LAr Dewar Coil Feed
Frame Pipe Analysis
(Structural Analysis of
General Structures, SAGS)

D0 ENGINEERING NOTE
EN-3740.510-239

A. W. Parker
January 31, 1990

LAr Dewar Coil Feed, Frame Pipe Analysis

This frame pipe analysis addresses the D0 LAr dewar Condenser tube (coil) feed pipe thermal contraction stresses and moments. The configuration is shown in PEI drawing C-32545, Rev 0, and the parameters detailed in the letter of November 20, 1989, located in appendix A.

Note that all other thermal considerations for these condensing coils have been made in D0 EN 3740.512-234. The conclusion of this report is the feed lines, previously deemed appropriate without detailed analysis, have been demonstrated to be adequately designed for the intended service and require no further investigation.

S A G S

STATIC ANALYSIS OF GENERAL STRUCTURES

STRUCTURAL DYNAMICS RESEARCH CORPORATION

FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

*** SPACE FRAME ANALYSIS ***

STRAIGHT BEAMS

BEAM	LENGTH	FORE END JOINT	AFT END JOINT	MATERIAL CODE	SECTION CODE	ROTATION ANGLE	TEMP.
1	3.00	1	2	1	1		
2	14.75	2	3	1	1		
3	9.75	3	4	1	2		
4	14.75	4	5	1	1		
5	3.00	5	6	1	1		

CODE CHECKING PARAMETERS

PARAMETER	VALUE	INITIAL BEAM	FINAL BEAM	INC.
SE	13950.00	1	5	1
SC	9300.00	1	5	1
SH	9300.00	1	5	1
PRESS	150.00	1	5	1

JOINT COORDINATES

JOINT	X	Y	Z
1	0.000	0.000	0.000
2	0.000	-3.000	0.000
3	0.000	-3.000	14.750
4	9.750	-3.000	14.750
5	9.750	-3.000	0.000
6	9.750	0.000	0.000

MATERIAL PROPERTIES

CODE	E	POISSON'S	DENSITY	THERMAL COEFFICIENT	YIELD
1	10.3E+06	0.334	9.700E-02	9.873E-06	1.900E+04

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SPECIAL CROSS SECTIONS

CODE	TYPE	P1	P2	P3	P4	P5	P6
1	PIPE	1.900	0.145				
2	PIPE	3.500	0.300				

CROSS-SECTION PROPERTIES

CODE	AREA	MOMENTS OF INERTIA		SHEAR RATIO		TORSION CONSTANT	WARPING CONSTANT	DEG. FIX.
		Z	Y	Y	Z			
1	7.99E-01	3.10E-01	3.10E-01	1.86	1.86	6.20E-01		
2	3.02E+00	3.89E+00	3.89E+00	1.85	1.85	7.79E+00		

PIPING CHARACTERISTICS

CODE	H	K	SIOUT	SIIN
1	0.000	1.000	1.000	1.000
2	0.000	1.000	1.000	1.000

TOTAL STRUCTURE WEIGHT/MASS = 5.605E+00

C.G. LOCATION: X = 4.875 Y = -2.875 Z = 10.516

SPECIFIED RESTRAINTS
JOINT DIRECTION VALUE

1 123456
6 123456

LOADING NO. 1: THERMAL

TEMPERATURE LOADING

REFERENCE TEMPERATURE = 77.
AMBIENT TEMPERATURE = -325.

TOTAL APPLIED FORCES:

F(X) = 0.000E+00 F(Y) = 0.000E+00 F(Z) = 0.000E+00

MOMENTS ABOUT ORIGIN:

M(X) = 0.000E+00 M(Y) = 0.000E+00 M(Z) = 0.000E+00

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FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

LOADING NO. 2: SUSTAINED

ACCELERATION LOADING

$A(X) = 0.000E+00$ $A(Y) = -1.000E+00$ $A(Z) = 0.000E+00$

TOTAL APPLIED FORCES:

$F(X) = 0.000E+00$ $F(Y) = -5.605E+00$ $F(Z) = 0.000E+00$

MOMENTS ABOUT ORIGIN:

$M(X) = 5.894E+01$ $M(Y) = 0.000E+00$ $M(Z) = -2.733E+01$

DEGREES OF FREEDOM = 24
MAXIMUM BANDWIDTH = 12
AVERAGE BANDWIDTH = 8
PROFILE SIZE = 192

NUMBER OF JOINTS = 6
NUMBER OF ELEMENTS = 5
MAXIMUM JOINT NUMBER = 6
MAXIMUM ELEMENT NUMBER = 5

DIAGONAL ELEMENTS: AVERAGE = 1.825E+06 SMALLEST = 1.694E+04 ROW 13

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STATIC ANALYSIS OF GENERAL STRUCTURES

STRUCTURAL DYNAMICS RESEARCH CORPORATION

FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

UNITS USED FOR RESULTS:

UNITS FOR DISPLACEMENT ARE: IN

UNITS FOR FORCE ARE: LB

UNITS FOR STRESS ARE: PSI

LOAD DESCRIPTION

- 1 THERMAL
- 2 SUSTAINED

JOINT	JOINT DISPLACEMENTS						
	LOAD	X	Y	Z	THETA(X)	THETA(Y)	THETA(Z)
2	1	5.256E-04	1.191E-02	-2.009E-18	4.405E-19	9.049E-04	1.480E-04
	2	-5.347E-08	-9.787E-07	-4.155E-05	2.770E-05	2.570E-09	-3.622E-08
3	1	1.933E-02	1.191E-02	-5.854E-02	-2.245E-19	1.286E-04	2.861E-06
	2	-6.628E-11	-1.049E-03	-4.155E-05	8.930E-05	3.650E-10	-2.770E-07
4	1	-1.933E-02	1.191E-02	-5.854E-02	-1.575E-19	-1.286E-04	-2.861E-06
	2	4.126E-11	-1.049E-03	-4.155E-05	8.930E-05	-3.652E-10	2.769E-07
5	1	-5.256E-04	1.191E-02	4.471E-18	-1.034E-18	-9.049E-04	-1.480E-04
	2	5.345E-08	-9.787E-07	-4.155E-05	2.770E-05	-2.570E-09	3.621E-08

JOINT	JOINT REACTIONS						
	LOAD	F(X)	F(Y)	F(Z)	M(X)	M(Y)	M(Z)
1	1	-1.206E+02	4.547E-13	5.358E-13	-1.272E-12	-7.217E+02	-3.384E+02
	2	-3.426E-04	2.803E+00	-3.198E-09	-2.947E+01	-2.050E-03	3.803E-02
6	1	1.206E+02	-4.547E-13	-1.160E-12	2.840E-12	7.217E+02	3.384E+02
	2	3.426E-04	2.803E+00	3.198E-09	-2.947E+01	2.050E-03	-3.801E-02

LOAD	JOINT REACTION TOTALS					
	F(X)	F(Y)	F(Z)	M(X)	M(Y)	M(Z)
1	0.000E+00	0.000E+00	-6.241E-13	1.568E-12	0.000E+00	0.000E+00
2	0.000E+00	5.605E+00	4.441E-16	-5.894E+01	3.120E-08	1.658E-05

STATIC ANALYSIS OF GENERAL STRUCTURES
FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

STRESS CALCULATIONS								
BEAM	LOAD	END	PT.	T SHEAR P/A	Y SHEAR Y BENDING	Z SHEAR Z BENDING	COMBINED	STRESS RATIO
1	1	FORE	1	1.106E+03	2.813E+02	-1.250E-12		
				5.688E-13	3.901E-12	-1.037E+03	2.444E+03	0.13
	2	AFT	1	3.142E-03	7.990E-04	7.457E-09		
				3.215E+00	9.035E+01	1.197E-01	9.035E+01	0.00
2	1	AFT	1	3.608E+01	1.489E-13	-2.813E+02		
				-1.706E-12	-3.243E+03	9.721E-13	3.243E+03	0.17
	2	FORE	1	5.986E-02	-5.993E+00	-7.990E-04		
				4.000E-09	6.284E-03	9.035E+01	9.035E+01	0.00
3	1	AFT	1	-4.637E-14	5.339E-14	-2.155E-13		
				4.000E+01	-4.753E+02	1.058E+01	4.754E+02	0.03
	2	FORE	1	9.860E-08	-8.737E-01	1.959E-09		
				1.136E-04	-1.350E-03	1.755E-02	1.760E-02	0.00
4	1	FORE	1	-3.608E+01	1.422E-13	2.813E+02		
				1.138E-12	-3.243E+03	-7.823E-13	3.243E+03	0.17
	2	AFT	1	-5.984E-02	5.993E+00	7.990E-04		
				-4.000E-09	6.284E-03	9.035E+01	9.035E+01	0.00
5	1	AFT	1	-1.106E+03	-2.813E+02	-2.705E-12		
				-5.688E-13	-8.707E-12	-1.037E+03	2.444E+03	0.13
	2	FORE	1	-3.142E-03	-7.990E-04	7.457E-09		
				3.215E+00	9.035E+01	1.197E-01	9.035E+01	0.00

S O R T E D S T R E S S			
BEAM	LOC	LOAD	STRESS RATIO
2	1.00	1	0.171
4	0.00	1	0.171
1	0.00	1	0.129
5	1.00	1	0.129
3	0.00	1	0.025

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STATIC ANALYSIS OF GENERAL STRUCTURES
FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

ANSI B31.3 CODE CHECKING CASES
CASE THERMAL SUSTAINED OCCASIONAL

1 1 2

ANSI B31.3 CODE CHECK RESULTS
BEAM JOINT CASE STATUS EQ RATIO

1	1	1	OK	3	0.18
1	2	1	OK	3	0.16
2	2	1	OK	3	0.16
2	3	1	OK	3	0.23
3	3	1	OK	1	0.07
3	4	1	OK	1	0.07
4	4	1	OK	3	0.23
4	5	1	OK	3	0.16
5	5	1	OK	3	0.16
5	6	1	OK	3	0.18

MAXIMUM RATIO = 0.23 ON BEAM 2

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STATIC ANALYSIS OF GENERAL STRUCTURES
FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

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OUTPUT BY JOINT AND ELEMENT

DISPLACEMENTS	1
REACTION FORCES	1
BEAM STRESSES	2
ANSI B31.3 CODE CHECK	3

SDRC I-DEAS 4.1: Frame Analysis

31-JAN-90 12:59:01

DATABASE: LAR STOR. DEWAR LN2 COIL FEED LINE (1/31/9)

VIEW : No stored VIEW

FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 1/31/90

UNITS : IN
DISPLAY : No stored OPTION

SDRC I-DEAS 4.1: Frame Analysis

31-JAN-90 12:51:46

DATABASE: LAR STOR. DEWAR LN2 COIL FEED LINE (1/31/9)

VIEW : No stored VIEW

FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 1/31/90

UNITS : IN

DISPLAY : No stored OPTION

SDRC I-DEAS 4.1: Frame Analysis

6-FEB-90 09:40:13

DATABASE: LAR STORAGE DEWAR COIL FEED LINES (2/6/90)

VIEW : No stored VIEW

FRAME PIPE ANALYSIS LAR DEWAR COIL FEED 2/6/90

UNITS : IN
DISPLAY : No stored OPTION

Appendix A

1. PEI drawing C-32545, Rev 0
see feed lines, item 5.
2. Scott C. Nason, PEI engineer, 11/20/89 letter
see items 1, 2, and 3.

APPROVALS	BY	DATE	TITLE:
DRAFTER	SA	10/13/80	INT COIL SUB-ASSY 343 1/2" LG
CHECKER	SA	10/16	1 1/2" SCH 40 ALUM.
ENGINEERING DESIGN	SA	11/11	
MANUFACTURING	72H	11/11	JOB NO. C-17888
WELDING ENGINEERING	-	-	U/M 18 SCALE 3/16"=1"
QUALITY ASSURANCE	-	-	PART NO. 841847
MAT. RES. PLANNING	K3	10/15	DRAWING NO. C-32545
			SHEET NO. 1 OF 1
			0 REV

[illegible]

Process Engineering Inc.

November 20, 1989

FERMI NATIONAL ACCELERATOR LABORATORY
Batavia Rd.; P.O. Box 500
Mail Station 357
Batavia, Illinois 60510

Attention: Mr. George Mulholland

Subject: Fermi P.O. No. 918320
Model 20000-H-65 Liquid Argon Storage Tank
PEI Job No. C-17986/N-03687

Dear George:

To address your recent questions on the subject unit:

1. The internal coil piping material is 1-1/2" schedule 40 (.145" wall), type 5083 or 5086 aluminum. The headers of the coil are 3" schedule 80 (.300" wall) type 5086 aluminum.
2. The coil feed lines are 1-1/2" schedule 10 (.109" wall) type 304 stainless steel (welded pipe), not 1-5/8" ODT as indicated on our customer drawing.
3. The internal coil, including the feed lines, was pneumatic tested at 200 psi.
4. The liquid level chart for this unit will not have the same 'trap error' as was found on the nitrogen dewar (C-28087 / N-64587) because the bottom gage line on this unit properly exits the annular space at the elevation of the bottom of the inner vessel. We believe the error in the layout of the bottom gage line on the nitrogen dewar was an isolated one.

Very truly yours,

Scott C. Nason
Design Engineer

cc: Mr. Kenneth L. Paul, Executive Vice President, PEI

PEI File C-85037

Hand-delivered, 11/20/89, at PEI