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RE & C REPORT NUMBER RE-A-78-095

AUGUST 18, 1978

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LOFT CIS ANALYSIS

24" H&V DUCT OUTSIDE PENETRATION S-12A

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 123-9

RE&C Report # RE-A-78-095

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RESEARCH, ENGINEERING AND CONSTRUCTION REPORT ENGINEERING ANALYSIS DIVISION

APPLIED MECHANICS BRANCH

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LOFT CIS ANALYSIS

24" H&V DUCT OUTSIDE PENETRATION S-12A

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IDAHO NATIONAL ENGINEERING LABORATORY
LOFT TECHNICAL REPORT
LOFT PROGRAM

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ABSTRACT

The 24" H&V Duct and related piping outside the LOFT containment and connected to containment penetration S-12A were analyzed to ASME Section III, Subsection NC (Class 2) criteria. The 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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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-12A 24" 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 LOFT specification [2].

III. PIPING SYSTEM DESCRIPTION

The piping being analyzed is outside LOFT containment penetration S-12A and begins at the containment vessel outside diameter. The line passes through two isolation valves and ends with an expansion joint. Two pipe saddle supports 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:

	<u>24" Pipe</u>	<u>24" Duct</u>
O.D. (inches)	24	24
Thickness (inches)	0.375	0.1046
Weight (lbs/inch)	143.0	27.5
Material	SA 106 Gr. B	SA 135 or 139 GR. A
E_{cold} (10^6 psi)	27.9	27.9
S (170°F) (psi)	15,000	9,600
S_y (psi)	35,000	
α (10^{-6} in./in. °F)	6.33	6.33

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 PEN S-12A OUT
NUPIPE MATHEMATICAL MODEL

LEGEND

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

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

See Reference 4.

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 specification.

1. DESIGN CONDITIONS

An internal pressure of 40 psig and a uniform temperature of 170°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:

Uniform temperature of 170°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

46 1323

K&E 10 X 10 TO 1/2 INCH 7 X 10 INCHES
 KEUFFEL & ESSER CO. MADE IN U.S.A.

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>
CV-HV-2-1 (24" butterfly)	586 lb (est.)	2.0 ft up
CV-HV-2-2 (24" butterfly)	586 lb (est.)	2.0 ft up

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	24	15,000	0.112	0.375

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 IIILOADS ON PIPING SUPPORTS

<u>Support Type</u>	<u>Node No.</u>	<u>Deadweight</u>	<u>Thermal</u>	<u>OBE</u>	<u>SSE</u>	<u>Rated Load</u>
Pipe saddle	35	-867	---	+127	+254	Vendor-designed
Pipe saddle	45	-2166	---	+207	+413	Vendor-designed

VIII. SPECIAL CONSIDERATIONS

None.

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. Specification ANC-HV-3, "Ductwork, Plenums, Hoods, and Accessories," July 17, 1972.
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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NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS - H 5 V PEN S-12A OUTSIDE - PIERCE

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CAROTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
XSECTN	0	1	.360E+02	.375E+00	.143E+03	.279E+02	.400E+02	0.
XSECTN	0	2	.240E+02	.375E+00	.143E+03	.279E+02	.400E+02	0.
XSECTN	0	3	.240E+02	.105E+00	.275E+02	.279E+02	.400E+02	0.
XSECTN	0	4	.180E+02	.105E+00	.206E+02	.279E+02	.400E+02	0.
OPVAL	1	1	.278E+02	.760E-02	0.	0.	.100E+02	0.
CHECK MAGNITUDE OF ENTRIES ON ABOVE OPVAL CARD ****								
ANCHOR	0	5	0.	0.	0.	0.	0.	0.
RUN	5	10	0.	0.	-.108E+01	.100E+01	.100E+01	0.
RED	10	15	0.	0.	-.200E+01	.100E+01	.100E+01	0.
RUN	15	20	0.	0.	-.350E+01	.200E+01	.100E+01	0.
VALVE	20	21	0.	0.	-.250E+00	.200E+01	.100E+01	0.
VALVE	21	22	0.	.200E+01	0.	.200E+01	.100E+01	0.
CWE	0	22	0.	.586E+03	0.	0.	0.	0.
VALVE	21	23	0.	0.	-.333E+00	.200E+01	.100E+01	0.
RUN	23	30	0.	0.	-.166E+01	.200E+01	.100E+01	0.
ELBOW	30	35	0.	0.	0.	.200E+01	.100E+01	0.
DUMMY	30	35	.100E+01	0.	-.100E+01	.200E+01	.100E+01	0.
RES	0	35	0.	.100E+07	0.	0.	0.	0.
RSKEW	0	35	.100E+01	.200E+01	.707E+00	0.	.707E+00	.400E+04
DUMMY	35	40	.100E+01	0.	-.100E+01	.200E+01	.100E+01	0.
ELBOW	35	40	0.	0.	0.	.200E+01	.100E+01	0.
RUN	40	43	.283E+01	0.	0.	.200E+01	.100E+01	0.
RUN	43	45	.250E+01	0.	0.	.200E+01	.100E+01	0.
RES	0	45	0.	.100E+07	0.	0.	0.	0.
RES	0	45	0.	0.	.400E+04	0.	0.	0.
RUN	45	50	.333E+00	0.	0.	.200E+01	.100E+01	0.

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 LOFT CIS ANALYSIS - H & V PEN 3-12A OUTSIDE - PIERCE

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*** INPUT DATA ***

CARDTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
VALVE	50	51	.250E+00	0.	0.	.200E+01	.100E+01	0.
VALVE	51	52	0.	.200E+01	0.	.200E+01	.100E+01	0.
CWE	0	52	0.	.586E+03	0.	0.	0.	0.
VALVE	51	53	.333E+00	0.	0.	.200E+01	.100E+01	0.
RUN	53	55	.117E+01	0.	0.	.300E+01	.100E+01	0.
TEE	55	60	0.	0.	0.	0.	0.	0.
RUN	55	60	-.200E+01	0.	0.	.400E+01	.100E+01	0.
CWE	0	60	0.	.125E+03	0.	0.	0.	0.
RUN	55	65	.433E+01	0.	0.	.300E+01	.100E+01	0.
ELBOW	65	66	0.	0.	0.	.300E+01	.100E+01	0.
DUNNY	65	66	0.	-.100E+01	0.	.300E+01	.100E+01	0.
MASSPT	0	15	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	21	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	22	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	30	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	35	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	40	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	43	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	51	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	52	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	55	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	60	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	65	.100E+01	.100E+01	.100E+01	0.	0.	0.
MASSPT	0	66	.100E+01	.100E+01	.100E+01	0.	0.	0.
STRESS7	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

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

DEADWEIGHT

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
5	FORCE	-0.	X COORD
5	FORCE	1620.	Y COORD
5	FORCE	-0.	Z COORD
5	MOMENT	77694.	X COORD
5	MOMENT	0.	Y COORD
5	MOMENT	-652.	Z COORD
6	FORCE	867.	Y COORD
6	FORCE	-0.	INCLINED
6	FORCE	2158.	Y COORD
6	FORCE	-0.	Z COORD

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NUPIPE-III - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1

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LOFT CIS ANALYSIS - H & V PEN S-12A 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
RUN	5	-0.	1620.	-0.	77694.	0.	-652.	.000	-.000	.000	-.0000	-.0000	.0000
	10	0.	-1465.	0.	-57642.	-0.	652.	.000	-.000	.000	-.0000	-.0000	.0000
REDUCE	10	-0.	1465.	-0.	57642.	0.	-652.	.000	-.000	.000	-.0000	-.0000	.0000
	15	0.	-1179.	0.	-25902.	-0.	652.	.000	-.000	.000	-.0000	-.0000	.0000
RUN	15	-0.	1179.	-0.	25902.	0.	-652.	.000	-.000	.000	-.0000	-.0000	.0000
	20	0.	-679.	0.	13126.	-0.	652.	.000	-.001	.000	-.0000	-.0000	.0000
VALVE	20	-0.	679.	-0.	-13126.	0.	-652.	.000	-.001	.000	-.0000	-.0000	.0000
	21	0.	-643.	0.	15110.	-0.	652.	.000	-.001	.000	-.0000	-.0000	.0000
VALVE	21	-0.	872.	0.	-0.	0.	0.	-.000	-.001	-.000	-.0000	-.0000	.0000
	22	0.	-586.	0.	-0.	-0.	0.	-.000	-.001	-.000	-.0000	-.0000	.0000
VALVE	21	-0.	-229.	0.	-15110.	0.	-652.	.000	-.001	.000	-.0000	-.0000	.0000
	23	0.	276.	-0.	14100.	-0.	652.	.000	-.001	.000	-.0000	-.0000	.0000
RUN	23	-0.	-276.	0.	-14100.	0.	-652.	.000	-.001	.000	-.0000	-.0000	.0000
	30	0.	336.	-0.	12571.	-0.	652.	.000	-.002	.000	-.0000	-.0000	.0000
ELBOW	30	-0.	-336.	0.	-12571.	0.	-652.	.000	-.002	.000	-.0000	-.0000	.0000
	35	0.	673.	-0.	-258.	-0.	-4666.	.000	-.001	.000	-.0000	-.0000	.0000
ELBOW	35	-0.	194.	0.	258.	0.	4666.	.000	-.001	.000	-.0000	-.0000	.0000
	40	0.	143.	-0.	0.	0.	-4018.	.000	-.001	.000	-.0000	-.0000	.0000
RUN	40	-0.	-143.	0.	-0.	-0.	4018.	.000	-.001	.000	-.0000	-.0000	.0000
	43	0.	369.	-0.	0.	0.	-8886.	.000	-.001	.000	-.0000	-.0000	.0000
RUN	43	-0.	-369.	0.	-0.	-0.	8886.	.000	-.001	.000	-.0000	-.0000	.0000
	45	0.	727.	-0.	0.	0.	-25332.	.000	-.002	.000	-.0000	-.0000	.0000
RUN	45	-0.	1439.	0.	-0.	-0.	25332.	.000	-.002	.000	-.0000	-.0000	.0000
	50	0.	-1320.	-0.	0.	0.	-11543.	.000	-.003	.000	-.0000	-.0000	.0000
VALVE	50	-0.	1320.	0.	-0.	-0.	11543.	.000	-.003	.000	-.0000	-.0000	.0000
	51	0.	-1284.	-0.	0.	0.	-7637.	.000	-.003	.000	-.0000	-.0000	.0000
VALVE	51	-0.	872.	-0.	0.	-0.	-0.	.000	-.003	.000	-.0000	-.0000	.0000
	52	0.	-586.	0.	0.	0.	0.	.001	-.003	.000	-.0000	-.0000	.0000

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 LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

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MEMBER	END	FX	FORCES (LBS)		FZ	MX	MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
			FY				MY	MZ		DX	DY	DZ	RX	RY	RZ
VALVE	51	-0.	412.		-0.	-0.	-0.	7637.		.000	-.003	.000	.0000	-.0000	-.0000
	53	0.	-365.		-0.	0.	0.	-6085.		.000	-.003	.000	.0000	-.0000	-.0000
RUN	53	-0.	365.		-0.	-0.	-0.	6085.		.000	-.003	.000	.0000	-.0000	-.0000
	55	0.	-332.		-0.	0.	0.	-1204.		.000	-.004	.000	.0000	-.0000	-.0000
RUN	55	-0.	166.		-0.	0.	-0.	-3494.		.000	-.004	.000	.0000	-.0000	-.0000
	60	-0.	-125.		0.	0.	-0.	-0.		.000	-.003	.000	.0000	-.0000	-.0000
RUN	55	-0.	166.		-0.	-0.	-0.	4699.		.000	-.004	.000	.0000	-.0000	-.0000
	65	0.	-130.		-0.	0.	0.	-2333.		.000	-.004	.000	.0000	-.0000	-.0000
ELBOW	55	-0.	130.		-0.	-0.	-0.	2333.		.000	-.004	.000	.0000	-.0000	-.0000
	60	0.	-0.		-0.	0.	-0.	-0.		-.008	-.011	-.001	.0000	-.0000	-.0002

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APPENDIX D
THERMAL EXPANSION ANALYSIS RESULTS

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LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

SUPPORT REACTIONS FOR LOAD CASE NO. 1

THERMAL

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
5	FORCE	-122.	X COORD
5	FORCE	0.	Y COORD
5	FORCE	-342.	Z COORD
5	MOMENT	0.	X COORD
5	MOMENT	34205.	Y COORD
5	MOMENT	0.	Z COORD
5	FORCE	0.	X COORD
5	FORCE	0.	Y COORD
5	FORCE	173.	INCLINED
5	FORCE	0.	Y COORD
5	FORCE	220.	Z COORD

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LOFT CIS ANALYSIS - H & V. PEN S-12A 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
D-2 RUN	5	-122.	0.	-342.	0.	-32205.	0.	.000	-.000	-.000	.0000	-.0000	.0000
	10	122.	0.	342.	0.	-32620.	0.	.000	-.000	-.008	.0000	-.0000	.0000
REDUCE	10	-122.	0.	-342.	0.	-32620.	0.	.000	-.000	-.008	.0000	-.0000	.0000
	15	122.	0.	342.	0.	-29692.	0.	.000	.000	-.023	.0000	-.0000	.0000
RUN	15	-122.	0.	-342.	0.	-29692.	0.	.000	.000	-.023	.0000	-.0000	.0000
	20	122.	0.	342.	0.	-24568.	0.	.000	.000	-.050	.0000	-.0000	.0000
VALVE	20	-122.	0.	-342.	0.	-24568.	0.	.001	.000	-.050	.0000	-.0000	.0000
	21	122.	0.	342.	0.	-24202.	0.	.001	.000	-.052	.0000	-.0000	.0000
VALVE	21	0.	0.	0.	0.	0.	0.	.001	.000	-.052	.0000	-.0000	.0000
	22	-0.	0.	-0.	0.	0.	0.	.001	.013	-.052	.0000	-.0000	.0000
VALVE	21	-122.	0.	-342.	0.	-24202.	0.	.001	.000	-.052	.0000	-.0000	.0000
	23	122.	0.	342.	0.	-23714.	0.	.001	.000	-.054	.0000	-.0000	.0000
RUN	23	-122.	0.	-342.	0.	-23714.	0.	.001	.000	-.054	.0000	-.0000	.0000
	30	122.	0.	342.	0.	-23105.	0.	.001	.000	-.058	.0000	-.0000	.0000
ELBOW	30	-122.	0.	-342.	0.	-23105.	0.	.001	.000	-.058	.0000	-.0000	.0000
	35	122.	0.	342.	0.	-16392.	0.	.011	.000	-.072	-.0000	-.0002	.0000
ELBOW	35	-0.	0.	-220.	0.	-16392.	0.	.011	.000	-.072	-.0000	-.0002	.0000
	40	0.	0.	220.	0.	-10787.	0.	.030	.000	-.072	-.0000	-.0003	.0000
RUN	40	-0.	0.	-220.	0.	-10787.	0.	.030	.000	-.072	-.0000	-.0003	.0000
	43	0.	0.	220.	0.	-6605.	0.	.042	.000	-.065	-.0000	-.0003	.0000
RUN	43	-0.	0.	-220.	0.	-6605.	0.	.042	.000	-.065	-.0000	-.0003	.0000
	45	0.	0.	220.	0.	0.	0.	.061	.000	-.055	-.0000	-.0003	.0000
RUN	45	-0.	0.	0.	0.	0.	0.	.061	.000	-.055	-.0000	-.0003	.0000
	50	0.	0.	-0.	0.	0.	0.	.067	.000	-.052	-.0000	-.0003	.0000
VALVE	50	-0.	0.	0.	0.	0.	0.	.067	.000	-.052	-.0000	-.0003	.0000
	51	0.	0.	-0.	0.	0.	0.	.069	.000	-.051	-.0000	-.0003	.0000
VALVE	51	-0.	0.	0.	0.	0.	0.	.069	.000	-.051	-.0000	-.0003	.0000
	52	0.	0.	-0.	0.	0.	0.	.069	.015	-.051	-.0000	-.0003	.0000

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LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
VALVE	51	-0:	-0:	-0:	-0:	-0:	-0:	.069	.000	-.051	-.0000	-.0003	.0000
	53	-0:	-0:	-0:	-0:	-0:	-0:	.072	.000	-.049	-.0000	-.0003	.0000
RUN	53	-0:	-0:	-0:	-0:	-0:	-0:	.072	.000	-.049	-.0000	-.0003	.0000
	55	-0:	-0:	-0:	-0:	-0:	-0:	.081	.000	-.045	-.0000	-.0003	.0000
RUN	55	-0:	-0:	-0:	-0:	-0:	-0:	.081	.000	-.045	-.0000	-.0003	.0000
	60	-0:	-0:	-0:	-0:	-0:	-0:	.065	.000	-.053	-.0000	-.0003	.0000
RUN	55	-0:	-0:	-0:	-0:	-0:	-0:	.081	.000	-.045	-.0000	-.0003	.0000
	65	-0:	-0:	-0:	-0:	-0:	-0:	.091	.000	-.039	-.0000	-.0003	.0000
ELBOW	65	-0:	-0:	-0:	-0:	-0:	-0:	.091	.000	-.039	-.0000	-.0003	.0000
	66	-0:	-0:	-0:	-0:	-0:	-0:	.113	-.023	-.027	-.0000	-.0003	-.0000

APPENDIX E
SEISMIC ANALYSES RESULTS

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LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

SUPPORT REACTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 5 BY RMS SUMMATION

SPECTRA SET = 1

NODE TYPE REACTIONS DIRECTION
(LBS OR IN-LBS)

5	FORCE	1486.	X COORD
5	FORCE	237.	Y COORD
5	FORCE	1118.	Z COORD
5	MOMENT	14470.	X COORD
5	MOMENT	229003.	Y COORD
5	MOMENT	9879.	Z COORD
35	FORCE	254.	Y COORD
35	FORCE	103.	INCLINED
45	FORCE	413.	Y COORD
45	FORCE	661.	Z COORD

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LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 5 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
E-2 RUN	5	1486.	237.	1118.	14470.	229003.	9879.	.000	.000	.000	.0000	.0000	.0000
	10	1486.	237.	1118.	11404.	213179.	9879.	.000	.000	.000	.0000	.0000	.0000
REDUCE	10	1486.	237.	1118.	11404.	213179.	9879.	.000	.000	.000	.0000	.0000	.0000
	15	1486.	237.	1118.	5763.	185698.	9879.	.001	.000	.000	.0000	.0000	.0000
RUN	15	1459.	236.	1118.	5763.	185698.	9879.	.001	.000	.000	.0000	.0000	.0000
	20	1459.	236.	1118.	4297.	146699.	9879.	.006	.000	.000	.0000	.0002	.0000
VALVE	20	1459.	236.	1118.	4297.	146699.	9879.	.006	.000	.000	.0000	.0002	.0000
	21	1459.	236.	1118.	4991.	144506.	9879.	.006	.000	.000	.0000	.0002	.0000
VALVE	21	147.	7.	3.	72.	0.	3534.	.006	.000	.000	.0000	.0002	.0000
	22	147.	7.	3.	0.	0.	0.	.007	.000	.000	.0000	.0002	.0000
VALVE	21	1233.	231.	1117.	4985.	144506.	8960.	.006	.000	.000	.0000	.0002	.0000
	23	1233.	231.	1117.	5898.	142003.	8960.	.007	.000	.000	.0000	.0002	.0000
RUN	23	1233.	231.	1117.	5898.	142003.	8960.	.007	.000	.000	.0000	.0002	.0000
	30	1233.	231.	1117.	7044.	139055.	8960.	.008	.000	.000	.0000	.0002	.0000
ELBOW	30	1175.	230.	1117.	7044.	139055.	8960.	.008	.000	.000	.0000	.0002	.0000
	35	1175.	230.	1117.	12879.	115956.	6542.	.026	.000	.010	.0001	.0013	.0000
ELBOW	35	1083.	150.	1172.	12879.	115956.	6542.	.026	.000	.010	.0001	.0013	.0000
	40	1083.	150.	1172.	13203.	82800.	6732.	.043	.001	.056	.0001	.0022	.0000
RUN	40	952.	141.	1099.	13203.	82800.	6732.	.043	.001	.056	.0001	.0022	.0000
	43	952.	141.	1099.	13203.	61981.	7938.	.043	.001	.098	.0001	.0022	.0000
RUN	43	780.	142.	928.	13203.	61981.	7938.	.043	.001	.098	.0001	.0022	.0000
	45	780.	142.	928.	13203.	34313.	10950.	.043	.000	.165	.0001	.0022	.0000
RUN	45	780.	300.	1580.	13203.	34313.	10950.	.043	.000	.165	.0001	.0022	.0000
	50	780.	300.	1580.	13203.	18846.	8874.	.044	.001	.188	.0001	.0022	.0000
VALVE	50	780.	300.	1580.	13203.	18846.	8874.	.044	.001	.188	.0001	.0022	.0000
	51	780.	300.	1580.	13203.	14343.	8360.	.044	.001	.195	.0001	.0022	.0000
VALVE	51	350.	124.	707.	16968.	0.	8408.	.044	.001	.195	.0001	.0022	.0000
	52	350.	124.	707.	0.	0.	0.	.044	.001	.197	.0001	.0022	.0000
VALVE	51	244.	116.	476.	5037.	14343.	8754.	.044	.001	.195	.0001	.0022	.0000
	53	244.	116.	476.	5037.	12494.	8409.	.044	.001	.204	.0001	.0022	.0000

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LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

MEMBER	END	FORCES (LBS)			MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ	MX	MY	MZ	DX	DY	DZ	RX	RY	RZ
RUN	53	244.	116.	476.	5037.	12494.	8409.	.044	.001	.204	.0001	.0022	.0000
	55	244.	116.	476.	5037.	6276.	7305.	.044	.001	.235	.0001	.0023	.0000
RUN	55	69.	23.	130.	0.	3112.	564.	.044	.001	.235	.0001	.0023	.0000
	60	69.	23.	130.	0.	0.	0.	.044	.001	.181	.0001	.0022	.0000
RUN	55	142.	81.	243.	5037.	8866.	7349.	.044	.001	.235	.0001	.0023	.0000
	65	142.	81.	243.	5037.	5037.	6242.	.044	.002	.271	.0001	.0023	.0000
ELBOW	65	112.	66.	140.	5037.	5037.	6242.	.044	.002	.271	.0001	.0023	.0000
	66	112.	66.	140.	0.	0.	0.	.053	.016	.368	.0003	.0028	.0008

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

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LOFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

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)
RUN	5	1.000	1168.	1475.	92.	1259.
	10	1.000	1114.	1400.	87.	1201.
REDUCE	10	2.000	1191.	1620.	175.	1366.
	15	2.000	1064.	1437.	159.	1223.
RUN	15	1.000	798.	1364.	181.	978.
	20	1.000	720.	1167.	149.	869.
RUN	23	1.000	726.	1159.	144.	870.
	30	1.000	717.	1141.	141.	857.
ELBOW	30	4.274	885.	2246.	601.	1486.
	35	4.274	731.	1870.	426.	1157.
ELBOW	35	4.274	731.	1870.	426.	1157.
	40	4.274	718.	1538.	280.	999.
RUN	40	1.000	664.	920.	66.	730.
	43	1.000	694.	888.	40.	734.
RUN	43	1.000	694.	888.	40.	734.
	49	1.000	794.	911.	0.	794.
RUN	45	1.000	794.	911.	0.	794.
	50	1.000	710.	785.	0.	710.
RUN	53	1.000	2424.	2593.	0.	2424.
	55	7.899	2447.	3133.	0.	2447.
RUN	55	7.899	2508.	2864.	0.	2508.
	60	1.000	1721.	1721.	0.	1721.
RUN	55	7.899	2888.	3682.	0.	2888.
	65	1.000	2344.	2445.	0.	2344.
ELBOW	65	10.169	2674.	3444.	0.	2674.
	66	10.169	2294.	2294.	0.	2294.

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APPENDIX G
LEVEL C SERVICE CONDITIONS
STRESS ANALYSIS RESULTS

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 LGFT CIS ANALYSIS - H & V PEN S-12A OUTSIDE - PIERCE

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

MEMBER	NODE	STRESS INTENSIFY FACTOR	SUSTAINED STRESS EC. 6 (PSI)	OCCASIONAL STRESS EC. 9 (PSI)	EXPANSION STRESS EQ. 10 (PSI)	SUSTAINED PLUS EXPANSION STRESS EQ. 11 (PSI)
RUN	5	1.000	1168.	1782.	0.	1168.
	10	1.000	1114.	1666.	0.	1114.
REDUCE	10	2.000	1191.	2049.	0.	1191.
	15	2.000	1064.	1811.	0.	1064.
RUN	15	1.000	758.	1929.	0.	758.
	20	1.000	720.	1615.	0.	720.
RUN	23	1.000	726.	1592.	0.	726.
	30	1.000	717.	1565.	0.	717.
ELBCW	30	4.274	885.	3606.	0.	885.
	35	4.274	731.	3010.	0.	731.
ELBOW	35	4.274	731.	3010.	0.	731.
	40	4.274	718.	2359.	0.	718.
RUN	40	1.000	664.	1176.	0.	664.
	43	1.000	694.	1083.	0.	694.
RUN	43	1.000	694.	1083.	0.	694.
	45	1.000	794.	1027.	0.	794.
RUN	45	1.000	794.	1027.	0.	794.
	50	1.000	710.	860.	0.	710.
RUN	53	1.000	2424.	2763.	0.	2424.
	55	7.899	2447.	3819.	0.	2447.
RUN	55	7.899	2508.	3220.	0.	2508.
	60	1.000	1721.	1721.	0.	1721.
RUN	55	7.899	2888.	4475.	0.	2888.
	65	1.000	2344.	2546.	0.	2344.
ELBCW	65	10.169	2674.	4213.	0.	2674.
	66	10.169	2294.	2294.	0.	2294.

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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