SEISMIC AND STRESS ANALYSIS OF THE LACBWR 14" SHUTDOWN CONDENSER VENT PIPING SYSTEM

PREPARED FOR

DAIRYLAND POWER COOPERATIVE

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Project Application	Prepared By	Date
5101	N. Cao [signature]	7/26/82
APPROVALS		
TITLE/DEPT.	SIGNATURE	DATE
Manager, Structural Engineering	[signature]	7/26/82
General Manager, General Engineering Svcs.	[signature]	7/26/82
Project Engineer	[signature]	7/26/82
V.P. Engineering Service Operations	[signature]	7/27/82
Quality Assurance Manager	[signature]	7/27/82
8208170112 820722 PDR ADOCK 05000409 P PDR		

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1.0 SUMMARY

This report, prepared for Dairyland Power Cooperative, presents the results of seismic stress analysis of the 14" Vent line of the shutdown condenser system. The shutdown condenser is a safety-related system at LACBWR. The analysis performed is in accordance with the design requirements of the ASME Boiler and Pressure Vessel Code, Section III, Division I, Class 2 piping code of 1980. The original design of LACBWR's piping was to the ANSI B-31.1 piping code. Class 2 piping analysis methods are considered to be appropriate and conservative.

It was necessary to assume that the vertical support at node 110 will be modified so that it can resist lateral loads. With this simple modification, results of the analysis indicate that the stresses are low compared to the allowable stresses. The bellows expansion joint included in this line undergoes an applied torque, which is considered an undesirable form of loading for expansion joints per Section III of the ASME 1980 code. The bellows' applied torques have been calculated to be 5034 lb-in and 8009 lb-in for OBE and SSE events respectively. However, an evaluation based on the bellows manufacturers recommendations (Ref. 6) shows that the bellows can withstand the applied torque. The maximum allowable applied torque according to the formula given in Reference 6 is 94,000 lb-in.

2.0 INTRODUCTION

At the LACBWR, the shutdown condenser system provides a backup heat sink for the reactor in the event that the reactor is isolated from the main condenser. The system consists of a condenser, piping, valves and instrumentation equipment. The shutdown condenser system is automatically started when the reactor building steam isolation valve or turbine building steam isolation valve is not fully open, or when the reactor pressure exceeds 1,325 psi. These are emergency conditions that also provide a scram signal to the reactor safety system.

The shutdown condenser is a horizontal U-tube heat exchanger, with reactor steam condensing inside the tubes. Reactor coolant sensible and latent heat is transferred to boiling, demineralized water on the shell side. The shell side vapor is vented directly to the outside atmosphere via the 14" vent line. The heat removal capacity of the shutdown condenser is well in excess of reactor decay heat generation rate for all times following reactor shutdown. The system provides adequate emergency shutdown cooling capability by cooling reactor water to 300° F at a rate of 50° F/hour. However, the normal mode of operation for reactor water cooling below 470° F is the decay heat cooling system.

Natural circulation is the driving force behind the system. Steam flows from the main steam lines into the shutdown condenser located ten feet above the main floor of the containment building. Condensate is collected in the lower channel section and is returned to the feedwater lines by gravity flow.

The shutdown condenser system has been designated as a safe shutdown system and, as such, it must be capable of operating during and after a seismic event. The 14-inch vent line to atmosphere must remain intact to ensure proper system operation since a break in this line would: (a) interfere with transfer of reactor decay heat to an external heat sink (atmosphere) as required; and (b) represent a breach of the containment boundary.

For the purpose of this analysis, the evaluation of the 14-inch atmospheric vent line is performed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NC (Class 2 components). These requirements are applied even though the vent line (and all other reactor plant piping) was originally designed and fabricated to ANSI B31.1 Power Piping code requirements. This is justified since the basic methodology and the allowable stresses are the same for ANSI B31.1 and ASME Section III Classes 2 and 3. This approach also allows for overall consistency with previous NES and Gulf United piping stress analyses performed for LACBWR.

Section 3.0 of this report describes the physical and geometrical properties of the shutdown condenser 14-inch vent line. The loading criteria, design criteria and analytical methods used in the analysis are given in Sections 4.0, 5.0 and 6.0 respectively. The results of the analysis are discussed in Section 7.0. The conclusions and recommendations are summarized in Section 8.0.

3.0 PIPING SYSTEM DESCRIPTION

The 14" vent line, which consists of carbon steel pipe, is designed to supply a path for steam from the shell side of the shutdown condenser to leave the Containment Building. It originates at the nozzle of the shutdown condenser and terminates upon leaving the containment vessel.

The layout of the shutdown condenser vent piping is shown in Figure 3.1. The mathematical model for the vent line is shown in Figure 3.2 . A bellows expansion joint is included in the vent line. This accommodates thermal expansion following shutdown condenser initiation.

The governing design specification used in the analysis of the 14" vent line piping system is given in Reference 3. The piping arrangement analyzed and piping suspension (support) characteristics have been taken from the drawings listed in Reference 4. Piping properties have been taken from the information given in Reference 3. Bellows properties have been taken from Reference 5. This information is summarized in Table A-I and Table A-II of Appendix A.

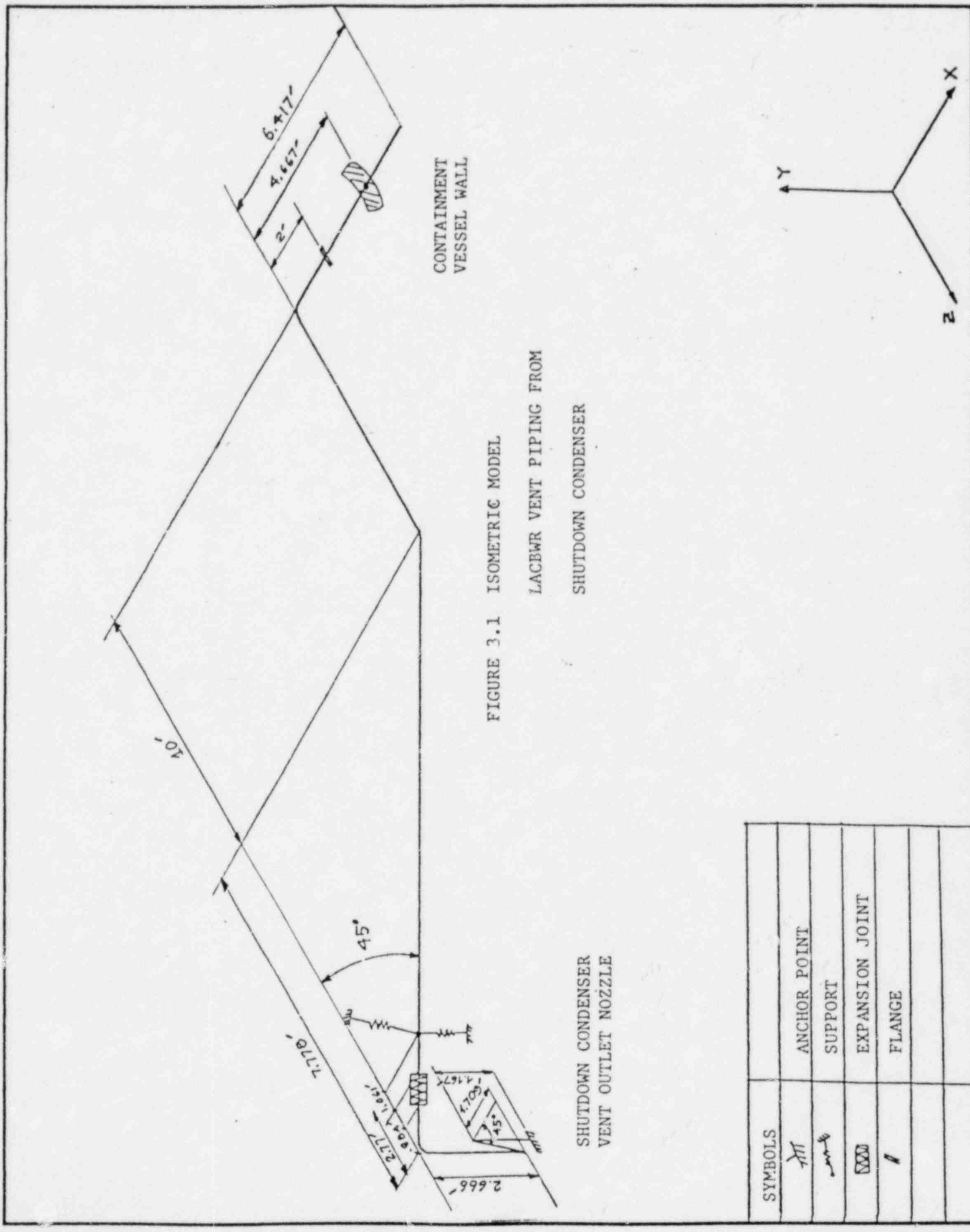


FIGURE 3.1 ISOMETRIC MODEL
LACBWR VENT PIPING FROM
SHUTDOWN CONDENSER

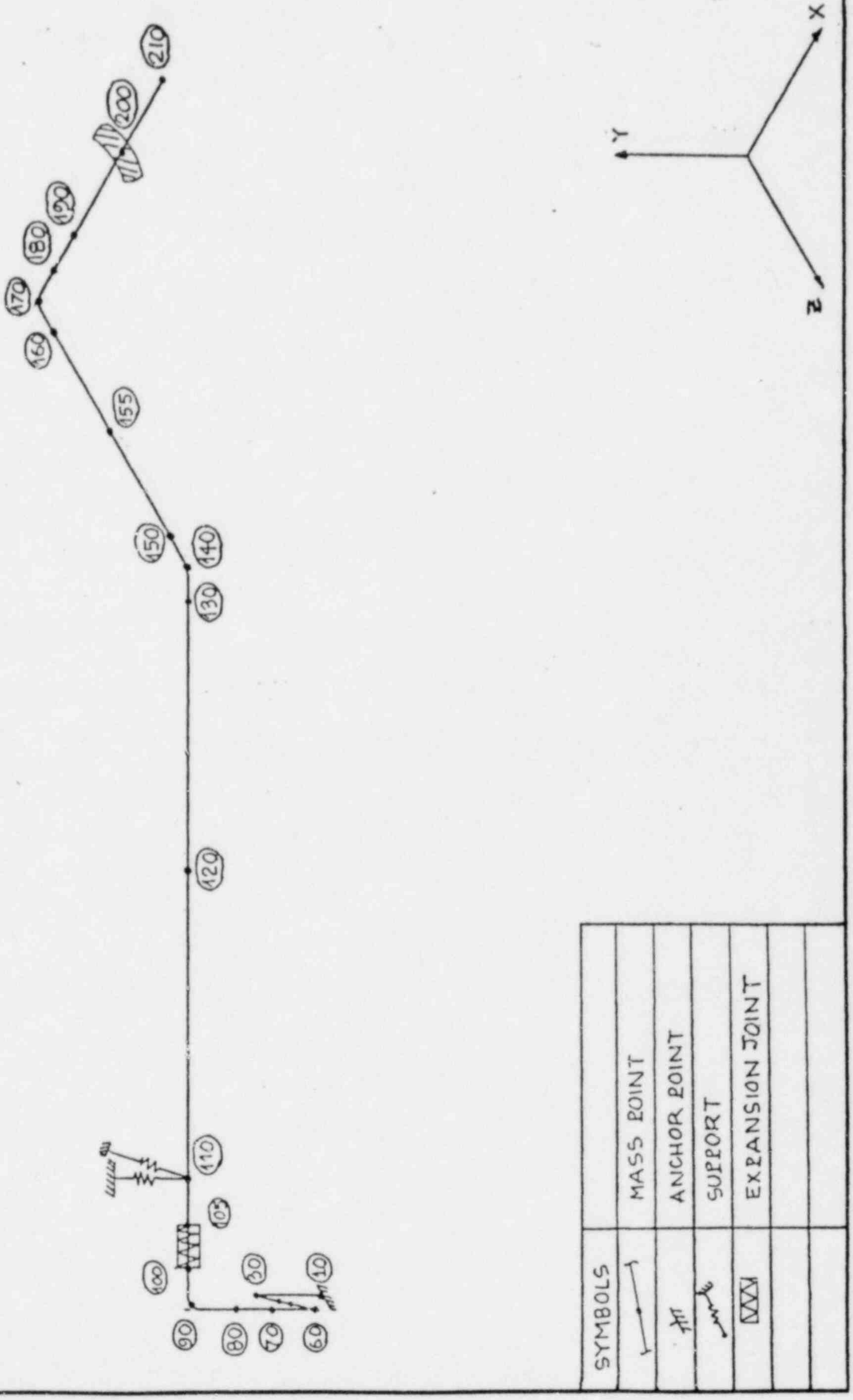


FIGURE 3.2 MATHEMATICAL MODEL
LACBWR VENT PIPING FROM
SHUTDOWN CONDENSER

4.0 LOADING CRITERIA

The load cases which must be considered in performing a Class 2 Stress Analysis include: Dead loads and sustained mechanical loads, internal pressure, thermal expansion loading and seismic loading. The static and dynamic load cases are summarized in Table A-III and A-IV of Appendix A.

4.1 DEADLOAD PLUS SUSTAINED MECHANICAL LOAD PLUS OPERATING PRESSURE: (Static Load Case 1)

The deadweight of the piping system is calculated assuming the system to be filled with evaporated water. The weight of expansion joint is also included in the analysis. Dimensions of expansion joint are taken from vendor drawings and specifications supplied by DPC and are given in Table A-II of Appendix A.

4.2 INTERNAL PRESSURE (Static Load Cases 1 and 3)

System normal operating pressure, Load Case 1 and peak pressure, Load Case 3 used in the analysis are 40 PSI. This corresponds to the internal design pressure of the shutdown condenser shell. The pressure in vent line will not exceed this limit.

4.3 THERMAL LOADING (Static Load Case 2)

The thermal expansion stresses are based on the thermal loading which could occur following a major primary system pipe rupture inside containment. A maximum temperature of 275° F is used for the Vent line analysis.

4.4 SEISMIC LOADING (Load Cases 4 and 5)

A dynamic analysis of the piping system is performed using the response spectrum method of analysis (Section 6.4). Two seismic loading events are considered: The Safe Shutdown Earthquake (SSE) and the Operating Basis Earthquake (OBE).

Seismic inertia loading is imposed on the piping system in the form of seismic acceleration spectra which were derived for the LACBWR plant (Ref. 1). The horizontal SSE and OBE acceleration spectra used for the Vent line are that corresponding to the crane support at an elevation of 726.5 ft. The vertical response spectra for the SSE and OBE loading are taken as 2/3 of the respective horizontal crane support spectra.

The spectra in the global X (horizontal), Y (vertical), Z (horizontal) are applied individually and the total response is formed by the square root of the sum of the squares (SRSS) of those individual resultants. Load case 4 represents the SSE earthquake while load case 5 represents the OBE earthquake. The applicable response spectra used in the analysis for dynamic load cases are shown in Table A-V of Appendix A.

SSE seismically induced anchor movements (static load case 7) for node 10 were estimated by taking the relative displacements of the Shutdown condenser platform with respect to the main floor (from the shutdown condenser platform analysis) added to the relative displacements of the crane support level with respect to the main floor (from the containment building analysis). For the OBE, seismic anchor movements (load case 6) were taken as one half of the SSE anchor movements.

5.0 STRESS ACCEPTANCE CRITERIA

The requirements for acceptability of a Class 2 piping system are given in Paragraph NC-3611 of Reference 2. Calculated stresses resulting from specified load combinations must meet the stress limits of equations 9 through 13 of Paragraph NC-3652 of Reference 2. For conservatism, stress limits no greater than those specified for Service Level B have been applied for acceptance of any combination of loads, including SSE, which are considered in the analysis.

5.1 DESIGN LOADINGS

The sum of stresses due to design internal pressure, weight, and other sustained loads shall not exceed S_h. This requirement is satisfied by meeting Equation (9), NC-3652.1.

5.2 LEVEL A SERVICE LIMITS

The stress range due to thermal expansion shall not exceed S_A, or the sum of stresses due to internal pressure, weight, other sustained loads, and the stress range due to thermal expansion shall not exceed the sum of S_A and S_h. This requirement is satisfied by meeting Equation (11) or (13), NC-3652.3.

5.3 LEVEL B SERVICE LIMITS

The sum of stresses due to internal pressure, live and dead loads, and those due to occasional loads such as wind or earthquake shall not exceed 1.2 times the allowable stress value S_h. This requirement is satisfied by meeting Equation (10), NC-3652.2.

6.0 ANALYTICAL METHODS

6.1 MATHEMATICAL MODEL

In order to perform static, dynamic and stress analyses, the continuous piping system is mathematically modeled as an assembly of elastic structural elements interconnected at discrete nodal points (Figure 3.1). Nodal points are located at all points of interest in the piping system such as elbows, valves, anchorages, hangers, tee intersection, load points, all structural and material discontinuities, etc. This three dimensional multidegree-of-freedom model of the piping system is attached to the "ground" (structure) by means of rigid hangers, support springs, hydraulic snubbers and anchors. Stiffness characteristics of structural elements are related to the moment of inertia and the axial and effective shear area of the pipe cross section. The stiffness characteristics of the elbows and tee connections are modified to account for local deformation by using the flexibility factors given in the ASME Code (Ref. 2).

For the seismic analysis the distributed mass of the piping system is lumped at the system nodal points. Masses are lumped so that the lumped mass, multidegree-of-freedom model represents the dynamic characteristics of the piping system. In order to reduce the number of dynamic degrees-of-freedom, only translational degrees-of-freedom are considered at each mass point (the masses associated with the rotational degrees-of-freedom are set to zero). This assumption has been shown to be completely satisfactory for accurate analysis of seismic response. Special items such as valves and actuators are modeled by lumping their masses at an appropriate offset from the center-line of the piping system.

6.2 STATIC LOAD ANALYSIS

The static load analysis involves the application of the following loading conditions and their combinations:

- Design Pressure
- Gravity Loading (dead weight) and Sustained Mechanical Loads
- Support Displacement
- Thermal Expansion

For the pressure loadings, the hoop and longitudinal stresses in the affected piping are calculated using the formulae given in the Code (see Section 6.5).

For the deadweight, support displacement, or thermal expansion loading conditions the following equations of equilibrium written in matrix form are solved:

$$[K]\{U\} = \{P\} \qquad (1)$$

where:

K = System stiffness matrix
U = Nodal point displacement vector
P = External forces, dead weight or equivalent thermal load vector.

The system stiffness matrix is obtained from element stiffness matrices using direct stiffness methods. The unknown nodal displacements U are obtained as follows:

$$\{U\} = (K)^{-1} \{P\} \qquad (2)$$

The inversion of the stiffness matrix is performed using the Gauss-Siedel technique.

From the nodal displacements U, the member internal forces are determined using the member stiffness matrix. Finally, the member internal forces are used in calculating the stresses.

6.3 EIGENVALUE ANALYSIS

The eigenvalues (natural frequencies) and the eigenvectors (mode shapes) for each of the natural modes of vibration are calculated by solving the following frequency equation:

$$(K - \omega_n^2 M) \{\phi_n\} = \{0\} \qquad (3)$$

where:

ω_n	=	Natural angular frequency for the n^{th} mode
M	=	System mass matrix
ϕ_n	=	Mode shape vector for the n^{th} mode
0	=	Null vector

The eigenvalue/eigenvector extraction is performed using the Householder-QR technique.

6.4 DYNAMIC (SEISMIC) LOAD ANALYSIS

Considering only translational degrees of freedom and assuming viscous (velocity proportional) form of damping, the equation of motion in matrix form can be expressed as follows:

$$M(\ddot{U}_t + \ddot{U}_{gt}) + C\dot{U}_t + KU_t = 0 \qquad (4)$$

where:

$\ddot{U}_t$	=	Relative acceleration time history vector
$\ddot{U}_{gt}$	=	Ground acceleration time history vector
C	=	Damping matrix
$\dot{U}_t$	=	Velocity time history vector
U_t	=	Relative displacement time history vector

Rearranging equation (4)

$$M\ddot{U}_t + C\dot{U}_t + KU_t = -M\ddot{U}_{gt} = P_{eff} \quad (5)$$

To uncouple equation (5), assume

$$U = \phi Y_t$$

where:

ϕ	=	Characteristic free vibration mode shapes matrix.
Y_t	=	Generalized coordinate displacement time history vector.

Pre-and post-multiplying equation (5) by the transpose of ϕ and by ϕ respectively and using orthogonality conditions, the following uncoupled equations of motion are obtained:

$$\ddot{Y}_{nt} + 2\omega_n \lambda_n \dot{Y}_{nt} + \omega_n^2 Y_{nt} = M_n^{*-1} R_n \ddot{U}_{gt} \quad (6)$$

where:

Y_{nt}	=	Generalized displacement coordinate time history for n^{th} mode
λ_n	=	Damping ratio for the n^{th} mode expressed as percent of critical damping
M_n^*	=	Generalized mass for the n^{th} mode
	=	$\phi_n^T M \phi_n = M_i \phi_{in}^2$

The mode shape ϕ_n is normalized such that $M_n^* = 1$

R_n = Participation factor for the n^{th} mode

= $\phi_n^T MI = \sum M_i \phi_{in}$

I = Column vector whose elements are generally unity

The solution for the differential equation (6) is given by the Duhamel Integral

$$Y_{nt} = \frac{R_n}{M_n^* \omega_n} \int_o^t \ddot{U}_{gt} e^{-\lambda_n \omega_n (t-\tau)} \text{Sin}\, \omega_n (t-\tau)\, d\tau$$

Using the response spectrum method of analysis, the maximum values of the generalized response for each mode is given by:

$$\ddot{Y}_{n\ max} = \frac{R_n S_{an}}{M^*_n} \qquad (7)$$

where:

$\ddot{Y}_{n\ max}$ = Maximum generalized coordinate acceleration response for the n^{th} mode.

S_{an} = Spectral acceleration value for the n^{th} mode (from the applicable response spectrum curve)

From the maximum generalized coordinate response, the maximum acceleration ($\ddot{U}_{n\ max}$) and maximum inertia forces ($F_{n\ max}$) at each mass point are given by:

$\ddot{U}_{n\ max}$ = $\ddot{Y}_{n\ max} \phi_{in}$

$F_{n\ max}$ = $M_n \ddot{U}_{n\ max}$

The inertia forces ($F_{n\ max}$) for each of the system natural modes are applied as external static forces, and the piping system response (displacements, member internal forces and stresses) are calculated using the procedure described in Section 6.2. total system response is then obtained by combining the individual modal response values by the square-root of the sum of the squares method; lower modes having large contribution to the response (all modes having natural frequency under 30 cycles per second) are considered and higher modes with negligible participation are neglected.

6.5 STRESS ANALYSIS

The design requirements of the ASME Code for Class 2 piping systems are satisfied when the calculated stresses in the piping system due to thermal expansion, weight, and other sustained and occasional loads are combined in accordance with and meet the limitations of equations 9, 10, 11 and 13 of Subsection NC-3652 of Reference 2. These requirements are described below: (Note: Equation numbers below have been adjusted to correspond to the equation numbers used by the ASME Code 1980 Edition, Subsection NC.)

A. Sustained Loads

The effects of pressure weight and other sustained mechanical loads must meet the requirements of equation (9).

$$S_{SL} = \frac{PD_o}{4t_n} + \frac{0.75iM_A}{Z} \leq 1.0S_h \qquad (9)$$

where:

P	=	Internal design pressure, psi
D_o	=	Outside diameter of pipe, in.
t_n	=	Nominal wall thickness, in.
M_A	=	Resultant moment loading on cross section due to weight and other sustained loads, in. (See NC-3652.4, Ref. 2)
Z	=	Section modulus of pipe, $in.^3$ (See NC-3652.4, Ref. 2)
i	=	Stress intensification factor (NC-3673.2 (b), Ref. 2) The product of 0.75i shall never be taken as less than 1.0
S_h	=	Basic material allowable stress at design temperature

B. Occasional Loads

The effects of pressure, weight, other sustained loads and occasional loads including earthquake must meet the requirements of Equation (10).

$$S_{OL} = \frac{P_{max} D_o}{4t_n} + \frac{0.75i\ (M_A + M_B)}{Z} \leq 1.2S_h \qquad (10)$$

where:

P_{max} = Peak pressure, psi

M_B = Resultant moment loading on cross section due to occasional loads such as earthquake loads

C. Thermal Expansion

The requirements of either Equation (11) or Equation (13) must be met.

1. The effects of thermal expansion must meet the requirements of Equation (11)

$$S_{TE} = \frac{iM_C}{Z} \leq S_A \qquad (11)$$

where:

M_C = Range of resultant moments due to thermal expansion. Also include moment effects of anchor displacements due to earthquake if anchor displacement effects were omitted from Equation (10)

S_A = Allowable stress range for expansion stesses (NC-3611.2, Ref. 2)

Or 2. The effects of pressure, weight, other sustained loads and thermal expansion shall meet the requirements of Equation (13)

$$S_{TE} = \frac{PD_o}{4t_n} + \frac{0.75i\ M_A}{Z} + \frac{iM_C}{Z} \leq (S_h + S_A) \qquad (13)$$

The above mentioned static, dynamic and stress analyses are carried out using the PIPESD computer code. PIPESD was developed by URS/John A. Blume and Associates, Engineers, San Francisco, California and has been extensively used in the seismic and stress analysis of piping system for a number of nuclear power plants. PIPESD is available to Nuclear Energy Services through the Control Data Corporation CYBERNET Service.

7. DISCUSSION OF RESULTS

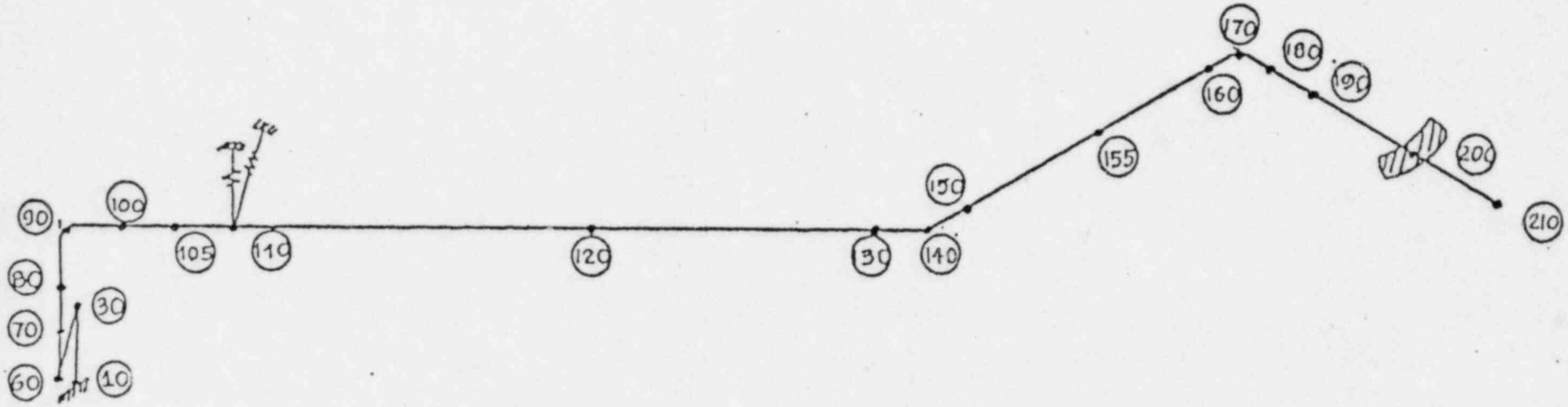
A seismic analysis of the 14" vent line from shutdown condenser piping system with its existing support modified in the lateral direction indicated that the stresses due to Operating Basis Earthquake and Safe Shutdown Earthquake would be lower than the allowable stress. Figures 7.1 through 7.5 summarize the maximum calculated stresses for the various load combinations considered and illustrate compliance with ASME code requirements.

The natural frequencies for the first 3 significant modes of vibration of the piping system are summarized in Table 7-1.

The deflections at each node point due to the various load cases are summarized in Table B-1 of Appendix B. The maximum deflection due to the SSE seismic inertia loading (Load Case 4) is .0168 inches at node point 140. For a flexible piping system this deflection is acceptable. The maximum deflection due to thermal expansion (Load Case 2) is .2282 inches at node 105. Table B-11, pages B-11 through B-14 of Appendix B, summarizes the elastic support reaction forces.

The applied torque on the bellows due to dead load plus thermal load, plus pressure is 1986 lb-in. SSE anchor movement + SSE seismic inertia forces apply an additional 6023 lb-in of torque. Section III of the ASME Boiler and Pressure Vessel code recommends that bellows expansion joints be installed so that they do not undergo torsion. Nevertheless, the bellows manufacturer has stated that the bellows can withstand some torsion and has given a formula to compute the maximum allowable torsion value (Ref. 6). According to this formula, the maximum allowable torque which can be applied to the bellows is 94,000 lb-in. The actual applied torque (1986 + 6023 = 8009 lb-in.) is significantly lower than this value.

FIGURE 7.1



COMPLIANCE WITH ASME CODE EQ. 9
Design Loadings

Applied Loads
Design Pressure Dead Weight and Other Sustained Mechanical Loads
Allowable Stress, 1.0 S_h = 15,000 psi Maximum Stress at Node 150 = 1,188 psi

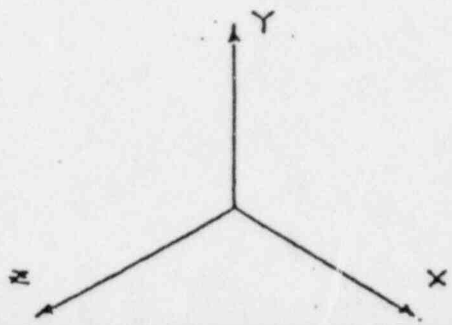
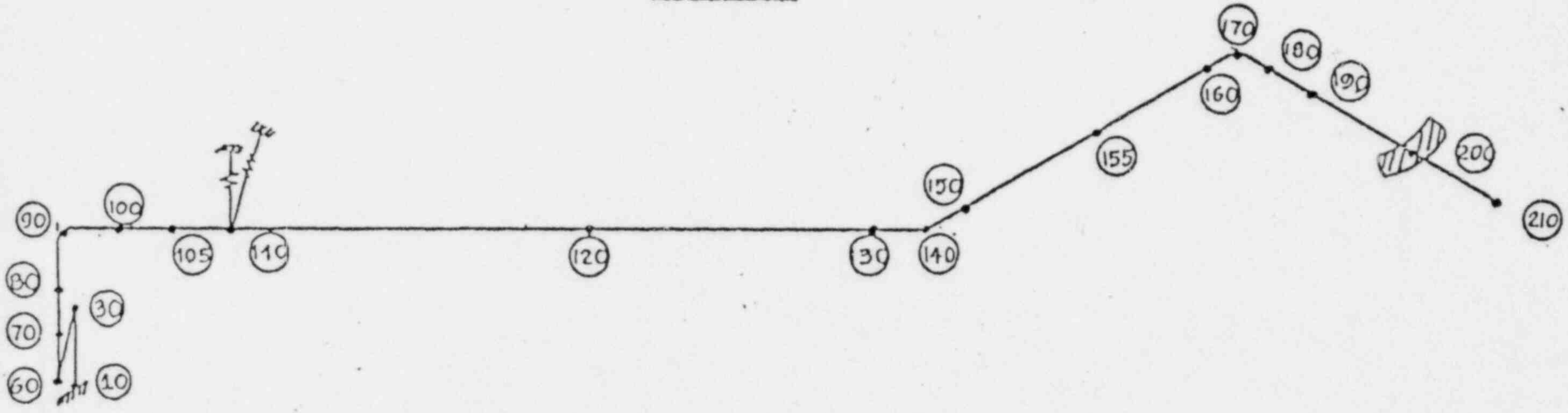


FIGURE 7.2



COMPLIANCE WITH ASME CODE EQ. 10
Level B Service Limit For OBE

Applied Loads
Peak Pressure Dead Weight and Other Sustained Mechanical Loads X+Y+Z Earthquake (½SSE) X+Y+Z Anchor Movement (½SSE)
Allowable Stress, 1.2 S_h = 18,000 psi Maximum Stress at Node 140 = 1,785 psi

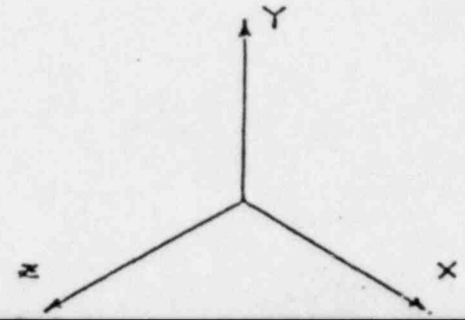
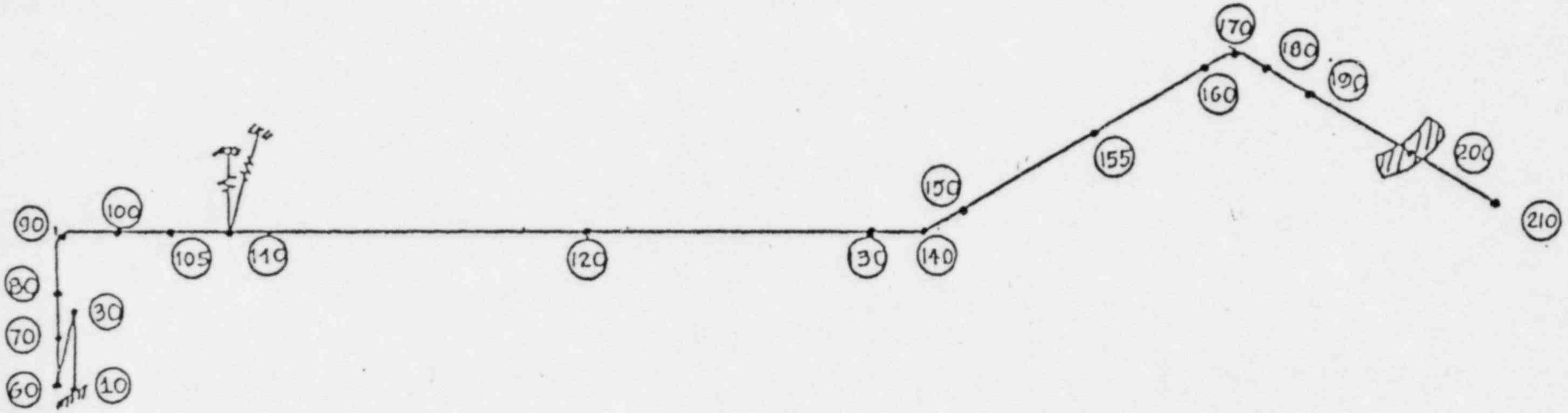
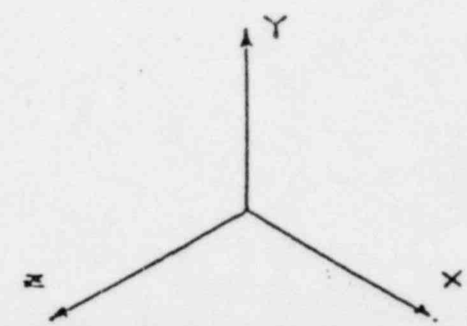


FIGURE 7.3

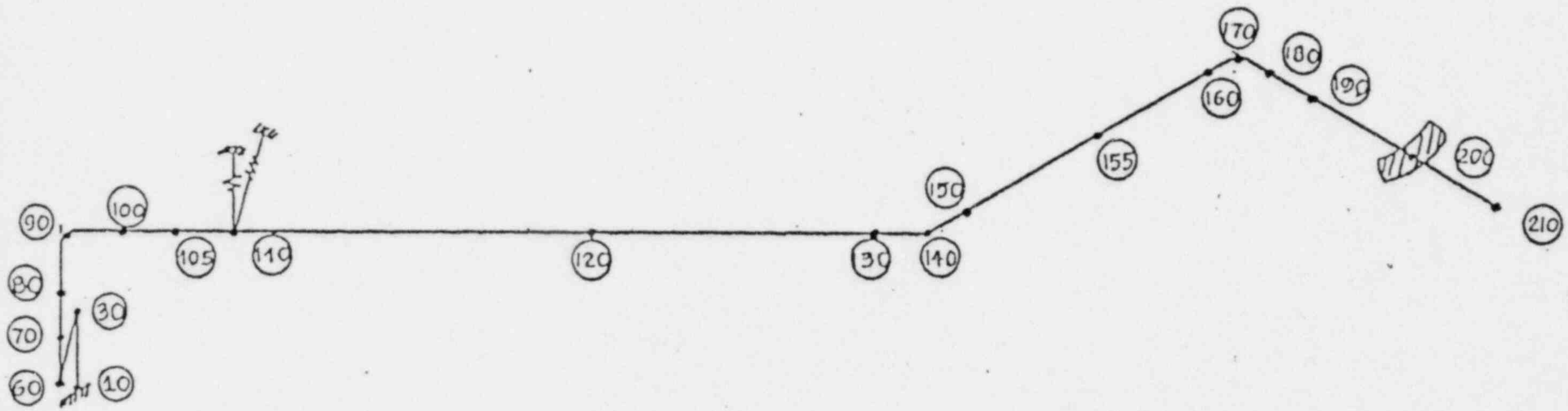




COMPLIANCE WITH ASME CODE EQ. 11
Level A Service Limit

Applied Loads
Design Temperature Thermal Anchor Movements
Allowable Stress, S_A = 22,500 psi Maximum Stress at Node 140 = 633 psi

FIGURE 7.4



COMPLIANCE WITH ASME CODE EQ. 13
Level A Service Limit

Applied Loads
Design Pressure and Temperature Dead Weight and Other Sustained Mechanical Loads Thermal Anchor Movement Seismic Anchor Movement
Allowable stress, $S_h + S_A$ = 37,500 psi Maximum Stress at Node 150 = 1821 psi

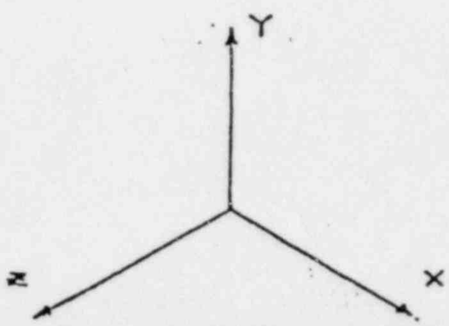
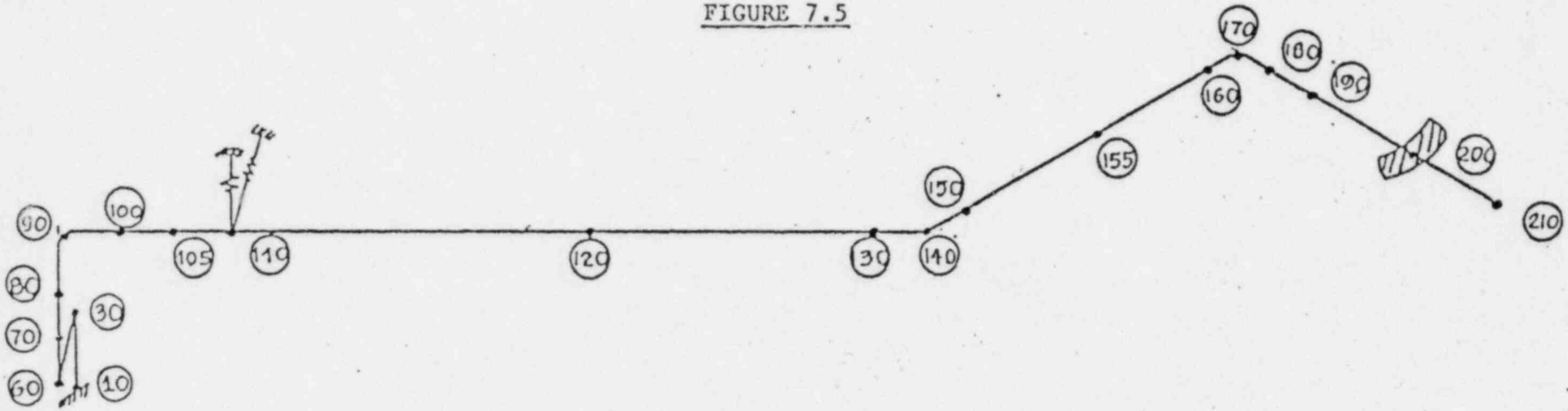


FIGURE 7.5



COMPLIANCE WITH ASME CODE EQ. 10

Level B Service Limit For SSE

Applied Loads
Peak Pressure Dead Weight and Other Sustained Mechanical Loads X+Y+Z Earthquake (SSE) X+Y+Z Anchor Movements (SSE)
Allowable Stress, 1.2 S_h = 18,000 psi Maximum Stress at Node 140 = 2,282 psi.

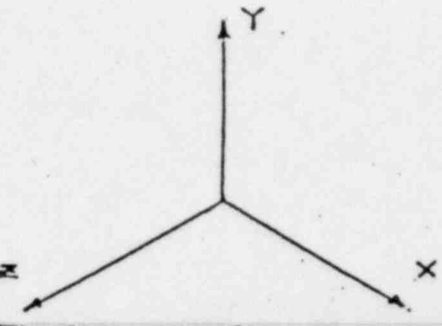


TABLE 7.1.

VIBRATION FREQUENCIES (PERIODS)

MODE	FREQUENCY (CPS)	PERIOD (SEC)	MODE	FREQUENCY (CPS)	PERIOD (SEC)
1	20.5646	.0486273	16	480.4491	.0020814
2	26.0020	.0384585	17	505.8260	.0019770
3	39.7532	.0251552	18	534.5363	.0018708
4	46.3107	.0215933	19	625.9840	.0015975
5	46.9636	.0212931	20	625.9841	.0015975
6	76.0288	.0131529	21	674.5639	.0014824
7	116.3767	.0085928	22	690.4489	.0014483
8	147.7348	.0067689	23	729.4692	.0013709
9	160.7971	.0062190	24	909.3581	.0010997
10	204.7682	.0048836	25	1040.9931	.0009606
11	222.0870	.0045027	26	1282.9654	.0007794
12	227.3131	.0043992	27	1301.7684	.0007682
13	252.0619	.0039673	28	2074.0304	.0004822
14	276.6335	.0036149	29	2131.8670	.0004691
15	392.5377	.0025475	30	2255.6881	.0004433

NUMBER OF SIGNIFICANT MODES = 3

8. CONCLUSION AND RECOMMENDATIONS

1. The results of the subject analysis, which includes the effects of additional lateral restraint at the existing support, indicate that the deflections of the 14" vent line piping system, due to dead load, thermal load and seismic load are nominal. In addition, the stress resulting from these loadings, as calculated and combined in accordance with the rule given in sub-article NC-3652 of Section III of the ASME Code (Reference 2), satisfy the design requirements of class 2 piping systems.

2. It is therefore recommended that the support near the bellow of 14" vent line be modified to provide restraint in the lateral direction.

9. REFERENCES

1. Gulf United Services Report No. SS-1162 "Seismic Evaluation of the LaCrosse Boiling Water Reactor", dated January 11, 1974.
2. ASME Boiler and Pressure Vessel Code, Section III, Division I, 1980 Edition, Nuclear Power Plant Components.
3. Sargent and Lundy Engineers "Specification for Piping System - LaCrosse Boiling Water Reactor" LACBWR No. 256.
4. Sargent and Lundy Engineers "LACBWR" Project Drawing Nos. 41-503362, 503370, 503372.
5. DPC Letter LAC-8244 dated April 28, 1982, Attachment 11, pg. 12 of 13.
6. Standards of the Expansion Joint Manufacturers Association, Inc. 1980 Ed., pg. 79.

UNCITED REFERENCES

1. U.S. Atomic Energy Commission - Regulatory Guide 1.60, Rev. 1, December 1973.
2. U.S. Atomic Energy Commission - Regulatory Guide 1.61, October 1973.

APPENDIX A

LACBWR 14" VENT LINE PIPING ANALYSIS

ANALYTICAL INPUT DATA

TABLE A-I - PIPE DATA

	Run 1	Run 2
From Point	10	105
To Point	100	210
O.D. (in)	14	14
Wall Thickness (in.)	.438	.438
Matl. ASTM	A106-B	A106-B
Fluid	Steam	Steam
Wt. of Pipe and Fluid (lb/in)	5.28	5.28
Design Temp. (^{o}F)	275	275
Design Pressure (psia)	40	40
Elastic Modulus (psia x 10^{-6})	29	29

TABLE A-II - BELLOWS DATA (FROM MANUFACTURER)

	Beam No.1
From Point	100
To Point	105
O.D. (in)	14
Wall Thickness (in), (2 plies)	.076
Matl. ASTM	A321
Fluid	Steam
Wt. of Bellows and Fluid (lb/in)	4.067
Axial Spring Rate (lb/in)	548
Lateral Spring Rate (lb/in)	2845
Bending Angular Spring Rate (lb/in)	335
Area (in^2)*	32.75×10^{-5}
I (in^4)**	.01737
J (in^4)***	860

* Area is computed from Axial Spring constant $A = \frac{KL}{E}$

** I is taken as the average value of I calculated from Lateral Spring rate and I from Bending Angular Spring rate.

*** According to the bellows manufacturer, the bellows is very stiff with respect to torsion. A value of J equal to that of the attached pipe is used in the analysis.

TABLE A-111 - STATIC LOAD CASES

1. STATIC LOAD CASE : 1
LOAD CASE TITLE : DEADLOAD + SUSTAINED LOAD + OPERATING PRESSURE

SINGLE JOINT FORCE AND MOMENT LOADING

JOINT ID	LOAD TYPE	LOAD DIRECTION	LOAD MAGNITUDE
170	FORCE	X	-69.3000

THERMAL AND PRESSURE LOADINGS FOR ALL PIPE RUNS

RUN ID	DESIGN PRESSURE PSI	TEMPERATURE CHANGE DEG.	LINEAR TEMPERATURE GRADIENT DEG.	NONLINEAR TEMPERATURE GRADIENT DEG.	LONG. PRESSURE STRESS
1	40.00	0.00	0.000	0.000	YES
2	40.00	0.00	0.000	0.000	YES

2. STATIC LOAD CASE : 2
LOAD CASE TITLE : THERMAL EXPANSION & ANCHOR MOVEMENT

SUPPORT DISPLACEMENTS

JOINT ID	LOAD TYPE	DISPLACEMENT DIRECTION	DISPLACEMENT MAGNITUDE
10	TRANS.	X	-.0606
10	TRANS.	Y	.1136
10	TRANS.	Z	-.0350

THERMAL AND PRESSURE LOADINGS FOR ALL PIPE RUNS

RUN ID	DESIGN PRESSURE PSI	TEMPERATURE CHANGE DEG.	LINEAR TEMPERATURE GRADIENT DEG.	NONLINEAR TEMPERATURE GRADIENT DEG.	LONG. PRESSURE STRESS
1	0.00	205.00	0.000	0.000	NO
2	0.00	205.00	0.000	0.000	NO

3. STATIC LOAD CASE : 3
LOAD CASE TITLE : MAXIMUM PRESSURE

THERMAL AND PRESSURE LOADINGS FOR ALL PIPE RUNS

RUN ID	DESIGN PRESSURE PSI	TEMPERATURE CHANGE DEG.	LINEAR TEMPERATURE GRADIENT DEG.	NONLINEAR TEMPERATURE GRADIENT DEG.	LONG. PRESSURE STRESS
1	40.00	0.00	0.000	0.000	YES
2	40.00	0.00	0.000	0.000	YES

4. STATIC LOAD CASE : 6
LOAD CASE TITLE : 1/2 SSE ANCHOR MOVEMENT

SUPPORT DISPLACEMENTS

JOINT ID	LOAD TYPE	DISPLACEMENT DIRECTION	DISPLACEMENT MAGNITUDE
10	TRANS.	X	.0902
10	TRANS.	Y	.0598
10	TRANS.	Z	.0818

5. STATIC LOAD CASE : 7
LOAD CASE TITLE : SSE ANCHOR MOVEMENT

SUPPORT DISPLACEMENTS

JOINT ID	LOAD TYPE	DISPLACEMENT DIRECTION	DISPLACEMENT MAGNITUDE
10	TRANS.	X	.1803
10	TRANS.	Y	.1195
10	TRANS.	Z	.1636

TABLE A-IV - DYNAMIC LOAD CASES

Load Case No	Load Description	Spectrum IDs*			Spectrum Multipliers		
		X	Y	Z	X	Y	Z
4	X+Y+Z Earthquake (SSE)	1	1	1	386.	257.3	386.
5	X+Y+Z Earthquake (OBE)	2	2	2	386.	257.3	386.

* 1 - SSE Horizontal
2 - OBE Horizontal

TABLE A-V - SEISMIC RESPONSE SPECTRA

SEISMIC RESPONSE SPECTRA

SPECTRUM ID	FREQUENCY (CPS)	PERIOD (SEC.)	ACCELERATION (G)
1	50.000	.020	.59000
	15.000	.067	.59000
	10.000	.100	.72000
	8.000	.125	1.10000
	5.000	.200	1.54000
	4.500	.222	1.74000
	3.600	.278	1.64000
	3.000	.333	1.50000
	2.400	.417	2.29000
	2.000	.500	4.09000
	1.700	.588	5.42000
	1.500	.667	4.09000
	1.300	.769	2.30000
	1.000	1.000	.91000
	.800	1.250	.54000
	.500	2.000	.25000
2	40.000	.025	.33100
	20.000	.050	.33100
	10.000	.099	.45700
	8.580	.117	.80000
	6.930	.144	.96200
	5.610	.178	1.08500
	4.590	.218	1.16000
	3.650	.260	1.02200
	2.860	.350	1.04800
	2.640	.379	1.43400
	2.280	.439	1.77100
	1.870	.535	3.96000
	1.530	.654	3.96000
	1.197	.835	1.11400
	.900	1.111	.45700
	.450	2.222	.14300
	.250	4.000	.14300
	.100	10.000	.14300

APPENDIX B

LACBWR 14" VENT LINE PIPING ANALYSIS

TABULATED RESULTS

TABLE B-1 - JOINT DISPLACEMENTS

J O I N T   D I S P L A C E M E N T S (LOAD CASE 1)

DEADLOAD + SUSTAINED LOAD + OPERATING PRESSURE

JOINT (GID)	/----DISPLACEMENTS (IN. X	Y	Z)-----/	/-------ROTATIONS (RADIANS) X	Y	Z ------/
10	-.0000000	-.0000000	-.0000000	.0000000	.0000000	-.0000000
30	.0003042	-.0001830	.0002436	.0000477	.0000028	-.0000581
40	.0006693	-.0012179	.0004891	.0000804	.0000064	-.0000946
50	.0006765	-.0013438	.0004872	.0000805	.0000065	-.0000948
60	.0011921	-.0026712	.0008245	.0000895	.0000103	-.0001077
70	.0023329	-.0032132	.0016655	.0000834	.0000132	-.0001123
80	.0027805	-.0031991	.0019970	.0000831	.0000132	-.0001124
90	.0038827	-.0032703	.0027323	.0000765	.0000143	-.0001155
100	.0042789	-.0035437	.0029083	.0000749	.0000157	-.0001160
105	-.0006700	.0048132	.0006948	-.0000997	.0000008	-.0002902
110	-.0006321	-.0001432	.0006360	-.0001009	.0000006	-.0002909
120	-.0005279	-.0117640	.0005120	-.0000848	.0000001	-.0002739
130	-.0004261	-.0202252	.0004167	-.0000483	-.0000003	-.0002365
140	-.0004122	-.0208690	.0004010	.0000398	-.0000007	-.0001746
150	-.0004029	-.0205831	.0003816	.0001288	-.0000012	-.0001495
155	-.0003281	-.0119453	.0001758	.0001823	-.0000015	-.0000670
160	-.0002510	-.0031886	.0000012	.0001797	-.0000018	.0000030
170	-.0002143	-.0017888	-.0000271	.0001002	-.0000025	-.0000020
180	-.0001650	-.0012714	-.0000214	.0000817	-.0000009	.0000287
190	-.0001257	-.0009047	-.0000128	.0000623	-.0000007	.0000311
200	-.0000000	-.0000000	-.0000000	.0000000	-.0000000	.0000000
210	.0000798	-.0000210	.0000000	.0000000	-.0000000	-.0000006

J O I N T   D I S P L A C E M E N T S   (LOAD CASE 2)

THERMAL EXPANSION & ANCHOR MOVEMENT

JOINT (GID)	/----DISPLACEMENTS (IN.)-----/ X	Y	Z	/-------ROTATIONS (RADIANS)------/ X	Y	Z
10	-.0606000	.1136000	-.0350000	.0000000	-.0000000	-.0000000
30	-.0567261	.1262940	-.0308503	.0000682	-.0000185	-.0000266
40	-.0477390	.1306885	-.0211056	.0001093	-.0000542	-.0000485
50	-.0468627	.1305749	-.0201507	.0001095	-.0000544	-.0000486
60	-.0379896	.1347048	-.0100762	.0001205	-.0000716	-.0000539
70	-.0338951	.1470895	-.0049443	.0001036	-.0000697	-.0000553
80	-.0336782	.1522738	-.0045281	.0001027	-.0000699	-.0000556
90	-.0290805	.1651885	-.0072634	.0000643	-.0000658	-.0000745
100	-.0191822	.1702459	-.0157136	.0000376	-.0000626	-.0000951
105	-.2282011	.0014663	.2170482	.0000090	-.0004397	-.0001190
110	-.2060330	.0000677	.2060767	.0000110	-.0004392	-.0001122
120	-.1538084	-.0025175	.1800903	.0000192	-.0004287	-.0000925
130	-.1091611	-.0041633	.1572027	.0000231	-.0004054	-.0000787
140	-.1034987	-.0042487	.1524464	.0000356	-.0003486	-.0000683
150	-.1004011	-.0041013	.1458232	.0000437	-.0002903	-.0000645
155	-.0858628	-.0016978	.0752900	.0000427	-.0002482	-.0000440
160	-.0751600	.0001232	.0154323	.0000346	-.0002189	-.0000265
170	-.0680164	.0002471	.0032343	.0000158	-.0001398	-.0000265
180	-.0546708	.0001258	-.0011707	.0000159	-.0000469	-.0000077
190	-.0416591	.0000649	-.0007234	.0000121	-.0000384	-.0000053
200	.0000000	-.0000000	-.0000000	.0000000	-.0000000	-.0000000
210	.0273368	-.0000000	.0000004	.0000000	-.0000000	-.0000000

JOINT DISPLACEMENTS (LOAD CASE 3)

MAXIMUM PRESSURE

JOINT (GID)	DISPLACEMENTS (IN.) X	Y	Z	ROTATIONS (RADIANS) X	Y	Z
10	-.0000000	-.0000000	.0000000	.0000000	-.0000000	.0000000
30	.0000103	.0000376	.0000118	.0000001	-.0000001	.0000001
40	.0000354	.0000530	.0000400	.0000002	-.0000002	.0000001
50	.0000379	.0000530	.0000428	.0000002	-.0000002	.0000002
60	.0000626	.0000685	.0000714	.0000002	-.0000002	.0000002
70	.0000709	.0001061	.0000848	.0000002	-.0000002	.0000002
80	.0000699	.0001213	.0000856	.0000002	-.0000002	.0000002
90	.0000792	.0001601	.0000770	.0000002	-.0000002	.0000002
100	.0001061	.0001784	.0000524	.0000002	-.0000002	.0000002
105	-.0006662	.0000011	.0006351	-.0000001	-.0000012	-.0000000
110	-.0006021	.0000001	.0006024	-.0000001	-.0000012	-.0000000
120	-.0004507	-.0000017	.0005256	-.0000000	-.0000012	-.0000000
130	-.0003208	-.0000026	.0004583	-.0000000	-.0000012	-.0000000
140	-.0003043	-.0000027	.0004444	-.0000000	-.0000010	.0000000
150	-.0002952	-.0000027	.0004251	.0000000	-.0000009	.0000000
155	-.0002519	-.0000016	.0002193	.0000000	-.0000007	.0000000
160	-.0002196	-.0000005	.0000446	.0000000	-.0000007	.0000000
170	-.0001986	-.0000002	.0000091	.0000000	-.0000004	.0000000
180	-.0001596	-.0000001	-.0000036	.0000000	-.0000001	.0000000
190	-.0001216	-.0000001	-.0000023	.0000000	-.0000001	.0000000
200	.0000000	-.0000000	-.0000000	.0000000	-.0000000	.0000000
210	.0000798	.0000000	.0000000	.0000000	-.0000000	.0000000

JOINT DISPLACEMENTS (LOAD CASE 4)

SRSS (X+Y+Z) SSE EARTHQUAKE

EARTHQUAKE RESPONSE - TOTAL X, Y AND Z RESPONSES COMBINED BY SQSS SUM.
TOTAL X, Y AND Z RESPONSES WERE FORMED BY CSF SUMMATION OF 3 MODES.

JOINT	DISPLACEMENTS (IN.)			ROTATIONS (RADIANS)		
GID	X	Y	Z	X	Y	Z
10	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
30	.0002173	.0000328	.0002210	.0000355	.0000222	.0000349
40	.0006796	.0002040	.0006864	.0000498	.0000548	.0000487
50	.0007188	.0002260	.0007257	.0000500	.0000550	.0000489
60	.0013859	.0004893	.0014004	.0000595	.0000728	.0000572
70	.0022243	.0006296	.0022693	.0000731	.0000793	.0000695
80	.0024986	.0006296	.0025582	.0000734	.0000793	.0000698
90	.0029894	.0007271	.0035316	.0000780	.0000792	.0000740
100	.0027724	.0014668	.0043874	.0000783	.0000789	.0000741
105	.0059849	.0018495	.0102015	.0000400	.0001698	.0001073
110	.0081470	.0000264	.0080373	.0000392	.0001698	.0001080
120	.0131236	.0043638	.0030469	.0000308	.0001505	.0001032
130	.0165473	.0075298	.0003994	.0000158	.0001070	.0000914
140	.0167969	.0077697	.0005917	.0000182	.0000046	.0000682
150	.0165337	.0076403	.0005617	.0000531	.0000984	.0000587
155	.0093019	.0041782	.0005914	.0000717	.0001582	.0000304
160	.0015447	.0007738	.0006159	.0000688	.0001637	.0000065
170	.0002548	.0002913	.0001536	.0000360	.0000843	.0000098
180	.0000254	.0002001	.0002202	.0000293	.0000018	.0000025
190	.0000194	.0001507	.0001879	.0000223	.0000023	.0000040
200	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
210	.0000000	.0000001	.0000001	.0000000	.0000000	.0000000

JOINT DISPLACEMENTS (LOAD CASE 5)

SRSS (X+Y+Z) 1/2 SSE EARTHQUAKE

EARTHQUAKE RESPONSE - TOTAL X, Y AND Z RESPONSES COMBINED BY SOSS SUM.
TOTAL X, Y AND Z RESPONSES WERE FORMED BY CSF SUMMATION OF 3 MODES.

JOINT	/----DISPLACEMENTS (IN.	)-----/		/-------ROTATIONS (RADIANS)------/		
GID	X	Y	Z	X	Y	Z
10	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
30	.0001219	.0000184	.0001240	.0000199	.0000125	.0000196
40	.0003813	.0001145	.0003851	.0000279	.0000308	.0000273
50	.0004033	.0001268	.0004071	.0000281	.0000308	.0000274
60	.0007775	.0002745	.0007856	.0000334	.0000408	.0000321
70	.0012478	.0003532	.0012731	.0000410	.0000445	.0000390
80	.0014017	.0003532	.0014352	.0000412	.0000445	.0000392
90	.0016771	.0004079	.0019813	.0000438	.0000444	.0000415
100	.0015554	.0008229	.0024614	.0000439	.0000443	.0000416
105	.0033576	.0010376	.0057232	.0000225	.0000953	.0000602
110	.0045706	.0000148	.0045091	.0000220	.0000953	.0000606
120	.0073626	.0024481	.0017094	.0000173	.0000845	.0000579
130	.0092833	.0042244	.0002241	.0000089	.0000600	.0000513
140	.0094234	.0043589	.0003319	.0000102	.0000026	.0000382
150	.0092757	.0042863	.0003151	.0000298	.0000552	.0000329
155	.0052185	.0023441	.0003318	.0000402	.0000887	.0000171
160	.0008666	.0004341	.0003455	.0000386	.0000918	.0000037
170	.0001430	.0001634	.0000862	.0000202	.0000473	.0000055
180	.0000143	.0001123	.0001235	.0000164	.0000010	.0000014
190	.0000109	.0000846	.0001054	.0000125	.0000013	.0000023
200	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
210	.0000000	.0000000	.0000001	.0000000	.0000000	.0000000

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J O I N T   D I S P L A C E M E N T S   (LOAD CASE 6)

1/2 SSE ANCHOR MOVEMENT

JOINT	/----DISPLACEMENTS (IN.	)-----/		/-------ROTATIONS (RADIANS)	------/	
(GID)	X	Y	Z	X	Y	Z
10	.0902000	.0598000	.0818000	-.0000000	.0000000	.0000000
30	.0902113	.0598679	.0816017	-.0000348	.0000159	-.0000029
40	.0904775	.0601675	.0811689	-.0000574	.0000551	-.0000036
50	.0905161	.0602045	.0811299	-.0000576	.0000554	-.0000036
60	.0910382	.0606773	.0803000	-.0000845	.0000953	-.0000005
70	.0913815	.0609476	.0789825	-.0001145	.0001119	-.0000104
80	.0914188	.0609469	.0785209	-.0001149	.0001135	-.0000108
90	.0912399	.0605263	.0769642	-.0001292	.0001193	-.0000236
100	.0904584	.0593766	.0755242	-.0001385	.0001319	-.0000316
105	-.0002133	.0001924	.0011777	-.0000566	.0000343	.0000434
110	-.0006504	.0000244	.0007410	-.0000515	.0000301	.0000413
120	-.0013362	-.0001262	.0000558	-.0000383	.0000170	.0000374
130	-.0016628	-.0000727	-.0002702	-.0000285	.0000094	.0000326
140	-.0016798	-.0000839	-.0002836	-.0000215	-.0000008	.0000353
150	-.0016485	-.0001306	-.0002788	-.0000101	-.0000102	.0000364
155	-.0009301	-.0004289	-.0002760	-.0000019	-.0000152	.0000287
160	-.0001907	-.0004126	-.0002737	.0000018	-.0000160	.0000221
170	-.0000442	-.0002964	-.0002154	.0000021	-.0000123	.0000195
180	-.0000014	-.0001568	-.0001263	-.0000015	-.0000048	.0000067
190	-.0000011	-.0000948	-.0000792	-.0000011	-.0000040	.0000053
200	-.0000000	-.0000000	-.0000000	-.0000000	-.0000000	.0000000
210	-.0000000	.0000000	.0000000	-.0000000	-.0000000	.0000000

J O I N T   D I S P L A C E M E N T S   (LOAD CASE 7)

SSE ANCHOR MOVEMENT

JOINT (GID)	/----DISPLACEMENTS (IN. X	Y	)-----/ Z	/-------ROTATIONS (RADIANS)------/ X	Y	Z
10	.1803000	.1195000	.1636000	-.0000000	.0000000	.0000000
30	.1803224	.1196358	.1632035	-.0000696	.00003[illegible]8	-.0000057
40	.1808547	.1202352	.1623380	-.0001148	.0001102	-.0000071
50	.1809319	.1203093	.1622600	-.0001152	.0001108	-.0000072
60	.1819757	.1212549	.1606005	-.0001691	.0001905	-.0000010
70	.1826617	.1217954	.1579662	-.0002289	.0002238	-.0000208
80	.1827361	.1217941	.1570432	-.0002298	.0002270	-.0000216
90	.1823781	.1209533	.1539306	-.0002582	.0002386	-.0000471
100	.1808153	.1186551	.1510514	-.0002770	.0002637	-.0000632
105	-.0004270	.0003842	.0023553	-.0001131	.0000687	.0000868
110	-.0013009	.0000489	.0014820	-.0001029	.0000602	.0000826
120	-.0026724	-.0002514	.0001119	-.0000766	.0000339	.0000748
130	-.0033257	-.0001439	-.0005402	-.0000569	.0000188	.0000651
140	-.0033596	-.0001662	-.0005669	-.0000430	-.0000016	.0000706
150	-.0032970	-.0002597	-.0005574	-.0000203	-.0000204	.0000728
155	-.0018602	-.0008569	-.0005519	-.0000038	-.0000304	.0000574
160	-.0003814	-.0008249	-.0005472	.0000035	-.0000321	.0000443
170	-.0000884	-.0005928	-.0004305	.0000041	-.0000246	.0000390
180	-.0000029	-.0003135	-.0002526	-.0000030	-.0000097	.0000134
190	-.0000022	-.0001895	-.0001583	-.0000023	-.0000081	.0000107
200	-.0000000	-.0000000	-.0000000	-.0000000	-.0000000	.0000000
210	-.0000000	.0000001	.0000001	-.0000000	-.0000000	.0000000

TABLE B-11 - ELASTIC SUPPORT REACTION

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 1)

DEADLOAD + SUSTAINED LOAD + OPERATING PRESSURE

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB) X	MOMENT (IN-LB) Y	MOMENT (IN-LB) Z
10	6.14	388.81	4.64	-4648.00	-132.73	5713.67
110	0.00	630.11	0.00	0.00	0.00	0.00
200	69.48	965.89	1.68	-18632.17	315.70	-23729.23

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	Y	Z
110	FORCE	-8.932	.7071	0.0000	.7071

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 2)

THERMAL EXPANSION & ANCHOR MOVEMENT

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB) X	MOMENT (IN-LB) Y	MOMENT (IN-LB) Z
10	106.86	259.01	-135.27	-6299.94	5408.42	3041.19
110	0.00	-297.86	0.00	0.00	0.00	0.00
200	-35.02	38.86	207.11	-3622.31	18240.47	1453.48

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	Y	Z
110	FORCE	-101.599	.7071	0.0000	.7071

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 3)

MAXIMUM PRESSURE

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB) X	MOMENT (IN-LB) Y	MOMENT (IN-LB) Z
10	.52904	.27572	-.21357	-13.02803	10.46359	-12.73117
110	0.00000	-.32267	0.00000	0.00000	0.00000	0.00000
200	-.07952	.04695	.66309	-1.74104	56.94293	-2.23403

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	Y	Z
110	FORCE	-.636	.7071	0.0000	.7071

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 4)

SRSS (X+Y+Z) SSE EARTHQUAKE

EARTHQUAKE RESPONSE - TOTAL X, Y AND Z RESPONSES COMBINED BY SQSS SUM.
TOTAL X, Y AND Z RESPONSES WERE FORMED BY CSF SUMMATION OF 3 MODES.

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB) X	MOMENT (IN-LB) Y	MOMENT (IN-LB) Z
10	97.0	7.9	105.1	3515.	3805.	3427.
110	0.0	116.2	0.0	0.	0.	0.
200	327.8	164.4	285.7	6676.	5477.	4187.

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	DIRECTION COSINES (INCLINED AXIS) Y	DIRECTION COSINES (INCLINED AXIS) Z
110	FORCE	255.3	.7071	0.0000	.7071

ELASTIC SUPPORT REACTIONS (LOAD CASE 5)

SRSS (X+Y+Z) 1/2 SSE EARTHQUAKE

EARTHQUAKE RESPONSE = TOTAL X, Y AND Z RESPONSES COMBINED BY SQSS SUM.
TOTAL X, Y AND Z RESPONSES WERE FORMED BY CSF SUMMATION OF 3 MODES.

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB) X	MOMENT (IN-LB) Y	MOMENT (IN-LB) Z
10	54.43	4.41	58.95	1972.	2135.	1922.
110	0.00	65.20	0.00	0.	0.	0.
200	183.91	92.20	160.29	3746.	3073.	2349.

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	Y	Z
110	FORCE	143.2	.7071	0.0000	.7071

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DOCUMENT NO. 81A0051

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 6)

1/2 SSE ANCHOR MOVEMENT

SUPPORT JOINT	FORCE (LB.) X	Y	Z	MOMENT (IN-LB) X	Y	Z
10	130.400	89.803	121.453	3188.369	-3643.144	-873.530
110	0.000	-107.568	0.000	0.000	0.000	0.000
200	18.630	17.765	27.577	341.920	2011.977	-2360.166

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	Y	Z

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 7)

SSE ANCHOR MOVEMENT

SUPPORT JOINT	FORCE (LB.) X	Y	Z	MOMENT (IN-LB) X	Y	Z
10	260.697	179.457	242.860	6376.159	-7285.185	-1748.373
110	0.000	-214.963	0.000	0.000	0.000	0.000
200	37.265	35.505	55.103	684.908	4021.505	-4719.349

INCLINED AXIS SUPPORT REACTIONS

SUPPORT JOINT	REACTION TYPE	REACTION MAGNITUDE	DIRECTION COSINES (INCLINED AXIS) X	Y	Z
110	FORCE	-421.383	.7071	0.0000	.7071

TABLE B-111 - CLASS 2 PIPING STRESS SUMMARY

D.1 CLASS 2 STRESSES FOR ANALYSIS SET NUMBER 1

ASSIGNED LOAD COMBINATION IDENTIFIERS
MA - 1 MB - 4 MC - 2 P - 1 PMAX - 3

D.1.1 SATISFACTION OF EQUATION 8 (ANALYSIS SET 1)

STRAIGHT MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (TB)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO TB/(1.0*SH)	MODIFIED STRESS RATIO
1S	40	319.635	0.000	50.063	0.000	0.000	369.698	37130.302	.02465	
	50	319.635	0.000	45.845	0.000	0.000	365.479	37134.521	.02437	
2S	70	319.635	0.000	13.879	0.000	0.000	333.514	37166.486	.02223	
	80	319.635	0.000	13.781	0.000	0.000	333.416	37166.584	.02223	

CURVED MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (TB)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO TB/(1.0*SH)	MODIFIED STRESS RATIO
1C	10	319.635	0.000	310.426	0.000	0.000	630.061	36869.939	.04200	
	30	319.635	0.000	251.877	0.000	0.000	571.512	36928.488	.03810	
2C	30	319.635	0.000	251.877	0.000	0.000	571.512	36928.488	.03810	
	40	319.635	0.000	129.439	0.000	0.000	449.074	37050.926	.02994	
3C	50	319.635	0.000	118.531	0.000	0.000	438.166	37061.834	.02921	
	60	319.635	0.000	36.767	0.000	0.000	356.401	37143.599	.02376	
4C	60	319.635	0.000	36.767	0.000	0.000	356.401	37143.599	.02376	
	70	319.635	0.000	35.884	0.000	0.000	355.518	37144.482	.02370	
5C	80	319.635	0.000	35.632	0.000	0.000	355.266	37144.734	.02368	
	90	319.635	0.000	18.777	0.000	0.000	338.412	37161.588	.02256	
6C	90	319.635	0.000	18.777	0.000	0.000	338.412	37161.588	.02256	
	100	319.635	0.000	7.129	0.000	0.000	326.764	37173.236	.02178	

STRAIGHT MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (TB)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO TB/(1.0*SH)	MODIFIED STRESS RATIO
3S	105	319.635	0.000	4.306	0.000	0.000	323.941	37176.059	.02160	
	110	319.635	0.000	31.348	0.000	0.000	350.983	37149.017	.02340	
4S	110	319.635	0.000	31.348	0.000	0.000	350.983	37149.017	.02340	
	120	319.635	0.000	229.305	0.000	0.000	548.940	36951.060	.03660	
5S	120	319.635	0.000	229.305	0.000	0.000	548.940	36951.060	.03660	
	130	319.635	0.000	329.093	0.000	0.000	648.728	36851.272	.04325	
6S	150	319.635	0.000	335.888	0.000	0.000	655.522	36844.478	.04370	
	155	319.635	0.000	266.926	0.000	0.000	586.560	36913.440	.03910	
7S	155	319.635	0.000	266.926	0.000	0.000	586.560	36913.440	.03910	
	160	319.635	0.000	295.239	0.000	0.000	614.874	36885.126	.04099	
8S	180	319.635	0.000	320.902	0.000	0.000	640.536	36859.464	.04270	
	190	319.635	0.000	303.727	0.000	0.000	623.362	36876.638	.04156	
9S	190	319.635	0.000	303.727	0.000	0.000	623.362	36876.638	.04156	
	200	319.635	0.000	506.808	0.000	0.000	826.443	36673.557	.05510	
10S	200	319.635	0.000	18.975	0.000	0.000	338.610	37161.390	.02257	
	210	319.635	0.000	.000	0.000	0.000	319.635	37180.365	.02131	

CURVED MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (TB)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO TB/(1.0*SH)	MODIFIED STRESS RATIO
7C	130	319.635	0.000	850.872	0.000	0.000	1170.506	36329.494	.07803	
	140	319.635	0.000	863.385	0.000	0.000	1183.020	36316.980	.07887	
8C	140	319.635	0.000	863.384	0.000	0.000	1183.018	36316.982	.07887	
	150	319.635	0.000	868.438	0.000	0.000	1188.073	36311.927	.07920	
9C	160	319.635	0.000	763.340	0.000	0.000	1082.975	36417.025	.07220	
	170	319.635	0.000	856.682	0.000	0.000	1176.317	36323.683	.07842	
10C	170	319.635	0.000	856.683	0.000	0.000	1176.318	36323.682	.07842	
	180	319.635	0.000	829.691	0.000	0.000	1149.326	36350.674	.07662	

D.1.2 SATISFACTION OF EQUATION 9 (ANALYSIS SET 1)

STRAIGHT MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
1S	40	0.000	319.635	50.063	100.892	0.000	470.590	37130.302	.02614	.01743
	50	0.000	319.635	45.845	100.516	0.000	465.996	37134.521	.02589	.01726
2S	70	0.000	319.635	13.879	77.217	0.000	410.731	37166.486	.02282	.01521
	80	0.000	319.635	13.781	75.302	0.000	408.718	37166.584	.02271	.01514

CURVED MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
1C	10	0.000	319.635	310.426	338.058	0.000	968.119	36869.939	.05378	.03586
	30	0.000	319.635	251.877	290.029	0.000	861.540	36928.488	.04786	.03191
2C	30	0.000	319.635	251.877	290.029	0.000	861.540	36928.488	.04786	.03191
	40	0.000	319.635	129.439	260.857	0.000	709.931	37050.926	.03944	.02629
3C	50	0.000	319.635	118.531	259.885	0.000	698.051	37061.834	.03878	.02585
	60	0.000	319.635	36.767	248.969	0.000	605.370	37143.599	.03363	.022
4C	60	0.000	319.635	36.767	248.969	0.000	605.370	37143.599	.03363	.02242
	70	0.000	319.635	35.884	199.593	0.000	555.111	37144.462	.03084	.02056
5C	80	0.000	319.635	35.632	193.500	0.000	548.767	37144.734	.03049	.02032
	90	0.000	319.635	18.777	180.485	0.000	518.897	37161.588	.02883	.01922
6C	90	0.000	319.635	18.777	180.486	0.000	518.897	37161.588	.02883	.01922
	100	0.000	319.635	7.129	143.663	0.000	470.427	37173.236	.02613	.01742

STRAIGHT MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
3S	105	0.000	319.635	4.306	55.654	0.000	379.595	37176.059	.02109	[illegible]
	110	0.000	319.635	31.348	98.019	0.000	449.002	37149.017	.02494	.01663
4S	110	0.000	319.635	31.348	98.019	0.000	449.002	37149.017	.02494	.01663
	120	0.000	319.635	229.305	178.054	0.000	726.994	36951.060	.04039	.02693
5S	120	0.000	319.635	229.305	178.054	0.000	726.994	36951.060	.04039	.02693
	130	0.000	319.635	329.093	221.593	0.000	870.321	36851.272	.04835	.03223
6S	150	0.000	319.635	335.888	226.437	0.000	881.959	36844.478	.04900	.03267
	155	0.000	319.635	266.926	125.004	0.000	711.564	36913.440	.03953	.02635
7S	155	0.000	319.635	266.926	125.004	0.000	711.564	36913.440	.03953	.02635
	160	0.000	319.635	295.239	102.426	0.000	717.300	36885.126	.03985	.02657
8S	180	0.000	319.635	320.902	111.671	0.000	752.208	36859.464	.04179	.02786
	190	0.000	319.635	303.727	93.090	0.000	716.452	36876.638	.03980	.02654
9S	190	0.000	319.635	303.727	93.090	0.000	716.452	36876.638	.03980	.02654
	200	0.000	319.635	506.808	131.134	0.000	957.577	36673.557	.05320	.03547
10S	200	0.000	319.635	18.975	.000	0.000	338.610	37161.390	.01881	.01254
	210	0.000	319.635	.000	.000	0.000	319.635	37180.365	.01776	.01184

CURVED MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
7C	130	0.000	319.635	850.872	572.930	0.000	1743.437	36329.494	.09686	.06457
	140	0.000	319.635	863.385	602.163	0.000	1785.184	36316.980	.09918	.06612
8C	140	0.000	319.635	863.384	602.162	0.000	1785.181	36316.982	.09918	.06612
	150	0.000	319.635	868.438	585.453	0.000	1773.525	36311.927	.09853	.06569
9C	160	0.000	319.635	763.340	264.823	0.000	1347.798	36417.025	.07488	.04992
	170	0.000	319.635	856.682	315.932	0.000	1492.250	36323.683	.08290	.05527
10C	170	0.000	319.635	856.683	315.932	0.000	1492.250	36323.682	.08290	.05527
	180	0.000	319.635	829.691	288.726	0.000	1438.052	36350.674	.07989	.05326

U.1.3 S A T I S F A C T I O N O F E Q U A T I O N 10 (ANALYSIS SET 1)

STRAIGHT MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T10)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T80/(1.0*SA)	MODIFIED STRESS RATIO T10/(1.0*SAM)
1S	40	0.000	0.000	0.000	0.000	65.895	65.895	37130.302	.00293	.00177
	50	0.000	0.000	0.000	0.000	61.040	61.040	37134.521	.00271	.00164
2S	70	0.000	C.000	0.000	0.000	47.684	47.684	37166.486	.00212	.00128
	80	0.000	0.000	0.000	0.000	58.002	58.002	37166.584	.00258	.00156

CURVED MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T10)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T10/(1.0*SA)	MODIFIED STRESS RATIO T10/(1.0*SAM)
1C	10	0.000	0.000	0.000	0.000	496.821	496.821	36869.939	.02208	.01347
	30	0.000	0.000	0.000	0.000	401.546	401.546	36928.488	.01785	.01087
2C	30	0.000	0.000	0.000	0.000	401.546	401.546	36928.488	.01785	.01087
	40	0.000	0.000	0.000	0.000	227.161	227.161	37050.926	.01010	.00613
3C	50	0.000	0.000	0.000	0.000	210.427	210.427	37061.834	.00935	.00568
	60	0.000	0.000	0.000	0.000	79.212	79.212	37143.599	.00352	.00213
4C	60	0.000	0.000	0.000	0.000	79.212	79.212	37143.599	.00352	.00213
	70	0.000	0.000	0.000	0.000	164.384	164.384	37144.482	.00731	.00443
5C	80	0.000	0.000	0.000	0.000	199.952	199.952	37144.734	.00889	.00538
	90	0.000	0.000	0.000	0.000	236.196	236.196	37161.588	.01050	.00636
6C	90	0.000	0.000	0.000	0.000	236.196	236.196	37161.588	.01050	.00636
	100	0.000	0.000	0.000	0.000	150.287	150.287	37173.236	.00668	.00404

STRAIGHT MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T10)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T10/(1.0*SA)	MODIFIED STRESS RATIO T10/(1.0*SAM)
3S	105	0.000	0.000	0.000	0.000	43.550	43.550	37176.059	.00194	.00117
	110	0.000	0.000	0.000	0.000	112.006	112.006	37149.017	.00498	.00302
4S	110	0.000	0.000	0.000	0.000	112.006	112.006	37149.017	.00498	.00302
	120	0.000	0.000	0.000	0.000	126.317	126.317	36951.060	.00561	.00342
5S	120	0.000	0.000	0.000	0.000	126.317	126.317	36951.060	.00561	.00342
	130	0.000	0.000	0.000	0.000	177.471	177.471	36851.272	.00789	.00482
6S	150	0.000	0.000	0.000	0.000	183.714	183.714	36844.478	.00817	.00499
	155	0.000	0.000	0.000	0.000	155.709	155.709	36913.440	.00692	.00422
7S	155	0.000	0.000	0.000	0.000	155.709	155.709	36913.440	.00692	.00422
	160	0.000	0.000	0.000	0.000	139.743	139.743	36885.126	.00621	.00379
8S	180	0.000	0.000	0.000	0.000	173.782	173.782	36859.464	.00772	.00471
	190	0.000	0.000	0.000	0.000	203.068	203.068	36876.638	.00903	.00551
9S	190	0.000	0.000	0.000	0.000	203.068	203.068	36876.638	.00903	.00551
	200	0.000	0.000	0.000	0.000	304.019	304.019	36673.557	.01351	.00829
10S	200	0.000	0.000	0.000	0.000	.000	.000	37161.390	.00000	.00000
	210	0.000	0.000	0.000	0.000	.000	.000	37180.365	.00000	.00000

CURVED MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T10)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T10/(1.0*SA)	MODIFIED STRESS RATIO T10/(1.0*SAM)
7C	130	0.000	0.000	0.000	0.000	611.803	611.803	36329.494	.02719	.01684
	140	0.000	0.000	0.000	0.000	633.278	633.278	36316.980	.02815	.01744
8C	140	0.000	0.000	0.000	0.000	633.277	633.277	36316.982	.02815	.01744
	150	0.000	0.000	0.000	0.000	633.323	633.323	36311.927	.02815	.01744
9C	160	0.000	0.000	0.000	0.000	481.739	481.739	36417.025	.02141	[illegible]
	170	0.000	0.000	0.000	0.000	509.786	509.786	36323.683	.02266	[illegible]
10C	170	0.000	0.000	0.000	0.000	509.786	509.786	36323.682	.02266	[illegible]
	180	0.000	0.000	0.000	0.000	599.083	599.083	36350.674	.02663	.01648

D.1.4 SATISFACTION OF EQUATION 11 (ANALYSIS SET 1)

STRAIGHT MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T11)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T11/(SH+SA)	MODIFIED STRESS RATIO T11/(SH+SAM)
1S	40	319.635	0.000	50.063	0.000	65.895	435.593	37130.302	.01162	.00836
	50	319.635	0.000	45.845	0.000	61.040	426.520	37134.521	.01137	.00818
2S	70	319.635	0.000	13.879	0.000	47.684	381.198	37166.486	.01017	.00731
	80	319.635	0.000	13.781	0.000	58.002	391.418	37166.584	.01044	.00750

CURVED MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T11)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T11/(SH+SA)	MODIFIED STRESS RATIO T11/(SH+SAM)
1C	10	319.635	0.000	310.426	0.000	496.821	1126.882	36869.939	.03005	.02173
	30	319.635	0.000	251.877	0.000	401.546	973.058	36928.488	.02595	.01874
2C	30	319.635	0.000	251.877	0.000	401.546	973.058	36928.488	.02595	.01874
	40	319.635	0.000	129.439	0.000	227.161	676.235	37050.926	.01803	.01299
3C	50	319.635	0.000	118.531	0.000	210.427	648.593	37061.834	.01730	[illegible]
	60	319.635	0.000	36.767	0.000	79.212	435.614	37143.599	.01162	.00835
4C	60	319.635	0.000	36.767	0.000	79.212	435.614	37143.599	.01162	.00835
	70	319.635	0.000	35.884	0.000	164.384	519.902	37144.482	.01386	.00997
5C	80	319.635	0.000	35.632	0.000	199.952	555.218	37144.734	.01481	.01065
	90	319.635	0.000	18.777	0.000	236.196	574.607	37161.588	.01532	.01102
6C	90	319.635	0.000	18.777	0.000	236.196	574.607	37161.588	.01532	.01102
	100	319.635	0.000	7.129	0.000	150.287	477.051	37173.236	.01272	.00914

STRAIGHT MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T11)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T11/(SH+SA)	MODIFIED STRESS RATIO T11/(SH+SAM)
3S	105	319.635	0.000	4.306	0.000	43.550	367.490	37176.059	.00980	.00704
	110	319.635	0.000	31.348	0.000	112.006	462.989	37149.017	.01235	.00888
4S	110	319.635	0.000	31.348	0.000	112.006	462.989	37149.017	.01235	.00888
	120	319.635	0.000	229.305	0.000	126.317	675.257	36951.060	.01801	.01300
5S	120	319.635	0.000	229.305	0.000	126.317	675.257	36951.060	.01801	.01300
	130	319.635	0.000	329.093	0.000	177.471	826.199	36851.272	.02203	.01593
6S	150	319.635	0.000	335.888	0.000	183.714	839.236	36844.478	.02238	.01619
	155	319.635	0.000	266.926	0.000	155.709	742.269	36913.440	.01979	.01430
7S	155	319.635	0.000	266.926	0.000	155.709	742.269	36913.440	.01979	.01430
	160	319.635	0.000	295.239	0.000	139.743	754.616	36885.126	.02012	.01454
8S	180	319.635	0.000	320.902	0.000	173.782	814.318	36859.464	.02172	.01570
	190	319.635	0.000	303.727	0.000	203.068	826.431	36876.638	.02204	.01591
9S	190	319.635	0.000	303.727	0.000	203.068	826.431	36876.638	.02204	.01591
	200	319.635	0.000	506.808	0.000	304.019	1130.462	36673.557	.03015	.02188
10S	200	319.635	0.000	18.975	0.000	.000	338.610	37161.390	.00903	.00649
	210	319.635	0.000	.000	0.000	.000	319.635	37180.365	.00852	.00613

CURVED MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T11)	MODIFIED ALLOWABLE STRESS (SAM)	DESIGN STRESS RATIO T11/(SH+SA)	MODIFIED STRESS RATIO T11/(SH+SAM)
7C	130	319.635	0.000	850.872	0.000	611.803	1782.310	36329.494	.04753	.03472
	140	319.635	0.000	863.385	0.000	633.278	1816.299	36316.980	.04843	.03539
8C	140	319.635	0.000	863.384	0.000	633.277	1816.296	36316.982	.04843	.03519
	150	319.635	0.000	868.438	0.000	633.323	1821.396	36311.927	.04857	[illegible]
9C	160	319.635	0.000	763.340	0.000	481.739	1564.714	36417.025	.04171	[illegible]
	170	319.635	0.000	856.682	0.000	509.786	1686.103	36323.683	.04496	[illegible]
10C	170	319.635	0.000	856.683	0.000	509.786	1686.103	36323.682	.04496	[illegible]
	180	319.635	0.000	829.691	0.000	599.083	1748.409	36350.674	.04662	.03405

D.2 CLASS 2 STRESSES FOR ANALYSIS SET NUMBER 2

ASSIGNED LOAD COMBINATION IDENTIFIERS
MA = 1 MB = 5 MC = 0 P = 0 PMAX = 3

D.2.1 SATISFACTION OF EQUATION 9 (ANALYSIS SET 2)

STRAIGHT MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
1S	40	0.0000	319.6347	50.0634	195.2993	0.0000	564.9974	0.0000	.03139	.02093
	50	0.0000	319.6347	45.8445	194.7506	0.0000	560.2298	0.0000	.03112	.02075
2S	70	0.0000	319.6347	13.8788	152.5423	0.0000	486.0558	0.0000	.02700	.01800
	80	0.0000	319.6347	13.7814	149.1497	0.0000	482.5658	0.0000	.02681	.01787

CURVED MEMBERS FOR RUN 1

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
1C	10	0.0000	319.6347	310.4259	646.2823	0.0000	1276.3429	0.0000	.07091	.047[illegible]
	30	0.0000	319.6347	251.8768	556.0511	0.0000	1127.5626	0.0000	.06264	.0417[illegible]
2C	30	0.0000	319.6347	251.8768	556.0511	0.0000	1127.5626	0.0000	.06264	.04176
	40	0.0000	319.6347	129.4390	504.9464	0.0000	954.0201	0.0000	.05300	.03533
3C	50	0.0000	319.6347	118.5311	503.5277	0.0000	941.6935	0.0000	.05232	.03488
	60	0.0000	319.6347	36.7667	485.6547	0.0000	842.0560	0.0000	.04678	.03119
4C	60	0.0000	319.6347	36.7666	485.6547	0.0000	842.0560	0.0000	.04678	.03119
	70	0.0000	319.6347	35.8837	394.3022	0.0000	749.8205	0.0000	.04166	.02777
5C	80	0.0000	319.6347	35.6317	383.4847	0.0000	738.7511	0.0000	.04104	.02736
	90	0.0000	319.6347	18.7768	358.0955	0.0000	696.5070	0.0000	.03869	.02580
6C	90	0.0000	319.6347	18.7768	358.0956	0.0000	696.5072	0.0000	.03869	[illegible]
	100	0.0000	319.6347	7.1294	284.3863	0.0000	611.1505	0.0000	.03395	[illegible]

STRAIGHT MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
3S	105	0.0000	319.6347	4.3061	110.1650	0.0000	434.1059	0.0000	.02412	.01608
	110	0.0000	319.6347	31.3480	195.0879	0.0000	546.0706	0.0000	.03034	.02022
4S	110	0.0000	319.6347	31.3480	195.0879	0.0000	546.0706	0.0000	.03034	.02022
	120	0.0000	319.6347	229.3055	332.0262	0.0000	880.9663	0.0000	.04894	.03263
5S	120	0.0000	319.6347	229.3055	332.0262	0.0000	880.9663	0.0000	.04894	.03263
	130	0.0000	319.6347	329.0929	404.6206	0.0000	1053.3482	0.0000	.05852	.03901
6S	150	0.0000	319.6347	335.8876	413.5588	0.0000	1069.0812	0.0000	.05939	.03960
	155	0.0000	319.6347	266.9256	229.1531	0.0000	815.7134	0.0000	.04532	.03021
7S	155	0.0000	319.6347	266.9256	229.1531	0.0000	815.7134	0.0000	.04532	.03021
	160	0.0000	319.6347	295.2393	187.2553	0.0000	802.1293	0.0000	.04456	.02971
8S	180	0.0000	319.6347	320.9017	204.4361	0.0000	844.9725	0.0000	.04694	.03130
	190	0.0000	319.6347	303.7275	171.7748	0.0000	795.1370	0.0000	.04417	.02945
9S	190	0.0000	319.6347	303.7275	171.7748	0.0000	795.1370	0.0000	.04417	.02945
	200	0.0000	319.6347	506.8084	243.7824	0.0000	1070.2255	0.0000	.05946	.03964
10S	200	0.0000	319.6347	18.9752	.0001	0.0000	338.6100	0.0000	.01881	.01254
	210	0.0000	319.6347	.0000	.0000	0.0000	319.6347	0.0000	.01776	.01184

CURVED MEMBERS FOR RUN 2

MEMBER NO.	MEMBER ENDS	INTERNAL PRESSURE STRESS (P)	PEAK PRESSURE STRESS (PMAX)	SUSTAINED LOAD STRESS (MA)	OCCASIONAL LOAD STRESS (MB)	THERMAL EXPANSION STRESS (MC)	TOTAL STRESS (T9)	MODIFIED ALLOWABLE STRESS (SAM)	UPSET STRESS RATIO T9/(1.2*SH)	EMERGENCY STRESS RATIO T9/(1.8*SH)
7C	130	0.0000	319.6347	850.8717	1046.1486	0.0000	2216.6551	0.0000	.12315	.08210
	140	0.0000	319.6347	863.3855	1099.4466	0.0000	2282.4668	0.0000	.12680	.08454
8C	140	0.0000	319.6347	863.3837	1099.4444	0.0000	2282.4628	0.0000	.12680	.08454
	150	0.0000	319.6347	868.4378	1069.2565	0.0000	2257.3290	0.0000	.12541	.08360
9C	160	0.0000	319.6347	763.3403	484.1482	0.0000	1567.1232	0.0000	.08706	.05804
	170	0.0000	319.6347	856.6824	576.1862	0.0000	1752.5033	0.0000	.09736	.06491
10C	170	0.0000	319.6347	856.6829	576.1861	0.0000	1752.5036	0.0000	.09736	.06491
	180	0.0000	319.6347	829.6910	528.5690	0.0000	1677.8947	0.0000	.09322	.06214