	(241.561)	(286.250)	(-18.820)	(.1000)	
73	TANGENT	61	67	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
74	BEND	67	73	1	3	70.00	270.00					IC
						(2.500)	( )	(218.611)	(286.250)	(4.130)	(.1000)	
75	TANGENT	73	78	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
76	TANGENT	78	82	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
77	TANGENT	82	90	1	7	70.00	270.00	0.0000	0.0000	0.0000	1	II
78	TANGENT	90	95	1	3	70.00	270.00	0.0000	0.0000	0.0000	1	II
79	TANGENT	95	100	1	9	70.00	270.00	0.0000	0.0000	0.0000	1	II
80	BEND	100	104	1	4	70.00	270.00					IC
						(2.500)	( )	(218.611)	(364.800)	(4.130)	(.1000)	
81	TANGENT	104	109	1	2	70.00	270.00	0.0000	0.0000	0.0000	1	II
82	TANGENT	109	114	1	10	70.00	270.00	0.0000	0.0000	0.0000	1	II
83	TANGENT	114	113	1	10	70.00	270.00	0.0000	0.0000	0.0000	1	II
84	TANGENT	113	115	1	2	70.00	270.00	0.0000	0.0000	0.0000	1	II
85	TANGENT	115	116	1	4	70.00	270.00	0.0000	0.0000	0.0000	1	II
86	TANGENT	116	117	1	2	70.00	270.00	0.0000	0.0000	0.0000	1	II
87	TANGENT	114	118	1	4	70.00	270.00	0.0000	0.0000	0.0000	1	II
88	BEND	118	122	1	4	70.00	270.00					IC
						(5.000)	( )	(212.090)	(359.262)	(3.613)	(.1000)	
89	TANGENT	122	123	1	4	70.00	270.00	0.0000	0.0000	0.0000	1	II
90	BEND	123	124	1	4	70.00	270.00					IC
						(5.000)	( )	(205.019)	(349.262)	(10.630)	(.1000)	
91	TANGENT	124	125	1	4	70.00	270.00	0.0000	0.0000	0.0000	1	II

A19

LTR115 38

B R A N C H   P O I N T   D A T A

BRANCH POINT	NODE NUMBER	CONNECTIONS . . .		
1	27	-23 AT J	29 AT I	0 NONE
2	114	-82 AT J	83 AT I	87 AT I

A20

LTR115 38

E Q U A T I O N   P A R A M E T E R S

```
TOTAL NUMBER OF EQUATIONS       =  588
BANDWIDTH                       =   60
NUMBER OF EQUATIONS IN A BLOCK  =  588
NUMBER OF BLOCKS                =    1
```

A21

LTR115 38

N O D A L   L O A D S   (S T A T I C)   O R   M A S S E S   (D Y N A M I C)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT
12	1	0.	-.10840E+02	0.	0.	0.	0.

STRUCTURE LOAD CASE	ELEMENT A	LOAD B	MULTIPLIERS C	D
1	1.000	0.000	0.000	0.000
2	0.000	1.000	0.000	0.000

A22

LTR115 38

* * LOFT AM GENERATOR MAIN FEED LOOP SEAL ADDITION - DYNAMIC - SSE

C O N T R O L   I N F O R M A T I O N

```
NUMBER OF NODAL POINTS      =   18
NUMBER OF ELEMENT TYPES     =    2
NUMBER OF LOAD CASES        =    0
NUMBER OF FREQUENCIES       =   25
ANALYSIS CODE (NDYN)        =    3
   EQ.0,  STATIC
   EQ.1,  MODAL EXTRACTION
   EQ.2,  FORCED RESPONSE
   EQ.3,  RESPONSE SPECTRUM
   EQ.4,  DIRECT INTEGRATION
SOLUTION MODE (MODEX)       =    0
   EQ.0,  EXECUTION
   EQ.1,  DATA CHECK
NUMBER OF SUBSPACE
ITERATION VECTORS (NAD)     =    0
EQUATIONS PER BLOCK         =    0
TAPE10 SAVE FLAG (N10SV)    =    0
```

NODAL POINT INPUT DATA

NODE NUMBER	BOUNDARY CONDITION CODES X	Y	Z	XX	YY	ZZ	NODAL POINT COORDINATES X	Y	Z		T
1	0	0	0	0	0	0	207.000	297.300	-13.760	0	407.000
2	0	0	0	0	0	0	214.100	289.800	-16.200	0	407.000
3	0	0	0	0	0	0	222.610	275.300	-19.130	0	407.000
4	0	0	0	0	0	0	222.610	271.430	-19.130	0	407.000
5	0	0	0	0	0	0	222.610	267.330	-19.130	0	407.000
6	0	0	0	0	0	0	222.610	263.460	-19.130	0	407.000
7	0	0	0	0	0	0	222.610	259.360	-19.130	0	407.000
8	0	0	0	0	0	0	231.120	284.300	-22.060	0	407.000
9	0	0	0	0	0	0	236.250	297.300	-29.520	0	407.000
10	0	0	0	0	0	0	241.380	297.300	-49.410	0	407.000
11	1	1	1	1	1	1	253.380	297.300	-49.410	0	70.000
12	1	1	1	1	1	1	241.380	297.300	-61.410	0	70.000
13	1	1	1	1	1	1	241.380	309.300	-49.410	0	70.000
14	1	1	1	1	1	1	207.000	297.300	-1.760	0	70.000
15	1	1	1	1	1	1	195.000	297.300	-13.760	0	70.000
16	1	1	1	1	1	1	207.000	309.300	-13.760	0	70.000
17	0	0	0	0	0	0	214.100	284.300	-16.200	0	407.000
18	0	0	0	0	0	0	231.120	288.300	-22.060	0	407.000

GENERATED NODAL DATA

NODE NUMBER	BOUNDARY CONDITION CODES X	Y	Z	XX	YY	ZZ	NODAL POINT COORDINATES X	Y	Z	T
1	0	0	0	0	0	0	207.000	297.300	-13.760	407.000
2	0	0	0	0	0	0	214.100	289.800	-16.200	407.000
3	0	0	0	0	0	0	222.610	275.300	-19.130	407.000
4	0	0	0	0	0	0	222.610	271.430	-19.130	407.000
5	0	0	0	0	0	0	222.610	267.330	-19.130	407.000
6	0	0	0	0	0	0	222.610	263.460	-19.130	407.000
7	0	0	0	0	0	0	222.610	259.360	-19.130	407.000
8	0	0	0	0	0	0	231.120	284.300	-22.060	407.000
9	0	0	0	0	0	0	236.250	297.300	-29.520	407.000
10	0	0	0	0	0	0	241.380	297.300	-49.410	407.000
11	1	1	1	1	1	1	253.380	297.300	-49.410	70.000
12	1	1	1	1	1	1	[illegible]	297.300	-61.410	70.000

A23

LTR115 38

13	1	1	1	1	1	1	241.380	309.300	-49.410	70.000
14	1	1	1	1	1	1	207.000	297.300	-1.760	70.000
15	1	1	1	1	1	1	195.000	297.300	-13.760	70.000
16	1	1	1	1	1	1	207.000	309.300	-13.760	70.000
17	0	0	0	0	0	0	214.100	284.300	-16.200	407.000
18	0	0	0	0	0	0	231.120	288.300	-22.060	407.000

EQUATION NUMBERS

N	X	Y	Z	XX	YY	ZZ
1	1	2	3	4	5	6
2	7	8	9	10	11	12
3	13	14	15	16	17	18
4	19	20	21	22	23	24
5	25	26	27	28	29	30
6	31	32	33	34	35	36
7	37	38	39	40	41	42
8	43	44	45	46	47	48
9	49	50	51	52	53	54
10	55	56	57	58	59	60
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	61	62	63	64	65	66
18	67	68	69	70	71	72

A24

LTR115 38

B O U N D A R Y   E L E M E N T S

ELEMENT TYPE   =   7
NUMBER OF ELEMENTS =   12

ELEMENT LOAD CASE MULTIPLIERS

CASE(A)	CASE(B)	CASE(C)	CASE(D)
1.0000	0.0000	0.0000	0.0000

ELEMENT NUMBER	NODE (N)	NODES DEFINING CONSTRAINT DIRECTION (NI)	(NJ)	(NK)	(NL)	CODE KD	CODE KR	GENERATION CODE (KN)	SPECIFIED DISPLACEMENT	SPECIFIED ROTATION	SPRING RATE
1	10	11	0	0	0	1	0	0	0.	0.	.1000E+11
2	10	11	0	0	0	0	1	0	0.	0.	.1000E+11
3	10	12	0	0	0	1	0	0	0.	0.	.1000E+11
4	10	12	0	0	0	0	1	0	0.	0.	.1000E+11
5	10	13	0	0	0	1	0	0	0.	0.	.1000E+11
6	10	13	0	0	0	0	1	0	0.	0.	.1000E+11
7	1	14	0	0	0	1	0	0	0.	0.	.1000E+11
8	1	14	0	0	0	0	1	0	0.	0.	.1000E+11
9	1	15	0	0	0	1	0	0	0.	0.	.1000E+11
10	1	15	0	0	0	0	1	0	0.	0.	.1000E+11
11	1	16	0	0	0	1	0	0	0.	0.	.1000E+11
12	1	16	0	0	0	0	1	0	0.	0.	.1000E+11

A25

LTR115 38

P I P E   E L E M E N T   I N P U T   D A T A

C O N T R O L   I N F O R M A T I O N

NUMBER OF PIPE ELEMENTS = 11

NUMBER OF MATERIAL SETS = 1

MAXIMUM NUMBER OF MATERIAL TEMPERATURE INPUT POINTS = 6

NUMBER OF SECTION PROPERTY SETS = 5

NUMBER OF BRANCH POINT NODES = 0

MAXIMUM NUMBER OF TANGENTS COMMON TO A BRANCH POINT = 4

FLAG FOR NEGLECTING AXIAL DEFORMATIONS IN BEND ELEMENTS = 0
(EQ.1, NEGLECT)

M A T E R I A L   P R O P E R T Y   T A B L E S

MATERIAL NUMBER = (1)
NUMBER OF TEMPERATURE POINTS = (6)
IDENTIFICATION = (ASTM A106 GR B CARBON STEEL)

POINT NUMBER	TEMPERATURE	YOUNG*S MODULUS	POISSON*S RATIO	THERMAL EXPANSION
1	70.00	27900000.0	.300	.607E-05
2	200.00	27700000.0	.300	.638E-05
3	300.00	27400000.0	.300	.660E-05
4	400.00	27000000.0	.300	.682E-05
5	500.00	26400000.0	.300	.702E-05
6	600.00	25700000.0	.300	.723E-05

SECTION PROPERTY TABLE

SECTION NUMBER	OUTSIDE DIAMETER	WALL THICKNESS	SHAPE FACTOR FOR SHEAR	WEIGHT/ UNIT LENGTH	MASS/ UNIT LENGTH	DESCRIPTION
1	6.625	.4320	0.0000	.3320E+01	.8592E-02	6 IN SCH 80 PIPE
2	.840	.1470	0.0000	.2210E+00	.5719E-03	.5 IN SCH 80 PIPE
3	.840	.1470	0.0000	.1200E+01	.3106E-02	.5 IN. VALVES
4	5.563	.3750	0.0000	.2389E+01	.6183E-02	5 IN SCH 80 PIPE
5	6.094	.4035	0.0000	.2855E+01	.7389E-02	6X5 RED AV PROP

ELEMENT LOAD CASE MULTIPLIERS

	CASE A	CASE B	CASE C	CASE D
X-DIRECTION GRAVITY	0.000	0.000	0.000	0.000
Y-DIRECTION GRAVITY	1.000	0.000	0.000	0.000
Z-DIRECTION GRAVITY	0.000	0.000	0.000	0.000
THERMAL DISTORTION	0.000	0.000	0.000	0.000
PRESSURE DISTORTION	0.000	0.000	0.000	0.000

A27

PIPE ELEMENT INPUT DATA

ELEMENT NUMBER	ELEMENT TYPE	NODE -I	NODE -J	MATL. NUMBER	SECTION NUMBER	REFERENCE TEMPERATURE (BEND RADIUS)	INTERNAL PRESSURE (THIRD POINT)	DIRECTION COSINES A(YX) (X3-ORDINATE)	A(YY) (Y3-ORDINATE)	A(YZ) (Z3-ORDINATE)	NODE INCREMENT (WALL FRACTION)	INPUT TAG
1	TANGENT	7	6	1	3	70.00	900.00	0.0000	0.0000	0.0000	1	II
2	TANGENT	6	5	1	2	70.00	900.00	0.0000	0.0000	0.0000	1	II
3	TANGENT	5	4	1	3	70.00	900.00	0.0000	0.0000	0.0000	1	II
4	TANGENT	4	3	1	2	70.00	900.00	0.0000	0.0000	0.0000	1	II
5	BEND	1	2	1	4	70.00	900.00					IC
						(7.500)	(CC)	(207.000)	(289.800)	(-13.760)	(.4000)	
6	TANGENT	2	17	1	5	70.00	900.00	0.0000	0.0000	0.0000	1	II
7	BEND	17	3	1	1	70.00	0.00					IC
						(9.000)	(CC)	(222.610)	(284.300)	(-19.130)	(.2500)	
8	BEND	3	8	1	1	70.00	900.00					IC
						(9.000)	(CC)	(222.610)	(284.300)	(-19.130)	(.2500)	
9	TANGENT	8	18	1	1	70.00	900.00	0.0000	0.0000	0.0000	1	II
10	BEND	18	9	1	1	70.00	900.00					IC
						(9.000)	(CC)	(236.250)	(288.300)	(-29.520)	(.2500)	
11	BEND	9	10	1	1	70.00	900.00					IC
						(30.000)	(CC)	(211.650)	(297.300)	(-46.700)	(.4000)	

A28

LTR115 38

E Q U A T I O N   P A R A M E T E R S

```
TOTAL NUMBER OF EQUATIONS       =   72
BANDWIDTH                       =   60
NUMBER OF EQUATIONS IN A BLOCK  =   72
NUMBER OF BLOCKS                =    1
```

A29

LTR115 38

N O D A L   L O A D S   (S T A T I C)   O R   M A S S E S   (D Y N A M I C)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT

STRUCTURE LOAD CASE	ELEMENT LOAD MULTIPLIERS A	B	C	D
1	0.000	0.000	0.000	0.000

A30

LTR115 38

APPENDIX B

MOMENT DATA

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : DEADWEIGHT

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	0	0	0
2	I	0	0	0	0	J	0	0	0	0
3	I	0	0	0	0	J	0	0	0	0
4	I	0	0	0	0	J	0	0	0	0
5	I	-16281	-24193	10677	31054	C	-28405	-4910	13895	32000
6	I	NOT	IN	MODEL		J	NOT	IN	MODEL	
7	C	-28828	5997	-7680	30430	J	-16477	23995	-10824	31055
8	C	-6918	-28005	4849	29252	J	-24928	-15477	-1111	29363
9	I	NOT	IN	MODEL		J	NOT	IN	MODEL	
10	C	-5855	26280	6437	27683	J	14817	23408	8810	29071
11	C	-22503	746	12463	25735	J	-22464	-579	13647	26291

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

81

LTR115 38

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : THERMAL EXPANSION

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	0	0	0
2	I	0	0	0	0	J	0	0	0	0
3	I	0	0	0	0	J	0	0	0	0
4	I	0	0	0	0	J	0	0	0	0
5	I	-4417	11659	-11290	16820	C	4938	10799	-10057	15561
6	I	NOT	IN	MODEL		J	NOT	IN	MODEL	
7	C	5338	-11837	12572	18074	J	-4325	-11630	11356	16820
8	C	12640	4551	10153	16839	J	12380	-5179	12059	18042
9	I	NOT	IN	MODEL		J	NOT	IN	MODEL	
10	C	7721	320	-11076	13505	J	5916	-4657	-13285	15270
11	C	2392	8551	3679	9611	J	5514	9138	5107	11832

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

32

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : THERMAL EXPANSION + Z DIR. ANCHOR MOVEMENT

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	0	0	0
2	I	0	0	0	0	J	0	0	0	0
3	I	0	0	0	0	J	0	0	0	0
4	I	0	0	0	0	J	0	0	0	0
5	I	5176	25503	-82791	86784	C	15530	20677	-64039	69063
6	I	T.E. NOT	IN	MODEL		J	T.E.	NOT IN	MODEL	
7	C	14909	-23533	-59046	65288	J	-6130	-27398	-81260	85973
8	C	-88	-6052	-65353	65633	J	-4420	-4406	42370	42827
9	I	T.E.	NOT IN	MODEL		J	T.E.	NOT IN	MODEL	
10	C	-14879	-14203	-46484	50832	J	-31484	-25713	-62124	74241
11	C	-48554	-21811	78430	94786	J	-52194	1191	148295	157217

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

83

LTR115 38

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : THERMAL EXPANSION + X DIR. ANCHOR MOVEMENT

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	0	0	0
2	I	0	0	0	0	J	0	0	0	0
3	I	0	0	0	0	J	0	0	0	0
4	I	0	0	0	0	J	0	0	0	0
5	I	6032	-13842	-27198	31108	C	-2116	-5925	-22023	22904
6	I	T.E.	NOT IN	MODEL		J	T.E.	NOT IN	MODEL	
7	C	-15998	-20584	-845	26084	J	-29913	-13146	-6788	33372
8	C	-10841	11153	-5144	16382	J	-3870	5675	5816	9000
9	I	T.E.	NOT IN	MODEL		J	T.E.	NOT IN	MODEL	
10	C	-4629	12686	-21071	25027	J	7206	15768	-27905	32852
11	C	-1146	-4096	-17802	18303	J	-1872	16	-9590	9771

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

84

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : LOCE

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	60	61	86
2	I	0	60	61	86	J	0	152	150	214
3	I	0	152	150	214	J	0	264	256	368
4	I	0	264	256	368	J	0	375	360	520
5	I	4597	1522	1577	5093	C	2800	2820	1100	4123
6	I	616	1310	2160	2600	J	616	485	954	1235
7	C	690	926	249	1181	J	719	2340	658	2535
8	C	2060	958	640	2360	J	2040	1020	841	2431
9	I	2040	1120	703	2431	J	2040	1540	1050	2763
10	C	3290	1150	477	3518	J	3670	220	1130	3846
11	C	2810	3890	2290	5317	J	1040	6220	4440	7713

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

86

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : SSE

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	29	32	43
2	I	0	29	32	43	J	0	75	82	110
3	I	0	75	82	110	J	0	132	144	195
4	I	0	132	144	195	J	0	190	207	281
5	I	1566	510	530	1730	C	962	957	371	1407
6	I	213	451	749	900	J	213	178	351	447
7	C	263	310	84	415	J	253	793	228	863
8	C	707	321	217	806	J	689	377	286	836
9	I	689	386	273	836	J	689	528	387	950
10	C	1120	402	197	1206	J	1250	78	391	1312
11	C	958	1320	769	1803	J	371	2110	1490	2610

NOTE: ALL MOMENTS IN UNITS OF IN-LB.

LTR115 38

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : LOCA

87

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	69	72	100.
2	I	0	69	72	100	J	0	172	173	244
3	I	0	172	173	244	J	0	295	288	412
4	I	0	295	288	412	J	0	416	402	578
5	I	6005	1991	2063	6654	C	3660	3680	1440	5386
6	I	804	1710	2820	3395	J	804	628	1230	1598
7	C	888	1210	325	1536	J	934	3050	852	3302
8	C	2690	1250	836	3082	J	2670	1320	1100	3175
9	I	2670	1460	900	3173	J	2670	2010	1350	3604
10	C	4290	1500	593	4583	J	4800	286	1470	5028
11	C	3660	5080	3000	6943	J	1350	8130	5810	10083

LTR115 38

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : LOCA + SSE (ADDITION OF RESULTANTS ONLY)

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I				0	J				143
2	I				143	J				354
3	I				354	J				607
4	I				607	J				859
5	I				8384	C				6793
6	I				4295	J				2045
7	C				1951	J				4165
8	C				3888	J				4011
9	I				4009	J				4554
10	C				5789	J				6340
11	C				8746	J				12693

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

STEAM GENERATOR MAIN FEED PIPING LOOP SEAL ADDITION

RESULTANT MOMENTS

CASE : ANCHOR MOVEMENT - $\delta X = 0.060$ IN.

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	0	0	0
2	I	0	0	0	0	J	0	0	0	0
3	I	0	0	0	0	J	0	0	0	0
4	I	0	0	0	0	J	0	0	0	0
5	I	10449	-25501	-15908	31821	C	-7054	-16724	-11966	21740
6	I	-13217	4403	441	13938	J	-13217	-138	11527	17538
7	C	-21336	-8747	-13417	26679	J	-25588	-1516	-18144	31405
8	C	-23481	6602	-15297	28791	J	-16250	10854	-6243	20515
9	I	-16251	-2653	-12392	20608	J	-16251	650	-4330	16831
10	C	-12350	12366	-9995	20133	J	1290	20425	-14620	25151
11	C	-3538	-12647	-21481	25177	J	-7386	-9154	-14697	18824

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

Steam Generator Main Feed Piping Loop Seal Addition

Resultant Moments

Case : Anchor Movement – $\delta Z = 0.177$ in.

EL.	END	TX	MY	MZ	RES.	END	TX	MY	MZ	RES.
1	I	0	0	0	0	J	0	0	0	0
2	I	0	0	0	0	J	0	0	0	0
3	I	0	0	0	0	J	0	0	0	0
4	I	0	0	0	0	J	0	0	0	0
5	I	759	13844	-71501	72833	C	10592	9878	-53982	55891
6	I	14736	14175	-4731	20987	J	14736	-23209	8808	28868
7	C	9571	-11696	-71618	73195	J	-1805	-15768	-92616	93966
8	C	-12728	-10603	-75506	77302	J	-16800	773	30311	34664
9	I	-16800	-28408	-10598	34664	J	-16800	-1220	-752	16861
10	C	-22600	-14523	-35408	44446	J	-37400	-21056	-48839	65018
11	C	-50946	-30362	74751	95420	J	-57708	-7947	143188	154584

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

R10

LTR115 38

APPENDIX C

PIPING EVALUATION

EVALUATION OF LOOP SEAL PIPING

THE FOLLOWING PAGES DESCRIBE THE STRUCTURAL ADEQUACY EVALUATION OF THE LOFT STEAM GENERATOR PIPING USING THE "MAXIMUM MOMENT METHOD". STRUCTURAL ADEQUACY CRITERIA IS AS SPECIFIED IN SUBSUBARTICLE NC-3650 OF THE ASME CODE.

THE PROCEDURE USED IN THE MAXIMUM MOMENT METHOD OF EVALUATION MAY BE VERY BRIEFLY DEFINED BY THE FOLLOWING STEPS:

1. CALCULATE MAXIMUM ALLOWABLE MOMENTS FOR EACH PIPE SIZE AND SERVICE CONDITION USING CODE EQUATIONS.

2. COMPARE MAXIMUM ALLOWABLE MOMENTS TO "ACTUAL" MOMENTS AS CALCULATED BY ANALYSIS.

THUS, THE EVALUATION IS COMPLETED AS FOLLOWS.

FOR CONSIDERATION OF SUSTAINED LOADS (DEAD WEIGHT, FOR EXAMPLE) EQUATION 8 MAY BE WRITTEN:

$$S_{SL} = \frac{Pd^2}{D_o^2 - d^2} + .75i\left(\frac{M_A}{Z}\right) \leq 1.0 S_H$$

WHERE
- P = DESIGN PRESSURE ~ PSI
- D_o = PIPE O.D. ~ IN.
- d = PIPE I.D. ~ IN
- M_A = RESULTANT MOMENT DUE TO SUSTAINED LOADS ~ IN-LB
- i = STRESS INTENSIFICATION FACTOR (.75i NEVER < 1.0)
- S_H = MATERIAL ALLOWABLE AT DESIGN TEMP.
- Z = PIPE SECTION MODULUS ~ IN^3

SUBPARAGRAPH NC-3652.4 ALLOWS THE SECTION MODULUS, Z, TO BE CALCULATED AS:

$$Z = \pi r^2 t_n$$

WHERE r = MEAN RADIUS ~ IN.
t_n = NOMINAL WALL THICKNESS ~ IN.

THE FOLLOWING TABLE SUMMARIZES THE CALCULATION OF Z FOR THE PIPE SIZES UNDER CONSIDERATION

PIPE	r (IN.)	t_n (IN.)	Z (IN^3)
6 INCH SCH 80	3.096	.432	13.013
5 INCH SCH 80	2.594	.375	7.927
1/2 INCH SCH 80	.3465	.147	.055

THE FOLLOWING DATA WILL ALSO BE USED.

PIPE	MAT'L	D_o (IN.)	d (IN.)	P (PSI)	S_H (PSI)
6" SCH 80	A106, GR B	6.625	5.761	1100	15000
5" SCH 80	↓	5.563	4.813	↓	
1/2" SCH 80		.840	.546		

NOTE: S_H VALUE AT 600°F.

STRESS INTENSIFICATION FACTORS ARE CALCULATED AS SHOWN IN FIG. NC-3673(b)-1. THUS, FOR ELBOWS AND PIPE BENDS:

$$h = \frac{t_n R}{r^2}$$

$$i = .9 / h^{2/3}$$

WHERE R = BEND RADIUS ~ IN

FOR A 5" L.R. ELBOW R = 1.5(5.0) = 7.5 IN.
" " 6" " " R = 1.5(6.0) = 9.0 IN.

FOR A 5" ELBOW:

$$h = \frac{.375(7.5)}{(2.594)^2} = .4180$$

$$i = .9/(.418)^{2/3} = \underline{\underline{1.610}}$$

FOR A 6" ELBOW:

$$h = \frac{.432(9)}{(3.096)^2} = .4056$$

$$i = .9/(.4056)^{2/3} = \underline{\underline{1.6425}}$$

FOR A 6" x 5" REDUCER α WILL BE ASSUMED AS 30°; THUS:

$$i = 0.5 + .01\alpha\,(D_2/t_2)^{1/2}$$

$$D_2 = 5.563$$
$$t_2 = .375$$

$$i = .5 + .01(30)\left(\frac{5.563}{.375}\right)^{1/2}$$

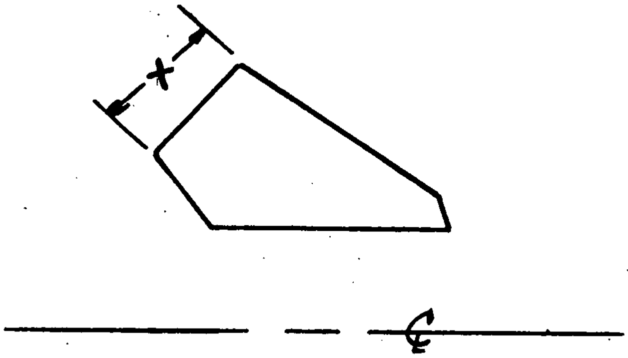
$$= .5 + .3(14.83)^{1/2}$$

$$= .5 + 1.155$$

$$\underline{\underline{i = 1.655}}$$

SINCE THE 30° ANGLE IS CONSERVATIVE FOR THIS SIZE REDUCER, THE ABOVE NUMBER WILL ALSO BE CONSERVATIVE.

A HALF SECTION OF THE 6 x ½ WELDOLET USED TO ATTACH THE HALF INCH DRAIN PIPING IS APPROXIMATED AS SHOWN BELOW:



$$X = t_{REQ'D} + T$$

$$t_{REQ'D} = \frac{P D_o}{2(S + Py)} \quad \text{FROM EQ. 3, NC-3641.1}$$

FOR 1/2 INCH SCH. 80 PIPE :

$$D_o = .840$$

ALSO HAVE $P = 1100$ PSI

$S = 17,500$ PSI @ 600°F FOR A105 MAT'L

$$t_R = \frac{1100(.840)}{2(17500 + 1100(.4))}$$

$$t_R = .0258$$

$$X \cong .6 \text{ IN}$$

$$\Rightarrow T = X - t_r$$

$$= .6 - .0258$$

$$T = .5742 \text{ IN}$$

STRESS INTENSIFICATION CAN BE CALCULATED AS

$$i = .9 / h^{2/3}$$

$$h = \frac{(t_p + \frac{1}{2}T)^{5/2}}{t_p^{3/2}(r_{op})}$$

WHERE t_p = THICKNESS OF RUN PIPE ~ IN.
r_{op} = OUTSIDE RADIUS OF RUN PIPE ~ IN.

FOR THE 6" SCH 80 RUN PIPE, $t_p = .432$, $r_{op} = 3.3125$

$$h = \frac{(.432 + .5(.574))^{5/2}}{(.432)^{3/2}(3.3125)}$$

$$h = .466$$

$$i = .9/(.466)^{2/3}$$

$$\underline{i = 1.497}$$

SINCE THE STRESS INTENSIFICATION FACTORS FOR THE 5 INCH ELBOW, 6 INCH ELBOWS, AND 6x5 INCH REDUCER ARE ALL FAIRLY SIMILAR, THE MAXIMUM VALUE OF 1.655 WILL BE USED FOR CONSERVATISM IN THE COMPLETION OF THESE CALCULATIONS.

FOR THE 6 INCH SCHEDULE 80 PIPE, THE MAXIMUM ALLOWABLE SUSTAINED LOAD MOMENT IS CALCULATED AS FOLLOWS:

$$\frac{Pd^2}{D_0^2 - d^2} + .75i\left(\frac{M_A}{Z}\right) \leq S_H$$

SUBSTITUTING QUANTITIES LISTED ABOVE:

$$\frac{1100(5.761)^2}{(6.625)^2 - (5.761)^2} + .75(1.655)\left(\frac{M_A}{13.013}\right) = 15000$$

$$3411 + .0954\, M_A = 15000$$

$$M_A = 121,497 \text{ IN-LB}$$

SIMILAR CALCULATIONS FOR THE 5 INCH AND ½ INCH PIPING YIELD:

$$M_{A_{5''}} = 74883 \text{ IN·LB}$$

$$M_{A_{1/2''}} = 695 \text{ IN-LB}$$

USING THE MOMENT DATA PRESENTED IN APPENDIX B, THE FOLLOWING COMPARISONS CAN BE MADE:

PIPE SIZE	MAX. ALLOWABLE MOMENT	MAX "ACTUAL" MOMENT
6" SCH 80	121 497	31055
5" SCH 80	74883	32 000
1/2" SCH 80	695	0

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

AS CAN BE SEEN IN THE ABOVE TABLE, ALL MOMENT VALUES ARE WELL WITHIN ALLOWABLE LIMITS.

FOR CONSIDERATION OF OCCASIONAL LOADS (SSE, FOR EXAMPLE), EQUATION 9 MAY BE WRITTEN AS:

$$S_{OL} = \frac{P_M d^2}{D_o^2 - d^2} + .75\,i\left(\frac{M_A + M_B}{Z}\right) \le 1.2\,S_H \quad \text{(NORMAL \& UPSET)}$$

$$\le 1.8\,S_H \quad \text{(EMERGENCY)}$$

$$\le 2.4\,S_H \quad \text{(FAULTED)}$$

WHERE M_B = RESULTANT MOMENT DUE TO OCCASIONAL LOADS ~ IN-LB
P_M = MAX. PRESSURE ~ PSI
ALL OTHER QUANTITIES AS PREVIOUSLY DEFINED

USING THE MAXIMUM MOMENTS LISTED ABOVE FOR THE M_A VALUES AND ASSUMING $P_M = P_{DESIGN}$, THE MAXIMUM ALLOWABLE OCCASIONAL LOAD MOMENT FOR THE 6 INCH SCH 80 PIPE IS CALCULATED AS FOLLOWS:

$$\frac{Pd^2}{D_o^2 - d^2} + .75\,i\left(\frac{M_A + M_B}{Z}\right) = 1.2\,S_H$$

$$\frac{1100\,(5.761)^2}{(6.625)^2 - (5.761)^2} + .75(1.655)\left(\frac{31055 + M_B}{13.013}\right) = 18000$$

$$3411 + 2963 + .0954\,M_B = 18000$$

M_B = 121866 IN-LB (NORMAL & UPSET CONDITIONS)

M_B = 216205 IN-LB (EMERGENCY CONDITIONS)

M_B = 310545 IN-LB (FAULTED CONDITIONS)

IT SHOULD BE NOTED THAT FOR THIS ANALYSIS, LOSS OF COOLANT EXPERIMENT (LOCE) LOADS WERE CONSIDERED AS UPSET CONDITION LOADS. SAFE SHUT-DOWN EARTHQUAKE (SSE) LOADS WERE CONSIDERED AS EMERGENCY CONDITION LOADS. SINCE AN EARTHQUAKE COULD CAUSE A LOSS OF COOLANT ACCIDENT (LOCA), LOCA + SSE LOADS WERE CONSIDERED AS FAULTED CONDITION OCCASIONAL LOADS. SIMILAR CALCULATIONS TO THOSE SHOWN ABOVE WERE PERFORMED FOR THE 5 INCH AND ½ INCH PIPE SIZES. THE RESULTS OF THESE CALCULATIONS ARE SHOWN IN THE COMPARISON TABLE BELOW.

PIPE SIZE	CONDITION	LOAD	MAX. ALLOWABLE MOMENT	MAX. MOMENT
6" SCH 80	NORMAL & UPSET	LOCE	121866	7713
	EMERGENCY	SSE	216205	2610
	FAULTED	LOCA + SSE	310545	12693
5" SCH 80	NORMAL & UPSET	LOCE	62042	5093
	EMERGENCY	SSE	119519	1730
	FAULTED	LOCA + SSE	176996	8384
½" SCH 80	NORMAL & UPSET	LOCE	842	520
	EMERGENCY	SSE	1283	281
	FAULTED	LOCA + SSE	1724	859

NOTE: ALL MOMENTS IN UNITS OF IN.-LB.

THE ABOVE TABLE SHOWS THAT ALL MOMENT VALUES ARE WELL WITHIN ALLOWABLE LIMITS.

THE EFFECTS OF THERMAL EXPANSION MAY BE CONSIDERED USING EQUATION 11:

$$S_{TE} = \frac{Pd^2}{D_o^2 - d^2} + .75i\left(\frac{M_A}{Z}\right) + i\left(\frac{M_C}{Z}\right) \leq (S_H + S_A)$$

WHERE M_C = RANGE OF RESULTANT MOMENTS DUE TO THERMAL EXPANSION INCLUDING EFFECTS OF ANCHOR DISPLACEMENTS IF NOT INCLUDED IN EQUATION 9 ~ IN-LB

S_A = ALLOWABLE STRESS RANGE FOR EXPANSION STRESSES
ALL OTHER QUANTITIES AS PREVIOUSLY DEFINED

FROM NC-3611.2 HAVE:

$$S_A = f\,(1.25\,S_C + .25\,S_H)$$

WHERE f = STRESS RANGE REDUCTION FACTOR FOR CYCLIC CONDITIONS
S_C = ALLOWABLE STRESS AT MINIMUM (COLD) TEMPERATURE ~ PSI
S_H = ALLOWABLE STRESS AT MAXIMUM (HOT) TEMPERATURE ~ PSI

USING $f = 1.0$
S_C = 15000 PSI (ASTM A106, GR B, @ 100°F)
S_H = 15000 PSI (A106, GR B, @ 650°F)

$$S_A = 1.0\,(1.25(15000) + .25(15000))$$

$$S_A = 22500 \text{ PSI}$$

THUS $S_H + S_A = 15000 + 22500 = 37500$ PSI

USING THE MAXIMUM DEADWEIGHT MOMENT PREVIOUSLY LISTED, THE CALCULATION FOR THE 6 INCH SCHEDULE 80 PIPE IS AS FOLLOWS:

$$\frac{Pd^2}{D_o^2-d^2} + .75i\left(\frac{M_A}{Z}\right) + i\left(\frac{M_C}{Z}\right) \le (S_H + S_A)$$

$$\frac{1100\,(5.761)^2}{(6.625)^2-(5.761)^2} + .75(1.653)\left(\frac{31055}{13.013}\right) + 1.655\left(\frac{M_c}{13.013}\right) = 37500$$

$$3411 + 2962 + .1272\,M_c = 37500$$

$$M_c = 244{,}745 \text{ IN-LB}$$

SIMILAR CALCULATIONS FOR THE 5 INCH AND 1/2 INCH PIPING AND THE RESULTS ARE SHOWN IN THE COMPARISON TABLE BELOW.

PIPE SIZE	MAX ALLOWABLE MOMENT	MAX MOMENTS T.E. + Z ANCH. DISP.	T.E. + X ANCH. DISP.
6" SCH 80	244745	157217	33372
5" SCH 80	139931	86784	31108
1/2" SCH 80	1348	0	0

NOTE: ALL MOMENT VALUES IN UNITS OF IN.-LB.

THE TABLE ABOVE SHOWS THAT ALL MOMENTS ARE WITHIN ALLOWABLE LIMITS.

FROM THE CALCULATIONS PRESENTED IN THE PRECEEDING PAGES IT CAN BE SEEN THAT ALL REQUIREMENTS OF SUBSUBARTICLE NC-3650 WILL BE MET.

APPENDIX D

MICROFICHE COPIES OF COMPUTER OUTPUT AND SAP IV LISTING