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LOFT TECHNICAL REPORT LTR 123-5

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NOVEMBER 17, 1978

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

W. J. Barry Jr.

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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RE&C Report # RE-A-78-045

DATE November 17, 1978 *Sh*

WORK REQUEST NO. _____

RESEARCH, ENGINEERING AND CONSTRUCTION REPORT ENGINEERING ANALYSIS DIVISION

APPLIED MECHANICS BRANCH

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

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REMARKS: The line analysed herein will be listed in the master Containment Isolation System technical report, LTR 128-5. This master LTR will be released after the completion of the 56 subtier LTRs. This master LTR will list all the CIS lines, P&ID drawings and the seismic analysis LTRs. SWR number 51747 covers recommendations of this LTR.

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LOFT TECHNICAL REPORT
LOFT PROGRAM

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

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PSE	for PSB Seismic P&CSB	PSE
	Mgr. Review	Mgr.

ECO
RSB Mgr.

ABSTRACT

The 12" H&V duct and related piping outside the LOFT containment connected to containment penetration S-11A was analyzed to ASME Code Subsection NC (Class 2) criteria. This duct is part of the Containment Isolation System and the analytical model considered the duct from the containment O.D. outward through the first and second isolation valves. Results of this analysis show that section of the line will meet Class 2 requirements if a restraint (two directions horizontal and one vertical translation) is installed at the second isolation valve.

CONTENTS

ABSTRACT	11
I. SCOPE	1
II. INTRODUCTION	2
III. PIPING SYSTEM DESCRIPTION	3
1. STRUCTURAL DESCRIPTION	3
2. MATERIAL AND GEOMETRIC DATA	3
IV. DESIGN AND SERVICE CONDITIONS	6
1. DESIGN CONDITIONS	6
2. LEVEL A SERVICE CONDITIONS	6
3. LEVEL B SERVICE CONDITIONS	7
4. LEVEL C SERVICE CONDITIONS	7
5. LEVEL D SERVICE CONDITIONS	7
6. TEST CONDITIONS	7
V. PIPING SYSTEM STRUCTURAL ANALYSIS	8
1. WEIGHT ANALYSIS	8
2. THERMAL EXPANSION ANALYSIS	8
3. SEISMIC ANALYSES	8
VI. ASME BOILER AND PRESSURE VESSEL CODE, SECTION III, STRESS ANALYSIS	11
1. MINIMUM THICKNESS CHECK	11
2. DESIGN, LEVEL A, AND LEVEL B SERVICE CONDITIONS STRESS ANALYSIS	12
3. LEVEL C SERVICE CONDITIONS STRESS ANALYSIS	12
4. LEVEL D SERVICE CONDITIONS STRESS ANALYSIS	12
VII. COMPONENT SUPPORT ANALYSIS	13
VIII. SPECIAL CONSIDERATIONS	15
IX. CONCLUSIONS	16

CONTENTS (continued)

X. REFERENCES	17
APPENDIX A -- BASIC DATA, INPUT PARAMETERS	A-i
APPENDIX B -- COMPUTER PROGRAM DESCRIPTION	B-i
APPENDIX C -- WEIGHT ANALYSIS RESULTS	C-i
APPENDIX D -- THERMAL EXPANSION ANALYSIS RESULTS	D-i
APPENDIX E -- SEISMIC ANALYSES RESULTS	E-i
APPENDIX F -- DESIGN, LEVEL A, AND LEVEL B SERVICE CONDITIONS STRESS ANALYSIS RESULTS	F-i
APPENDIX G -- LEVEL C SERVICE CONDITIONS STRESS ANALYSIS RESULTS . . .	G-i
APPENDIX H -- LEVEL D SERVICE CONDITIONS STRESS ANALYSIS RESULTS . . .	H-i
APPENDIX I -- COMPONENT SUPPORT ANALYSIS RESULTS	J-i

TABLES

I. Piping System Valve Design Weights and Centers of Gravity . . .	10
II. Minimum Thickness Parameters	11
III. Loads on Piping Supports	14

FIGURES

1. Piping System Computer Model Plot	4
2. SSE-Seismic Response Spectra Envelope	9

LOFT CIS ANALYSIS S-11A
PENETRATION 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 12" H&V duct connected to the containment penetration S-11A. 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 and includes a 12-inch, Schedule 40 line from the containment penetration S-11A outward through a butterfly valve, then through an elbow and up through another butterfly valve.

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
Thickness (inches)	.406
Weight (lbs/inch)	4.46
Material	A106, Gr B
E_{cold} (10^6 psi)	27.9
S (105°F) (psi)	15,000
S_y (psi)	32,000
α (10^{-6} in./in. $^{\circ}\text{F}$)	6.22

FIG 1

46 4243

MADE IN U.S.A.

K&E ISOMETRIC • 4 X 4 TO THE INCH
7 X 10 INCHES

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 design specification.

1. DESIGN CONDITIONS

An internal pressure of 40 psig and a uniform temperature of 105°F was 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

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>
12" Butterfly - horizontal approx. 16" from wall	325 (est.)	24"
12" Butterfly - vertical approx. 22" above penetration	325 (est.)	24"

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:

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

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

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

Level D service conditions do not apply to this line.

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>
Horizontal - rigid	1	-100	-288	39	78	N.A.
Horizontal - rigid	2	-113	-540	24	47	N.A.
Vertical - rigid	3	165	-560	1	1	N.A.

VIII. SPECIAL CONSIDERATIONS

To meet Class 2 requirements, two orthogonal, horizontal restraints should be installed at the second (vertical) butterfly isolation valve as shown on Fig.

1. Also, a vertical support should be installed in line with the vertical pipe axis. Loads for these supports are shown in Table III.

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 HV-3, Ductwork, Plenums, Hoods, and Accessories, Rev. 11, July 17, 1972 (L-1904).
3. American Institute of Steel Construction, Manual of Steel Construction, Seventh Edition, pp 5-6 to 5-24, 1973.

APPENDIX A
BASIC DATA, INPUT PARAMETERS

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 LOFT CIS ANALYSIS -S-11A-PENETRATION DUCT (H8V) WXB-03

PAGE 3

Appendix 2

CARDTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
XSECT	0	1	.128E+02	.406E+00	.535E+02	.279E+02	.400E+02	0.
OPVAL	1	1	.279E+02	.270E-02	0.	0.	.400E+02	0.
CHECK MAGNITUDE OF ENTRIES ON ABOVE OPVAL CARD ****								
ANCHOR	0	1	0.	0.	0.	0.	0.	0.
FGRUN	1	5	.550E+00	0.	.103E+01	.100E+01	.100E+01	0.
MASSPT	0	5	.100E+01	.100E+01	.100E+01	0.	0.	0.
VALVE	5	10	.600E-01	0.	.110E+00	.100E+01	.100E+01	0.
MASSPT	0	10	.250E+03	.250E+03	.250E+03	0.	0.	0.
CWEIGHT	0	10	0.	.250E+03	0.	0.	0.	0.
RUN	10	15	.177E+01	0.	.940E+00	.100E+01	.100E+01	0.
MASSPT	0	15	.750E+02	.750E+02	.750E+02	0.	0.	0.
CWEIGHT	0	15	0.	.750E+02	0.	0.	0.	0.
VALVE	10	20	.600E-01	0.	.110E+00	.100E+01	.100E+01	0.
MASSPT	0	20	.100E+01	.100E+01	.100E+01	0.	0.	0.
FGRUN	20	25	.660E+00	0.	.162E+01	.100E+01	.100E+01	0.
MASSPT	0	25	.100E+01	.100E+01	.100E+01	0.	0.	0.
ELBOW	25	30	0.	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	30	.100E+01	.100E+01	.100E+01	0.	0.	0.
FGRUN	30	35	0.	.183E+01	0.	.100E+01	.100E+01	0.
MASSPT	0	35	.100E+01	.100E+01	.100E+01	0.	0.	0.
RESTRAINT	0	50	.100E+06	.100E+06	.100E+06	0.	0.	0.
VALVE	35	40	0.	.125E+00	0.	.100E+01	.100E+01	0.
MASSPT	0	40	.250E+03	.250E+03	.250E+03	0.	0.	0.
CWEIGHT	0	40	0.	.250E+03	0.	0.	0.	0.
RUN	40	45	.200E+01	0.	0.	.100E+01	.100E+01	0.
MASSPT	0	45	.750E+02	.750E+02	.750E+02	0.	0.	0.

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 LOFT CIS ANALYSIS -S-11A-PENETRATION DUCT (H8V) WXB-03

PAGE 4

CARDTYPE	I1	I2	DELTA(1)	DELTA(2)	DELTA(3)	DELTA(4)	DELTA(5)	DELTA(6)
CWEIGHT	0	45	0.	.750E+02	0.	0.	0.	0.
VALVE	40	50	0.	.125E+00	0.	.100E+01	.100E+01	0.

 LTR 123-5
 Page 1

03/08/76

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 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 4

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*** INPUT DATA ***
CARDTYPE  I1      I2      DELTA(1)  DELTA(2)  DELTA(3)  DELTA(4)  DELTA(5)  DELTA(6)
CWEIGHT    0      45      0.        .750E+02  0.        0.        0.        0.
VALVE      40      50      0.        .125E+00  0.        .100E+01  .100E+01  0.
MASSPT     0      50      .100E+01  .100E+01  .100E+01  0.        0.        0.
STRESS7    0      0      0.        0.        0.        0.        0.        0.
9CASES     0      0      1      0      4      0      0      0      0      0      0      0      0      0
10CASES    0      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      0
ALLODNE    0      0      0      0      0      0      0      0      0      0      0      0      0      0
  
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 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 5

STRAIGHT ELEMENTS

MEMBER	NI	END NJ	SECTION NUMBER	LENGTH FT	OUTSIDE DIAMETER IN	WALL THICKNESS IN	WEIGHT LB/FT	MODULUS COLO * 1.0E-6 PSI	OPERATING VALUE
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LTR 123-5
 Page 2

03/08/78

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 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WX8-03

PAGE 5

STRAIGHT ELEMENTS

MEMBER	NI	END NJ	SECTION NUMBER	LENGTH FT	OUTSIDE DIAMETER IN	WALL THICKNESS IN	WEIGHT LB/FT	MODULUS COLD * 1.0E-6 PSI	OPERATING VALUE
FGRUN	1	5	1	1.17	12.750	.4060	53.53	27.90000	1
VALVE	5	10	1	.13	12.750	.4060	53.53	27.90000	1
RUN	10	15	1	2.00	12.750	.4060	53.53	27.90000	1
VALVE	10	20	1	.13	12.750	.4060	53.53	27.90000	1
FGRUN	20	25	1	.33	12.750	.4060	53.53	27.90000	1
FGRUN	30	35	1	.33	12.750	.4060	53.53	27.90000	1
VALVE	35	40	1	.13	12.750	.4060	53.53	27.90000	1
RUN	40	45	1	2.00	12.750	.4060	53.53	27.90000	1
VALVE	40	50	1	.13	12.750	.4060	53.53	27.90000	1

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PAGE 6

ELBOW ELEMENTS

MEMBER	NI	END NJ	SECTION NUMBER	RADIUS IN	OUTSIDE DIAMETER IN	WALL THICKNESS IN	WEIGHT LB/FT	MODULUS COLD * 1.0E-6 PSI	OPERATING VALUE
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LTR 123-5
 Page 3

03/08/76

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

PAGE 6

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ELBOW ELEMENTS

MEMBER	END NI NJ	SECTION NUMBER	RADIUS IN	OUTSIDE DIAMETER IN	WAL THICKNESS IN	WEIGHT LB/FT	MODULUS COLD * 1.0E-6 PSI	OPERATING VALUE
ELBOW	25 30	1	18.00	12.750	.4050	53.53	27.90000	1

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PAGE 7

LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

OPERATING CONDITIONS

OPERATING VALUE	MODE	MODULUS HOT * 1.0E-6 PSI	ALPHA T-BAR IN/FT	ALPHA DT-1 IN/FT	ALPHA DT-2 IN/FT	OPERATING PRESSURE PSI	ALLOWABLE STRESS PSI
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LTR 123-5
Page 4

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PAGE 7

OPERATING CONDITIONS

OPERATING VALUE	MODE	MODULUS HOT * 1.0E-6 PSI	ALPHA T-BAR IN/FT	ALPHA DT-1 IN/FT	ALPHA DT-2 IN/FT	OPERATING PRESSURE PSI	ALLOWABLE STRESS PSI
1	1	27.90000	.2700000E-02	0.	0.	40.0000	0.00

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PAGE 8

STATIC RESTRAINT TABLE

NODE	TYPE	STIFFNESS TRANS LB/IN ROT FT-LB/RAD	DIRECTION	DIRECTION COSINES FOR SKEW RESTRAINTS		
				X	Y	Z
1	TRANS	.5004172E+13 .2002175E+13	X			

LTR 123-5
 Page 5

03/02/78

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 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 8

STATIC RESTRAINT TABLE

NODE	TYPE	STIFFNESS TRANS LB/IN ROT FT-LB/RAD	DIRECTION	DIRECTION COSINES FOR SKEW RESTRAINTS		
				X	Y	Z
1	TRANS	.6004172E+13	X			
1	TRANS	.6004172E+13	Y			
1	TRANS	.6004172E+13	Z			
1	ROT	.6004172E+13	X			
1	ROT	.6004172E+13	Y			
1	ROT	.6004172E+13	Z			
35	TRANS	.1000000E+06	X			
35	TRANS	.1000000E+06	Y			
35	TRANS	.1000000E+06	Z			

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 9

SECTION PROPERTIES

NSECT	OUTSIDE DIAMETER IN	WALL THICKNESS IN	WEIGHT LB/FT	MODULUS COLD * 1.0E-6 PSI	DESIGN PRESSURE PSI	WELD REF.NO.

LTR 123-5
 Page 6

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 10

CONCENTRATED WEIGHTS

NODE	WEIGHT LB	NODE	WEIGHT LB	NODE	WEIGHT LB	NODE	WEIGHT LB
10	250.000	15	75.000	40	250.000	45	75.000

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 11

*** NODE GLOBAL COORDINATES ***

POINT NO.	X-COORDINATE (F)	Y-COORDINATE (FT)	Z-COORDINATE (FT)
1	0.000	0.000	0.000
5	.550	0.000	1.030

LTR 123-5
Page 7

03/06/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 11

*** NODE GLOBAL COORDINATES ***

POINT NO.	X-COORDINATE (FT)	Y-COORDINATE (FT)	Z-COORDINATE (FT)
1	0.000	0.000	0.000
5	.550	0.000	1.030
10	.610	0.000	1.140
15	-1.160	0.000	2.060
20	.670	0.000	1.250
25	.827	0.000	1.545
30	1.530	1.500	2.870
35	1.530	1.830	2.870
40	1.530	1.955	2.870
45	3.530	1.955	2.870
50	1.530	2.060	2.870

TOTAL STATIC DEGREES OF FREEDOM = 66

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

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 14

SUPPORT REACTIONS FOR LOAD CASE NO. 1

DEADWEIGHT

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
1	FORCE	100.	X COORD
1	FORCE	950.	Y COORD
1	FORCE	113.	Z COORD
1	MOMENT	-19351.	X COORD
1	MOMENT	1356.	Y COORD
1	MOMENT	9046.	Z COORD
35	FORCE	-100.	X COORD
35	FORCE	169.	Y COORD
35	FORCE	-113.	Z COORD

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 15

EXTERNAL FORCES FOR LOAD CASE NO. 1

DEADWEIGHT

NODE	TYPE	FORCES (LBS OR IN-LBS)	AXIS
------	------	------------------------	------

LTR 123-5
 Page 1

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WX8-03

PAGE 15

EXTERNAL FORCES FOR LOAD CASE NO. 1

DEADWEIGHT

NODE	TYPE	FORCES (LBS OR IN-LBS)	AXIS
------	------	------------------------	------

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WX8-03

PAGE 16

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 1

DEADWEIGHT

MEMO	END	FX	FORCES (LBS)	FZ	MX	MOMENTS (IN-LBS)	MZ	DEFLECTIONS (IN)	ROTATIONS (RAD)
			FY			MY		DX	RY
								DY	RZ

LTR 123-5

LTR 123-5
Page 2

Appendix

03/06/78

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

PAGE 16

LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H&V) WXB-03

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 1

DEADWEIGHT

MEMBER	END	FX	FORCES (LBS)		MX	MOMENTS (IN-LBS)		MZ	DEFLECTIONS (IN)			ROTATIONS (RAD)		
			FY	FZ		MY			DX	DY	DZ	RX	RY	RZ
FGRUN	1	100.	950.	113.	-19351.	1356.	9046.	-0.000	-0.000	-0.000	.0000	-0.0000	-0.0000	
	5	-100.	-888.	-113.	-7992.	-870.	-2980.	-0.000	-0.000	.000	.0000	-0.0000	-0.0000	
VALVE	5	100.	888.	113.	-7992.	870.	2980.	-0.000	-0.000	.000	.0000	-0.0000	-0.0000	
	10	-100.	-881.	-113.	6824.	-820.	-2343.	-0.000	-0.000	.000	.0000	-0.0000	-0.0000	
RUN	10	-0.	182.	0.	-1451.	0.	-2732.	-0.000	-0.000	-0.000	.0000	-0.0000	-0.0000	
	15	0.	-75.	-0.	-0.	-0.	0.	-0.000	-0.001	-0.000	.0000	-0.0000	-0.0000	
VALVE	10	100.	449.	113.	-5373.	820.	5076.	-0.000	-0.000	.000	.0000	-0.0000	-0.0000	
	20	-100.	-442.	-113.	4785.	-770.	-4755.	-0.000	-0.000	.000	.0000	-0.0000	-0.0000	
FGRUN	20	100.	442.	113.	-4785.	770.	4755.	-0.000	-0.000	.000	.0000	-0.0000	-0.0000	
	25	-100.	-424.	-113.	3252.	-630.	-3941.	-0.000	-0.001	.000	.0000	-0.0000	-0.0000	
ELBOW	25	100.	424.	113.	-3252.	630.	3941.	-0.000	-0.001	.000	.0000	-0.0000	-0.0000	
	30	-100.	-298.	-113.	-449.	0.	-2689.	.001	-0.002	.001	.0000	.0000	-0.0001	
FGRUN	30	100.	298.	113.	449.	-0.	2689.	.001	-0.002	.001	.0000	.0000	-0.0001	
	35	-100.	-280.	-113.	0.	0.	-3085.	.001	-0.002	.001	.0000	.0000	-0.0001	
VALVE	35	-0.	445.	-0.	-0.	-0.	3085.	.001	-0.002	.001	.0000	.0000	-0.0001	
	40	0.	-439.	0.	0.	0.	-3085.	.001	-0.002	.001	.0000	.0000	-0.0001	
RUN	40	0.	182.	-0.	0.	0.	3085.	.001	-0.002	.001	.0000	.0000	-0.0001	
	45	-0.	-75.	0.	-0.	0.	0.	.001	-0.003	.001	.0000	.0000	-0.0001	
VALVE	40	-0.	7.	-0.	-0.	0.	0.	.001	-0.002	.001	.0000	.0000	-0.0001	
	50	0.	-0.	0.	0.	0.	-0.	.001	-0.002	.001	.0000	.0000	-0.0001	

APPENDIX D
THERMAL EXPANSION ANALYSIS RESULTS

03/06/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (HEV) WXB-03

PAGE 17

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

NODE	TYPE	REACTION (LBS OR IN-LBS)	DIRECTION
1	FORCE	289.	X COORD
1	FORCE	560.	Y COORD
1	FORCE	540.	Z COORD
1	MOMENT	-7429.	X COORD
1	MOMENT	-7.	Y COORD
1	MOMENT	3965.	Z COORD
35	FORCE	-288.	X COORD
35	FORCE	-560.	Y COORD
35	FORCE	-540.	Z COORD

03/06/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (HEV) WXB-03

PAGE 18

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 2
 THERMAL EXPANSION PLUS ANCHOR MOVEMENTS

MEMBER	END	FORCES (LBS)			MX	MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ		MY	MZ	DX	DY	DZ	RX	RY	RZ	
50000	1	289	560	540	-7429	-7	3965	-0.000	-0.000	-0.000	0.0000	0.0000	-0.0000	

LTR 123-5
 Approved

LTR 123-5
 Page 1

03/08/78

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

PAGE 18

LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WX8-03

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	288.	560.	540.	-7429.	-7.	3965.	-.000	-.000	-.000	.0000	.0000	-.0000
	5	-288.	-560.	-540.	507.	-2.	-269.	.001	-.000	.003	.0000	.0000	-.0000
VALVE	5	288.	560.	540.	-507.	2.	269.	.001	-.000	.003	.0000	.0000	-.0000
	10	-288.	-560.	-540.	-232.	-11.	135.	.002	-.000	.003	.0000	.0000	-.0000
RUN	10	-0.	0.	0.	0.	-0.	-0.	.002	-.000	.003	.0000	.0000	-.0000
	15	0.	-0.	-0.	-0.	0.	-0.	-.003	-.000	.006	.0000	.0000	-.0000
VALVE	10	288.	560.	540.	232.	11.	-135.	.002	-.000	.003	.0000	.0000	-.0000
	20	-288.	-560.	-540.	-971.	-20.	538.	.002	-.000	.003	.0000	.0000	-.0000
FGRUN	20	288.	560.	540.	971.	20.	-538.	.002	-.000	.003	.0000	.0000	-.0000
	25	-288.	-560.	-540.	-2955.	-16.	1591.	.002	-.000	.004	.0000	-.0000	-.0000
ELBOW	25	288.	560.	540.	2955.	16.	-1591.	.002	-.000	.004	.0000	-.0000	-.0000
	30	-288.	-560.	-540.	-2138.	-0.	1139.	.003	-.005	.006	-.0001	-.0000	.0001
FGRUN	30	288.	560.	540.	2138.	0.	-1139.	.003	.005	.006	-.0001	-.0000	.0001
	35	-288.	-560.	-540.	-0.	-0.	0.	.003	.006	.005	-.0001	-.0000	.0001
VALVE	35	-0.	-0.	-0.	-0.	0.	-0.	.003	.006	.005	-.0001	-.0000	.0001
	40	0.	0.	0.	-0.	-0.	0.	.003	.006	.005	-.0001	-.0000	.0001
RUN	40	-0.	0.	0.	-0.	0.	-0.	.003	.006	.005	-.0001	-.0000	.0001
	45	0.	-0.	-0.	0.	-0.	-0.	.008	.008	.005	-.0001	-.0000	.0001
VALVE	40	-0.	0.	0.	-0.	0.	-0.	.003	.006	.005	-.0001	-.0000	.0001
	50	0.	-0.	-0.	-0.	-0.	0.	.003	.006	.005	-.0001	-.0000	.0001

APPENDIX E
SEISMIC ANALYSES RESULTS

03/08

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 23

SUPPORT REACTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING
 COMBINED RESULT FOR MODE 1 THRU 1

BY RMS SUMMATION

SPECTRA SET = 1

NODE	TYPE	REACTIONS (LBS OR IN-LBS)	DIRECTION
1	FORCE	38.	X COORD.
1	FORCE	13.	Y COORD.
1	FORCE	41.	Z COORD.
1	MOMENT	485.	X COORD.
1	MOMENT	2751.	Y COORD.
1	MOMENT	1371.	Z COORD.
35	FORCE	78.	X COORD.
35	FORCE	1.	Y COORD.
35	FORCE	47.	Z COORD.

03/06/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 24

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 1 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

LTR 123-5
 Page 1

03/08/78

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

PAGE 24

LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WX8-03

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 1 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 5	38. 38.	13. 13.	41. 41.	485. 648.	2751. 2014.	1371. 1264.	.000 .000	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
VALVE	5 10	37. 37.	13. 13.	41. 41.	648. 666.	2014. 1936.	1284. 1274.	.000 .000	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
RUN	10 15	2. 2.	2. 2.	2. 2.	21. 0.	59. 0.	39. 0.	.000 .000	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
VALVE	10 20	32. 32.	15. 15.	41. 41.	645. 664.	1877. 1806.	1235. 1225.	.000 .000	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
FGRUN	20 25	31. 31.	15. 15.	40. 40.	664. 716.	1806. 1619.	1225. 1197.	.000 .000	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
ELBOW	25 30	30. 30.	14. 14.	40. 40.	716. 232.	1619. 810.	1197. 538.	.000 .001	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
FGRUN	30 35	14. 14.	15. 15.	30. 30.	232. 114.	810. 810.	538. 484.	.001 .001	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
VALVE	35 40	89. 89.	14. 14.	75. 75.	114. 1.	810. 810.	484. 351.	.001 .001	.000 .000	.000 .000	.0000 .0000	.0000 .0000	.0000 .0000
RUN	40 45	20. 20.	15. 15.	34. 34.	0. 0.	810. 0.	350. 0.	.001 .001	.000 .001	.000 .001	.0000 .0000	.0000 .0000	.0000 .0000
VALVE	40 50	1. 1.	0. 0.	1. 1.	1. 0.	0. 0.	1. 0.	.001 .001	.000 .000	.000 .001	.0000 .0000	.0000 .0000	.0000 .0000

03/08/78

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

PAGE 25

LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WX8-03

SYSTEM ACCELERATION FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING

COMBINED RESULT FOR MODE 1 THRU 1 BY RMS SUMMATION

SPECTRA SET = 1

POINT NO.	X-DIRECTION (G)	Y-DIRECTION (G)	Z-DIRECTION (G)
--------------	--------------------	--------------------	--------------------

LTR 123-5
Page 2

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 25

SYSTEM ACCELERATION FOR LOAD CASE NO. 3

SSE RESPONSE SPECTRUM - 1% DAMPING
COMBINED RESULT FOR MODE 1 THRU 1 BY RMS SUMMATION SPECTRA SET = 1

POINT NO.	X-DIRECTION (G)	Y-DIRECTION (G)	Z-DIRECTION (G)
1	.000	.000	.000
5	.011	.001	.006
10	.013	.002	.007
15	.029	.025	.022
20	.015	.002	.008
25	.021	.002	.012
30	.225	.004	.135
35	.257	.004	.156
40	.270	.004	.164
45	.270	.194	.450
50	.282	.004	.172

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 26

SUPPORT REACTIONS FOR LOAD COMBINATION CASE NO. 4

OBE RESPONSE SPECTRUM - ONE-HALF SSE

NODE	TYPE	REACTIONS (RS OR IN-RS)	DIRECTION
------	------	----------------------------	-----------

LTR 123-5
Page 3

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 26

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

NODE	TYPE	REACTIONS (LBS OR IN-LBS)	DIRECTION
1	FORCE	19.	X COORD
1	FORCE	7.	Y COORD
1	FORCE	21.	Z COORD
1	MOMENT	242.	X COORD
1	MOMENT	1375.	Y COORD
1	MOMENT	686.	Z COORD
35	FORCE	39.	X COORD
35	FORCE	1.	Y COORD
35	FORCE	24.	Z COORD

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

PAGE 27

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

LTR 123-5
 Page 4

03/08/78

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

PAGE 27

LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H8V) WXB-03

INTERNAL FORCES AND DEFLECTIONS FOR LOAD CASE NO. 4

OBE RESPONSE SPECTRUM - ONE-HALF SSE

MEMBER	END	FORCES (LBS)			MX	MOMENTS (IN-LBS)			DEFLECTIONS (IN)			ROTATIONS (RAD)		
		FX	FY	FZ		MY	MZ		DX	DY	DZ	RX	RY	RZ
FGRUN	1	19.	7.	21.	242.	1375.	686.		.000	.000	.000	.0000	.0000	.0000
	5	19.	7.	21.	324.	1007.	642.		.000	.000	.000	.0000	.0000	.0000
VALVE	5	18.	7.	20.	324.	1007.	642.		.000	.000	.000	.0000	.0000	.0000
	10	18.	7.	20.	333.	968.	637.		.000	.000	.000	.0000	.0000	.0000
RUN	10	1.	1.	1.	10.	30.	20.		.000	.000	.000	.0000	.0000	.0000
	15	1.	1.	1.	0.	0.	0.		.000	.000	.000	.0000	.0000	.0000
VALVE	10	16.	7.	20.	322.	938.	618.		.000	.000	.000	.0000	.0000	.0000
	20	16.	7.	20.	332.	903.	612.		.000	.000	.000	.0000	.0000	.0000
FGRUN	20	16.	7.	20.	332.	903.	612.		.000	.000	.000	.0000	.0000	.0000
	25	16.	7.	20.	358.	809.	599.		.000	.000	.000	.0000	.0000	.0000
ELBOW	25	15.	7.	20.	358.	809.	599.		.000	.000	.000	.0000	.0000	.0000
	30	15.	7.	20.	116.	405.	269.		.000	.000	.000	.0000	.0000	.0000
FGRUN	30	7.	7.	15.	116.	405.	269.		.000	.000	.000	.0000	.0000	.0000
	35	7.	7.	15.	57.	405.	242.		.000	.000	.000	.0000	.0000	.0000
VALVE	35	44.	7.	38.	57.	405.	242.		.000	.000	.000	.0000	.0000	.0000
	40	44.	7.	38.	0.	405.	175.		.000	.000	.000	.0000	.0000	.0000
RUN	40	10.	7.	17.	0.	405.	175.		.000	.000	.000	.0000	.0000	.0000
	45	10.	7.	17.	0.	0.	0.		.000	.000	.001	.0000	.0000	.0000
VALVE	40	0.	0.	0.	0.	0.	1.		.000	.000	.000	.0000	.0000	.0000
	50	0.	0.	0.	0.	0.	0.		.000	.000	.000	.0000	.0000	.0000

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

03/08/78

NUPIPE-IIM - NUCLEAR SERVICES CORPORATION PIPING ANALYSIS PROGRAM - VERSION 1.1
 LOFT CIS ANALYSIS -S-11A PENETRATION DUCT (H6V) WXB-03

PAGE 30

LIR 123-5
App. 1-2 F, G, H

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	1	1.000	755.	787.	173.	928.
	5	1.000	490.	516.	12.	502.
RUN	10	1.000	378.	378.	0.	378.
	15	1.000	314.	314.	0.	314.
FGRUN	20	1.000	454.	477.	23.	477.
	25	1.000	420.	442.	69.	489.
ELBOW	25	2.707	529.	574.	187.	716.
	30	2.707	428.	449.	135.	563.
FGRUN	30	1.000	370.	380.	50.	420.
	35	1.000	378.	387.	0.	378.
RUN	40	1.000	378.	387.	0.	378.
	45	1.000	314.	314.	0.	314.

APPENDIX G
LEVEL C SERVICE CONDITIONS
STRESS ANALYSIS RESULTS

03/06/78

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

PAGE 30

LOFT CIS ANALYSIS - S-11A PENETRATION DUCT (HGV) WXB-03

ASME SECTION III CLASS 2 70° ANST 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	755.	819.	0.	755.
	5	1.000	490.	541.	0.	490.
RUN	10	1.000	378.	379.	0.	378.
	15	1.000	314.	314.	0.	314.
FGRUN	20	1.000	454.	501.	0.	454.
	25	1.000	420.	464.	0.	420.
ELBOW	25	2.707	529.	618.	0.	529.
	30	2.707	428.	470.	0.	428.
FGRUN	30	1.000	370.	391.	0.	370.
	35	1.000	378.	397.	0.	378.
RUN	40	1.000	378.	396.	0.	378.
	45	1.000	314.	314.	0.	314.

APPENDIX H
LEVEL D SERVICE CONDITIONS
STRESS ANALYSIS RESULTS

Level D service conditions do not apply to this line.

APPENDIX I
COMPONENT SUPPORT ANALYSIS RESULTS

Support/restraint loads and locations are listed in the body of the report. Support designs were not available at the time of the analysis.