DØ ENGINEERING NOTE

EN#: 3823.115 - 425

Thermal Contraction Analysis of the Solenoid and VLPC Cryogenic
Transfer Lines for the DØ Upgrade

Todd M. Leicht
6 / 6 / 95

Approval: _____

A handwritten signature in cursive script, appearing to read "Kurt J. Kempert", is written over a horizontal line.

Summary:

The stresses developed in the solenoid and VLPC transfer lines have been investigated with the PipePlus v4.5 software package from Algor. 4 cases were considered for each transfer line and the following results were obtained.

Table 1: Maximum Stresses, Solenoid Transfer Line

Case	Pipe Conditions	Max. Hoop Stress (psi)	Max. Longitudinal Stress (psi)	Max. Principal Stress (psi)	Max. Code Stress (psi)	Allowable Stress (psi)	Stress Ratio (code/allow)
1	LHe return, warm LHe supply, cold	7,360	6,994	7,360	7,177	25,050	0.29
2	LHe return, cold LHe supply, warm	7,360	16,475	16,517	17,950	25,050	0.72
3	LHe return, cold LHe supply, cold	7,360	20,417	20,418	20,313	25,050	0.81
4	N2 supply & return, cold	3,154	21,229	21,231	21,201	25,050	0.85

Table 2: Maximum Stresses, VLPC Transfer Line

Case	Pipe Conditions	Max. Hoop Stress (psi)	Max. Longitudinal Stress (psi)	Max. Principal Stress (psi)	Max. Code Stress (psi)	Allowable Stress (psi)	Stress Ratio (code/allow)
1	LHe supply, cold	7,360	16,020	16,028	16,268	25,050	0.65
2	LHe return, cold	7,360	20,527	20,527	20,595	25,050	0.82
3	N2 supply, cold	3,154	17,198	17,198	17,078	25,050	0.68
4	N2 return, cold	3,154	21,447	21,447	21,065	25,050	0.84

Pipe deflections have also been kept to a minimum by carefully considering the location of spider guides. Their placement should be as close as possible to the locations shown in Figures 4-7.

With regard to chosen pipe sizes, the 2.5" OD Cu radiation shield in the solenoid transfer line should be replaced with a 3.5" OD tube. The vacuum jackets should also be replaced with 5" or larger pipe. These changes should safely accommodate the maximum displacements caused by thermal loading.

Introduction:

This engineering note investigates the ability of the solenoid and VLPC cryogenic transfer lines to accommodate thermal stresses. The solenoid and VLPC transfer lines are similar in their construction in that they consist of an outer vacuum jacket, liquid nitrogen supply and return lines, a copper thermal radiation shield, and liquid helium supply and return lines. See Figure 1 for details on their specific construction. Line drawings for the solenoid and VLPC transfer lines are shown in Figures 2 and 3, respectively.

The transfer line system, as a whole, does not lend itself to simple analysis such as the "Simplified Method for Flexibility Analysis" [1] or the chart method [2]. These methods demand that the piping system be rigidly anchored at two ends with no intermediate branches. Therefore, a major part of the analysis was performed on the PipePlus v4.5 software package by Algor. Considerations have been given to dead weight, pressure, and thermal loads, boundary conditions such as end displacements, and restraints caused by intermediate supports.

The Appendices contain selected information from the PipePlus analysis. Only the pipe geometry, boundary conditions, loading, node displacements and stresses have been reported. The electronic version of the PipePlus databases are stored on the DMACS NT Fileserver under the "Pipe" directory. These databases can be used to generate the complete reports.

Code and Allowables:

Section 302.3.5 of ANSI/ASME B31.3-1984 demands that the allowable displacement stress range S_A be determined by the following:

$$S_A = f(1.25 S_C + 0.25 S_H)$$

Where, S_C = basic allowable stress at minimum metal temperature expected during displacement.

S_H = basic allowable stress at maximum metal temperature expected during displacement.

f = stress-range reduction factor for displacement cycle conditions.

In Table A-1 of ANSI/ASME B31.3-1984 the allowable stress SE of 304 stainless steel is 16.7 ksi for $-425^\circ\text{F} < T < 100^\circ\text{F}$. Therefore, $S_C = S_H = 16.7$ ksi. Using $f = 1$ in the above equation we find $S_A = 25,050$ psi.

It should be noted that PipePlus found the allowable limit to be 41,750 psi which is the sum of the allowable displacement stress (25,050 psi) and the basic allowable stress (16,700 psi). I don't believe, however, that this is the proper interpretation of the code. I will use the more conservative value of 25,050 psi for the allowable limit.

Analysis:

Since the transfer lines consist of several small pipes within one or more larger pipes the possibility for cold pipes contacting warm pipes is very high. In particular, the LHe lines must not touch the Cu thermal radiation shield and the LN2 pipes must not touch the outer vacuum jacket. Spider type guides will be used both to support the pipes within the vacuum jacket and restrict their movement under thermal loading. Guide locations are crucial to the proper functionality of the design and much consideration has been given to their placement. Guide locations used in this analysis are shown in Figures 4-7.

In both transfer lines, the nitrogen and helium pipes do not share a common anchor. This simplifies the analysis by allowing them to be treated as independent systems. The 4 thermal cases for each transfer line are considered below. Please note that warm conditions have been omitted from the PipePlus analysis because they will yield only pressure loading. In which case, the stress due to pressure alone can be found for each pipe in Tables 1 & 2 in the Maximum Hoop Stress column.

Solenoid Transfer Line:

The solenoid transfer line demands careful attention due to the fact that the helium supply and return pipes are concentric (see Figure 1). The larger, stiffer return piping is constructed from 1.5" SCH 10S pipe so it naturally controls the design. For this reason, an earlier analysis of the LHe supply piping has been omitted. The analysis of the helium piping, therefore, will be restricted to the 1.5" return pipe including the two 5/8" branch sections at the valve box and the assembly hall feed can. One branch will be the LHe supply and the other for the LHe return.

A transient cooldown case where the entire supply is cold and the return is warm was not considered. Per Kurt Krempetz, the maximum ΔT that could be present in the concentric pipes would be less than 50K since there would be heat transfer in the He return. Therefore, differential thermal contraction of the supply and return would be negligible. Similar concentric designs at Meson have never given any problems.

Cases 1&2. These cases are intended to investigate the flexibility of the 5/8" O.D. branches in the valve box and feed cans. For case 1 the supply branch was cold and the return was warm. Case 2 considers the return cold and the supply warm.

Loading for Cases 1&2:	Design Pressure:	350 psig
	Cold Temperature:	-450°F
	Warm Temperature:	70°F

Case 3. This is simply the steady-state condition of the LHe supply/return system where the supply and return are cold. It was this case which prompted the use of a 1" section of pipe for the vertical leg of the He return by the valve box (see Figure 4). The 1" pipe allows greater flexibility of the concentric tube system at the solenoid valve box.

Loading for Case 3:	Design Pressure:	350 psig
	Cold Temperature:	-315°F

Case 4. This is simply the steady-state condition of the LN2 supply/return system where the supply, return, and Cu shield are cold. Both the supply and return were modeled as 3/8" X 0.049" S.S. tube.

Loading for Case 4:	Design Pressure:	150 psig
	Cold Temperature:	-315°F

VLPC Transfer Line:

Cases 1&2. These cases consider the LHe supply/return system in the steady-state operating condition. The supply was modeled as 3/8" O.D. X 0.035" S.S. tube and the return was 1/2" O.D. X 0.049" S.S.

Loading for Cases 1&2:	Design Pressure:	350 psig
	Cold Temperature:	-450°F

Cases 3&4. This is simply the steady-state condition of the LN2 supply/return system where the supply, return, and Cu shield are cold. The supply was modeled as 1/2" O.D. X 0.049" S.S. tube and the return as 1/2" SCH 10S pipe.

Loading for Case 3&4:	Design Pressure:	150 psig
	Cold Temperature:	-315°F

Conclusions and Recommendations:

With regard to the chosen pipe sizes, the ones shown in Figure 1 are adequate with the exception of the vacuum jackets and the Cu radiation shields. Since the major concern is to keep the LHe pipes from having direct thermal contact with the radiation shield, a 3.5" O.D. Cu tube should replace the current radiation shields in both transfer lines. 3.5" O.D. is the minimum recommended size for the Cu radiation shield for the solenoid and VLPC transfer lines. The 4" vacuum jackets are also inadequate when considering the maximum deflections of the internal piping. 5" pipe is the minimum recommended size for both transfer lines.

The pipe terminations at the collision hall feed can were assumed to allow contraction along the axial direction of the pipes. It is therefore recommended that flex-hose is used within the collision hall feed can to connect bayonets to the transfer line piping. With regard to the valve boxes and assembly hall feed cans, any additional pipe bends or loops provided by the designer will provide greater flexibility to the piping system and will result in stresses lower than predicted by this analysis.

It is also recommended that the spider guides be placed as close as possible to the locations used in this analysis.

FIGURE 1 : X-SECTIONS OF SOLENOID
AND VLPC TRANSFER LINES
(PRIOR TO THIS ANALYSIS)

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F E R M I L A B

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FIGURE 2: LINE DRAWING, SOLENOID TRANSFER LINE

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FIGURE 3: LINE DRAWING, VLPC
TRANSFER LINE

Figure 4: Solenoid He Return Guide Locations (NOT TO SCALE !)

Figure 5: Solenoid N2 Supply & Return Guide Locations

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Figure : VLPC He Supply & Return Guide Locations

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References:

1. The M.W. Kellogg Company, *Design of Piping Systems*, 2nd Ed., Chap.2&4, Wiley-Interscience, New York, 1956.
2. Tube Turns, Inc., *Piping Engineering*, 6th Ed., Tube Turns, Inc., Kentucky, 1986.
3. ANSI/ASME B31.3, *Chemical Plant and Petroleum Refinery Piping*, 1984 Ed., The American Society of Mechanical Engineers, New York, 1984.

Appendicies:

- A. Solenoid Transfer Line, LHe return/supply piping analysis

PipePlus filename: SOLHERET

- B. Solenoid Transfer Line, LN2 piping analysis

PipePlus filename: SOLLN2

- C. VLPC Transfer Line, LHe supply piping analysis

PipePlus filename: VLPCHE SUP

- D. VLPC Transfer Line, LHe return piping analysis

PipePlus filename: VLPCHERET

- E. VLPC Transfer Line, LN2 supply piping analysis

PipePlus filename: VLPCN2S

- E. VLPC Transfer Line, LN2 return analysis

PipePlus filename: VLPCN2R

File Name SOLHERET
Project D-Zero Solenoid Upgrade
Department Research Division / D-Zero Mechanical
Contract Number
Description Solenoid Transfer Line, He Return
Preliminary Solution #1.
Prepared by Todd M. Leicht
Checked by

ANSI code ANSI B31.3
Input unit English
Output unit English
Output columns 80
Base temperature 70
F factor 1.0
E factor 1.33

Number of dynamic modes.. 8
Cut-off frequency 33 Hz
Max no. of iterations ... 12
Convergence tolerance ... 3
Force tolerance 5 lb

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)
C This analysis is intended as a preliminary estimate of the deflectins C and stresses in the 1.5" He Return. The He Return has been chosen because C it is the stiffest pipe in the x-fer line so it will experience the C highest stresses.							
C							
C Load combination considered -							
C 1. supply cold and return warm							
C 2. supply warm and return cold							
C 3. steady-state (supply and return cold)							
C All points followed by a number represent spider-type guide locations.							
C							
F Aret1					0.000	0.000	0.000
T Aret2 -2"				2"	-0.167	0.000	0.000
T Aret3		-2'		5"	-0.167	-2.000	0.000
T Aret4 -10"				5"	-1.000	-2.000	0.000
T Aret5		2'8"		2"	-1.000	0.667	0.000
T Aret6			-5"		-1.000	0.667	-0.417
T Aret7			-1"		-1.000	0.667	-0.500
F Asup1 -2"		-2"	-6"		-0.167	-0.167	-0.500
T Asup2		-1'10"		5"	-0.167	-2.000	-0.500
T Asup3 -10"				5"	-1.000	-2.000	-0.500
C Asup4		1'5"		3"	0.000	0.000	0.000
C Asup5 8"				3"	0.000	0.000	0.000
C Asup6		6"		3"	0.000	0.000	0.000
C Asup7 -8"				3"	0.000	0.000	0.000
T Asup8		2'7"			-1.000	0.583	-0.500
T Aret7 0.000		0.083	0.000		-1.000	0.667	-0.500
T A		4'			-1.000	4.667	-0.500
T A1a 1'11"					0.917	4.667	-0.500
T A1 1"					1.000	4.667	-0.500
T A2 10'					11.000	4.667	-0.500
T A3 10'					21.000	4.667	-0.500
T A4 10'					31.000	4.667	-0.500
T B 2'					33.000	4.667	-0.500
T C			-8"		33.000	4.667	-1.167
T C1		-2'			33.000	2.667	-1.167
T D		-5'6"			33.000	-2.833	-1.167
T D1			-2'6"		33.000	-2.833	-3.667
T D2			-5'		33.000	-2.833	-8.667
T E			-10"		33.000	-2.833	-9.500
C							
F B 33.000	4.667		-0.500		33.000	4.667	-0.500
T B1			2'		33.000	4.667	1.500
T B2			5'		33.000	4.667	6.500
T G			1'		33.000	4.667	7.500
T Gsup1			1"		33.000	4.667	7.583
T Gsup2			3"	3"	33.000	4.667	7.833
T Gsup3	12"			3"	33.000	5.667	7.833
T Gsup4			6"	3"	33.000	5.667	8.333
T Gsup5	-12"			3"	33.000	4.667	8.333

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)
T Gsup6			6"	3"	33.000	4.667	8.833
T Gsup7		12"			33.000	5.667	8.833
T Gsup8		1'7"			33.000	7.250	8.833
F G	33.000	4.667	7.500		33.000	4.667	7.500
T Gret1		-1"			33.000	4.583	7.500
T Gret2		-6"		3"	33.000	4.083	7.500
T Gret3 1'				3"	34.000	4.083	7.500
T Gret4		1'6"			34.000	5.583	7.500
T Gret5		1'7"			34.000	7.167	7.500
C							
C Node F is assumed to be a flexible connection at the C.H. Feed Can, C therefore, no forces or moments will be exerted at F and it is free to C rotate and translate.							
C							
F E	33.000	-2.833	-9.500		33.000	-2.833	-9.500
T E1	3'				36.000	-2.833	-9.500
T E2	10'				46.000	-2.833	-9.500
T E3	10'				56.000	-2.833	-9.500
T E4	10'				66.000	-2.833	-9.500
T E5	10'				76.000	-2.833	-9.500
T E6	10'				86.000	-2.833	-9.500
T E7	10'				96.000	-2.833	-9.500
T F	2'				98.000	-2.833	-9.500

Point	Data	Description

Aret1	Pipe	Pipe data identifier = 5/8 Nominal Diameter = 0"5/8 Pipe Schedule = Actual Pipe O. D. = 0.625 inch Wall Thickness = 0.035 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1 Material Data Identifier = SS Austenitic stainless (301-309, 316, 321, 237) Density = 0.2899 lb/cu.inch Tempera. Modulus Expansion (deg.F) (psi) (inch/inch) -325. 30400000 -0.00321 -150. 29900000 -0.00189 -50. 29400000 -0.00103 70. 28300000 0.00000 200. 27700000 0.00122 300. 27100000 0.00218 400. 26600000 0.00317 500. 26100000 0.00417 600. 25400000 0.00520 700. 24800000 0.00625 800. 24100000 0.00733 900. 23400000 0.00843 1000. 22700000 0.00957 1100. 22000000 0.01070 1200. 21300000 0.01183 1300. 20700000 0.01297 1400. 19300000 0.01410 Temperature Allowable stresses (deg.F) (psi) -325 16700 Load data identifier = RET Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch) 1 70 350 0.000000 2 -450 350 -0.003210 3 -450 350 -0.003210 Anchor Rigid in all directions
Aret2		
Aret3		
Aret4		
Aret5		
Aret6	Reducer	Weight = 0.07 lb

Point	Data	Description
Aret7	Pipe	Pipe data identifier = 1" Nominal Diameter = 1 Pipe Schedule = 10S Actual Pipe O. D. = 1.315 inch Wall Thickness = .109 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1
Asup1	Tee	Welding tee per ANSI B16.9
	Pipe	Pipe data identifier = 5/8
	Load	Load data identifier = SUP
		Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch)
		1 -450 350 -0.003210
		2 70 350 0.000000
		3 -450 350 -0.003210
	Anchor	Rigid in all directions
Asup2		
Asup3		
Asup8	Reducer	Weight = 0.07 lb
Aret7	Pipe	Pipe data identifier = 1"
	Load	Load data identifier = RET
Asup9		
A		
A1a	Reducer	Weight = 0.15 lb
A1	Pipe	Pipe data identifier = 1.5 Nominal Diameter = 1"1/2 Pipe Schedule = 10S Actual Pipe O. D. = 1.900 inch Wall Thickness = .109 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1
	Guide	
A2	Guide	
A3	Guide	
A4	Guide	
B	Tee	Welding tee per ANSI B16.9
C		
C1	Guide	
D		
D1	Guide	
D2	Guide	
E		
B		
B1	Guide	
B2	Guide	
G	Tee	Welding tee per ANSI B16.9
	Reducer	Weight = 0.10 lb

Point	Data	Description
Gsup1	Pipe	Pipe data identifier = 5/8
	Load	Load data identifier = SUP
Gsup2		
Gsup3		
Gsup4		
Gsup5		
Gsup6		
Gsup7	Pipe	Pipe data identifier = BAY
		Nominal Diameter = 1"1/2
		Pipe Schedule =
		Actual Pipe O. D. = 1.5 inch
		Wall Thickness = 0.035" inch
		Corrosion Allowance = 0 inch
		Insulation Thickness = 0 inch
		Insulation Density = 0 lb/cu.ft
		Content S. G. = 1
Gsup8	Anchor	Rigid in all directions
G	Pipe	Pipe data identifier = 1.5
	Reducer	Weight = 0.10 lb
Gret1	Pipe	Pipe data identifier = 5/8
	Load	Load data identifier = RET
Gret2		
Gret3		
Gret4	Pipe	Pipe data identifier = BAY
Gret5	Anchor	Rigid in all directions
E	Load	Load data identifier = RET
E1	Guide	
E2	Guide	
E3	Guide	
E4	Guide	
E5	Guide	
E6	Guide	
E7	Guide	
F		

Case number	Combination
1	D.W. + Pres1 + Ther1
2	D.W. + Pres2 + Ther2
3	D.W. + Pres3 + Ther3

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
Aret1	0.000	-0.000	0.000	-0.000	-0.000	0.000
Aret2.Nea	0.000	-0.000	0.000	-0.000	-0.000	0.000
Aret2.Far	0.001	-0.001	-0.000	-0.000	-0.000	0.044
Aret3.Nea	0.024	-0.001	0.000	0.000	-0.003	0.094
Aret3.Far	0.032	-0.008	-0.000	0.001	-0.004	0.076
Aret4.Nea	0.032	-0.008	-0.000	0.001	-0.004	0.076
Aret4.Far	0.028	-0.013	-0.000	0.003	-0.006	0.030
Aret5.Nea	0.030	-0.013	0.001	0.003	-0.013	-0.006
Aret5.Far	0.031	-0.013	0.001	0.001	-0.010	0.010
Aret6	0.031	-0.013	0.001	-0.000	-0.007	0.024
Aret7	0.031	-0.013	0.001	-0.001	-0.007	0.025
Asup1	-0.000	0.000	0.000	-0.000	-0.000	-0.000
Asup2.Nea	-0.013	0.055	0.000	-0.001	-0.000	-0.089
Asup2.Far	-0.006	0.080	0.000	0.001	-0.000	-0.113
Asup3.Nea	-0.006	0.080	0.000	0.001	-0.000	-0.113
Asup3.Far	0.019	0.073	0.000	0.002	-0.001	-0.088
Asup8	0.032	-0.010	0.001	-0.001	-0.007	0.024
Aret7	0.031	-0.013	0.001	-0.001	-0.007	0.025
Asup9	0.029	-0.013	0.001	-0.001	-0.006	0.026
A	0.002	-0.013	-0.001	-0.004	-0.003	0.050
Ala	0.002	0.000	-0.000	-0.007	-0.001	-0.011
A1	0.002	-0.000	-0.000	-0.007	-0.001	-0.015
A2	0.002	-0.000	-0.000	-0.012	0.001	0.004
A3	0.002	-0.000	0.000	-0.017	-0.001	-0.000
A4	0.002	-0.000	-0.000	-0.022	0.005	-0.002
B	0.002	-0.008	-0.001	-0.022	-0.002	-0.022
C	0.002	-0.011	-0.001	-0.015	-0.003	-0.013
C1	-0.000	-0.011	0.000	0.003	-0.002	-0.002
D	0.001	-0.011	-0.010	0.021	0.001	0.003
D1	-0.000	-0.000	-0.010	0.011	0.001	0.005
D2	0.000	-0.000	-0.010	0.004	-0.004	0.011
E	0.001	0.001	-0.010	0.004	-0.006	0.012
B	0.002	-0.008	-0.001	-0.022	-0.002	-0.022
B1	0.000	-0.000	-0.001	-0.008	-0.005	-0.022
B2	-0.000	-0.000	-0.001	-0.014	0.002	-0.023
G	0.000	0.004	-0.001	-0.020	0.002	-0.023
Gsup1	0.000	0.004	-0.001	-0.021	0.002	-0.023
Gsup2.Nea	0.000	0.004	-0.001	-0.021	0.002	-0.023
Gsup2.Far	0.001	-0.002	-0.015	-0.121	-0.002	-0.019
Gsup3.Nea	0.003	-0.022	-0.035	-0.264	-0.005	-0.016
Gsup3.Far	0.004	-0.011	-0.062	-0.465	-0.007	-0.015
Gsup4.Nea	0.004	-0.011	-0.062	-0.465	-0.007	-0.015
Gsup4.Far	0.003	0.026	-0.043	-0.564	-0.007	-0.014
Gsup5.Nea	0.001	0.045	0.016	-0.555	-0.007	-0.012
Gsup5.Far	0.000	0.081	0.034	-0.437	-0.007	-0.007
Gsup6.Nea	0.000	0.081	0.034	-0.437	-0.007	-0.007
Gsup6.Far	0.000	0.090	0.009	-0.210	-0.005	-0.002
Gsup7	0.000	0.061	-0.004	0.013	-0.001	0.001

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
Gsup8	0.000	-0.000	-0.000	0.000	-0.000	0.000
G	0.000	0.004	-0.001	-0.020	0.002	-0.023
Gret1	-0.000	0.007	-0.001	-0.020	0.002	-0.023
Gret2.Nea	-0.001	0.007	0.000	-0.018	0.001	-0.029
Gret2.Far	-0.003	0.005	0.001	-0.014	-0.000	-0.036
Gret3.Nea	-0.003	0.001	0.001	-0.010	-0.001	-0.031
Gret3.Far	-0.002	-0.000	0.001	-0.006	-0.001	-0.019
Gret4	0.000	-0.000	-0.000	-0.000	-0.000	0.000
Gret5	0.000	-0.000	-0.000	0.000	-0.000	0.000
E	0.001	0.001	-0.010	0.004	-0.006	0.012
E1	0.001	-0.000	-0.000	0.004	-0.017	-0.044
E2	0.001	-0.000	0.000	0.004	0.005	0.012
E3	0.001	-0.000	-0.000	0.004	-0.001	-0.002
E4	0.001	-0.000	0.000	0.004	0.000	-0.002
E5	0.001	-0.000	-0.000	0.004	-0.000	0.011
E6	0.001	-0.000	0.000	0.004	0.000	-0.041
E7	0.001	-0.000	-0.000	0.004	-0.000	0.155
F	0.001	0.061	0.000	0.004	-0.000	0.144

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
Aret1	1.01	1.00	0.01	2985	2651	2985	2919	41750
Aret2.Nea	1.01	1.00	0.01	2985	2651	2985	2919	41750
Aret2.Far	1.01	1.00	0.01	2985	2232	2985	2484	41750
Aret3.Nea	1.00	1.00	0.01	2985	1338	2985	1636	41750
Aret3.Far	1.00	1.00	0.01	2985	2043	2985	2311	41750
Aret4.Nea	1.00	1.00	0.01	2985	2043	2985	2311	41750
Aret4.Far	1.00	1.00	0.01	2985	2176	2985	2445	41750
Aret5.Nea	1.01	1.00	0.01	2985	1741	2985	2012	41750
Aret5.Far	1.01	1.00	0.01	2985	1399	3029	2047	41750
Aret6	1.00	1.00	0.01	2985	1573	3035	2332	41750
Aret7	1.04	1.05	0.12	2218	950	2218	1250	41750
Asup1	1.00	1.00	0.01	2985	2161	2985	3863	41750
Asup2.Nea	1.00	1.00	0.01	2985	2031	2985	2493	41750
Asup2.Far	1.00	1.00	0.01	2985	1318	2985	2432	41750
Asup3.Nea	1.00	1.00	0.01	2985	1318	2985	2432	41750
Asup3.Far	1.00	1.00	0.01	2985	2087	2985	3324	41750
Asup8	1.00	1.00	0.01	2985	1914	2985	2144	41750
Aret7	1.04	1.05	0.12	2218	982	2218	1228	41750
Asup9	1.00	1.00	0.12	1971	920	1971	1182	41750
A	1.00	1.00	0.12	1971	1086	1971	1360	41750
A1a	1.00	1.00	0.12	2441	3147	3148	3404	41750
A1	1.00	1.00	0.26	2910	2257	2911	2515	41750
A2	1.00	1.00	0.26	2910	2518	2911	2854	41750
A3	1.00	1.00	0.26	2910	2436	2911	2700	41750
A4	1.00	1.00	0.26	2910	2504	2911	2862	41750
B	1.27	1.36	0.26	2910	1942	2911	2580	41750
C	1.00	1.00	0.26	2910	2119	2911	2443	41750
C1	1.00	1.00	0.26	2910	1320	2910	1658	41750
D	1.00	1.00	0.26	2910	1510	2910	1841	41750
D1	1.00	1.00	0.26	2910	1963	2911	2304	41750
D2	1.00	1.00	0.26	2910	1359	2911	1620	41750
E	1.00	1.00	0.26	2910	1359	2911	1619	41750
B	1.27	1.36	0.26	2910	1589	2910	2055	41750
B1	1.00	1.00	0.26	2910	2053	2910	2308	41750
B2	1.00	1.00	0.26	2910	1543	2910	2030	41750
G	1.27	1.36	0.26	2929	1458	2929	1735	41750
Gsup1	1.00	1.00	0.01	2985	4545	4548	5330	41750
Gsup2.Nea	1.00	1.00	0.01	2985	4545	4548	5330	41750
Gsup2.Far	1.00	1.00	0.01	2985	3918	3919	4245	41750
Gsup3.Nea	1.00	1.00	0.01	2985	6264	6264	6442	41750
Gsup3.Far	1.00	1.00	0.01	2985	5460	5460	5667	41750
Gsup4.Nea	1.00	1.00	0.01	2985	5460	5460	5667	41750
Gsup4.Far	1.00	1.00	0.01	2985	2167	2985	2519	41750
Gsup5.Nea	1.00	1.00	0.01	2985	2604	2985	3088	41750
Gsup5.Far	1.00	1.00	0.01	2985	6007	6008	6215	41750
Gsup6.Nea	1.00	1.00	0.01	2985	6007	6008	6215	41750
Gsup6.Far	1.00	1.00	0.01	2985	6994	6994	7177	41750

*** System Stresses (ANSI B31.3) ***

Point	In-Plane	Out-Plane	Section	Stresses/psi			Code	Allow.
Name	SIF	SIF	Modulus	Hoop	Longitu.	Principal		
Gsup7	1.00	1.00	0.06	7360	3857	7360	4087	41750
Gsup8	1.00	1.00	0.06	7360	4386	7360	4614	41750
G	1.27	1.36	0.26	2929	1296	2929	1585	41750
Gret1	1.00	1.00	0.01	2985	1629	2985	2582	41750
Gret2.Nea	1.00	1.00	0.01	2985	1590	2985	2455	41750
Gret2.Far	1.00	1.00	0.01	2985	1345	2986	2023	41750
Gret3.Nea	1.00	1.00	0.01	2985	1551	2987	1841	41750
Gret3.Far	1.00	1.00	0.01	2985	1618	2985	2126	41750
Gret4	1.00	1.00	0.06	7360	3507	7360	3809	41750
Gret5	1.00	1.00	0.06	7360	3530	7360	3941	41750
E	1.00	1.00	0.06	7360	3933	7360	4197	41750
E1	1.00	1.00	0.06	7360	5202	7360	5478	41750
E2	1.00	1.00	0.06	7360	5800	7360	6063	41750
E3	1.00	1.00	0.06	7360	5627	7360	5888	41750
E4	1.00	1.00	0.06	7360	5710	7360	5971	41750
E5	1.00	1.00	0.06	7360	5548	7360	5809	41750
E6	1.00	1.00	0.06	7360	6113	7360	6374	41750
E7	1.00	1.00	0.06	7360	4013	7360	4273	41750
F	1.00	1.00	0.06	7360	3490	7360	3750	41750

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
Aret1	0.000	0.000	-0.000	0.000	-0.000	-0.000
Aret2.Nea	0.000	0.000	-0.000	0.000	-0.000	-0.000
Aret2.Far	0.003	0.008	-0.001	0.018	-0.017	-0.152
Aret3.Nea	-0.140	0.063	-0.010	0.037	-0.075	-0.941
Aret3.Far	-0.224	0.192	-0.021	0.023	-0.096	-1.476
Aret4.Nea	-0.224	0.192	-0.021	0.023	-0.096	-1.476
Aret4.Far	-0.061	0.316	-0.028	0.011	-0.104	-1.760
Aret5.Nea	0.690	0.236	-0.018	0.059	-0.122	-1.404
Aret5.Far	0.738	0.232	-0.009	0.063	-0.078	-1.142
Aret6	0.742	0.234	0.001	0.018	-0.052	-0.938
Aret7	0.743	0.235	0.004	0.014	-0.050	-0.929
Asup1	0.000	0.000	0.000	0.000	-0.000	-0.000
Asup2.Nea	-0.071	0.000	-0.000	0.003	-0.012	-0.701
Asup2.Far	-0.153	0.099	-0.002	0.007	-0.017	-1.371
Asup3.Nea	-0.153	0.099	-0.002	0.007	-0.017	-1.371
Asup3.Far	-0.008	0.235	-0.003	0.012	-0.024	-1.777
Asup8	0.726	0.235	0.004	0.014	-0.050	-0.942
Aret7	0.743	0.235	0.004	0.014	-0.050	-0.929
Asup9	0.838	0.216	0.005	0.008	-0.046	-0.891
A	1.323	0.081	-0.004	-0.031	-0.016	-0.352
Ala	1.249	0.002	-0.000	-0.055	-0.006	-0.104
A1	1.246	-0.000	0.000	-0.055	-0.006	-0.103
A2	0.861	-0.000	-0.000	-0.093	0.004	0.017
A3	0.476	-0.000	0.000	-0.130	-0.011	0.036
A4	0.090	-0.000	-0.000	-0.168	0.041	-0.161
B	0.013	-0.080	-0.012	-0.175	-0.013	-0.156
C	0.016	-0.100	0.014	-0.094	-0.023	-0.089
C1	-0.000	-0.023	0.000	0.108	-0.029	-0.016
D	-0.026	0.189	0.000	-0.288	-0.047	-0.027
D1	0.000	0.000	0.097	-0.291	-0.055	-0.027
D2	-0.000	-0.000	0.289	0.153	0.120	-0.029
E	-0.026	0.027	0.321	0.153	0.181	-0.029
B	0.013	-0.080	-0.012	-0.175	-0.013	-0.156
B1	0.000	-0.000	-0.089	-0.145	-0.032	-0.122
B2	0.000	0.000	-0.281	0.051	0.016	-0.035
G	0.003	-0.010	-0.320	0.051	0.012	-0.018
Gsup1	0.003	-0.011	-0.323	0.056	0.012	-0.018
Gsup2.Nea	0.003	-0.011	-0.323	0.056	0.012	-0.018
Gsup2.Far	0.004	-0.023	-0.306	0.444	0.004	-0.011
Gsup3.Nea	0.005	-0.023	-0.257	0.391	-0.004	-0.009
Gsup3.Far	0.006	-0.028	-0.245	-0.107	-0.010	-0.012
Gsup4.Nea	0.006	-0.028	-0.245	-0.107	-0.010	-0.012
Gsup4.Far	0.004	-0.012	-0.222	-0.572	-0.012	-0.014
Gsup5.Nea	0.003	-0.012	-0.157	-0.576	-0.013	-0.012
Gsup5.Far	0.002	0.004	-0.134	-0.117	-0.013	-0.005
Gsup6.Nea	0.002	0.004	-0.134	-0.117	-0.013	-0.005
Gsup6.Far	0.001	-0.000	-0.122	0.382	-0.010	0.001
Gsup7	0.001	-0.000	-0.055	0.270	-0.001	0.003

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
Gsup8	0.000	-0.000	-0.000	0.000	-0.000	0.000
G	0.003	-0.010	-0.320	0.051	0.012	-0.018
Gret1	0.003	-0.010	-0.321	0.051	0.008	-0.013
Gret2.Nea	0.009	-0.001	-0.323	0.068	-0.210	0.235
Gret2.Far	0.020	0.034	-0.308	0.242	-0.511	0.573
Gret3.Nea	0.000	0.096	-0.247	0.520	-0.607	0.540
Gret3.Far	-0.027	0.109	-0.183	0.695	-0.505	0.200
Gret4	-0.017	0.061	-0.035	0.183	-0.039	-0.083
Gret5	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
E	-0.026	0.027	0.321	0.153	0.181	-0.029
E1	-0.142	-0.000	0.000	0.153	0.535	-0.077
E2	-0.527	-0.000	-0.000	0.153	-0.143	0.021
E3	-0.912	-0.000	0.000	0.153	0.038	-0.005
E4	-1.297	-0.000	-0.000	0.153	-0.010	-0.001
E5	-1.683	-0.000	0.000	0.153	0.003	0.011
E6	-2.068	-0.000	-0.000	0.153	-0.001	-0.041
E7	-2.453	-0.000	0.000	0.153	0.000	0.155
F	-2.530	0.061	-0.000	0.153	0.000	0.144

PipePlus version 4.50
D-Zero Solenoid Upgrade
Load : Dead Weight + Pressure 2 + Thermal 2

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File : SOLHERET

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
Aret1	1.01	1.00	0.01	2985	5614	5638	7288	41750
Aret2.Nea	1.01	1.00	0.01	2985	5614	5638	7288	41750
Aret2.Far	1.01	1.00	0.01	2985	4993	5013	6139	41750
Aret3.Nea	1.00	1.00	0.01	2985	11811	11816	12254	41750
Aret3.Far	1.00	1.00	0.01	2985	10061	10063	10382	41750
Aret4.Nea	1.00	1.00	0.01	2985	10061	10063	10382	41750
Aret4.Far	1.00	1.00	0.01	2985	4286	4288	4436	41750
Aret5.Nea	1.01	1.00	0.01	2985	8726	8726	8871	41750
Aret5.Far	1.01	1.00	0.01	2985	2555	6813	9661	41750
Aret6	1.00	1.00	0.01	2985	5458	8445	10680	41750
Aret7	1.04	1.05	0.12	2218	1344	2321	1946	41750
Asup1	1.00	1.00	0.01	2985	1562	2986	3361	41750
Asup2.Nea	1.00	1.00	0.01	2985	13570	13570	14124	41750
Asup2.Far	1.00	1.00	0.01	2985	13086	13086	13447	41750
Asup3.Nea	1.00	1.00	0.01	2985	13086	13086	13447	41750
Asup3.Far	1.00	1.00	0.01	2985	5651	5653	5798	41750
Asup8	1.00	1.00	0.01	2985	15580	15581	15717	41750
Aret7	1.04	1.05	0.12	1971	2771	2780	3000	41750
Asup9	1.00	1.00	0.12	1971	3200	3206	3427	41750
A	1.00	1.00	0.12	1971	6873	6874	7094	41750
Ala	1.00	1.00	0.12	2441	1936	2471	5798	41750
A1	1.00	1.00	0.26	2910	1570	2913	3511	41750
A2	1.00	1.00	0.26	2910	3018	3042	3270	41750
A3	1.00	1.00	0.26	2910	1802	2913	3344	41750
A4	1.00	1.00	0.26	2910	4759	4760	5007	41750
B	1.27	1.36	0.26	2910	7157	7158	7405	41750
C	1.00	1.00	0.26	2910	9041	9041	9121	41750
C1	1.00	1.00	0.26	2910	2486	2916	2553	41750
D	1.00	1.00	0.26	2910	8074	8075	8704	41750
D1	1.00	1.00	0.26	2910	7699	7699	9379	41750
D2	1.00	1.00	0.26	2910	4199	4199	4577	41750
E	1.00	1.00	0.26	2910	4198	4198	4576	41750
B	1.27	1.36	0.26	2910	5455	5481	5854	41750
B1	1.00	1.00	0.26	2910	5386	5413	5632	41750
B2	1.00	1.00	0.26	2910	1658	2962	2324	41750
G	1.27	1.36	0.26	2910	1924	2975	2319	41750
Gsup1	1.00	1.00	0.01	2985	13268	13268	13223	41750
Gsup2.Nea	1.00	1.00	0.01	2985	13268	13268	13223	41750
Gsup2.Far	1.00	1.00	0.01	2985	6727	6729	7007	41750
Gsup3.Nea	1.00	1.00	0.01	2985	9456	9457	9697	41750
Gsup3.Far	1.00	1.00	0.01	2985	15884	15884	15831	41750
Gsup4.Nea	1.00	1.00	0.01	2985	15884	15884	15831	41750
Gsup4.Far	1.00	1.00	0.01	2985	8126	8126	8418	41750
Gsup5.Nea	1.00	1.00	0.01	2985	7939	7939	8363	41750
Gsup5.Far	1.00	1.00	0.01	2985	15806	15807	15755	41750
Gsup6.Nea	1.00	1.00	0.01	2985	15806	15807	15755	41750
Gsup6.Far	1.00	1.00	0.01	2985	9563	9563	9808	41750

Load : Dead Weight + Pressure 2 + Thermal 2

*** System Stresses (ANSI B31.3) ***

Point Name	In-Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
Gsup7	1.00	1.00	0.01	2985	13408	13408	13634	41750
Gsup8	1.00	1.00	0.06	7360	12147	12147	12400	41750
G	1.27	1.36	0.26	2929	1925	2951	2300	41750
Gret1	1.00	1.00	0.01	2985	14999	16388	17950	41750
Gret2.Nea	1.00	1.00	0.01	2985	12910	14524	16221	41750
Gret2.Far	1.00	1.00	0.01	2985	8389	9546	10500	41750
Gret3.Nea	1.00	1.00	0.01	2985	7372	8700	9648	41750
Gret3.Far	1.00	1.00	0.01	2985	10599	11023	11346	41750
Gret4	1.00	1.00	0.01	2985	14844	15125	15381	41750
Gret5	1.00	1.00	0.06	7360	9412	9452	9612	41750
E	1.00	1.00	0.06	7360	16475	16475	17522	41750
E1	1.00	1.00	0.06	7360	9360	9360	11354	41750
E2	1.00	1.00	0.06	7360	6338	7360	7636	41750
E3	1.00	1.00	0.06	7360	5641	7360	6309	41750
E4	1.00	1.00	0.06	7360	5720	7360	6084	41750
E5	1.00	1.00	0.06	7360	5547	7360	5839	41750
E6	1.00	1.00	0.06	7360	6114	7360	6381	41750
E7	1.00	1.00	0.06	7360	4013	7360	4273	41750
F	1.00	1.00	0.06	7360	3490	7360	3750	41750

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
Aret1	0.000	0.000	-0.000	0.000	-0.000	-0.000
Aret2.Nea	0.000	0.000	-0.000	0.000	-0.000	-0.000
Aret2.Far	0.004	0.008	-0.001	0.017	-0.017	-0.127
Aret3.Nea	-0.127	0.063	-0.010	0.034	-0.075	-0.890
Aret3.Far	-0.206	0.188	-0.020	0.022	-0.097	-1.436
Aret4.Nea	-0.206	0.188	-0.020	0.022	-0.097	-1.436
Aret4.Far	-0.045	0.309	-0.028	0.011	-0.106	-1.747
Aret5.Nea	0.707	0.229	-0.018	0.056	-0.129	-1.406
Aret5.Far	0.756	0.225	-0.009	0.059	-0.084	-1.133
Aret6	0.760	0.227	0.001	0.016	-0.056	-0.919
Aret7	0.761	0.227	0.004	0.013	-0.054	-0.909
Asup1	0.000	0.000	0.000	-0.000	-0.000	-0.000
Asup2.Nea	-0.093	0.055	-0.000	0.003	-0.012	-0.834
Asup2.Far	-0.172	0.182	-0.002	0.007	-0.017	-1.520
Asup3.Nea	-0.172	0.182	-0.002	0.007	-0.017	-1.520
Asup3.Far	0.000	0.314	-0.003	0.012	-0.025	-1.874
Asup8	0.745	0.231	0.004	0.013	-0.054	-0.922
Aret7	0.761	0.227	0.004	0.013	-0.054	-0.909
Asup9	0.854	0.208	0.005	0.006	-0.049	-0.871
A	1.323	0.073	-0.005	-0.031	-0.018	-0.330
Ala	1.249	0.002	-0.000	-0.055	-0.006	-0.093
A1	1.246	-0.000	0.000	-0.055	-0.006	-0.092
A2	0.861	-0.000	-0.000	-0.092	0.004	0.014
A3	0.476	-0.000	0.000	-0.129	-0.010	0.036
A4	0.091	-0.000	-0.000	-0.166	0.037	-0.159
B	0.014	-0.079	-0.010	-0.174	-0.015	-0.156
C	0.017	-0.098	0.016	-0.091	-0.025	-0.090
C1	-0.000	-0.022	0.000	0.112	-0.031	-0.018
D	-0.027	0.190	-0.000	-0.290	-0.048	-0.026
D1	0.000	0.000	0.096	-0.292	-0.055	-0.027
D2	-0.000	-0.000	0.288	0.154	0.120	-0.029
E	-0.026	0.027	0.320	0.153	0.181	-0.029
B	0.014	-0.079	-0.010	-0.174	-0.015	-0.156
B1	0.000	-0.000	-0.087	-0.141	-0.032	-0.123
B2	0.000	0.000	-0.280	0.037	0.016	-0.040
G	0.003	-0.007	-0.318	0.030	0.012	-0.024
Gsup1	0.003	-0.007	-0.321	0.033	0.011	-0.024
Gsup2.Nea	0.003	-0.007	-0.321	0.033	0.011	-0.024
Gsup2.Far	0.005	-0.025	-0.318	0.315	0.003	-0.016
Gsup3.Nea	0.006	-0.044	-0.290	0.119	-0.006	-0.013
Gsup3.Far	0.006	-0.038	-0.305	-0.575	-0.011	-0.015
Gsup4.Nea	0.006	-0.038	-0.305	-0.575	-0.011	-0.015
Gsup4.Far	0.005	0.015	-0.264	-1.132	-0.014	-0.017
Gsup5.Nea	0.003	0.034	-0.140	-1.123	-0.015	-0.015
Gsup5.Far	0.002	0.085	-0.100	-0.547	-0.015	-0.007
Gsup6.Nea	0.002	0.085	-0.100	-0.547	-0.015	-0.007
Gsup6.Far	0.001	0.090	-0.113	0.174	-0.011	0.001
Gsup7	0.001	0.061	-0.058	0.282	-0.001	0.003

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
Gsup8	0.000	-0.000	-0.000	0.000	-0.000	0.000
G	0.003	-0.007	-0.318	0.030	0.012	-0.024
Gret1	0.003	-0.003	-0.319	0.030	0.007	-0.018
Gret2.Nea	0.008	0.006	-0.320	0.049	-0.209	0.217
Gret2.Far	0.017	0.039	-0.304	0.224	-0.507	0.538
Gret3.Nea	-0.002	0.098	-0.244	0.505	-0.603	0.505
Gret3.Far	-0.028	0.109	-0.180	0.682	-0.502	0.181
Gret4	-0.017	0.061	-0.035	0.181	-0.038	-0.081
Gret5	-0.000	-0.000	-0.000	0.000	-0.000	-0.000
E	-0.026	0.027	0.320	0.153	0.181	-0.029
E1	-0.142	-0.000	0.000	0.153	0.533	-0.078
E2	-0.527	-0.000	-0.000	0.153	-0.143	0.021
E3	-0.912	-0.000	0.000	0.153	0.038	-0.005
E4	-1.297	-0.000	-0.000	0.153	-0.010	-0.001
E5	-1.683	-0.000	0.000	0.153	0.003	0.011
E6	-2.068	-0.000	-0.000	0.153	-0.001	-0.041
E7	-2.453	-0.000	0.000	0.153	0.000	0.155
F	-2.530	0.061	-0.000	0.153	0.000	0.144

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
Aret1	1.01	1.00	0.01	2985	4931	4959	6608	41750
Aret2.Nea	1.01	1.00	0.01	2985	4931	4959	6608	41750
Aret2.Far	1.01	1.00	0.01	2985	4476	4504	5618	41750
Aret3.Nea	1.00	1.00	0.01	2985	11848	11852	12284	41750
Aret3.Far	1.00	1.00	0.01	2985	10482	10484	10807	41750
Aret4.Nea	1.00	1.00	0.01	2985	10482	10484	10807	41750
Aret4.Far	1.00	1.00	0.01	2985	4778	4780	4935	41750
Aret5.Nea	1.01	1.00	0.01	2985	9021	9021	9172	41750
Aret5.Far	1.01	1.00	0.01	2985	2543	6993	10027	41750
Aret6	1.00	1.00	0.01	2985	5364	8562	10978	41750
Aret7	1.04	1.05	0.12	2218	1335	2329	1966	41750
Asup1	1.00	1.00	0.01	2985	3107	3120	4933	41750
Asup2.Nea	1.00	1.00	0.01	2985	14371	14371	14955	41750
Asup2.Far	1.00	1.00	0.01	2985	12660	12660	13015	41750
Asup3.Nea	1.00	1.00	0.01	2985	12660	12660	13015	41750
Asup3.Far	1.00	1.00	0.01	2985	4423	4426	4542	41750
Asup8	1.00	1.00	0.01	2985	15731	15731	15838	41750
Aret7	1.04	1.05	0.12	1971	2808	2818	3035	41750
Asup9	1.00	1.00	0.12	1971	3231	3238	3455	41750
A	1.00	1.00	0.12	1971	6868	6870	7086	41750
Ala	1.00	1.00	0.12	2441	1643	2460	5499	41750
A1	1.00	1.00	0.26	2910	1439	2913	3373	41750
A2	1.00	1.00	0.26	2910	2978	3009	3231	41750
A3	1.00	1.00	0.26	2910	1816	2913	3324	41750
A4	1.00	1.00	0.26	2910	4718	4720	4964	41750
B	1.27	1.36	0.26	2910	6973	6974	7223	41750
C	1.00	1.00	0.26	2910	9089	9089	9170	41750
C1	1.00	1.00	0.26	2910	2433	2915	2498	41750
D	1.00	1.00	0.26	2910	8105	8105	8734	41750
D1	1.00	1.00	0.26	2910	7737	7737	9417	41750
D2	1.00	1.00	0.26	2910	4190	4190	4568	41750
E	1.00	1.00	0.26	2910	4189	4189	4567	41750
B	1.27	1.36	0.26	2910	5484	5507	5885	41750
B1	1.00	1.00	0.26	2910	5505	5528	5741	41750
B2	1.00	1.00	0.26	2910	2049	2977	2615	41750
G	1.27	1.36	0.26	2910	1815	2964	2220	41750
Gsup1	1.00	1.00	0.01	2985	9852	9854	9756	41750
Gsup2.Nea	1.00	1.00	0.01	2985	9852	9854	9756	41750
Gsup2.Far	1.00	1.00	0.01	2985	4243	4249	4429	41750
Gsup3.Nea	1.00	1.00	0.01	2985	14365	14366	14512	41750
Gsup3.Far	1.00	1.00	0.01	2985	19863	19863	19758	41750
Gsup4.Nea	1.00	1.00	0.01	2985	19863	19863	19758	41750
Gsup4.Far	1.00	1.00	0.01	2985	8835	8835	9220	41750
Gsup5.Nea	1.00	1.00	0.01	2985	9279	9279	9797	41750
Gsup5.Far	1.00	1.00	0.01	2985	20417	20418	20313	41750
Gsup6.Nea	1.00	1.00	0.01	2985	20417	20418	20313	41750
Gsup6.Far	1.00	1.00	0.01	2985	15103	15103	15255	41750

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
Gsup7	1.00	1.00	0.01	2985	11408	11409	11540	41750
Gsup8	1.00	1.00	0.06	7360	12968	12968	13184	41750
G	1.27	1.36	0.26	2929	1895	2950	2269	41750
Gret1	1.00	1.00	0.01	2985	14351	15784	17361	41750
Gret2.Nea	1.00	1.00	0.01	2985	12375	14036	15748	41750
Gret2.Far	1.00	1.00	0.01	2985	8211	9410	10392	41750
Gret3.Nea	1.00	1.00	0.01	2985	7108	8504	9487	41750
Gret3.Far	1.00	1.00	0.01	2985	10195	10634	10975	41750
Gret4	1.00	1.00	0.01	2985	14666	14947	15214	41750
Gret5	1.00	1.00	0.06	7360	9325	9366	9530	41750
E	1.00	1.00	0.06	7360	16435	16435	17483	41750
E1	1.00	1.00	0.06	7360	9345	9345	11339	41750
E2	1.00	1.00	0.06	7360	6337	7360	7632	41750
E3	1.00	1.00	0.06	7360	5640	7360	6308	41750
E4	1.00	1.00	0.06	7360	5720	7360	6083	41750
E5	1.00	1.00	0.06	7360	5547	7360	5839	41750
E6	1.00	1.00	0.06	7360	6114	7360	6381	41750
E7	1.00	1.00	0.06	7360	4013	7360	4273	41750
F	1.00	1.00	0.06	7360	3490	7360	3750	41750

File Name SOLLN2
Project D-Zero Solenoid Upgrade
Department Research Division / D-Zero Mechanical
Contract Number
Description Solenoid X-fer Line, LN2 Supply & Return
First Revision.
Prepared by Todd M. Leicht
Checked by

ANSI code ANSI B31.3
Input unit English
Output unit English
Output columns 80
Base temperature 70
F factor 1.0
E factor 1.33

Number of dynamic modes.. 8
Cut-off frequency 33 Hz
Max no. of iterations ... 12
Convergence tolerance ... 3
Force tolerance 5 lb

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)

C This analysis is intended as a preliminary estimate of the deflections							
C and stresses in the 3/8" Nitrogen lines of the Solenoid Transfer Line.							
C							
C Load combination considered -							
C 1. cold condition: dead weight + pressure + thermal							
C All points followed by a number represent spider-type guide locations.							
C							
F VBa					0.000	0.000	0.000
T VBb			1'	Short	0.000	0.000	1.000
T VBc		3'			0.000	3.000	1.000
T A		3'			0.000	6.000	1.000
T A1	1'				1.000	6.000	1.000
T A2	8'				9.000	6.000	1.000
T A3	8'				17.000	6.000	1.000
T A4	8'				25.000	6.000	1.000
T A5	8'				33.000	6.000	1.000
T B	1'				34.000	6.000	1.000
T C			-8"		34.000	6.000	0.333
T C1		-3'			34.000	3.000	0.333
T D		-4'6"			34.000	-1.500	0.333
T D1			-2'		34.000	-1.500	-1.667
T D2			-5'4"		34.000	-1.500	-7.000
T E			-1'		34.000	-1.500	-8.000
C							
F B	34.000	6.000	1.000		34.000	6.000	1.000
T B1			1'		34.000	6.000	2.000
T B2			5'6"		34.000	6.000	7.500
T AH			1'	Short	34.000	6.000	8.500
T AHa		1'			34.000	7.000	8.500
T AHb		1'7"			34.000	8.583	8.500
C							
C Node F is assumed to be a flexible connection at the C.H. Feed Can,							
C therefore, no forces or moments will be exerted at F and it is free to							
C rotate and translate in the x-direction.							
C							
F E	34.000	-1.500	-8.000		34.000	-1.500	-8.000
T E1	1'				35.000	-1.500	-8.000
T E2	10'				45.000	-1.500	-8.000
T E3	10'				55.000	-1.500	-8.000
T E4	10'				65.000	-1.500	-8.000
T E5	10'				75.000	-1.500	-8.000
T E6	10'				85.000	-1.500	-8.000
T E7	10'				95.000	-1.500	-8.000
T F	4'				99.000	-1.500	-8.000

Point	Data	Description
VBa	Pipe	Pipe data identifier = 3/8 Nominal Diameter = 3/8 Pipe Schedule = Actual Pipe O. D. = 0.375 inch Wall Thickness = 0.049 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0 Material Data Identifier = SS Austenitic stainless (301-309, 316, 321, 237) Density = 0.2899 lb/cu.inch Tempera. Modulus Expansion (deg.F) (psi) (inch/inch) -325. 30400000 -0.00321 -150. 29900000 -0.00189 -50. 29400000 -0.00103 70. 28300000 0.00000 200. 27700000 0.00122 300. 27100000 0.00218 400. 26600000 0.00317 500. 26100000 0.00417 600. 25400000 0.00520 700. 24800000 0.00625 800. 24100000 0.00733 900. 23400000 0.00843 1000. 22700000 0.00957 1100. 22000000 0.01070 1200. 21300000 0.01183 1300. 20700000 0.01297 1400. 19300000 0.01410 Temperature Allowable stresses (deg.F) (psi) -325 16700 Load Load data identifier = LN2 Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch) 1 -315 150 -0.003135 Anchor Rigid in all directions
VBb		
VBc	Guide	
A		
A1	Guide	
A2	Guide	
A3	Guide	
A4	Guide	
A5	Guide	
B	Tee	Welding tee per ANSI B16.9
C		
C1	Guide	
D		
D1	Guide	

Point	Data	Description
D2	Guide	
E		
B		
B1	Guide	
B2	Guide	
AH		
AHa	Pipe	Pipe data identifier = 1.5 Nominal Diameter = 1"1/2 Pipe Schedule = Actual Pipe O. D. = 1.5 inch Wall Thickness = .035" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
AHb	Anchor	Rigid in all directions
E	Pipe	Pipe data identifier = 3/8
E1	Guide	
E2	Guide	
E3	Guide	
E4	Guide	
E5	Guide	
E6	Guide	
E7	Guide	
F		

Case number	Combination
1	D.W. + Pres1 + Ther1

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
VBa	-0.000	0.000	0.000	-0.000	-0.000	0.000
VBb.Near	-0.043	0.115	-0.036	-0.680	-0.310	0.444
VBb.Far	-0.048	0.118	-0.042	-0.593	-0.313	0.474
VBc	0.000	0.006	-0.000	0.236	-0.139	-1.671
A	1.315	-0.106	0.010	-0.097	0.037	-0.273
A1	1.277	-0.000	0.000	-0.104	0.047	0.706
A2	0.977	-0.000	-0.000	-0.156	0.008	-0.188
A3	0.676	-0.000	0.000	-0.208	-0.080	0.045
A4	0.375	-0.000	-0.000	-0.260	0.310	0.009
A5	0.075	-0.000	0.000	-0.311	-1.162	-0.080
B	0.037	-0.049	0.226	-0.318	-0.661	-0.291
C	0.128	-0.085	0.251	-0.139	-0.636	-0.262
C1	0.000	0.028	0.000	0.632	-0.499	-0.136
D	-0.101	0.197	-0.285	-0.247	-0.292	-0.163
D1	-0.000	-0.000	-0.210	-0.601	-0.171	-0.326
D2	0.000	-0.000	-0.009	0.846	0.115	-0.760
E	-0.026	0.192	0.029	0.956	0.136	-0.842
B	0.037	-0.049	0.226	-0.318	-0.661	-0.291
B1	-0.000	-0.000	0.189	-0.071	0.055	-0.256
B2	0.000	0.000	-0.018	-0.585	-0.018	-0.063
AH.Near	-0.003	0.097	-0.054	-0.139	-0.011	-0.029
AH.Far	-0.003	0.096	-0.056	-0.002	-0.010	-0.026
AHa	-0.000	0.060	-0.014	0.069	-0.000	-0.001
AHb	0.000	-0.000	-0.000	0.000	-0.000	-0.000
E	-0.026	0.192	0.029	0.956	0.136	-0.842
E1	-0.064	-0.000	0.000	0.956	0.125	-1.043
E2	-0.440	-0.000	-0.000	0.956	-0.034	0.279
E3	-0.816	-0.000	0.000	0.956	0.009	-0.074
E4	-1.192	-0.000	-0.000	0.956	-0.002	0.018
E5	-1.568	-0.000	0.000	0.956	0.001	0.001
E6	-1.945	-0.000	-0.000	0.956	-0.000	-0.021
E7	-2.321	-0.000	0.000	0.956	0.000	0.082
F	-2.471	-0.507	-0.000	0.956	0.000	-0.834

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
VBa	1.00	1.00	0.00	514	17086	17196	18738	41750
VBb.Near	1.15	1.00	0.00	514	6362	6663	7432	41750
VBb.Far	1.15	1.00	0.00	514	7652	7656	8082	41750
VBc	1.00	1.00	0.00	514	14129	14131	14118	41750
A	1.00	1.00	0.00	514	21229	21231	21201	41750
A1	1.00	1.00	0.00	514	6147	6147	6191	41750
A2	1.00	1.00	0.00	514	3148	3148	4656	41750
A3	1.00	1.00	0.00	514	3984	3984	4160	41750
A4	1.00	1.00	0.00	514	3818	3818	4935	41750
A5	1.00	1.00	0.00	514	5702	5702	7680	41750
B	1.00	1.00	0.00	514	11875	11875	12818	41750
C	1.00	1.00	0.00	514	4575	4580	4806	41750
C1	1.00	1.00	0.00	514	753	814	1338	41750
D	1.00	1.00	0.00	514	2873	2880	4810	41750
D1	1.00	1.00	0.00	514	1035	1130	5839	41750
D2	1.00	1.00	0.00	514	1777	1822	2914	41750
E	1.00	1.00	0.00	514	350	687	813	41750
B	1.00	1.00	0.00	514	11599	11600	12789	41750
B1	1.00	1.00	0.00	514	4000	4003	4014	41750
B2	1.00	1.00	0.00	514	2094	2101	4839	41750
AH.Near	1.15	1.00	0.00	514	10645	10646	10658	41750
AH.Far	1.15	1.00	0.00	514	10413	10413	10559	41750
AHa	1.00	1.00	0.00	514	7963	7963	8003	41750
AHb	1.00	1.00	0.06	3154	3722	3722	3810	41750
E	1.00	1.00	0.00	514	692	692	1086	41750
E1	1.00	1.00	0.00	514	2932	2932	4016	41750
E2	1.00	1.00	0.00	514	6448	6448	6614	41750
E3	1.00	1.00	0.00	514	5499	5499	5677	41750
E4	1.00	1.00	0.00	514	5758	5758	5869	41750
E5	1.00	1.00	0.00	514	5670	5670	5782	41750
E6	1.00	1.00	0.00	514	5763	5763	5870	41750
E7	1.00	1.00	0.00	514	5479	5479	5586	41750
F	1.00	1.00	0.00	514	180	514	287	41750

File Name VLPCHEsu
Project D-Zero Solenoid Upgrade
Department Research Division / D-Zero Mechanical
Contract Number
Description VLPC Transfer Line, LHe Supply
First Revision.
Prepared by Todd M. Leicht
Checked by

ANSI code ANSI B31.3
Input unit English
Output unit English
Output columns 80
Base temperature 70
F factor 1.0
E factor 1.33

Number of dynamic modes.. 8
Cut-off frequency 33 Hz
Max no. of iterations ... 12
Convergence tolerance ... 3
Force tolerance 5 lb

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)
C This analysis is intended as a preliminary estimate of the deflectins C and stresses in the 3/8" LHe Suplly lines of the VLPC Transfer Line. C							
C Load combination considered - C 1. cold condition: dead weight + pressure + thermal C							
C All points followed by a number represent spider-type guide locations. C							
F VBa					0.000	0.000	0.000
T VBb			1'	Short	0.000	0.000	1.000
T VBc		2'			0.000	2.000	1.000
T A		3'			0.000	5.000	1.000
T A1	2'				2.000	5.000	1.000
T A2	5'9"				7.750	5.000	1.000
T A3	7'3"				15.000	5.000	1.000
T A4	7'3"				22.250	5.000	1.000
T A5	7'3"				29.500	5.000	1.000
T B	6"				30.000	5.000	1.000
T B1		-6"			30.000	4.500	1.000
T B2		-5'			30.000	-0.500	1.000
T D		-6"			30.000	-1.000	1.000
T D1			-3'		30.000	-1.000	-2.000
T D2			-4'		30.000	-1.000	-6.000
T E			-1'10"		30.000	-1.000	-7.833
C							
F B	30.000	5.000	1.000		30.000	5.000	1.000
T C1		6"			30.000	5.500	1.000
T C		1'			30.000	6.500	1.000
T C2			2'		30.000	6.500	3.000
T C3			2'		30.000	6.500	5.000
T AHa			6"	4"	30.000	6.500	5.500
T AHb		1'			30.000	7.500	5.500
T AHc		1'7"			30.000	9.083	5.500
C							
C Node F is assumed to be a flexible connection at the C.H. Feed Can, C therefore, no forces or moments will be exerted at F and it is free to C rotate and translate. C							
F E	30.000	-1.000	-7.833		30.000	-1.000	-7.833
T E1	2'5"				32.417	-1.000	-7.833
T E2	10'				42.417	-1.000	-7.833
T E3	10'				52.417	-1.000	-7.833
T E4	10'				62.417	-1.000	-7.833
T E5	10'				72.417	-1.000	-7.833
T E6	10'				82.417	-1.000	-7.833
T E7	10'				92.417	-1.000	-7.833
T F	2'5"				94.833	-1.000	-7.833

Point	Data	Description
VBa	Pipe	Pipe data identifier = 3/8 Nominal Diameter = 0"3/8 Pipe Schedule = Actual Pipe O. D. = 0.375 inch Wall Thickness = 0.035" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
	Material	Data Identifier = SS Austenitic stainless (301-309, 316, 321, 237) Density = 0.2899 lb/cu.inch Tempera. Modulus Expansion (deg.F) (psi) (inch/inch) -325. 30400000 -0.00321 -150. 29900000 -0.00189 -50. 29400000 -0.00103 70. 28300000 0.00000 200. 27700000 0.00122 300. 27100000 0.00218 400. 26600000 0.00317 500. 26100000 0.00417 600. 25400000 0.00520 700. 24800000 0.00625 800. 24100000 0.00733 900. 23400000 0.00843 1000. 22700000 0.00957 1100. 22000000 0.01070 1200. 21300000 0.01183 1300. 20700000 0.01297 1400. 19300000 0.01410 Temperature Allowable stresses (deg.F) (psi) -325 16700
	Load	Load data identifier = LHe Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch) 1 -450 350 -0.003210
	Anchor	Rigid in all directions
VBb		
VBc	Guide	
A		
A1	Guide	
A2	Guide	
A3	Guide	
A4	Guide	
A5	Guide	
B	Tee	Welding tee per ANSI B16.9
B1	Guide	
B2	Guide	
D		
D1	Guide	

Point	Data	Description
D2	Guide	
E		
B		
C1	Guide	
C		
C2	Guide	
C3	Guide	
AHa		
AHb	Pipe	Pipe data identifier = 1.5 Nominal Diameter = 1"1/2 Pipe Schedule = Actual Pipe O. D. = 1.5 inch Wall Thickness = 0.035" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
AHc	Material	Data Identifier = SS
	Anchor	Rigid in all directions
E	Pipe	Pipe data identifier = 1/2 Nominal Diameter = 3/8 Pipe Schedule = Actual Pipe O. D. = 0.375 inch Wall Thickness = 0.035 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
	Material	Data Identifier = SS
E1	Guide	
E2	Guide	
E3	Guide	
E4	Guide	
E5	Guide	
E6	Guide	
E7	Guide	
F		

Case number	Combination
1	D.W. + Pres1 + Ther1

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
VBa	-0.000	0.000	0.000	-0.000	-0.000	0.000
VBb.Near	-0.056	0.021	-0.037	-0.094	-0.403	0.256
VBb.Far	-0.060	0.020	-0.039	-0.047	-0.404	0.277
VBc	0.000	-0.056	-0.000	0.113	-0.254	-1.163
A	1.151	-0.171	0.004	-0.048	-0.026	-0.712
A1	1.074	-0.000	0.000	-0.051	0.021	0.683
A2	0.852	-0.000	-0.000	-0.059	-0.009	-0.325
A3	0.573	-0.000	-0.000	-0.069	0.015	0.101
A4	0.294	-0.000	0.000	-0.080	-0.053	-0.080
A5	0.015	0.000	-0.000	-0.090	0.195	0.219
B	-0.004	0.014	-0.021	-0.091	0.192	0.036
B1	-0.000	0.033	-0.000	-0.227	0.179	0.039
B2	-0.000	0.226	-0.000	-0.127	0.052	-0.036
D	-0.004	0.245	0.019	-0.245	0.040	-0.041
D1	0.000	-0.000	0.135	-0.357	-0.069	-0.070
D2	-0.000	-0.000	0.289	0.329	0.244	-0.109
E	-0.167	0.143	0.359	0.407	0.628	-0.127
B	-0.004	0.014	-0.021	-0.091	0.192	0.036
C1	-0.000	-0.005	0.000	0.598	0.135	-0.067
C	0.009	-0.044	0.204	0.733	0.023	-0.030
C2	0.000	-0.000	0.127	-0.034	-0.024	-0.015
C3	-0.000	0.000	0.050	-0.907	0.007	-0.001
AHa.Near	0.000	0.036	0.044	-1.075	0.005	0.000
AHa.Far	0.000	0.086	-0.017	-0.327	0.003	0.003
AHb	0.000	0.061	-0.015	0.071	0.000	0.000
AHc	0.000	-0.000	-0.000	0.000	0.000	0.000
E	-0.167	0.143	0.359	0.407	0.628	-0.127
E1	-0.260	-0.000	0.000	0.407	0.621	-0.637
E2	-0.646	-0.000	-0.000	0.407	-0.166	0.169
E3	-1.031	-0.000	0.000	0.407	0.045	-0.039
E4	-1.416	-0.000	-0.000	0.407	-0.012	-0.014
E5	-1.801	-0.000	0.000	0.407	0.003	0.094
E6	-2.186	-0.000	-0.000	0.407	-0.001	-0.361
E7	-2.572	-0.000	0.000	0.407	0.000	1.349
F	-2.665	0.606	-0.000	0.407	0.000	1.146

PipePlus version 4.50
D-Zero Solenoid Upgrade

Fermi Nat'l Accelerator Lab

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File : VLPCHESU

Load : Dead Weight + Pressure 1 + Thermal 1

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
VBa	1.00	1.00	0.00	1735	8133	8227	12359	41750
VBb.Near	1.52	1.26	0.00	1735	3655	3934	6815	41750
VBb.Far	1.52	1.26	0.00	1735	4304	4324	7319	41750
VBc	1.00	1.00	0.00	1735	13387	13392	13689	41750
A	1.00	1.00	0.00	1735	15698	15698	15894	41750
A1	1.00	1.00	0.00	1735	5372	5372	5572	41750
A2	1.00	1.00	0.00	1735	2494	2494	4226	41750
A3	1.00	1.00	0.00	1735	3925	3925	4124	41750
A4	1.00	1.00	0.00	1735	3795	3795	4103	41750
A5	1.00	1.00	0.00	1735	3017	3017	4537	41750
B	1.00	1.00	0.00	1735	6712	6713	7267	41750
B1	1.00	1.00	0.00	1735	2518	2525	2770	41750
B2	1.00	1.00	0.00	1735	2187	2200	2443	41750
D	1.00	1.00	0.00	1735	2860	2865	3114	41750
D1	1.00	1.00	0.00	1735	1411	1738	3957	41750
D2	1.00	1.00	0.00	1735	2333	2334	3002	41750
E	1.00	1.00	0.00	1735	2309	2310	2554	41750
B	1.00	1.00	0.00	1735	7786	7804	8374	41750
C1	1.00	1.00	0.00	1735	16047	16055	16293	41750
C	1.00	1.00	0.00	1735	13963	13972	14487	41750
C2	1.00	1.00	0.00	1735	8615	8615	8685	41750
C3	1.00	1.00	0.00	1735	14902	14902	15351	41750
AHa.Near	1.00	1.00	0.00	1735	2374	2374	2588	41750
AHa.Far	1.00	1.00	0.00	1735	15287	15287	15145	41750
AHb	1.00	1.00	0.00	1735	6072	6072	5967	41750
AHc	1.00	1.00	0.06	7360	6143	7360	6323	41750
E	1.00	1.00	0.00	1735	2301	2301	2570	41750
E1	1.00	1.00	0.00	1735	4875	4875	6631	41750
E2	1.00	1.00	0.00	1735	6717	6717	7351	41750
E3	1.00	1.00	0.00	1735	6099	6099	6484	41750
E4	1.00	1.00	0.00	1735	6341	6341	6623	41750
E5	1.00	1.00	0.00	1735	5971	5971	6234	41750
E6	1.00	1.00	0.00	1735	7207	7207	7463	41750
E7	1.00	1.00	0.00	1735	2630	2630	2884	41750
F	1.00	1.00	0.00	1735	684	1735	938	41750

File Name VLPCHERE
Project D-Zero Solenoid Upgrade
Department Research Division / D-Zero Mechanical
Contract Number
Description VLPC Transfer Line, LHe Return
First Revision.
Prepared by Todd M. Leicht
Checked by

ANSI code ANSI B31.3
Input unit English
Output unit English
Output columns 80
Base temperature 70
F factor 1.0
E factor 1.33

Number of dynamic modes.. 8
Cut-off frequency 33 Hz
Max no. of iterations ... 12
Convergence tolerance ... 3
Force tolerance 5 lb

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)
C This analysis is intended as a preliminary estimate of the deflectins C and stresses in the 1/2" LHe Return lines of the VLPC Transfer Line. C							
C Load combination considered - C 1. cold condition: dead weight + pressure + thermal C							
C All points followed by a number represent spider-type guide locations. C							
F VBa					0.000	0.000	0.000
T VBb			1'	Short	0.000	0.000	1.000
T VBc		2'			0.000	2.000	1.000
T A		3'			0.000	5.000	1.000
T A1	2'				2.000	5.000	1.000
T A2	5'9"				7.750	5.000	1.000
T A3	7'3"				15.000	5.000	1.000
T A4	7'3"				22.250	5.000	1.000
T A5	7'3"				29.500	5.000	1.000
T B	6"				30.000	5.000	1.000
T B1		-6"			30.000	4.500	1.000
T B2		-5'			30.000	-0.500	1.000
T D		-6"			30.000	-1.000	1.000
T D1			-3'		30.000	-1.000	-2.000
T D2			-4'		30.000	-1.000	-6.000
T E			-1'10"		30.000	-1.000	-7.833
C							
F B	30.000	5.000	1.000		30.000	5.000	1.000
T C1		6"			30.000	5.500	1.000
T C		1'			30.000	6.500	1.000
T C2			2'		30.000	6.500	3.000
T C3			2'		30.000	6.500	5.000
T AHa			6"	4"	30.000	6.500	5.500
T AHb		1'			30.000	7.500	5.500
T AHc		1'7"			30.000	9.083	5.500
C							
C Node F is assumed to be a flexible connection at the C.H. Feed Can, C therefore, no forces or moments will be exerted at F and it is free to C rotate and translate. C							
F E	30.000	-1.000	-7.833		30.000	-1.000	-7.833
T E1	2'5"				32.417	-1.000	-7.833
T E2	10'				42.417	-1.000	-7.833
T E3	10'				52.417	-1.000	-7.833
T E4	10'				62.417	-1.000	-7.833
T E5	10'				72.417	-1.000	-7.833
T E6	10'				82.417	-1.000	-7.833
T E7	10'				92.417	-1.000	-7.833
T F	2'5"				94.833	-1.000	-7.833

Point	Data	Description
VBa	Pipe	Pipe data identifier = 1/2 Nominal Diameter = 1/2 Pipe Schedule = Actual Pipe O. D. = 0.5 inch Wall Thickness = 0.049 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0 Material Data Identifier = SS Austenitic stainless (301-309, 316, 321, 237) Density = 0.2899 lb/cu.inch Tempera. Modulus Expansion (deg.F) (psi) (inch/inch) -325. 30400000 -0.00321 -150. 29900000 -0.00189 -50. 29400000 -0.00103 70. 28300000 0.00000 200. 27700000 0.00122 300. 27100000 0.00218 400. 26600000 0.00317 500. 26100000 0.00417 600. 25400000 0.00520 700. 24800000 0.00625 800. 24100000 0.00733 900. 23400000 0.00843 1000. 22700000 0.00957 1100. 22000000 0.01070 1200. 21300000 0.01183 1300. 20700000 0.01297 1400. 19300000 0.01410 Temperature Allowable stresses (deg.F) (psi) -325 16700 Load Load data identifier = LHe Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch) 1 -450 350 -0.003210 Anchor Rigid in all directions
VBb		
VBc	Guide	
A		
A1	Guide	
A2	Guide	
A3	Guide	
A4	Guide	
A5	Guide	
B	Tee	Welding tee per ANSI B16.9
B1	Guide	
B2	Guide	
D		
D1	Guide	

Point	Data	Description
D2	Guide	
E		
B		
C1	Guide	
C		
C2	Guide	
C3	Guide	
AHa		
AHb	Pipe	Pipe data identifier = 1.5 Nominal Diameter = 1"1/2 Pipe Schedule = Actual Pipe O. D. = 1.5 inch Wall Thickness = 0.035" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
	Material	Data Identifier = SS
AHc	Anchor	Rigid in all directions
E	Pipe	Pipe data identifier = 1/2
	Material	Data Identifier = SS
E1	Guide	
E2	Guide	
E3	Guide	
E4	Guide	
E5	Guide	
E6	Guide	
E7	Guide	
F		

Case number	Combination
1	D.W. + Pres1 + Ther1

PipePlus version 4.50
D-Zero Solenoid Upgrade
Load : Dead Weight + Pressure 1 + Thermal 1

Fermi Nat'l Accelerator Lab

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File : VLPCHERE

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
VBa	-0.000	0.000	0.000	-0.000	-0.000	0.000
VBb.Near	-0.054	0.028	-0.037	-0.143	-0.400	0.251
VBb.Far	-0.060	0.028	-0.039	-0.074	-0.401	0.277
VBc	0.000	-0.048	-0.000	0.125	-0.250	-1.157
A	1.150	-0.163	0.007	-0.046	-0.017	-0.730
A1	1.073	-0.000	0.000	-0.048	0.027	0.695
A2	0.852	-0.000	-0.000	-0.054	-0.011	-0.276
A3	0.573	-0.000	-0.000	-0.062	0.014	0.085
A4	0.294	-0.000	0.000	-0.069	-0.045	-0.065
A5	0.015	0.000	-0.000	-0.077	0.167	0.174
B	-0.004	0.012	-0.018	-0.078	0.163	0.034
B1	-0.000	0.031	-0.000	-0.192	0.153	0.040
B2	-0.000	0.224	-0.000	-0.131	0.047	-0.035
D	-0.004	0.243	0.019	-0.243	0.037	-0.040
D1	0.000	0.000	0.135	-0.325	-0.068	-0.064
D2	-0.000	-0.000	0.289	0.238	0.244	-0.096
E	-0.167	0.099	0.359	0.273	0.628	-0.111
B	-0.004	0.012	-0.018	-0.078	0.163	0.034
C1	-0.000	-0.007	0.000	0.513	0.114	-0.067
C	0.009	-0.045	0.174	0.608	0.015	-0.033
C2	0.000	-0.000	0.097	-0.009	-0.022	-0.017
C3	-0.000	0.000	0.020	-0.897	0.007	-0.002
AHa.Near	0.000	0.035	0.014	-1.064	0.006	-0.001
AHa.Far	0.000	0.086	-0.047	-0.335	0.003	0.002
AHb	0.000	0.061	-0.040	0.185	0.000	0.001
AHc	0.000	-0.000	-0.000	0.000	0.000	0.000
E	-0.167	0.099	0.359	0.273	0.628	-0.111
E1	-0.260	-0.000	0.000	0.273	0.621	-0.386
E2	-0.646	-0.000	-0.000	0.273	-0.166	0.103
E3	-1.031	-0.000	0.000	0.273	0.045	-0.024
E4	-1.416	-0.000	-0.000	0.273	-0.012	-0.007
E5	-1.801	-0.000	0.000	0.273	0.003	0.052
E6	-2.186	-0.000	-0.000	0.273	-0.001	-0.202
E7	-2.572	-0.000	0.000	0.273	0.000	0.756
F	-2.665	0.339	-0.000	0.273	0.000	0.642

Load : Dead Weight + Pressure 1 + Thermal 1

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
VBa	1.00	1.00	0.01	1646	11282	11392	14675	41750
VBb.Near	1.46	1.22	0.01	1646	4981	5277	7410	41750
VBb.Far	1.46	1.22	0.01	1646	5899	5921	8084	41750
VBc	1.00	1.00	0.01	1646	17531	17537	17771	41750
A	1.00	1.00	0.01	1646	20444	20444	20595	41750
A1	1.00	1.00	0.01	1646	6105	6105	6259	41750
A2	1.00	1.00	0.01	1646	1603	1646	3800	41750
A3	1.00	1.00	0.01	1646	3226	3226	3380	41750
A4	1.00	1.00	0.01	1646	3062	3062	3339	41750
A5	1.00	1.00	0.01	1646	2346	2346	3947	41750
B	1.00	1.00	0.01	1646	7514	7515	7971	41750
B1	1.00	1.00	0.01	1646	2806	2812	3052	41750
B2	1.00	1.00	0.01	1646	2530	2537	2777	41750
D	1.00	1.00	0.01	1646	3428	3432	3674	41750
D1	1.00	1.00	0.01	1646	2214	2216	4196	41750
D2	1.00	1.00	0.01	1646	2814	2815	3389	41750
E	1.00	1.00	0.01	1646	2811	2812	3049	41750
B	1.00	1.00	0.01	1646	9079	9100	9544	41750
C1	1.00	1.00	0.01	1646	18259	18268	18441	41750
C	1.00	1.00	0.01	1646	16306	16317	16695	41750
C2	1.00	1.00	0.01	1646	10480	10480	10451	41750
C3	1.00	1.00	0.01	1646	19280	19280	19530	41750
AHa.Near	1.00	1.00	0.01	1646	3151	3152	3231	41750
AHa.Far	1.00	1.00	0.01	1646	20527	20527	20021	41750
AHb	1.00	1.00	0.06	7360	4220	7360	4130	41750
AHc	1.00	1.00	0.06	7360	10721	10721	10673	41750
E	1.00	1.00	0.01	1646	2797	2797	3061	41750
E1	1.00	1.00	0.01	1646	4187	4187	6126	41750
E2	1.00	1.00	0.01	1646	5203	5203	5948	41750
E3	1.00	1.00	0.01	1646	4681	4681	5108	41750
E4	1.00	1.00	0.01	1646	4869	4869	5160	41750
E5	1.00	1.00	0.01	1646	4590	4590	4856	41750
E6	1.00	1.00	0.01	1646	5515	5515	5771	41750
E7	1.00	1.00	0.01	1646	2094	2094	2347	41750
F	1.00	1.00	0.01	1646	640	1646	893	41750

File Name vlpcn2s
Project D-Zero Solenoid Upgrade
Department Research Division / D-Zero Mechanical
Contract Number
Description VLPC Transfer Line, LN2 Supply
First Revision.
Prepared by Todd M. Leicht
Checked by

ANSI code ANSI B31.3
Input unit English
Output unit English
Output columns 80
Base temperature 70
F factor 1.0
E factor 1.33

Number of dynamic modes.. 8
Cut-off frequency 33 Hz
Max no. of iterations ... 12
Convergence tolerance ... 3
Force tolerance 5 lb

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)
C This analysis is intended as a preliminary estimate of the deflectins C and stresses in the 1/2" Nitrogen lines of the VLPC Transfer Line.							
C							
C Load combination considered -							
C 1. cold condition: dead weight + pressure + thermal							
C							
C All points followed by a number represent spider-type guide locations.							
C							
F VBa					0.000	0.000	0.000
T VBb		-1'7"			0.000	-1.583	0.000
T VBc		-1'			0.000	-2.583	0.000
T VBd			1'		0.000	-2.583	1.000
T VBe		1'6"			0.000	-1.083	1.000
T A		3'6"			0.000	2.417	1.000
T A1	1'				1.000	2.417	1.000
T A2	9'4"				10.333	2.417	1.000
T A3	9'4"				19.667	2.417	1.000
T A4	9'4"				29.000	2.417	1.000
T B	1'				30.000	2.417	1.000
T B2		-5'			30.000	-2.583	1.000
T D		-1'			30.000	-3.583	1.000
T D1			-2'6"		30.000	-3.583	-1.500
T D2			-3'10"		30.000	-3.583	-5.333
T E			-2'6"		30.000	-3.583	-7.833
C							
F B	30.000	2.417	1.000		30.000	2.417	1.000
T C1		1'			30.000	3.417	1.000
T C		6"			30.000	3.917	1.000
T C2			1'		30.000	3.917	2.000
T C3			2'		30.000	3.917	4.000
T AH			1'		30.000	3.917	5.000
T AHa		1'			30.000	4.917	5.000
T AHb		1'7"			30.000	6.500	5.000
C							
C Node F is assumed to be a flexible connection at the C.H. Feed Can,							
C therefore, no forces or moments will be exerted at F and it is free to							
C rotate and translate.							
C							
F E	30.000	-3.583	-7.833		30.000	-3.583	-7.833
T E1	1'				31.000	-3.583	-7.833
T E2	10'				41.000	-3.583	-7.833
T E3	10'				51.000	-3.583	-7.833
T E4	10'				61.000	-3.583	-7.833
T E5	10'				71.000	-3.583	-7.833
T E6	10'				81.000	-3.583	-7.833
T E7	10'				91.000	-3.583	-7.833
T F	4'				95.000	-3.583	-7.833

Point	Data	Description
VBa	Pipe	Pipe data identifier = 1.5 Nominal Diameter = 1"1/2 Pipe Schedule = Actual Pipe O. D. = 1.500 inch Wall Thickness = 0.035" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
	Material	Data Identifier = SS Austenitic stainless (301-309, 316, 321, 237) Density = 0.2899 lb/cu.inch Tempera. Modulus Expansion (deg.F) (psi) (inch/inch) -325. 30400000 -0.00321 -150. 29900000 -0.00189 -50. 29400000 -0.00103 70. 28300000 0.00000 200. 27700000 0.00122 300. 27100000 0.00218 400. 26600000 0.00317 500. 26100000 0.00417 600. 25400000 0.00520 700. 24800000 0.00625 800. 24100000 0.00733 900. 23400000 0.00843 1000. 22700000 0.00957 1100. 22000000 0.01070 1200. 21300000 0.01183 1300. 20700000 0.01297 1400. 19300000 0.01410 Temperature Allowable stresses (deg.F) (psi) -325 16700
	Load	Load data identifier = LN2 Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch) 1 -315 150 -0.003135
VBb	Anchor	Rigid in all directions
	Pipe	Pipe data identifier = 1/2 Nominal Diameter = 1/2 Pipe Schedule = Actual Pipe O. D. = 0.5 inch Wall Thickness = 0.049 inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0

Point	Data	Description

		Material Data Identifier = SS
VBc		
VBd		
VBe	Guide	
A		
A1	Guide	
A2	Guide	
A3	Guide	
A4	Guide	
B	Tee	Welding tee per ANSI B16.9
B2	Guide	
D		
D1	Guide	
D2	Guide	
E		
B		
C1	Guide	
C		
C2	Guide	
C3	Guide	
AH		
AHa	Pipe	Pipe data identifier = 1.5
AHb	Anchor	Rigid in all directions
E	Pipe	Pipe data identifier = 1/2
	Material	Data Identifier = SS
E1	Guide	
E2	Guide	
E3	Guide	
E4	Guide	
E5	Guide	
E6	Guide	
E7	Guide	
F		

Case number	Combination
-----	-----
1	D.W. + Pres1 + Ther1

PipePlus version 4.50
D-Zero Solenoid Upgrade
Load : Dead Weight + Pressure 1 + Thermal 1

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File : vlpn2s

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
VBa	-0.000	0.000	0.000	-0.000	-0.000	-0.000
VBb	-0.013	0.060	0.016	-0.085	-0.039	-0.067
VBc	-0.071	0.097	0.112	-0.749	-0.632	-0.403
VBd	-0.233	0.258	0.074	-0.598	-0.819	-0.490
VBe	0.000	0.202	-0.000	-0.060	-0.661	-1.195
A	1.124	0.071	-0.053	-0.074	-0.293	-0.684
A1	1.087	-0.000	-0.000	-0.069	-0.214	-0.233
A2	0.736	-0.000	0.000	-0.017	0.072	0.095
A3	0.385	-0.000	0.000	0.035	-0.074	-0.145
A4	0.034	0.000	-0.000	0.087	0.224	0.485
B	-0.003	0.071	-0.048	0.093	0.199	0.134
B2	-0.000	0.259	-0.000	0.116	0.022	-0.148
D	-0.037	0.297	-0.012	-0.149	-0.014	-0.205
D1	0.000	0.000	0.082	-0.542	-0.152	-0.356
D2	-0.000	-0.000	0.226	0.301	0.463	-0.588
E	-0.507	0.162	0.320	0.329	1.473	-0.739
B	-0.003	0.071	-0.048	0.093	0.199	0.134
C1	-0.000	0.034	0.000	0.414	0.066	-0.070
C	0.006	0.015	0.044	0.308	-0.001	-0.046
C2	0.000	-0.000	0.006	0.046	-0.028	-0.035
C3	-0.000	0.000	-0.069	-0.450	0.007	-0.012
AH	0.000	0.097	-0.106	-0.062	0.000	-0.001
AHa	0.000	0.059	-0.043	0.210	0.000	0.001
AHb	0.000	-0.000	-0.000	0.000	0.000	0.000
E	-0.507	0.162	0.320	0.329	1.473	-0.739
E1	-0.544	-0.000	0.000	0.329	1.427	-0.818
E2	-0.921	-0.000	-0.000	0.329	-0.382	0.219
E3	-1.297	-0.000	0.000	0.329	0.102	-0.058
E4	-1.673	-0.000	-0.000	0.329	-0.027	0.015
E5	-2.049	-0.000	0.000	0.329	0.007	-0.001
E6	-2.425	-0.000	-0.000	0.329	-0.002	-0.011
E7	-2.801	-0.000	0.000	0.329	0.001	0.046
F	-2.952	-0.286	-0.001	0.329	0.001	-0.470

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane SIF	Out Plane SIF	Section Modulus	Stresses/psi		Principal	Code	Allow.
				Hoop	Longitu.			
VBa	1.00	1.00	0.06	3154	4313	4382	4540	41750
VBb	1.00	1.00	0.01	705	11428	11919	12630	41750
VBc	1.00	1.00	0.01	705	6677	6697	6819	41750
VBd	1.00	1.00	0.01	705	7907	7931	7965	41750
VBe	1.00	1.00	0.01	705	9363	9383	9439	41750
A	1.00	1.00	0.01	705	12382	12397	12421	41750
A1	1.00	1.00	0.01	705	3230	3230	4417	41750
A2	1.00	1.00	0.01	705	4042	4042	4257	41750
A3	1.00	1.00	0.01	705	4376	4376	4470	41750
A4	1.00	1.00	0.01	705	2302	2302	5439	41750
B	1.00	1.00	0.01	705	6006	6006	7502	41750
B2	1.00	1.00	0.01	705	2350	2362	2747	41750
D	1.00	1.00	0.01	705	7675	7678	8267	41750
D1	1.00	1.00	0.01	705	4043	4060	6058	41750
D2	1.00	1.00	0.01	705	4519	4534	5547	41750
E	1.00	1.00	0.01	705	4509	4524	4602	41750
B	1.00	1.00	0.01	705	5771	5826	6370	41750
C1	1.00	1.00	0.01	705	5220	5281	5439	41750
C	1.00	1.00	0.01	705	9511	9542	9576	41750
C2	1.00	1.00	0.01	705	4373	4373	4256	41750
C3	1.00	1.00	0.01	705	9121	9121	9158	41750
AH	1.00	1.00	0.01	705	17179	17179	17078	41750
AHa	1.00	1.00	0.01	705	11585	11585	11477	41750
AHb	1.00	1.00	0.06	3154	8427	8427	8446	41750
E	1.00	1.00	0.01	705	4457	4457	5043	41750
E1	1.00	1.00	0.01	705	5510	5510	7186	41750
E2	1.00	1.00	0.01	705	5392	5392	6571	41750
E3	1.00	1.00	0.01	705	4232	4232	4723	41750
E4	1.00	1.00	0.01	705	4486	4486	4683	41750
E5	1.00	1.00	0.01	705	4398	4398	4535	41750
E6	1.00	1.00	0.01	705	4473	4473	4588	41750
E7	1.00	1.00	0.01	705	4259	4259	4368	41750
F	1.00	1.00	0.01	705	274	705	383	41750

File Name vlpcn2r
Project D-Zero Solenoid Upgrade
Department Research Division / D-Zero Mechanical
Contract Number
Description VLPC Transfer Line, LN2 Return
First Revision.
Prepared by Todd M. Leicht
Checked by

ANSI code ANSI B31.3
Input unit English
Output unit English
Output columns 80
Base temperature 70
F factor 1.0
E factor 1.33

Number of dynamic modes.. 8
Cut-off frequency 33 Hz
Max no. of iterations ... 12
Convergence tolerance ... 3
Force tolerance 5 lb

Frm Point /To name	DX (feet)	DY (feet)	DZ (feet)	Radius (inch)	X (feet)	Y (feet)	Z (feet)
C This analysis is intended as a preliminary estimate of the deflectins C and stresses in the 1/2" Nitrogen lines of the VLPC Transfer Line.							
C							
C Load combination considered -							
C 1. cold condition: dead weight + pressure + thermal							
C							
C All points followed by a number represent spider-type guide locations.							
C							
F VBa					0.000	0.000	0.000
T VBb		-1'7"			0.000	-1.583	0.000
T VBc		-1'			0.000	-2.583	0.000
T VBd			1'		0.000	-2.583	1.000
T VBe		1'6"			0.000	-1.083	1.000
T A		3'6"			0.000	2.417	1.000
T A1	1'				1.000	2.417	1.000
T A2	9'4"				10.333	2.417	1.000
T A3	9'4"				19.667	2.417	1.000
T A4	9'4"				29.000	2.417	1.000
T B	1'				30.000	2.417	1.000
T B2		-5'			30.000	-2.583	1.000
T D		-1'			30.000	-3.583	1.000
T D1			-2'6"		30.000	-3.583	-1.500
T D2			-3'10"		30.000	-3.583	-5.333
T E			-2'6"		30.000	-3.583	-7.833
C							
F B	30.000	2.417	1.000		30.000	2.417	1.000
T C1		1'			30.000	3.417	1.000
T C		6"			30.000	3.917	1.000
T C2			1'		30.000	3.917	2.000
T C3			2'		30.000	3.917	4.000
T AH			1'		30.000	3.917	5.000
T AHa		1'			30.000	4.917	5.000
T AHb		1'7"			30.000	6.500	5.000
C							
C Node F is assumed to be a flexible connection at the C.H. Feed Can,							
C therefore, no forces or moments will be exerted at F and it is free to							
C rotate and translate.							
C							
F E	30.000	-3.583	-7.833		30.000	-3.583	-7.833
T E1	1'				31.000	-3.583	-7.833
T E2	10'				41.000	-3.583	-7.833
T E3	10'				51.000	-3.583	-7.833
T E4	10'				61.000	-3.583	-7.833
T E5	10'				71.000	-3.583	-7.833
T E6	10'				81.000	-3.583	-7.833
T E7	10'				91.000	-3.583	-7.833
T F	4'				95.000	-3.583	-7.833

Point	Data	Description
VBa	Pipe	Pipe data identifier = 1.5 Nominal Diameter = 1"1/2 Pipe Schedule = Actual Pipe O. D. = 1.500 inch Wall Thickness = 0.035" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0
	Material	Data Identifier = SS Austenitic stainless (301-309, 316, 321, 237) Density = 0.2899 lb/cu.inch Tempera. Modulus Expansion (deg.F) (psi) (inch/inch) -325. 30400000 -0.00321 -150. 29900000 -0.00189 -50. 29400000 -0.00103 70. 28300000 0.00000 200. 27700000 0.00122 300. 27100000 0.00218 400. 26600000 0.00317 500. 26100000 0.00417 600. 25400000 0.00520 700. 24800000 0.00625 800. 24100000 0.00733 900. 23400000 0.00843 1000. 22700000 0.00957 1100. 22000000 0.01070 1200. 21300000 0.01183 1300. 20700000 0.01297 1400. 19300000 0.01410 Temperature Allowable stresses (deg.F) (psi) -325 16700
	Load	Load data identifier = LN2 Case Temperature Pressure Expansion No. (deg.F) (psig) (inch/inch) 1 -315 150 -0.003135
VBb	Anchor	Rigid in all directions
	Pipe	Pipe data identifier = 1/2 Nominal Diameter = 1/2 Pipe Schedule = Actual Pipe O. D. = 0.84" inch Wall Thickness = .083" inch Corrosion Allowance = 0 inch Insulation Thickness = 0 inch Insulation Density = 0 lb/cu.ft Content S. G. = 1.0

Point	Data	Description

	Material Data Identifier = SS	
VBC		
VBd		
VBe	Guide	
A		
A1	Guide	
A2	Guide	
A3	Guide	
A4	Guide	
B	Tee	Welding tee per ANSI B16.9
B2	Guide	
D		
D1	Guide	
D2	Guide	
E		
B		
C1	Guide	
C		
C2	Guide	
C3	Guide	
AH		
AHa	Pipe	Pipe data identifier = 1.5
AHb	Anchor	Rigid in all directions
E	Pipe	Pipe data identifier = 1/2
	Material Data Identifier = SS	
E1	Guide	
E2	Guide	
E3	Guide	
E4	Guide	
E5	Guide	
E6	Guide	
E7	Guide	
F		

Case number	Combination
-----	-----
1	D.W. + Pres1 + Ther1

*** System Deflections ***

Point Name	Displacements/inch			Rotations/degree		
	X	Y	Z	X	Y	Z
VBa	-0.000	0.000	0.000	-0.000	-0.000	-0.000
VBb	-0.070	0.060	0.067	-0.377	-0.192	-0.371
VBc	-0.183	0.097	0.199	-0.846	-0.558	-0.652
VBd	-0.318	0.285	0.161	-0.797	-0.674	-0.802
VBe	0.000	0.228	-0.000	-0.304	-0.578	-1.347
A	1.111	0.097	-0.067	0.014	-0.352	-0.777
A1	1.073	-0.000	-0.000	0.013	-0.276	-0.313
A2	0.723	-0.000	0.000	-0.002	0.074	0.099
A3	0.372	-0.000	-0.000	-0.017	-0.020	-0.082
A4	0.021	0.000	-0.000	-0.032	0.008	0.231
B	-0.016	0.033	-0.001	-0.034	-0.005	0.036
B2	-0.000	0.221	-0.000	0.204	0.002	-0.069
D	-0.019	0.259	-0.029	-0.073	0.003	-0.109
D1	0.000	0.000	0.065	-0.467	-0.119	-0.172
D2	-0.000	-0.000	0.209	0.185	0.429	-0.269
E	-0.477	0.072	0.302	0.118	1.391	-0.333
B	-0.016	0.033	-0.001	-0.034	-0.005	0.036
C1	-0.000	-0.004	0.000	0.051	-0.038	-0.117
C	0.011	-0.023	0.004	-0.032	-0.054	-0.097
C2	0.000	-0.000	-0.034	-0.032	-0.036	-0.075
C3	-0.000	0.000	-0.109	-0.388	0.010	-0.029
AH	0.001	0.097	-0.146	-0.191	0.002	-0.006
AHa	0.001	0.059	-0.100	0.438	0.001	0.004
AHb	0.000	-0.000	-0.000	0.000	0.000	0.000
E	-0.477	0.072	0.302	0.118	1.391	-0.333
E1	-0.514	-0.000	0.000	0.118	1.350	-0.352
E2	-0.890	-0.000	-0.000	0.118	-0.362	0.094
E3	-1.266	-0.000	0.000	0.118	0.097	-0.025
E4	-1.643	-0.000	-0.000	0.118	-0.026	0.006
E5	-2.019	-0.000	0.000	0.118	0.007	-0.001
E6	-2.395	-0.000	-0.000	0.118	-0.002	-0.004
E7	-2.771	-0.000	0.000	0.118	0.001	0.016
F	-2.922	-0.101	-0.001	0.118	0.001	-0.167

*** System Stresses (ANSI B31.3) ***

Point Name	In- Plane	Out Plane	Section Modulus	Stresses/psi			Code	Allow.
	SIF	SIF		Hoop	Longitu.	Principal		
VBa	1.00	1.00	0.06	3154	14604	14782	15311	41750
VBb	1.00	1.00	0.03	699	12533	13014	13795	41750
VBc	1.00	1.00	0.03	699	8387	8514	8704	41750
VBd	1.00	1.00	0.03	699	8921	8943	8867	41750
VBe	1.00	1.00	0.03	699	11535	11552	11508	41750
A	1.00	1.00	0.03	699	16715	16726	16638	41750
A1	1.00	1.00	0.03	699	2160	2160	4682	41750
A2	1.00	1.00	0.03	699	3002	3002	3188	41750
A3	1.00	1.00	0.03	699	2780	2780	2807	41750
A4	1.00	1.00	0.03	699	1128	1129	3583	41750
B	1.00	1.00	0.03	699	6433	6433	7315	41750
B2	1.00	1.00	0.03	699	3176	3176	3341	41750
D	1.00	1.00	0.03	699	12534	12534	12848	41750
D1	1.00	1.00	0.03	699	7093	7098	8172	41750
D2	1.00	1.00	0.03	699	7251	7255	7767	41750
E	1.00	1.00	0.03	699	7138	7142	7075	41750
B	1.00	1.00	0.03	699	6892	6900	7114	41750
C1	1.00	1.00	0.03	699	2779	2801	2769	41750
C	1.00	1.00	0.03	699	8271	8277	8174	41750
C2	1.00	1.00	0.03	699	8445	8448	8282	41750
C3	1.00	1.00	0.03	699	14348	14350	14278	41750
AH	1.00	1.00	0.03	699	21447	21447	21065	41750
AHa	1.00	1.00	0.06	3154	2743	3154	2255	41750
AHb	1.00	1.00	0.06	3154	19838	19838	19344	41750
E	1.00	1.00	0.03	699	6934	6934	7336	41750
E1	1.00	1.00	0.03	699	8363	8363	9498	41750
E2	1.00	1.00	0.03	699	3998	3998	5419	41750
E3	1.00	1.00	0.03	699	2661	2661	3326	41750
E4	1.00	1.00	0.03	699	2788	2788	3035	41750
E5	1.00	1.00	0.03	699	2723	2723	2876	41750
E6	1.00	1.00	0.03	699	2770	2770	2888	41750
E7	1.00	1.00	0.03	699	2642	2642	2750	41750
F	1.00	1.00	0.03	699	271	699	380	41750