MASTER

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LOFT CIS ANALYSIS
PENETRATION S-11B 12" H & V DUCT

C. G. Condie

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DEPARTMENT OF ENERGY

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RESEARCH, ENGINEERING AND CONSTRUCTION REPORT ENGINEERING ANALYSIS DIVISION

APPLIED MECHANICS BRANCH

LOFT CIS ANALYSIS

PENETRATION S-11B 12" H & V DUCT

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C. G. Condie/ *CG Condie*

AUTHOR

CHECKED BY: J. W. Muffett/ *JW Muffett*

APPROVED BY: C. A. Moore/ *CA Moore*

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cc: J. G. Arendts
C. G. Condie
S. M. Gardner (3)
C. A. Moore
J. W. Muffett
AM File (5)

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LOFT TECHNICAL REPORT
LOFT PROGRAM

FORM EG&G-229
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[Signature]
PSB Mgr.

[Signature]
P&CSB Mgr.

[Signature]
RSB Mgr.

ABSTRACT

The 12" H & V Duct and related piping outside the LOFT containment and connected to containment penetration S-11B was analyzed to ASME Code, Subsection NC (Class 2) criteria. This duct is part of the Containment Isolation System. The model considered the duct from the containment O.D. outward through the second isolation valve. Results of this analysis show that this section of the line will meet Class 2 requirements without modification.

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LOFT CIS ANALYSIS
PENETRATION S-11B 12" H & V DUCT

I. SCOPE

This document constitutes the stress report required by Subarticle NCA-3350 of the ASME Boiler and Pressure Vessel Code, Section III, "Nuclear Power Plant Components", 1977 through Winter 1977 Addenda*. The piping system analyzed, to be installed as part of the "Loss-of-Fluid-Test" (LOFT) Reactor, was the Penetration S-11B 12" H & V Duct. The line was analyzed as part of the Containment Isolation System.

*Hereafter referred to as the Code^[1].

II. INTRODUCTION

The piping system was analyzed according to the procedures specified in Subsection NC-3600 of the Code and found acceptable. The governing conditions, engineering assumptions, and analytical techniques used in completing the analysis are described in the following pages. All loading conditions and design data used in performing the analysis were obtained from the design specification^[2].

III. PIPING SYSTEM DESCRIPTION

The piping being analyzed is outside LOFT containment penetration S-11B and begins at the containment vessel outside diameter. The line passes through two isolation valves and ends with an expansion joint, which is 4.2 feet past the second isolation valve. Three vertical rod hangers are used to support this section of piping.

1. STRUCTURAL DESCRIPTION

Figure 1 is an isometric plot of the Class 2 piping system analyzed in this report. The data points and elements are identified on the plot and a listing of the geometric data used in performing the system's structural analysis appears in Appendix A.

2. MATERIAL AND GEOMETRIC DATA

The piping has the following design parameters:

O.D. (inches)	12.75	8.625
Thickness (inches)	.406	.322
Weight (lbs/inch)	53.5	28.55
Material	A 106 Gr. B	A 106 Gr. B
E_{cold} (10^6 psi)	27.9	27.9
S (105°F) (psi)	15,000	15,000
S_y (psi)	35,000	35,000
α (10^{-6} in./in. °F)	6.14	6.14

The expansion coefficients and thermal conductivities of SA-106, Gr. B steel are defined in Tables I-4.0 and I-5.0 of the Code.

LOFT CIS ANALYSIS - H & V S-118 - 12.
NUPIPE MATHEMATICAL MODEL

••LEGEND••

- / - NODE LOCATION
- - MASSPOINT LOCATION
- ⚡ - SPRING HANGER
- ▭ - SNUBBER
- ⬆ - RIGID SUPPORT
- ⌋ - ANCHOR
- * - ELASTO JOINT
- ⌋ - FLEXIBLE ANCHOR
- ⌋ - VALVE

ROTATION ABOUT Y-AXIS
X-Z PLANE TILT

45.418 G.
45.418 G.

See Reference 4.

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IV. DESIGN AND SERVICE CONDITIONS

Listed in the following sections are the various design and service conditions used in analyzing the piping. This information was obtained from the design specification.

1. DESIGN CONDITIONS

An internal pressure of 40 psig and a uniform temperature of 105°F were used in this model.

2. LEVEL A SERVICE CONDITIONS

Level A service conditions, dealing mainly with the stress range due to thermal expansion, are based on the operating temperature(s) given below:

Entire Model: 105°F

3. LEVEL B SERVICE CONDITIONS

The only Level B service condition resulting in significant dynamic loads for the piping system is the Operating Basis Earthquake (OBE).

4. LEVEL C SERVICE CONDITIONS

The only significant Level C service condition which affects the piping system is the Safe Shutdown Earthquake (SSE).

5. LEVEL D SERVICE CONDITIONS

The SSE plus Loss-of-Coolant Accident (LOCA) response envelopes all other Level D service responses for LOFT and will be used as the basis for Level D service conditions analysis.

6. TEST CONDITIONS

Cold Hydrostatic Test - Design Pressure x 1.25

Cold Leakage Test - Design Pressure Only

Hot Leakage Test - Design Pressure and Level A Service Temperature(s).

V. PIPING SYSTEM STRUCTURAL ANALYSIS

The piping system was analyzed for the various structural loads described in Section IV using the computer code NUPIPE-II, developed by Nuclear Services Corporation. This computer program is described in Appendix B. All limiting assumptions made in performing the analysis are listed in the following subsections.

1. WEIGHT ANALYSIS

An analysis for normal weight loading was performed for the system; the piping uniform weights used are listed in Section III.2 of this report. The weights and C.G.'s of the valves and operators are given in Table I. The results of the weight analysis are contained in Appendix C of this report.

2. THERMAL EXPANSION ANALYSIS

The piping system addressed in this report was analyzed for the steady-state temperature conditions as outlined in Section IV.2. The results of this analysis are contained in Appendix D.

3. SEISMIC ANALYSES

The piping system was analyzed for the effects of the Operating Basis Earthquake (OBE) and the Safe Shutdown Earthquake (SSE). For this analysis, OBE is to be considered one-half the magnitude of the SSE. The SSE response spectra is shown in Figure 2. This response spectra, multiplied by conservative directional intensity factors, was applied in all three directions simultaneously. Any seismic differential anchor movement effects present on the piping were taken into account. The results of the seismic analyses are contained in Appendix E.

FIGURE 2
SSE - SEISMIC RESPONSE SPECTRA ENVELOPE

1% DAMPING

TABLE I.

Piping System Valve Design Weights
And Centers of Gravity

<u>Valve</u>	<u>Flooded Weight</u>	<u>(Distance from C.G. axis of Pipe)</u>
12" butterfly - horizontal- 14.5' from vessel		
Body	265 lb (est.)	
Operator	200 lb (est.)	2.0 ft.
12" butterfly - horizontal- 18' from vessel		
Body	265 lb (est.)	
Operator	200 lb (est.)	2.0 ft.

VI. ASME BOILER AND PRESSURE VESSEL CODE, SECTION III, STRESS ANALYSIS

A stress analysis of the Class 2 piping addressed in this report, per rules of Subsection NC-3600 of the Code, was performed using the results obtained from the analyses described in Section V of this report.

1. MINIMUM THICKNESS CHECK

The Code requires verification that the piping minimum wall thickness is satisfactory. The thickness was checked against Equation (1) of NC-3641.1:

$$t_M = \frac{P D_o}{2 (S + P_y)} + A$$

where t_M = Minimum required wall thickness
 P = Internal design pressure
 D_o = Outside diameter
 S = Allowable stress
 $y = .4$ or $\frac{d}{d + D_o}$ if $D_o/t_M < 6$ (per Code)
 A = Corrosion allowance (.08).

Results of this calculation are contained in Table II.

TABLE II.

MINIMUM THICKNESS PARAMETERS

<u>Pressure (psi)</u>	<u>O.D. (inches)</u>	<u>S (psi)</u>	<u>t_M (inches)</u>	<u>t_{actual} (inches)</u>
40	12.75	15,000	.10	.406
40	8.625	15,000	.09	.322

Since the actual thicknesses are all greater than the t_m calculated, the system meets the requirements of NC-3641.1.

2. DESIGN, LEVEL A, AND LEVEL B SERVICE CONDITIONS STRESS ANALYSIS

The loading conditions, defined as Design, Level A, and Level B in Section IV.1, 2, and 3, were used in performing a stress analysis of the piping system per the rules given in Subsection NC-3650 of the Code. The computer program NUPIPE-II was used for this analysis. The results of Equations (8), (9), (10), and (11) are detailed in Appendix F. Test conditions are encompassed by this stress analysis.

3. LEVEL C SERVICE CONDITIONS STRESS ANALYSIS

The only loading which was postulated as a Level C service condition is the SSE. NC-3611.2 (c) requires that Equation (9) of NC-3652.2 be satisfied with an allowable of $1.8 S_h$. These results, as calculated using NUPIPE-II, are contained in Appendix G.

4. LEVEL D SERVICE CONDITIONS STRESS ANALYSIS

Not applicable.

VII. COMPONENT SUPPORT ANALYSIS

Any component supports designed and built by EG&G Idaho, Inc. have been analyzed in accordance with the AISC Manual of Steel Construction^[3]. The analysis of these component supports would be contained in Appendix I. All component supports which have been supplied by a commercial manufacturer carry loads which are less than the manufacturer's stated load capacity. A summary of sustained loads on all piping supports is contained in Table III.

TABLE III

LOADS ON PIPING SUPPORTS

<u>Support Type</u>	<u>Support No.</u>	<u>Deadweight</u>	<u>Thermal</u>	<u>OBE</u>	<u>SSE</u>	<u>Rated Load</u>
Vertical Rod Hanger	1	722 lb	-318 lb	522 lb	1044 lb	3800 lb
Vertical Rod Hanger	2	551 lb	-10 lb	1600 lb	3199 lb	3800 lb
Vertical Rod Hanger	3	744 lb	104 lb	750 lb	1501 lb	3800 lb

VIII. SPECIAL CONSIDERATIONS

None.

IX. CONCLUSIONS

The piping system addressed in this report was analyzed for the loads and operating conditions given in the design specification using the techniques described herein. All stresses have been found to be within limits established by Section III of the ASME Boiler and Pressure Vessel Code.

X. REFERENCES

1. American Society of Mechanical Engineers, ASME Boiler & Pressure Vessel Code, Section III, Division 1, "Nuclear Power Plant Components", Subsection NC, 1977 Edition, Winter 1977 Addenda.
2. Specification ANC-HV-3, "Ductwork, Plenums, Hoods, and Accessories", April 16, 1970.
3. American Institute of Steel Construction, Manual of Steel Construction, Seventh Edition, pp 5-6 to 5-24, 1973.
4. Mathematical Model is based on a field isometric drawn in February, 1978.

APPENDIX A
BASIC DATA, INPUT PARAMETERS

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PROGRAM CONTROL CARD

CARDTYPE	NCHECK	DAMP	CODE	GLOB	DYN	THEATA	INTOUT	STORE
CONTROL	0	0	2.	0.	0.	0.0000	0.	0.

CARDTYPE	NPR	NPIPS	UNITS	EIGSAV
CONTROL	10	0	ENGLISH	0

FLEXIBILITY ANALYSIS CONTROL CARDS

CARDTYPE	NCASE	MODE	TLOAD	CMODE	CFREQ	SPEC	SAVE	CYCLE	TITLE
FLEXAN	1	1	3.	0.	0.	0.00	1.	0.	DEADWEIGHT
FLEXAN	2	1	2.	0.	0.	0.00	1.	0.	THERMAL EXPANSION PLUS ANCHOR MOVEMENTS
FLEXAN	3	1	11.	30.	50.	1.00	1.	0.	SSE RESPONSE SPECTRUM - 1% DAMPING

CASE COMBINATION CONTROL CARDS

CARDTYPE	NCASE	CASES-COMD	AMULT	BMULT	CCODE	SAVE	CYCLE	TITLE
MODFLEX	4	3 AND 1	.5	0.0	0.0	1.0	0.0	OBE RESPONSE SPECTRUM - ONE-HALF SSE

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SEISMIC RESPONSE SPECTRA - SET 1

A-2

X-EARTHQUAKE	
PERIOD (SEC)	ACCELERATION (G)
0.000	.342
.010	.342
.250	1.460
.800	.637
1.400	.342
2.200	.217
3.000	.186
10.000	.186

Y-EARTHQUAKE	
PERIOD (SEC)	ACCELERATION (G)
0.000	.228
.010	.228
.250	.973
.800	.422
1.400	.228
2.200	.145
3.000	.124
10.000	.124

Z-EARTHQUAKE	
PERIOD (SEC)	ACCELERATION (G)
0.000	.342
.010	.342
.250	1.460
.800	.637
1.400	.342
2.200	.217
3.000	.186
10.000	.186

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*** INPUT DATA ***

CARDTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
XSECTN	0	1	.128E+02	.406E+00	.535E+02	.279E+02	.400E+02	0.
XSECTN	0	2	.863E+01	.322E+00	.286E+02	.279E+02	.400E+02	0.
OPVAL	1	1	.278E+02	.270E-02	0.	0.	0.	0.
CHECK MAGNITUDE OF ENTRIES ON ABOVE OPVAL CARD ****								
ANCHOR	0	1	0.	0.	0.	0.	0.	0.
FGRUN	1	3	-.227E+01	0.	-.131E+01	.100E+01	.100E+01	0.
MASSPT	0	3	.100E+01	.100E+01	.100E+01	0.	0.	0.
FGRUN	3	5	-.227E+01	0.	-.131E+01	.100E+01	.100E+01	0.
MASSPT	0	5	.100E+01	.100E+01	.100E+01	0.	0.	0.
CWEIGHT	0	5	0.	.176E+03	0.	0.	0.	0.
FGRUN	5	10	-.159E+01	0.	-.920E+00	.100E+01	.100E+01	0.
MASSPT	0	10	.100E+01	.100E+01	.100E+01	0.	0.	0.
ELBCW	10	15	0.	0.	0.	.100E+01	.100E+01	0.
FGRUN	15	20	0.	.500E+01	0.	.100E+01	.100E+01	0.
MASSPT	0	20	.100E+01	.100E+01	.100E+01	0.	0.	0.
ELBCW	20	25	0.	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	25	.100E+01	.100E+01	.100E+01	0.	0.	0.
FGRUN	25	30	-.165E+01	0.	.165E+01	.100E+01	.100E+01	0.
MASSPT	0	30	.100E+01	.100E+01	.100E+01	0.	0.	0.
BRANCH	30	35	.106E+01	0.	.106E+01	.200E+01	.100E+01	.400E+01
MASSPT	0	35	.100E+01	.100E+01	.100E+01	0.	0.	0.
CWEIGHT	0	35	0.	.750E+02	0.	0.	0.	0.
FGRUN	30	40	-.590E+00	0.	.590E+00	.100E+01	.100E+01	0.
MASSPT	0	40	0.	0.	0.	0.	0.	0.
RESTRAINT	0	40	0.	.100E+06	0.	0.	0.	0.
FGRUN	40	45	-.180E+00	0.	.180E+00	.100E+01	.100E+01	0.

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*** INPUT DATA ***

CARDTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
MASSPT	0	45	.10CE+01	.100E+01	.10CE+01	0.	0.	0.
VALVE	45	50	-.16CE+00	0.	.160E+00	.100E+01	.100E+01	0.
MASSPT	0	50	.100E+01	.100E+01	.10CE+01	0.	0.	0.
CWEIGHT	0	50	0.	.200E+03	0.	0.	0.	0.
RUN	50	55	-.122E+01	-.100E+01	-.122E+01	.100E+01	.100E+01	0.
MASSPT	0	55	.10CE+01	.100E+01	.100E+01	0.	0.	0.
CWEIGHT	0	55	0.	.150E+03	0.	0.	0.	0.
VALVE	50	60	-.16CE+00	0.	.16CE+00	.100E+01	.100E+01	0.
MASSPT	0	60	.10CE+01	.100E+01	.10CE+01	0.	0.	0.
FGRUN	60	65	-.136E+01	0.	.136E+01	.100E+01	.100E+01	0.
MASSPT	0	65	.10CE+01	.100E+01	.10CE+01	0.	0.	0.
RESTRAINT	0	65	0.	.100E+00	0.	0.	0.	0.
ELBOW	65	70	0.	0.	0.	.100E+01	.100E+01	0.
FGRUN	70	75	-.850E+00	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	75	.10CE+01	.100E+01	.10CE+01	0.	0.	0.
VALVE	75	80	-.230E+00	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	80	.10CE+01	.100E+01	.100E+01	0.	0.	0.
CWEIGHT	0	80	0.	.200E+03	0.	0.	0.	0.
RUN	80	85	0.	0.	.200E+01	.100E+01	.100E+01	0.
MASSPT	0	85	.100E+01	.100E+01	.100E+01	0.	0.	0.
CWEIGHT	0	85	0.	.150E+03	0.	0.	0.	0.
VALVE	80	90	-.230E+00	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	90	.10CE+01	.100E+01	.100E+01	0.	0.	0.
FGRUN	90	100	-.11CE+01	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	100	.10CE+01	.100E+01	.10CE+01	0.	0.	0.

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CARDTYPE	I1	I2	*** INPUT DATA ***											
			DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)						
BRANCH	100	105	0.	0.	-.150E+01	.200E+01	.100E+01	.400E+01						
MASSPT	0	105	.100E+01	.100E+01	.100E+01	0.	0.	0.						
CWEIGHT	0	105	0.	.750E+02	0.	0.	0.	0.						
FGRUN	100	110	-.830E+00	0.	0.	.100E+01	.100E+01	0.						
MASSPT	0	110	.100E+01	.100E+01	.100E+01	0.	0.	0.						
RESTRAINT	0	110	0.	.100E+06	0.	0.	0.	0.						
FGRUN	110	115	-.380E+00	0.	0.	.100E+01	.100E+01	0.						
MASSPT	0	115	.100E+01	.100E+01	.100E+01	0.	0.	0.						
CWEIGHT	0	115	0.	.225E+03	0.	0.	0.	0.						
FGRUN	115	120	-.167E+01	0.	0.	.100E+01	.100E+01	0.						
MASSPT	0	120	.100E+01	.100E+01	.100E+01	0.	0.	0.						
STRESS7	0	0	0.	0.	0.	0.	0.	0.						
9CASES		0	1	0	4	0	0	0	0	0	0	0	0	0
10CASES		0	2	0	0	0	0	0	0	0	0	0	0	0
CKNODES		0	0	0	0	0	0	0	0	0	0	0	0	0
ALLDONE		0	0	0	0	0	0	0	0	0	0	0	0	0

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APPENDIX B
COMPUTER PROGRAM DESCRIPTION

The NUPIPE-II computer program performs linear elastic analysis of three-dimensional piping systems subject to thermal, deadweight, seismic, and other static and dynamic loads. The NUPIPE-II program is also designed to perform stress and fatigue analyses in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, 1974 Edition through the Summer 1975 Addenda; and the ANSI B31.1 Code, 1967 and Summer 1973 versions. Piping systems of more than one classification can be analyzed.

NUPIPE-II utilizes the finite element method of analysis with special features incorporated to accommodate specific requirements of piping system analysis. In accordance with the finite element method, the continuous piping is mathematically idealized as an assembly of elastic structural members connecting discrete nodal points. Nodal points are placed in such a manner as to isolate particular types of piping elements, such as straight runs of pipe, elbows, valves, etc., for which force-deformation characteristics can be categorized. Nodal points are also placed at all discontinuities, such as piping supports, concentrated weights, branch lines, and changes in cross-section. System loads such as weights, equivalent thermal forces, and earthquake inertia forces are applied at the nodal points. For the deadweight and dynamic time-history and response spectra analyses, distributed weight properties of the piping as well as concentrated weights, such as valves, pumps, or snubbers, can be considered. A lumped mass model of the piping system is used for all dynamic analyses. Both translational and rotational degrees-of-freedom may be considered.

For further information concerning NUPIPE-II capabilities or analytical procedures, contact Applied Mechanics Branch.

APPENDIX C
WEIGHT ANALYSIS RESULTS

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 LOFT CIS ANALYSIS - H & V S-118 - 12"

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SUPPORT REACTIONS FOR LOAD CASE NO. 1

DEADWEIGHT

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
1	FORCE	0.	X COCRD
1	FORCE	760.	Y COCRD
1	FORCE	0.	Z COCRD
1	MOMENT	20955.	X COCRD
1	MOMENT	0.	Y COCRD
1	MOMENT	0.	Z COCRD
40	FORCE	-32019.	X COCRD
65	FORCE	722.	Y COCRD
110	FORCE	551.	Y COCRD
110	FORCE	744.	Y COCRD

110
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LOFT CIS ANALYSIS - H & V S-11B - 12"

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 1

DEADWEIGHT

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	1	0.	700.	0.	20955.	0.	-32019.	-.000	-.000	-.000	-.0000	-.0000	.0000
	3	-0.	-560.	-0.	-11056.	-0.	14866.	.000	-.002	-.000	-.0001	-.0000	.0001
FGRUN	3	0.	560.	0.	11056.	0.	-14866.	.000	-.002	-.000	-.0001	-.0000	.0001
	5	-0.	-419.	-0.	-3362.	-0.	1533.	.000	-.006	-.000	-.0001	-.0000	.0001
FGRUN	5	0.	243.	0.	3362.	0.	-1533.	.000	-.006	-.000	-.0001	-.0000	.0001
	10	-0.	-225.	-0.	-2887.	-0.	712.	.000	-.007	-.000	-.0001	-.0000	.0001
ELBOW	10	0.	225.	0.	2887.	0.	-712.	-.000	-.007	-.000	-.0001	-.0000	.0001
	15	-0.	-99.	-0.	-1424.	-0.	-1816.	-.002	-.010	-.002	-.0001	-.0000	.0001
FGRUN	15	0.	99.	0.	1424.	0.	1816.	-.002	-.010	-.002	-.0001	-.0000	.0001
	20	-0.	8.	-0.	-1424.	-0.	-1816.	-.005	-.010	-.005	-.0001	-.0000	.0001
ELBOW	20	0.	-8.	0.	1424.	0.	1816.	-.005	-.010	-.005	-.0001	-.0000	.0001
	25	-0.	134.	-0.	-524.	-0.	-916.	-.006	-.009	-.008	-.0002	-.0000	.0001
FGRUN	25	0.	-134.	0.	524.	0.	916.	-.006	-.009	-.008	-.0002	-.0000	.0001
	30	-0.	178.	-0.	580.	-0.	188.	-.006	-.008	-.008	-.0002	-.0000	.0001
BRANCH	30	0.	118.	0.	-1226.	0.	1226.	-.006	-.008	-.008	-.0002	-.0000	.0001
	35	-0.	-75.	-0.	-0.	0.	0.	-.006	-.005	-.008	-.0002	-.0000	.0001
FGRUN	30	0.	-256.	0.	646.	0.	-1414.	-.006	-.008	-.008	-.0002	-.0000	.0001
	40	-0.	341.	-0.	1609.	-0.	3669.	-.006	-.007	-.008	-.0002	-.0000	.0001
FGRUN	40	0.	381.	0.	-1609.	0.	-3669.	-.006	-.007	-.008	-.0002	-.0000	.0001
	45	-0.	-368.	-0.	800.	-0.	2860.	-.006	-.007	-.008	-.0002	-.0000	.0001
VALVE	45	0.	368.	0.	-800.	0.	-2860.	-.006	-.007	-.008	-.0002	-.0000	.0001
	50	-0.	-356.	-0.	106.	-0.	2166.	-.006	-.007	-.008	-.0002	-.0000	.0001
RUN	50	0.	257.	0.	2977.	0.	-2977.	-.006	-.007	-.008	-.0002	-.0000	.0001
	55	-0.	-150.	-0.	-0.	-0.	0.	-.005	-.010	-.007	-.0002	-.0000	.0001
VALVE	50	0.	-101.	0.	-3082.	0.	811.	-.006	-.007	-.008	-.0002	-.0000	.0001
	60	-0.	113.	-0.	3288.	-0.	-605.	-.006	-.007	-.008	-.0002	-.0000	.0001
FGRUN	60	0.	-113.	0.	-3288.	0.	605.	-.006	-.007	-.008	-.0002	-.0000	.0001
	65	-0.	163.	-0.	4924.	-0.	1030.	-.007	-.006	-.009	-.0002	-.0000	.0001

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MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
ELBOW	65	0.	368.	0.	-4924.	0.	-1030.	-.007	-.006	-.009	-.0002	-.0000	.0001
	70	-0.	-305.	-0.	3149.	-0.	-3255.	-.007	-.006	-.009	-.0001	-.0000	.0001
FGRUN	70	0.	305.	0.	-3149.	0.	3255.	-.007	-.006	-.009	-.0001	-.0000	.0001
	75	-0.	-293.	-0.	3149.	-0.	-4076.	-.007	-.006	-.009	-.0001	-.0000	.0001
VALVE	75	0.	293.	0.	-3149.	0.	4076.	-.007	-.006	-.009	-.0001	-.0000	.0001
	80	-0.	-281.	-0.	3149.	-0.	-4868.	-.007	-.006	-.009	-.0001	-.0000	.0001
RUN	80	0.	257.	0.	-4884.	0.	0.	-.007	-.006	-.009	-.0001	-.0000	.0001
	85	-0.	-150.	-0.	-0.	-0.	-0.	-.007	-.003	-.009	-.0001	-.0000	.0001
VALVE	80	0.	-176.	0.	1735.	0.	-4868.	-.007	-.006	-.009	-.0001	-.0000	.0001
	90	-0.	189.	-0.	-1735.	-0.	-4364.	-.007	-.006	-.009	-.0001	-.0000	.0001
FGRUN	90	0.	-189.	0.	1735.	0.	4364.	-.007	-.006	-.009	-.0001	-.0000	.0001
	100	-0.	248.	-0.	-1735.	-0.	-1485.	-.007	-.007	-.009	-.0001	-.0000	.0001
BRANCH	100	0.	118.	0.	1735.	0.	0.	-.007	-.007	-.009	-.0001	-.0000	.0001
	105	-0.	-75.	-0.	-0.	-0.	-0.	-.006	-.010	-.009	-.0001	-.0000	.0001
FGRUN	100	0.	-365.	0.	0.	0.	1485.	-.007	-.007	-.009	-.0001	-.0000	.0001
	110	-0.	410.	-0.	-0.	-0.	2375.	-.007	-.007	-.009	-.0001	-.0000	.0001
FGRUN	110	0.	335.	0.	0.	0.	-2375.	-.007	-.007	-.009	-.0001	-.0000	.0001
	115	-0.	-314.	-0.	-0.	-0.	895.	-.007	-.008	-.009	-.0001	-.0000	.0001
FGRUN	115	0.	89.	0.	0.	0.	-895.	-.007	-.008	-.009	-.0001	-.0000	.0001
	120	-0.	-0.	-0.	-0.	-0.	0.	-.007	-.009	-.010	-.0001	-.0000	.0001

APPENDIX D
THERMAL EXPANSION ANALYSIS RESULTS

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 LOFT CIS ANALYSIS - H & V S-11B - 12"

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SUPPORT REACTIONS FOR LOAD CASE NO. 2
 THERMAL EXPANSION PLUS ANCHOR MOVEMENTS

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
1	FORCE	0.	X COCRD
1	FORCE	224.	Y COCRD
1	FORCE	-0.	Z COCRD
1	MOMENT	5636.	X COCRD
1	MOMENT	-0.	Y COCRD
1	MOMENT	-16339.	Z COCRD
400	FORCE	-318.	Y COCRD
65	FORCE	-10.	Y COCRD
110	FORCE	104.	Y COCRD

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LOFT CIS ANALYSIS - H & V S-11B - 12"

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 2

THERMAL EXPANSION PLUS ANCHOR MOVEMENTS

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	1	0.	224.	-0.	5636.	-0.	-16339.	-.000	-.000	-.000	-.0000	.0000	.0000
	3	-0.	-224.	0.	-2114.	0.	10236.	-.006	-.001	-.004	-.0000	.0000	.0001
FGRUN	3	0.	224.	-0.	2114.	-0.	-10236.	-.006	-.001	-.004	-.0000	.0000	.0001
	5	-0.	-224.	0.	1409.	-0.	4133.	-.012	-.003	-.007	-.0000	.0000	.0001
FGRUN	5	0.	224.	-0.	1409.	-0.	-4133.	-.012	-.003	-.007	-.0000	.0000	.0001
	10	-0.	-224.	0.	1862.	-0.	3349.	-.013	-.003	-.008	-.0000	.0000	.0001
ELBOW	10	0.	224.	-0.	1862.	-0.	-3349.	-.013	-.003	-.008	-.0000	.0000	.0001
	15	-0.	-224.	0.	3882.	-0.	-142.	-.018	-.001	-.009	.0000	.0000	.0001
FGRUN	15	0.	224.	-0.	3882.	-0.	142.	-.018	-.001	-.009	.0000	.0000	.0001
	20	-0.	-224.	0.	3882.	-0.	-142.	-.021	-.005	-.008	.0001	.0000	.0001
ELBOW	20	0.	224.	-0.	3882.	-0.	142.	-.021	.005	-.008	.0001	.0000	.0001
	25	-0.	-224.	0.	1030.	-0.	-2994.	-.025	.006	-.003	.0001	.0000	.0001
FGRUN	25	0.	224.	-0.	1030.	-0.	2994.	-.025	.006	-.003	.0001	.0000	.0001
	30	-0.	-224.	0.	-554.	-0.	-4578.	-.026	.005	-.001	.0001	.0000	.0001
BRANCH	30	0.	0.	0.	0.	-0.	-0.	-.026	.005	-.001	.0001	.0000	.0001
	35	-0.	0.	-0.	0.	0.	-0.	-.022	.004	.001	.0001	.0000	.0001
FGRUN	30	0.	224.	-0.	554.	-0.	4578.	-.026	.005	-.001	.0001	.0000	.0001
	40	-0.	-224.	0.	-2140.	-0.	-6164.	-.027	.003	.001	.0001	.0000	.0001
FGRUN	40	0.	-94.	-0.	2140.	-0.	6164.	-.027	.003	.001	.0001	.0000	.0001
	45	-0.	94.	0.	-1938.	-0.	-5962.	-.028	.003	.002	.0001	.0000	.0001
VALVE	45	0.	-94.	-0.	1938.	-0.	5962.	-.028	.003	.002	.0001	.0000	.0001
	50	-0.	94.	0.	-1759.	-0.	-5783.	-.028	.002	.002	.0001	.0000	.0001
RUN	50	0.	0.	-0.	0.	-0.	-0.	-.028	.002	-.002	.0001	.0000	.0001
	55	-0.	0.	0.	-0.	-0.	0.	-.031	.000	.000	.0001	.0000	.0001
VALVE	50	0.	-94.	-0.	1759.	-0.	5783.	-.028	.002	.002	.0001	.0000	.0001
	60	-0.	94.	0.	-1579.	-0.	-5603.	-.028	.002	.003	.0001	.0000	.0001
FGRUN	60	0.	-94.	-0.	1579.	-0.	5603.	-.028	.002	.003	.0001	.0000	.0001
	65	-0.	94.	0.	-546.	-0.	-4570.	-.030	.000	.006	.0001	.0000	.0001

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MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
ELBOW	65	0.	-104.	-0.	546.	0.	4570.	-.030	-.000	.006	.0001	.0000	.0001
	70	-0.	104.	-0.	0.	0.	-3252.	-.033	-.001	.008	.0001	.0000	.0000
FGRUN	70	0.	-104.	-0.	-0.	-0.	3252.	-.033	-.001	.008	.0001	.0000	.0000
	75	-0.	104.	-0.	0.	0.	-2968.	-.033	-.001	.008	.0001	.0000	.0000
VALVE	75	0.	-104.	-0.	-0.	-0.	2968.	-.033	-.001	.008	.0001	.0000	.0000
	80	-0.	104.	-0.	0.	0.	-2683.	-.034	-.001	.008	.0001	.0000	.0000
RUN	80	-0.	0.	-0.	-0.	-0.	0.	-.034	-.001	.008	.0001	.0000	.0000
	85	0.	-0.	-0.	0.	0.	-0.	-.033	-.003	.013	.0001	.0000	.0000
VALVE	80	0.	-104.	-0.	-0.	-0.	2683.	-.034	-.001	.008	.0001	.0000	.0000
	90	-0.	104.	-0.	0.	0.	-2397.	-.035	-.001	.008	.0001	.0000	.0000
FGRUN	90	0.	-104.	-0.	-0.	-0.	2397.	-.035	-.001	.008	.0001	.0000	.0000
	100	-0.	104.	-0.	0.	0.	-1031.	-.038	-.001	.009	.0001	.0000	.0000
BRANCH	100	-0.	0.	-0.	-0.	0.	0.	-.038	-.001	.009	.0001	.0000	.0000
	105	0.	0.	-0.	0.	0.	0.	-.038	-.001	.004	.0001	.0000	.0000
FGRUN	100	0.	-104.	-0.	-0.	-0.	1031.	-.038	-.001	.009	.0001	.0000	.0000
	110	-0.	104.	-0.	0.	0.	0.	-.040	-.001	.009	.0001	.0000	.0000
FGRUN	110	0.	0.	-0.	-0.	-0.	0.	-.040	-.001	.009	.0001	.0000	.0000
	115	-0.	-0.	-0.	0.	0.	-0.	-.041	-.001	.009	.0001	.0000	.0000
FGRUN	115	0.	0.	-0.	-0.	-0.	0.	-.041	-.001	.009	.0001	.0000	.0000
	120	0.	-0.	-0.	0.	0.	-0.	-.045	-.001	.010	.0001	.0000	.0000

APPENDIX E
SEISMIC ANALYSES RESULTS

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LOFT CIS ANALYSIS - H & V S-11B - 12"

*** PIPING DYNAMIC ANALYSIS ***
- FREE VIBRATION RESULTS -

NO. OF SIGNIFICANT MODES = 7

- MODE ORTHOGONALITY CHECK -

MAX. ON DIAGONAL TERM = .100E+01
MIN. ON DIAGONAL TERM = .10CE+01
MAX. OFF DIAGONAL TERM = .361E-13
MIN. OFF DIAGONAL TERM = -.330E-13

MASS PARTICIPATION FACTOR = SUM(M(I)XPHI(I))

MODE	X	Y	Z
1	.8081E+00	.2844E-01	.2018E+01
2	.2162E+01	.7328E-01	.9980E+00
3	.1435E+00	.2241E+00	.7168E+00
4	.1728E+00	.495CE+00	.4030E+00
5	.1202E+00	.2457E+01	.1698E+00
6	.1767E+00	.457CE+00	.1917E+00
7	.1491E+00	.159CE+00	.6423E+00

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SUPPORT REACTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING
 COMBINED RESULT FOR MODE 1 THRU 7 BY RMS SUMMATION

SPECTRA SET = 1

MODE	TYPE	REACTIONS (LBS OR IN-LBS)	DIRECTION
1	FORCE	1757.	X COGRD
1	FORCE	1077.	Y COGRD
1	FORCE	2500.	Z COGRD
1	MOMENT	137792.	X COGRD
1	MOMENT	340177.	Y COGRD
1	MOMENT	109362.	Z COGRD
40	FORCE	1044.	Y COGRD
65	FORCE	3199.	Y COGRD
110	FORCE	1501.	Y COGRD

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LOFT CIS ANALYSIS - H & V S-118 - 12"

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 7 BY RMS SUMMATION

SPECTRA SET = 1

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	1 3	1757.	1077.	2500.	137792.	340177.	109362.	.000	.000	.000	.0000	.0000	.0000
		1757.	1077.	2500.	122273.	282137.	87861.	.010	.009	.017	.0006	.0012	.0003
FGRUN	3 5	1753.	1071.	2493.	122273.	282137.	87861.	.010	.009	.017	.0006	.0012	.0003
		1753.	1071.	2493.	107230.	228263.	72142.	.036	.034	.063	.0010	.0021	.0006
FGRUN	5 10	1742.	1051.	2462.	107230.	228263.	72142.	.036	.034	.063	.0010	.0021	.0006
		1742.	1051.	2462.	105357.	221873.	70767.	.040	.039	.071	.0011	.0022	.0006
ELBOW	10 15	1736.	1042.	2445.	105357.	221873.	70767.	.040	.039	.071	.0011	.0022	.0006
		1736.	1042.	2445.	54107.	195232.	36422.	.060	.076	.194	.0043	.0061	.0018
FGRUN	15 20	1736.	1042.	2445.	54107.	195232.	36422.	.060	.076	.194	.0043	.0061	.0018
		1736.	1042.	2445.	16050.	195232.	13286.	.052	.076	.298	.0044	.0068	.0018
ELBOW	20 25	1659.	1031.	2365.	16050.	195232.	13286.	.052	.076	.298	.0044	.0068	.0018
		1659.	1031.	2365.	38196.	152721.	36246.	.134	.044	.484	.0050	.0095	.0025
FGRUN	25 30	1603.	1032.	2306.	38196.	152721.	36246.	.134	.044	.484	.0050	.0095	.0025
		1603.	1032.	2306.	31059.	129707.	37084.	.197	.027	.551	.0049	.0096	.0025
BRANCH	30 35	78.	27.	66.	348.	1236.	348.	.197	.027	.551	.0049	.0096	.0025
		78.	27.	66.	0.	0.	0.	.315	.068	.429	.0049	.0096	.0025
FGRUN	30 40	1479.	1037.	2196.	31120.	129822.	37237.	.197	.027	.551	.0049	.0096	.0025
		1479.	1037.	2196.	24041.	108062.	39497.	.263	.010	.620	.0049	.0098	.0024
FGRUN	40 45	1479.	1757.	2196.	24041.	108062.	39497.	.263	.010	.620	.0049	.0098	.0024
		1479.	1757.	2196.	20426.	101459.	42630.	.284	.006	.641	.0049	.0098	.0024
VALVE	45 50	1469.	1757.	2185.	20426.	101459.	42630.	.284	.006	.641	.0049	.0098	.0024
		1469.	1757.	2185.	17277.	95637.	45500.	.302	.004	.660	.0049	.0098	.0024
RUN	50 55	139.	84.	216.	2798.	3929.	1383.	.302	.004	.660	.0049	.0098	.0024
		139.	84.	216.	0.	0.	0.	.136	.107	.747	.0049	.0098	.0024
VALVE	50 60	1140.	1732.	1734.	14783.	93223.	45109.	.302	.004	.660	.0049	.0098	.0024
		1140.	1732.	1734.	11675.	88454.	47996.	.321	.006	.679	.0049	.0098	.0024
FGRUN	60 65	1108.	1733.	1697.	11675.	88454.	47996.	.321	.006	.679	.0049	.0098	.0024
		1108.	1733.	1697.	9645.	61827.	65423.	.429	.032	.789	.0048	.0100	.0023
ELBOW	65 70	1043.	1520.	1620.	9645.	61827.	65423.	.429	.032	.789	.0048	.0100	.0023
		1043.	1520.	1620.	2246.	37938.	46117.	.482	.034	.921	.0051	.0107	.0016

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MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	70	1043.	1520.	1620.	2246.	37938.	46117.	.482	.034	.921	.0051	.0107	.0016
	75	1043.	1520.	1620.	2246.	33528.	41959.	.482	.029	.951	.0051	.0107	.0016
VALVE	75	1002.	1517.	1564.	2246.	33528.	41959.	.482	.029	.951	.0051	.0107	.0016
	80	1002.	1517.	1564.	2246.	29253.	37783.	.482	.025	.980	.0051	.0107	.0016
RUN	80	244.	85.	269.	2037.	5848.	0.	.482	.025	.980	.0051	.0107	.0016
	85	244.	85.	269.	0.	0.	0.	.738	.147	.980	.0051	.0107	.0016
VALVE	80	516.	1458.	948.	692.	25017.	37783.	.482	.025	.980	.0051	.0107	.0016
	90	516.	1458.	948.	692.	22406.	33759.	.482	.021	1.010	.0051	.0107	.0016
FGRUN	90	483.	1458.	900.	692.	22406.	33759.	.482	.021	1.010	.0051	.0107	.0016
	100	483.	1458.	900.	692.	10579.	14522.	.482	.003	1.152	.0051	.0107	.0015
BRANCH	100	80.	38.	149.	692.	1443.	0.	.482	.003	1.152	.0051	.0107	.0015
	105	80.	38.	149.	0.	0.	0.	.292	.092	1.152	.0051	.0107	.0015
FGRUN	100	337.	1475.	639.	0.	10870.	14522.	.482	.003	1.152	.0051	.0107	.0015
	110	337.	1475.	639.	0.	4509.	834.	.482	.015	1.259	.0051	.0108	.0015
FGRUN	110	306.	106.	584.	0.	4509.	834.	.482	.015	1.259	.0051	.0108	.0015
	115	306.	106.	584.	0.	1847.	352.	.482	.022	1.308	.0051	.0108	.0015
FGRUN	115	42.	18.	92.	0.	1847.	352.	.482	.022	1.308	.0051	.0108	.0015
	120	42.	18.	92.	0.	0.	0.	.482	.053	1.524	.0051	.0108	.0015

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SYSTEM ACCELERATION FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING
 COMBINED RESULT FOR MODE 1 THRU 7 BY RMS SUMMATION

SPECTRA SET = 1

POINT NO.	X-DIRECTION (G)	Y-DIRECTION (G)	Z-DIRECTION (G)
1	.000	.000	.000
15	.042	.089	.072
33	.128	.265	.222
55	.140	.289	.242
77	.302	.374	.398
99	.568	.374	.527
121	.734	.325	.734
143	.751	.290	.805
165	.812	.284	.683
187	.781	.258	.881
209	.793	.251	.906
231	.804	.245	.928
253	.683	.413	1.060
275	.816	.240	1.050
297	.898	.223	1.083
319	.943	.238	1.246
341	.944	.241	1.283
363	.944	.245	1.320
385	1.197	.417	1.320
407	.944	.249	1.358
429	.944	.276	1.545
451	.832	.399	1.545
473	.944	.302	1.690
495	.944	.313	1.798
517	.944	.393	2.063

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SUPPORT REACTIONS FOR LOAD COMBINATION CASE NO. 4
 OBE RESPONSE SPECTRUM - ONE-HALF SSE

NODE	TYPE	REACTIONS (LBS OR IN-LBS)	DIRECTION
1	FORCE	878.	X COORD
11	FORCE	536.	Y COORD
11	FORCE	1250.	Z COORD
11	MOMENT	68896.	X COORD
11	MOMENT	170086.	Y COORD
11	MOMENT	54681.	Z COORD
40	FORCE	522.	Y COORD
65	FORCE	1600.	Y COORD
110	FORCE	750.	Y COORD

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LOFT CIS ANALYSIS - H & V S-118 - 12"

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 4

OBE RESPONSE SPECTRUM - ONE-HALF SSE

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	1	876.	539.	1250.	68896.	170088.	54681.	.000	.000	.000	.0000	.0000	.0000
	3	876.	539.	1250.	61136.	141068.	43930.	.005	.005	.009	.0003	.0006	.0002
FGRUN	3	877.	535.	1246.	61136.	141068.	43930.	.005	.005	.009	.0003	.0006	.0002
	5	877.	535.	1246.	53615.	114131.	36071.	.018	.017	.031	.0005	.0011	.0003
FGRUN	5	871.	525.	1231.	53615.	114131.	36071.	.018	.017	.031	.0005	.0011	.0003
	10	871.	525.	1231.	52678.	110937.	35384.	.020	.019	.035	.0006	.0011	.0003
ELBOW	10	868.	521.	1223.	52678.	110937.	35384.	.020	.019	.035	.0006	.0011	.0003
	15	868.	521.	1223.	27053.	97616.	18211.	.030	.038	.097	.0021	.0030	.0009
FGRUN	15	868.	521.	1223.	27053.	97616.	18211.	.030	.038	.097	.0021	.0030	.0009
	20	868.	521.	1223.	8025.	97616.	6643.	.026	.038	.149	.0022	.0034	.0009
ELBOW	20	829.	515.	1182.	8025.	97616.	6643.	.026	.038	.149	.0022	.0034	.0009
	25	829.	515.	1182.	19098.	76360.	18123.	.067	.022	.242	.0025	.0047	.0013
FGRUN	25	802.	516.	1153.	19098.	76360.	18123.	.067	.022	.242	.0025	.0047	.0013
	30	802.	516.	1153.	15529.	64853.	18542.	.098	.014	.276	.0025	.0048	.0013
BRANCH	30	39.	14.	33.	174.	618.	174.	.098	.014	.276	.0025	.0048	.0013
	35	39.	14.	33.	0.	0.	0.	.158	.034	.214	.0025	.0048	.0013
FGRUN	30	740.	519.	1098.	15560.	64911.	18618.	.098	.014	.276	.0025	.0048	.0013
	40	740.	519.	1098.	12020.	54031.	19748.	.131	.005	.310	.0024	.0049	.0012
FGRUN	40	740.	878.	1098.	12020.	54031.	19748.	.131	.005	.310	.0024	.0049	.0012
	45	740.	878.	1098.	10213.	50729.	21315.	.142	.003	.321	.0024	.0049	.0012
VALVE	45	735.	878.	1092.	10213.	50729.	21315.	.142	.003	.321	.0024	.0049	.0012
	50	735.	878.	1092.	8638.	47818.	22750.	.151	.002	.330	.0024	.0049	.0012
RUN	50	69.	42.	108.	1399.	1965.	692.	.151	.002	.330	.0024	.0049	.0012
	55	69.	42.	108.	0.	0.	0.	.068	.053	.373	.0024	.0049	.0012
VALVE	50	570.	866.	867.	7391.	46612.	22555.	.151	.002	.330	.0024	.0049	.0012
	60	570.	866.	867.	5837.	44227.	23998.	.160	.003	.340	.0024	.0049	.0012
FGRUN	60	554.	866.	848.	5837.	44227.	23998.	.160	.003	.340	.0024	.0049	.0012
	65	554.	866.	848.	4823.	30913.	32711.	.214	.016	.394	.0024	.0050	.0011
ELBOW	65	521.	760.	810.	4823.	30913.	32711.	.214	.016	.394	.0024	.0050	.0011
	70	521.	760.	810.	1123.	18969.	23058.	.241	.017	.461	.0025	.0054	.0008

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MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	70	521.	760.	810.	1123.	18969.	23058.	.241	.017	.461	.0025	.0054	.0008
	75	521.	760.	810.	1123.	16764.	20979.	.241	.015	.475	.0025	.0054	.0008
VALVE	75	501.	759.	782.	1123.	16764.	20979.	.241	.015	.475	.0025	.0054	.0008
	80	501.	759.	782.	1123.	14627.	18892.	.241	.013	.490	.0025	.0054	.0008
RUN	80	122.	42.	134.	1019.	2924.	0.	.241	.013	.490	.0025	.0054	.0008
	85	122.	42.	134.	0.	0.	0.	.369	.074	.490	.0025	.0054	.0008
VALVE	80	258.	729.	474.	346.	12509.	18892.	.241	.013	.490	.0025	.0054	.0008
	90	258.	729.	474.	346.	11203.	16879.	.241	.010	.505	.0025	.0054	.0008
FGRUN.	90	241.	729.	450.	346.	11203.	16879.	.241	.010	.505	.0025	.0054	.0008
	100	241.	729.	450.	346.	5290.	7261.	.241	.001	.576	.0025	.0054	.0008
BRANCH	100	40.	19.	74.	346.	722.	0.	.241	.001	.576	.0025	.0054	.0008
	105	40.	19.	74.	0.	0.	0.	.146	.046	.576	.0025	.0054	.0008
FGRUN	100	168.	737.	319.	0.	5435.	7261.	.241	.001	.576	.0025	.0054	.0008
	110	168.	737.	319.	0.	2254.	417.	.241	.008	.629	.0025	.0054	.0008
FGRUN	110	153.	53.	292.	0.	2254.	417.	.241	.008	.629	.0025	.0054	.0008
	115	153.	53.	292.	0.	924.	176.	.241	.011	.654	.0025	.0054	.0008
FGRUN	115	21.	9.	46.	0.	924.	176.	.241	.011	.654	.0025	.0054	.0008
	120	21.	9.	46.	0.	0.	0.	.241	.026	.762	.0025	.0054	.0008

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APPENDIX F
DESIGN, LEVEL A, AND LEVEL B SERVICE
CONDITIONS STRESS ANALYSIS RESULTS

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ASME SECTION III CLASS 2 OR ANSI B31.1.8 STRESS SUMMARY

MEMBER	NODE	STRESS INTENSIF FACTOR	SUSTAINED STRESS EQ. 8 (PSI)	OCCASIONAL STRESS EQ. 9 (PSI)	EXPANSION STRESS EQ. 10 (PSI)	SUSTAINED PLUS EXPANSION STRESS EQ. 11 (PSI)
FGRUN	1	1.000	1102.	5043.	356.	1457.
	3	1.000	695.	3986.	215.	910.
FGRUN	3	1.000	695.	3986.	215.	910.
	5	1.000	390.	3089.	90.	480.
FGRUN	5	1.000	390.	3089.	90.	480.
	10	1.000	375.	3006.	79.	454.
ELBOW	10	2.707	438.	5779.	213.	652.
	15	2.707	410.	4711.	216.	627.
FGRUN	15	1.000	362.	2480.	80.	441.
	20	1.000	362.	2382.	80.	441.
ELBOW	20	2.707	410.	4513.	216.	627.
	25	2.707	358.	3733.	176.	535.
FGRUN	25	1.000	336.	1998.	65.	401.
	30	5.769	368.	6532.	548.	916.
BRANCH	30	5.769	609.	740.	0.	609.
	35	1.000	268.	268.	0.	268.
FGRUN	30	5.769	453.	6624.	548.	1000.
	40	1.000	396.	1606.	134.	531.
FGRUN	40	1.000	396.	1606.	134.	531.
	45	1.000	375.	1527.	129.	504.
RUN	50	1.000	401.	452.	0.	401.
	55	1.000	314.	314.	0.	314.
FGRUN	60	1.000	383.	1425.	120.	503.
	65	1.000	418.	1349.	95.	512.
ELBOW	65	2.707	524.	2416.	256.	781.
	70	2.707	503.	1752.	181.	685.
FGRUN	70	1.000	407.	1022.	67.	474.
	75	1.000	420.	973.	61.	481.

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ASME SECTION III CLASS 2 OR ANSI B31.1.8 STRESS SUMMARY

MEMBER	NODE	STRESS INTERFAC FACTOR	SUSTAINED STRESS EQ. 8 (PSI)	OCCASIONAL STRESS EQ. 9 (PSI)	EXPANSION STRESS EQ. 10 (PSI)	SUSTAINED PLUS EXPANSION STRESS EQ. 11 (PSI)
RUN	80	1.000	415.	478.	0.	415.
	85	1.000	314.	314.	0.	314.
FGRUN	90	1.000	411.	828.	45.	460.
	100	5.769	517.	1318.	122.	640.
BRANCH	100	5.769	609.	767.	0.	609.
	105	1.000	268.	268.	0.	268.
FGRUN	100	5.769	446.	1254.	122.	569.
	110	1.000	363.	410.	0.	363.
FGRUN	110	1.000	363.	410.	0.	363.
	115	1.000	332.	352.	0.	332.
FGRUN	115	1.000	332.	352.	0.	332.
	120	1.000	314.	314.	0.	314.

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APPENDIX G
LEVEL C SERVICE CONDITIONS
STRESS ANALYSIS RESULTS

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ASME SECTION III CLASS 2 OR ANSI B31.1.8 STRESS SUMMARY

MEMBER	NODE	STRESS INTENSIF FACTOR	SUSTAINED STRESS EQ. 8 (PSI)	OCCASIONAL STRESS EQ. 9 (PSI)	EXPANSION STRESS EQ. 10 (PSI)	SUSTAINED PLUS EXPANSION STRESS EQ. 11 (PSI)
FGRUN	1 3	1.000 1.000	1102. 695.	8984. 7277.	C. C.	1102. 695.
FGRUN	3 5	1.000 1.000	695. 390.	7277. 5789.	C. C.	695. 390.
FGRUN	5 10	1.000 1.000	390. 375.	5789. 5636.	C. C.	390. 375.
ELBOW	10 15	2.707 2.707	438. 410.	11120. 9012.	C. C.	438. 410.
FGRUN	15 20	1.000 1.000	362. 362.	4598. 4402.	C. C.	362. 362.
ELBOW	20 25	2.707 2.707	410. 358.	8615. 7109.	C. C.	410. 358.
FGRUN	25 30	1.000 5.769	336. 368.	3661. 12696.	C. C.	336. 368.
BRANCH	30 35	5.769 1.000	609. 268.	871. 268.	C. C.	609. 268.
FGRUN	30 40	5.769 1.000	453. 396.	12795. 2816.	C. C.	453. 396.
FGRUN	40 45	1.000 1.000	396. 375.	2816. 2679.	C. C.	396. 375.
RUN	50 55	1.000 1.000	401. 314.	504. 314.	C. C.	401. 314.
FGRUN	60 65	1.000 1.000	383. 418.	2468. 2281.	C. C.	383. 418.
ELBOW	65 70	2.707 2.707	524. 503.	4307. 3000.	C. C.	524. 503.
FGRUN	70 75	1.000 1.000	407. 420.	1637. 1526.	C. C.	407. 420.

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ASME SECTION III CLASS 2 OR ANSI B31.1.B STRESS SUMMARY

MEMBER	NODE	STRESS INTENSIFY FACTOR	SUSTAINED STRESS EQ. 8 (PSI)	OCCASIONAL STRESS EQ. 9 (PSI)	EXPANSION STRESS EQ. 10 (PSI)	SUSTAINED PLUS EXPANSION STRESS EQ. 11 (PSI)
Q RUN	80	1.000	415.	542.	0.	415.
	85	1.000	314.	314.	0.	314.
P FGRUN	90	1.000	411.	1245.	0.	411.
	100	5.769	517.	2119.	0.	517.
BRANCH	100	5.769	609.	924.	0.	609.
	105	1.000	268.	268.	0.	268.
FGRUN	100	5.769	446.	2062.	0.	446.
	110	1.000	363.	457.	0.	363.
FGRUN	110	1.000	363.	457.	0.	363.
	115	1.000	332.	371.	0.	332.
FGRUN	115	1.000	332.	371.	0.	332.
	120	1.000	314.	314.	0.	314.

APPENDIX H
LEVEL D SERVICE CONDITIONS
STRESS ANALYSIS RESULTS

Level D service conditions are
not applicable to this stress analysis.

APPENDIX I
COMPONENT SUPPORT ANALYSIS RESULTS

ALL SUPPORTS ARE LOAD RATED BY
MANUFACTURER.