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LOFT CIS ANALYSIS

LINE 2"-LS-120-AB OUTSIDE CONTAINMENT PENETRATION S-1A

A. T. Pierce

EG&G Idaho, Inc.

IDAHO NATIONAL ENGINEERING LABORATORY

DEPARTMENT OF ENERGY

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

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LOFT TECHNICAL REPORT LTR 137-1

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APPLIED MECHANICS BRANCH

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LOFT CIS ANALYSIS

LINE 2"-LS-120-AB OUTSIDE CONTAINMENT PENETRATION S-1A

A. T. Pierce/ *A. T. Pierce*
AUTHOR

CHECKED BY: *J. W. Muffett*

APPROVED BY: *J. G. Arendts*

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cc: J. G. Arendts
S. M. Gardner (3)
M. M. Laughlin (5)
C. A. Moore
J. W. Muffett
A. T. Pierce

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LOFT TECHNICAL REPORT
LOFT PROGRAM

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

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[Signature]
RSB Mgr.

[Signature]
PSE 8-16-78

ABSTRACT

Line 2"-LS-120-AB outside containment penetration S-1A was analyzed to ASME Section III, Subsection NC (Class 2) criteria. The line is part of the Containment Isolation System. The model considered the line from the penetration outward through the second isolation valve. Results of the analysis show that this section of the line meets Class 2 requirements without modification.

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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, were lines 2"-LS-120-AB and 2"-LS-119-A outside containment penetrations S-1A. The lines were analyzed as part of the Containment Isolation System.

*Hereinafter 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 LOFT specifications^[2]. The design specification is to be issued at a later date.

III. PIPING SYSTEM DESCRIPTION

Line 2"-LS-120-AB begins outside containment penetration S-1A. The line passes through two hand valves, changes to 2"-LS-119-A and tees into line 6"-LS-7-A. The lines are supported by a hanger inside the penetration and by two rod hangers, and have one inch of insulation.

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:

	2"-LS-120-AB	2"-LS-119-A
O.D. (inches)	2.375	2.375
Thickness (inches)	0.154	0.154
Weight (lbs/inch)	6.06	6.06
Material	SA 106 Gr. B	SA 53 or SA 120
E_{cold} (10^6 psi)	27.9	27.9
S (250°F) (psi)	15,000	8,800 (worst case)
S_y (psi)	35,000	
α (10^{-6} in./in.°F)	6.48	6.48

LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE
NUPIPE MATHEMATICAL MODEL

LEGEND

- / - NODE LOCATION
- - MASSPOINT LOCATION
- ←--- SPRING HANGER
- SNUBBER
- ← RIGID SUPPORT
- ANCHOR
- * - ELASTO JOINT
- FLEXIBLE ANCHOR
- VALVE

ROTATION ABOUT Y-AXIS = -44.8EG.
X-Z PLANE TILT = 45.4DEG.

See Reference 4.

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.

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 LOFT specifications.

1. DESIGN CONDITIONS

An internal pressure of 50 psig and a uniform temperature of 250°F were used in the 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: 250°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.

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>
V-1749	45 lbs.	6" south
V-1380	45 lbs.	6" west

FIGURE 2
SSE - SEISMIC RESPONSE SPECTRA ENVELOPE

1% DAMPING

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>
50	2.375	8800	0.087	0.154

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>Node No.</u>	<u>Total Load (SRSS)</u>			<u>SSE</u>	<u>Rated Load</u>
		<u>Deadweight</u>	<u>Thermal</u>	<u>OBE</u>		
Guide	10	52	67	116	232	1220
Rod Hanger	50	-229	-4	46	92	610
Rod Hanger	60	+10	+40	41	81	610

VIII. SPECIAL CONSIDERATIONS

The tee between 2"-LS-119-A and 6"-LS-7-A was treated as an assumed anchor.

IX. CONCLUSIONS

The piping system addressed in this report was analyzed for the stated loads and operating conditions 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. LOFT Specifications P-1, "Line Designation Tables," 3-9-76, and P-4, "Piping Materials," 8-14-72.
3. American Institute of Steel Construction, Manual of Steel Construction, Seventh Edition, pp 5-6 to 5-24, 1973.
4. Piping model based upon field measurements by Applied Mechanics Branch personnel, February, 1978.

APPENDIX A
BASIC DATA, INPUT PARAMETERS

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 LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

PAGE 3

*** INPUT DATA ***

CARDTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
XSECTN	0	1	.238E+01	.154E+00	.606E+01	.279E+02	.500E+02	0.
OPVAL	1	1	.276E+02	.140E-01	0.	0.	.120E+02	0.
CHECK MAGNITUDE OF ENTRIES ON ABOVE OPVAL CARD ****								
ANCHOR	0	5	0.	0.	0.	0.	0.	0.
FGRUN	5	7	.192E+01	0.	-.192E+01	.100E+01	.100E+01	0.
FGRUN	7	10	.192E+01	0.	-.192E+01	.100E+01	.100E+01	0.
RESTRAINT	0	10	0.	.100E+07	0.	0.	0.	0.
RSKEW	0	10	.100E+01	.200E+01	.707E+00	0.	.707E+00	.100E+07
FGRUN	10	12	.224E+01	0.	-.224E+01	.100E+01	.100E+01	0.
FGRUN	12	15	.224E+01	0.	-.224E+01	.100E+01	.100E+01	0.
ELBOW	15	16	0.	0.	0.	.100E+01	.100E+01	0.
DUMMY	15	16	0.	0.	-.100E+01	.100E+01	.100E+01	0.
DUMMY	16	20	0.	0.	-.100E+01	.100E+01	.100E+01	0.
ELBOW	16	20	0.	0.	0.	.100E+01	.100E+01	0.
FGRUN	20	25	0.	.500E+00	0.	.100E+01	.100E+01	0.
VALVE	25	26	0.	.333E+00	0.	.100E+01	.100E+01	0.
RUN	26	27	-.500E+00	0.	0.	.100E+01	.100E+01	0.
CWEIGHT	0	27	0.	.450E+02	0.	0.	0.	0.
VALVE	26	28	0.	.333E+00	0.	.100E+01	.100E+01	0.
FGRUN	28	30	0.	.417E+00	0.	.100E+01	.100E+01	0.
FGRUN	30	35	0.	.750E+00	0.	.100E+01	.100E+01	0.
VALVE	35	36	0.	.333E+00	0.	.100E+01	.100E+01	0.
RUN	36	37	0.	0.	-.500E+00	.100E+01	.100E+01	0.
CWEIGHT	0	37	0.	.450E+02	0.	0.	0.	0.
VALVE	36	38	0.	.333E+00	0.	.100E+01	.100E+01	0.
FGRUN	38	40	0.	.917E+00	0.	.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)
CWEIGHT	0	40	0.	.100E+02	0.	0.	0.	0.
SRUN	40	45	0.	.127E+01	0.	.100E+01	.100E+01	0.
TEE	45	40	0.	0.	0.	0.	0.	0.
SRUN	45	46	0.	0.	.333E+00	.100E+01	.100E+01	0.
SRUN	45	50	0.	0.	-.15E+01	.100E+01	.100E+01	0.
RESTRAINT	0	50	0.	.100E+06	0.	0.	0.	0.
FGRUN	50	55	0.	0.	-.350E+01	.100E+01	.100E+01	0.
FGRUN	50	60	0.	0.	-.350E+01	.100E+01	.100E+01	0.
RESTRAINT	0	60	0.	.100E+06	0.	0.	0.	0.
FGRUN	60	65	0.	0.	-.317E+01	.100E+01	.100E+01	0.
SRUN	65	70	0.	0.	-.317E+01	.100E+01	.100E+01	0.
SRUN	70	75	0.	-.100E+01	0.	.100E+01	.100E+01	0.
ANCHOR	0	75	0.	0.	0.	0.	0.	0.
MASSPT	0	7	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	12	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	15	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	20	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	26	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	27	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	36	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	37	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	45	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	50	.100E+01	0.	.100E+01	0.	0.	0.
MASSPT	0	55	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	60	.100E+01	0.	.100E+01	0.	0.	0.

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CARDTYPE	I1	I2	*** INPUT DATA ***						DELTA(4)	DELTA(5)	DELTA(6)
			DELTA(1)	DELTA(2)	DELTA(3)	DELTA(3)	DELTA(3)	DELTA(3)			
MASSPT	0	65	.100E+01	.100E+01	.100E+01	0.	0.	0.			
MASSPT	0	70	.100E+01	.100E+01	.100E+01	0.	0.	0.			
STRESS7	0	0	0.	0.	0.	0.	0.	0.			
9CASES		2	0	0	0	0	0	0	0	0	0
10CASES		1	0	0	0	0	0	0	0	0	0
CKNODES		0	0	0	0	0	0	0	0	0	0
ALLDONE		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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SUPPORT REACTIONS FOR LOAD CASE NO. 2

DEADWEIGHT

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
5	FGS	-10.	X COORD
5	FGS	9.	Y COORD
5	FGS	1.	Z COORD
5	FGS	-16.	X COORD
5	FGS	135.	Y COORD
5	FGS	-24.	Z COORD
10	FGS	51.	Y COORD
10	FGS	12.	INCLINED
60	FGS	229.	Y COORD
60	FGS	-10.	X COORD
75	FGS	2.	X COORD
75	FGS	29.	Y COORD
75	FGS	-10.	Z COORD
75	FGS	-320.	X COORD
75	FGS	136.	Y COORD
75	FGS	-32.	Z COORD

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LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 2

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	5	-10.	9.	1.	-6.	135.	-29.	.000	-.000	-.000	.0000	-.0000	.0000
	7	10.	7.	-1.	25.	68.	49.	.001	.001	.001	.0000	-.0001	.0001
FGRUN	7	-10.	-7.	1.	-25.	-68.	-49.	.001	-.001	-.001	.0000	-.0001	.0001
	10	10.	24.	-1.	-332.	271.	-309.	.000	-.000	-.000	-.0003	.0002	-.0001
FGRUN	10	-2.	28.	10.	332.	-271.	309.	.000	-.000	-.000	-.0002	.0002	-.0001
	12	2.	-8.	-10.	153.	62.	177.	-.012	-.020	-.012	-.0004	.0006	-.0003
FGRUN	12	-2.	8.	10.	-153.	-62.	-177.	-.012	-.020	-.012	-.0004	.0006	-.0003
	15	2.	10.	-10.	132.	-140.	155.	-.027	-.030	-.027	-.0002	.0005	.0001
ELBOW	15	-2.	-10.	10.	-132.	140.	-155.	-.027	-.030	-.027	-.0002	.0005	.0001
	16	2.	11.	-10.	109.	-144.	146.	-.026	-.030	-.027	-.0001	.0004	.0001
ELBOW	16	-2.	-11.	10.	-109.	144.	-146.	-.028	-.030	-.027	-.0001	.0004	.0001
	20	2.	14.	-10.	101.	-138.	152.	-.030	-.031	-.027	-.0000	.0004	.0002
FGRUN	20	-2.	-14.	10.	-101.	138.	-152.	-.030	-.031	-.027	.0000	.0004	.0002
	25	2.	15.	-10.	131.	-138.	158.	-.030	-.031	-.027	.0000	.0003	.0002
VALVE	25	-2.	-15.	10.	-131.	138.	-158.	-.030	-.031	-.027	.0000	.0003	.0002
	26	2.	17.	-10.	170.	-138.	166.	-.031	-.031	-.027	.0000	.0003	.0002
RUN	26	0.	46.	0.	-0.	-0.	-279.	-.031	-.031	-.027	.0000	.0003	.0002
	27	-0.	-45.	-0.	0.	0.	0.	-.031	-.032	-.025	.0000	.0003	.0003
VALVE	26	-2.	-65.	10.	-170.	138.	113.	-.031	-.031	-.027	.0000	.0003	.0002
	28	2.	67.	-10.	209.	-138.	-105.	-.032	-.030	-.027	.0001	.0003	.0002
FGRUN	28	-2.	-67.	10.	-209.	138.	105.	-.032	-.030	-.027	.0001	.0003	.0002
	30	2.	70.	-10.	258.	-138.	-95.	-.033	-.030	-.027	.0001	.0003	.0002
FGRUN	30	-2.	-70.	10.	-258.	138.	95.	-.033	-.030	-.027	.0001	.0003	.0002
	35	2.	74.	-10.	346.	-138.	-77.	-.034	-.030	-.025	.0003	.0002	.0001
VALVE	35	-2.	-74.	10.	-346.	138.	77.	-.034	-.030	-.025	.0003	.0002	.0001
	36	2.	76.	-10.	385.	-138.	-69.	-.035	-.030	-.024	.0003	.0002	.0001
RUN	36	0.	48.	0.	279.	-0.	0.	-.035	-.030	-.024	.0003	.0002	.0001
	37	-0.	-45.	-0.	0.	0.	-0.	-.036	-.029	-.024	.0003	.0002	.0001

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 LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

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MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		F1	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
VALVE	36	-2.	-124.	-10.	-654.	138.	69.	-.035	-.030	-.024	.0003	.0002	.0001
	38	2.	126.	-10.	703.	-138.	-61.	-.035	-.030	-.023	.0003	.0001	.0001
FGRUN	38	-2.	-126.	-10.	-703.	138.	61.	-.035	-.030	-.023	.0003	.0001	.0001
	40	2.	132.	-10.	811.	-138.	-38.	-.037	-.030	-.016	.0008	.0003	.0001
SRUN	40	-2.	-142.	-10.	-811.	138.	38.	-.037	-.030	-.016	.0008	.0003	.0001
	45	2.	150.	-10.	960.	-138.	-8.	-.038	-.030	-.001	.0015	-.0001	.0001
SRUN	45	0.	2.	-0.	-4.	0.	-0.	-.038	-.030	.001	.0015	-.0001	.0001
	46	-0.	-0.	0.	-0.	0.	0.	-.039	-.036	.001	.0015	-.0001	.0001
SRUN	45	-2.	-152.	-10.	-956.	138.	8.	-.038	-.030	.001	.0015	-.0001	.0001
	50	2.	161.	-10.	1856.	-102.	-8.	-.035	-.002	.001	.0011	-.0002	.0001
FGRUN	50	0.	21.	-0.	445.	0.	0.	-.035	-.002	.001	.0011	-.0002	.0001
	55	-0.	0.	0.	-0.	-0.	-0.	-.026	.029	.001	.0006	-.0002	.0001
FGRUN	50	-2.	47.	-10.	1410.	102.	8.	-.035	-.002	.001	.0011	-.0002	.0001
	60	2.	-26.	-10.	109.	-17.	-8.	-.022	.000	.001	-.0004	-.0004	.0001
FGRUN	60	-2.	15.	-10.	-109.	17.	8.	-.022	-.000	.001	-.0004	-.0004	.0001
	65	2.	4.	-10.	318.	60.	-8.	-.009	-.008	.001	.0001	-.0003	.0000
SRUN	65	-2.	-4.	-10.	-318.	-60.	8.	-.009	-.008	.001	.0001	-.0003	.0000
	70	2.	23.	-10.	-203.	136.	-8.	-.000	-.000	.001	.0002	-.0001	.0000
SRUN	70	-2.	-23.	-10.	-203.	-136.	8.	-.000	-.000	.001	.0002	-.0001	.0000
	75	2.	29.	-10.	-320.	136.	-32.	-.000	-.000	.000	.0000	-.0000	.0000

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APPENDIX D
THERMAL EXPANSION ANALYSIS RESULTS

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NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

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SUPPORT REACTIONS FOR LOAD CASE NO. 1

THERMAL

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
5	FORC	42.	X CUORD
5	FORC	-22.	Y CUORD
5	FORC	-9.	Z CUORD
5	MOM	-486.	X CUORD
5	MOM	-505.	Y CUORD
5	MOM	-178.	Z CUORD
10	FORC	49.	Y CUORD
10	FORC	-45.	INCLINED
50	FORC	4.	Y CUORD
60	FORC	-40.	Y CUORD
75	FORC	-10.	X CUORD
75	FORC	8.	Y CUORD
75	FORC	41.	Z CUORD
75	MOMENT	211.	X CUORD
75	MOMENT	-791.	Y CUORD
75	MOMENT	139.	Z CUORD

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LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 1

THERMAL

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
FGRUN	5												
	7	42.	-22.	-9.	-486.	-505.	-178.	-.000	.000	-.000	.0000	.0000	.0000
FGRUN	7	-42.	22.	9.	-15.	-257.	-322.	.022	.007	-.032	.0005	.0002	-.0002
	10	42.	-22.	-9.	15.	257.	322.	.022	.007	-.032	.0005	.0002	-.0002
FGRUN	10	-42.	22.	9.	-515.	-1018.	-823.	.024	-.000	-.054	.0001	-.0009	-.0013
	12	10.	-28.	-41.	515.	1018.	823.	.054	-.000	-.054	.0001	-.0009	-.0013
FGRUN	12	-10.	28.	41.	224.	-184.	-84.	.129	-.055	-.040	-.0001	-.0021	-.0023
	15	10.	-28.	-41.	-224.	184.	84.	.129	-.055	-.040	-.0001	-.0021	-.0023
ELBOW	15	-10.	28.	41.	-939.	-623.	-631.	.213	-.102	-.017	.0011	-.0017	-.0019
	16	10.	-28.	-41.	939.	623.	631.	.217	-.100	-.018	.0017	-.0013	-.0016
ELBOW	16	-10.	28.	-41.	-997.	-638.	-655.	.217	-.100	-.018	.0017	-.0013	-.0016
	20	10.	-28.	41.	956.	607.	625.	.224	-.091	-.015	.0023	-.0007	-.0010
FGRUN	20	-10.	28.	-41.	-956.	-607.	-625.	.224	-.091	-.015	.0023	-.0007	-.0010
	25	10.	-28.	41.	832.	607.	594.	.227	-.087	-.006	.0030	-.0006	-.0009
VALVE	25	-10.	28.	-41.	-832.	-607.	-594.	.227	-.087	-.006	.0030	-.0006	-.0009
	26	10.	-28.	41.	667.	607.	553.	.230	-.083	.005	.0030	-.0005	-.0008
RUN	26	-0.	0.	0.	0.	0.	-0.	.230	-.083	.005	.0030	-.0005	-.0008
	27	0.	-0.	-0.	-0.	-0.	0.	.223	-.078	.003	.0030	-.0005	-.0008
VALVE	26	-10.	28.	-41.	-667.	-607.	-553.	.230	-.083	.006	.0030	-.0005	-.0008
	28	10.	-28.	41.	502.	607.	512.	.233	-.078	.018	.0031	-.0005	-.0008
FGRUN	28	-10.	28.	-41.	-502.	-607.	-512.	.233	-.078	.018	.0031	-.0005	-.0008
	30	10.	-28.	41.	295.	607.	460.	.237	-.072	.034	.0032	-.0003	-.0007
FGRUN	30	-10.	28.	-41.	-295.	-607.	-460.	.237	-.072	.034	.0032	-.0003	-.0007
	35	10.	-28.	41.	-77.	607.	358.	.242	-.062	.063	.0032	.0001	-.0005
VALVE	35	-10.	28.	-41.	77.	-607.	-358.	.242	-.062	.063	.0032	.0001	-.0005
	35	10.	-28.	41.	-242.	607.	327.	.244	-.057	.076	.0032	.0002	-.0004
RUN	35	-10.	28.	-41.	-242.	607.	327.	.244	-.057	.076	.0032	.0002	-.0004
	37	0.	-0.	0.	0.	0.	-0.	.244	-.057	.076	.0032	.0002	-.0004
RUN	36	-0.	0.	-0.	-0.	-0.	0.	.243	-.038	.069	.0032	.0002	-.0004
	37	0.	-0.	0.	0.	0.	-0.	.243	-.038	.069	.0032	.0002	-.0004

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 LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

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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
VALVE	36	10.	28.	-41.	242.	-607.	-327.	.244	-.057	.075	.0032	.0002	-.0004
	38	-10.	-28.	41.	-407.	607.	286.	.246	-.052	.069	.0032	.0002	-.0004
FORUN	36	10.	28.	-41.	407.	-607.	-286.	.246	-.052	.089	.0032	.0002	-.0004
	40	-10.	-28.	41.	-862.	607.	173.	.249	-.039	.122	.0028	.0007	-.0003
SRUN	40	10.	28.	-41.	862.	-607.	-173.	.249	-.039	.122	.0028	.0007	-.0003
	45	-10.	-28.	41.	-1493.	607.	16.	.253	-.022	.158	.0018	.0013	-.0002
SRUN	45	-0.	0.	-0.	-0.	-0.	0.	.253	-.022	.158	.0018	.0013	-.0002
	46	0.	-0.	0.	-0.	-0.	-0.	.258	-.029	.163	.0018	.0013	-.0002
SRUN	45	10.	28.	-41.	1493.	-607.	-16.	.253	-.022	.158	.0018	.0013	-.0002
	50	-10.	-28.	41.	-998.	422.	16.	.224	-.000	.137	.0006	.0018	-.0002
FORUN	50	-0.	0.	-0.	-0.	-0.	0.	.224	-.000	.137	.0006	.0018	-.0002
	55	0.	0.	0.	-0.	0.	-0.	.147	.027	.088	.0006	.0018	-.0002
FORUN	50	10.	32.	-41.	998.	-422.	-16.	.224	-.000	.137	.0006	.0018	-.0002
	60	-10.	-32.	41.	346.	-10.	16.	.134	.000	.088	-.0001	.0023	-.0001
FORUN	60	10.	-8.	-41.	-346.	10.	-16.	.134	.000	.088	-.0001	.0023	-.0001
	65	-10.	8.	41.	30.	-400.	16.	.051	.006	.044	.0003	.0019	-.0001
SRUN	65	10.	-8.	-41.	-30.	400.	-16.	.051	.006	.044	.0003	.0019	-.0001
	70	-10.	8.	41.	-285.	-791.	16.	.000	.014	-.000	.0000	.0007	-.0001
SRUN	70	10.	-8.	-41.	285.	791.	-16.	.000	.014	-.000	.0000	.0007	-.0001
	75	-10.	8.	41.	211.	-791.	139.	.000	-.000	-.000	-.0000	.0000	-.0000

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APPENDIX E
SEISMIC ANALYSES RESULTS

04/13/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LDFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

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SUPPORT REACTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING
 COMBINED RESULT FOR MODE 1 THRU 12 BY RMS SUMMATION

SPECTRA SET = 1

MODE	TYPE	REACTIONS (LBS OR IN-LBS)	DIRECTION
5	FORCE	91.	X COORD
5	FORCE	50.	Y COORD
5	FORCE	192.	Z COORD
5	MOMENT	491.	X COORD
5	MOMENT	1902.	Y COORD
5	MOMENT	1561.	Z COORD
10	FORCE	160.	Y COORD
10	FORCE	168.	INCLINED
50	FORCE	92.	Y COORD
50	FORCE	81.	Y COORD
75	FORCE	93.	X COORD
75	FORCE	13.	Y COORD
75	FORCE	136.	Z COORD
75	MOMENT	1224.	X COORD
75	MOMENT	5559.	Y COORD
75	MOMENT	2900.	Z COORD

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LOFT CIS ANALYSIS - 2-LS-120-A3 OUTSIDE - PIERCE

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 12 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	5	91.	50.	192.	491.	1902.	1561.	.000	.000	.000	.0000	.0000	.0000
	7	91.	50.	192.	1217.	976.	598.	.019	.015	.019	.0017	.0008	.0023
FGRUN	7	91.	49.	191.	1217.	976.	598.	.019	.015	.019	.0017	.0008	.0023
	10	91.	49.	191.	2289.	3782.	917.	.000	.000	.000	.0052	.0033	.0030
FGRUN	10	188.	111.	92.	2289.	3782.	917.	.000	.000	.000	.0052	.0033	.0030
	12	188.	111.	92.	759.	764.	2323.	.167	.101	.166	.0074	.0079	.0054
FGRUN	12	182.	107.	94.	759.	764.	2323.	.167	.101	.166	.0074	.0079	.0054
	15	182.	107.	94.	3492.	1868.	5068.	.371	.066	.370	.0046	.0069	.0128
ELBOW	15	176.	107.	98.	3492.	1868.	5068.	.371	.066	.370	.0046	.0069	.0128
	16	176.	107.	98.	3717.	2153.	5161.	.384	.060	.375	.0034	.0059	.0144
ELBOW	16	176.	107.	98.	3717.	2153.	5161.	.384	.060	.375	.0034	.0059	.0144
	20	176.	107.	98.	3750.	2671.	4646.	.430	.051	.365	.0049	.0052	.0174
FGRUN	20	174.	106.	99.	3750.	2671.	4646.	.430	.051	.365	.0049	.0052	.0174
	25	174.	106.	99.	3462.	2671.	4138.	.467	.051	.350	.0054	.0047	.0181
VALVE	25	174.	106.	99.	3462.	2671.	4138.	.467	.051	.350	.0054	.0047	.0181
	26	174.	106.	99.	3080.	2671.	3469.	.522	.051	.328	.0055	.0045	.0183
RUN	26	43.	17.	32.	0.	194.	100.	.522	.051	.328	.0055	.0045	.0183
	27	43.	17.	32.	0.	0.	0.	.522	.143	.302	.0055	.0045	.0183
VALVE	26	140.	99.	117.	3080.	2543.	3416.	.522	.051	.328	.0055	.0045	.0183
	28	140.	99.	117.	2618.	2543.	2860.	.583	.051	.306	.0057	.0043	.0186
FGRUN	28	140.	99.	117.	2618.	2543.	2860.	.583	.051	.306	.0057	.0043	.0186
	30	140.	99.	117.	2042.	2543.	2169.	.664	.051	.276	.0062	.0037	.0192
FGRUN	30	140.	99.	117.	2042.	2543.	2169.	.664	.051	.276	.0062	.0037	.0192
	35	140.	99.	117.	1030.	2543.	967.	.824	.051	.217	.0068	.0029	.0200
VALVE	35	140.	99.	117.	1030.	2543.	967.	.824	.051	.217	.0068	.0029	.0200
	36	140.	99.	117.	626.	2543.	536.	.898	.051	.189	.0069	.0028	.0200
RUN	36	61.	14.	22.	85.	364.	0.	.898	.051	.189	.0069	.0028	.0200
	37	61.	14.	22.	0.	0.	0.	.900	.015	.169	.0069	.0028	.0200
VALVE	36	73.	103.	134.	651.	2894.	536.	.898	.051	.189	.0069	.0028	.0200
	38	73.	103.	134.	436.	2894.	347.	.973	.052	.162	.0069	.0028	.0200

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 LOFT C/S ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

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MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		F _X	F _Y	F _Z	M _X	M _Y	M _Z	D _X	D _Y	D _Z	R _X	R _Y	R _Z
FGRUN	38	73.	103.	134.	436.	2894.	347.	.973	.052	.162	.0069	.0028	.0200
	40	73.	103.	134.	1592.	2894.	740.	1.183	.052	.087	.0064	.0033	.0198
SRUN	40	73.	103.	134.	1592.	2894.	740.	1.183	.052	.087	.0064	.0033	.0198
	45	73.	103.	134.	3605.	2894.	1816.	1.470	.052	.004	.0043	.0057	.0188
SRUN	45	0.	0.	0.	0.	0.	0.	1.470	.052	.004	.0043	.0057	.0188
	45	0.	0.	0.	0.	0.	0.	1.492	.069	.004	.0043	.0057	.0188
SRUN	45	17.	105.	135.	3605.	2894.	1816.	1.470	.052	.004	.0043	.0057	.0188
	50	17.	105.	135.	2293.	2932.	1816.	1.346	.001	.003	.0016	.0083	.0165
FGRUN	50	18.	14.	1.	569.	753.	0.	1.346	.001	.003	.0016	.0083	.0165
	55	18.	14.	1.	0.	0.	0.	1.021	.074	.003	.0019	.0076	.0165
FGRUN	50	60.	69.	135.	2364.	3568.	1816.	1.346	.001	.003	.0016	.0083	.0165
	60	60.	69.	135.	531.	1116.	1816.	.871	.001	.003	.0005	.0134	.0112
FGRUN	60	83.	13.	135.	531.	1116.	1816.	.871	.001	.003	.0005	.0134	.0112
	65	53.	13.	135.	129.	2067.	1816.	.359	.004	.003	.0001	.0125	.0063
SRUN	65	93.	13.	136.	129.	2067.	1816.	.359	.004	.003	.0001	.0125	.0063
	70	93.	13.	136.	426.	5559.	1816.	.010	.000	.003	.0003	.0047	.0015
SRUN	70	93.	13.	136.	426.	5559.	1816.	.010	.000	.003	.0003	.0047	.0015
	75	93.	13.	136.	1224.	5559.	2900.	.000	.000	.000	.0000	.0000	.0000

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

04/13/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS - 2-LS-120-AB OUTSIDE - PIERCE

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ASME SECTION III CLASS 2 OR ANSI B31.1.8 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)
FGRUN	5	1.000	424.	2527.	1211.	1635.
	7	1.000	340.	1740.	691.	1031.
FGRUN	7	1.000	340.	1740.	691.	1031.
	10	1.000	1078.	4862.	2358.	3436.
FGRUN	10	1.000	1078.	4862.	2358.	3436.
	12	1.000	598.	2744.	506.	1104.
FGRUN	12	1.000	598.	2744.	506.	1104.
	15	1.000	607.	5997.	2165.	2772.
ELBOW	15	1.732	731.	7734.	3750.	4481.
	16	1.732	698.	8010.	3929.	4627.
ELBOW	16	1.732	698.	8010.	3929.	4627.
	20	1.732	691.	7813.	3754.	4445.
FGRUN	20	1.000	576.	6057.	2167.	2743.
	25	1.000	607.	5652.	1992.	2599.
RUN	26	1.000	661.	843.	0.	661.
	27	1.000	193.	193.	0.	193.
FGRUN	28	1.000	648.	4533.	1574.	2221.
	30	1.000	708.	3990.	1369.	2077.
FGRUN	30	1.000	708.	3990.	1369.	2077.
	35	1.000	830.	3268.	1196.	2026.
RUN	36	1.000	661.	974.	0.	661.
	37	1.000	193.	193.	0.	193.
FGRUN	38	1.000	1398.	3868.	1315.	2713.
	40	1.000	1573.	4409.	1790.	3363.
SRUN	40	2.100	2366.	6834.	3760.	6126.
	45	2.100	2754.	9309.	5672.	8426.
SRUN	45	2.100	203.	203.	0.	203.
	46	2.100	193.	193.	0.	193.

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ASME SECTION III CLASS 2 OR ANSI B31.1.8 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)
SRUN	45	2.100	2743.	9299.	5672.	8416.
	50	2.100	5099.	10566.	3813.	8912.
FGRUN	50	1.000	939.	1731.	0.	939.
	55	1.000	193.	193.	0.	193.
FGRUN	50	1.000	2563.	6459.	1816.	4378.
	60	1.000	378.	2219.	580.	958.
FGRUN	60	1.000	378.	2219.	580.	958.
	65	1.000	735.	3044.	673.	1408.
SRUN	55	2.100	1047.	4683.	1414.	2461.
	70	2.100	838.	8577.	2959.	3797.
SRUN	70	2.100	838.	8577.	2959.	3797.
	75	2.100	1115.	9547.	2922.	4037.

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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.B 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	5	1.000	424.	4629.	0.	424.
	7	1.000	340.	3140.	0.	340.
FGRUN	7	1.000	340.	3140.	0.	340.
	10	1.000	1078.	8646.	0.	1078.
FGRUN	10	1.000	1078.	8646.	0.	1078.
	12	1.000	598.	4889.	0.	598.
FGRUN	12	1.000	598.	4889.	0.	598.
	15	1.000	607.	11387.	0.	607.
ELBOW	15	1.732	731.	14737.	0.	731.
	16	1.732	698.	15321.	0.	698.
ELBOW	16	1.732	698.	15321.	0.	698.
	20	1.732	691.	14934.	0.	691.
FGRUN	20	1.000	576.	11539.	0.	576.
	25	1.000	607.	10697.	0.	607.
RUN	26	1.000	661.	1026.	0.	661.
	27	1.000	193.	193.	0.	193.
FGRUN	28	1.000	648.	8419.	0.	648.
	30	1.000	708.	7272.	0.	708.
FGRUN	30	1.000	708.	7272.	0.	708.
	35	1.000	830.	5706.	0.	830.
RUN	36	1.000	661.	1267.	0.	661.
	37	1.000	193.	193.	0.	193.
FGRUN	38	1.000	1398.	6337.	0.	1398.
	40	1.000	1573.	7246.	0.	1573.
SRUN	40	2.100	2366.	11301.	0.	2366.
	45	2.100	2754.	15865.	0.	2754.
SRUN	45	2.100	203.	203.	0.	203.
	46	2.100	193.	193.	0.	193.

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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)
SRUN	45	2.100	2743.	15854.	0.	2743.
	50	2.100	5099.	16032.	0.	5099.
FGRUN	50	1.000	939.	2522.	0.	939.
	55	1.000	193.	193.	0.	193.
FGRUN	50	1.000	2563.	10355.	0.	2563.
	60	1.000	378.	4060.	0.	378.
FGRUN	60	1.000	378.	4060.	0.	378.
	65	1.000	735.	5352.	0.	735.
SRUN	65	2.100	1047.	8319.	0.	1047.
	70	2.100	838.	16316.	0.	838.
SRUN	70	2.100	838.	16316.	0.	838.
	75	2.100	1115.	17973.	0.	1115.

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APPENDIX H
LEVEL D SERVICE CONDITIONS
STRESS ANALYSIS RESULTS

THERE ARE NO LEVEL D SERVICE
CONDITIONS FOR THIS SYSTEM

APPENDIX I
COMPONENT SUPPORT ANALYSIS RESULTS

THERE ARE NO COMPONENT SUPPORTS
WHICH REQUIRE ANALYSIS