

PRESHOWER

LEAD THICKNESS MEASUREMENTS

D-ZERO ENGINEERING NOTE # 3823.114-EN-486

February 16, 1998

Author: Russ Rucinski
PPD/ETT/D-Zero Upgrade project

The preshower lead thickness applied to the outside of D-Zero's superconducting solenoid vacuum shell was measured at the time of application. This engineering documents those thickness measurements.

The lead was ordered in sheets 0.09375" and 0.0625" thick. The tolerance on thickness was specified to be +/- 0.003". The sheets all were within that thickness tolerance.

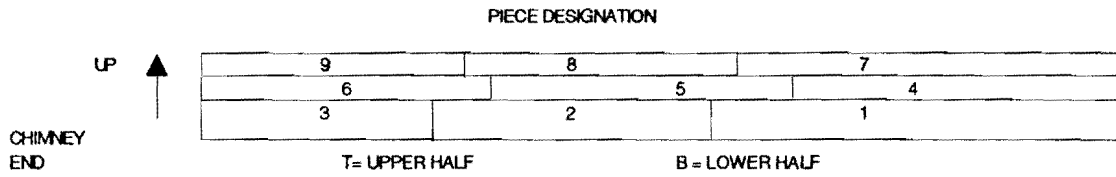
The nomenclature for each sheet was designated 1T, 1B, 2T, 2B...where the numeral designates it's location in the wrap and "T" or "B" is short for 'top' or 'bottom' half of the solenoid.

Micrometer measurements were taken at six locations around the perimeter of each sheet. The width, length, and weight of each piece was then measured. Using an assumed pure lead density of 0.40974 lb/in³, an average sheet thickness was calculated and compared to the perimeter thickness measurements.

In every case, the calculated average thickness was a few mils thinner than the perimeter measurements. The ratio was constant, 0.98. This discrepancy is likely due to the assumed pure lead density. It is not felt that the perimeter is thicker than the center regions. The data suggests that the physical thickness of the sheets is uniform to +/- 0.0015".

PRESHOWER LEAD

R. Rucinski
2/12/98



Specification on thickness = +/- 0.003

→ NORTH

PIECE	NOM. DIMENSIONS	MEASURED LENGTH (in.)	MEASURED WIDTH (in.)	MEASURED WT. OF LEAD+CARRIER	MEASURED WT. OF CARRIER	Net LEAD WT. (lbs)	AVG. THKNS MEASURED AT EDGE	CALC. AVG. THICKNESS (BY WT.)
1T	3/32 x 36 x 87 3/16	87.375	36.0625	158.7	42.8	115.9	0.0913	0.0897
1B	3/32 x 36 x 87 3/16	87.375	36.0625	161.1	42.8	118.3	0.0938	0.0916
2T	3/32 x 36 x 87 3/16	87.375	36.0625	160.3	42.8	117.5	0.0932	0.0909
2B	3/32 x 36 x 87 3/16	87.375	36.0625	160.2	42.8	117.4	0.0925	0.0909
3T	3/32 x 24 x 87 3/16	87.375	24.03125	123.1	42.8	80.3	0.0943	0.0933
3B	3/32 x 24 x 87 3/16	87.25	24.0625	120.6	42.8	77.8	0.0918	0.0904
4T	1/16 x 24 x 88 3/16	88.375	24.125	97.9	42.8	55.1	0.0635	0.0630
4B	1/16 x 24 x 88 3/16	88.375	24.125	98	42.8	55.2	0.064	0.0631
5T	1/16 x 36 x 88 3/16	88.375	36	121.8	42.8	79	0.0615	0.0606
5B	1/16 x 36 x 88 3/16	88.3125	36	124.3	42.8	81.5	0.063	0.0625
6T	1/16 x 36 x 88 3/16	88.375	36	122.7	42.8	79.9	0.0625	0.0612
6B	1/16 x 36 x 88 3/16	88.375	36	122.2	42.8	79.4	0.063	0.0609
7T	1/16 x 34 x 88 3/8	88.625	34	122.6	42.8	79.8	0.0655	0.0646

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7B	1/16 x 34 x 88 3/8	88.4375	34	121.5	42.8	78.7	0.0653	0.0638
8T	1/16 x 34 x 88 3/8	88.625	34	120.6	42.7	77.9	0.0643	0.0631
8B	1/16 x 34 x 88 3/8	88.5625	34	117.9	42.7	75.2	0.06283	0.0609
9T	1/16 x 28 x 88 3/8	88.625	28	104.9	42.7	62.2	0.0615	0.0611
9B	1/16 x 28 x 88 3/8	88.5625	28	104.4	42.7	61.7	0.0615	0.0607
THICK SPARE	3/32 x 36 x 87 3/16	87.375	36.0625	158.2	42.8	115.4	0.0907	0.0893
THIN SPARE	1/16 x 34 x 88 3/8							

MEASUREMENTS MADE BY PAT HEALY & CRAIG ROGERS, 2/98

42.8
42.7*

RAW MEASUREMENTS
PERIMETER & WEIGHT
Sheet

3	2	7
4	5	6

#	Length	Width	Diagonal 1	Diagonal 2	THICKNESS 1	2	3	4	5	6	Weight	
1	87 ³ / ₈	36 ¹ / ₁₆	94 ⁷ / ₁₆	94 ¹ / ₂	.0905	.0905	.0905	.092	.092	.0925	158.7	3687 Π
2	87 ³ / ₈	36 ¹ / ₁₆	94 ¹ / ₂	94 ¹ / ₂	.092	.092	.092	.095	.096	.096	161.1	3687 IF
3	87 ³ / ₈	36 ¹ / ₁₆	94 ⁷ / ₁₆	94 ¹ / ₂	.093	.094	.093	.093	.093	.093	160.3	3687 Z
4	87 ³ / ₈	36 ¹ / ₁₆	94 ¹ / ₂	94 ¹ / ₂	.093	.093	.093	.092	.092	.092	160.2	3687 ZP
5	87 ³ / ₈	24 ¹ / ₃₂	90 ⁵ / ₁₆	90 ⁹ / ₁₆	.094	.094	.093	.095	.095	.095	123.1	2487 3T
6	87 ¹ / ₄	24 ¹ / ₁₆	90 ⁹ / ₁₆	90 ⁹ / ₁₆	.091	.091	.091	.092	.093	.093	120.6	2487 3E
7	87 ³ / ₈	36 ¹ / ₁₆	94 ¹ / ₂	94 ¹ / ₂	.091	.091	.090	.091	.090	.091	158.2	3687 SF
8	88 ³ / ₈	36	95 ³ / ₈	95 ⁷ / ₁₆	.063	.063	.063	.062	.062	.062	122.7	3688 6T
9	88 ³ / ₈	36	95 ³ / ₈	95 ³ / ₈	.063	.063	.063	.063	.063	.063	122.2	3688 6E
10	88 ³ / ₈	36	95 ³ / ₈	95 ³ / ₈	.063	.063	.064	.064	.062	.062	121.8	3688 5
11	88 ⁵ / ₁₆	36	95 ⁵ / ₁₆	95 ⁷ / ₁₆	.063	.063	.063	.063	.063	.063	124.3	3688 5L
12	88 ³ / ₈	24 ¹ / ₈	91 ⁵ / ₈	91 ⁵ / ₈	.064	.064	.064	.063	.063	.063	97.9	2488 4+
13	88 ³ / ₈	24 ¹ / ₈	91 ⁷ / ₈	91 ⁷ / ₈	.064	.064	.064	.064	.064	.064	98.0	2488 4B
*14	88 ⁵ / ₈	28	92 ¹⁵ / ₁₆	92 ¹⁵ / ₁₆	.062	.062	.062	.061	.061	.061	104.9	2888 9T
*15	88 ⁹ / ₁₆	28	92 ⁷ / ₈	92 ⁷ / ₈	.062	.062	.062	.061	.061	.061	104.4	2888 9B
*16	88 ⁵ / ₈	34	94 ⁷ / ₈	94 ⁷ / ₈	.065	.065	.066	.064	.063	.063	120.6	3488 8T
*17	88 ⁹ / ₁₆	34	95	94 ¹⁵ / ₁₆	.063	.062	.062	.065	.063	.062	117.9	3488 8L
18	88 ⁵ / ₈	34	94 ⁷ / ₈	94 ¹³ / ₁₆	.064	.064	.064	.067	.067	.067	122.6	3488 7T
19	88 ⁷ / ₁₆	34	94 ⁷ / ₈	95	.065	.065	.065	.066	.066	.065	121.5	3488 7L

55.72

231.4
188.5
42.9

D0 Purchase Requisition

Requestor Information:

Name: Krempetz, Kurt J
 ID No.: 3679
 E-mail: krempetz@fnal.gov
 Phone: 4657

Vendor Information:

Name: Vulcan Lead Prod Co
 Phone: 414-645-2040
 Fax:
 Street 1: 1400 W Pierce St
 Street 2:
 Attn:
 City State, Zip: Milwaukee WI 53204
 Buyers Note:

Sol. OD = $1415^{+0}_{-3} \text{mm} = 55.70866 \text{in } \phi$
 or 27.85433" RAD
 MEAN RAD 1 = $27.85433 + \frac{3}{64} = 27.90121$ "
 TTR = 87.654"
 MEAN RAD 2 = $27.85433 + \frac{3}{32} + \frac{1}{32} = 27.97933$ "
 TTR = 87.89966"
 MEAN RAD 3 = $27.85433 + \frac{3}{32} + \frac{1}{16} + \frac{1}{32}$
 = 28.04183
 TTR = 88.096"

Requisition Information:

Requestor ID: D0986365
 Entry Date: 10/27/1997
 ProCard Number:
 PO Number: 505339
 PO Date: 11/07/1997
 Requisition Number: 106757
 Requisition Date: 11/06/1997
 Delivery Date: 12/03/1997
 Date Received:
 Last Modified: 02/04/1998
 Previous PO:
 Project Description : D0 Upgrade Central Preshower
 Short Description: PRESHOWER LEAD
 Buyer : Johnson
 Status : PO
 Urgency : Rush
 Desired Delivery Date: 11/17/1997

.092' - END
 .094'
 .0935
 .094
 .090 - END
 .075
 36 1/6" x 37 1/4"
 5 1-LEAD PRESHOWER LEAD
 LEAD 3 PLACES.
 THICK

[Help](#)

Line Items:

Qty	Type	Description	Unit Price	Total	WBS	% of Cost Est.	Budget Code
2	Good	Lead Sheet, .09375" 3/32"X24"X87 3/16"	85.25	170.50	1.1.3.9.2	11.67	DJY
		Lead Sheet					

5	Good	Lead Sheet, .09375" 3/32"X36"X87 3/16"	85.25	426.25	1.1.3.9.2	11.67	DJY
2	Good	Lead Sheet, .0625" 1/16"X24"X88 3/16"	85.25	170.50	1.1.3.9.2	11.67	DJY
4	Good	Lead Sheet, .0625" 1/16"X36"X88 3/16"	85.25	341.00	1.1.3.9.2	11.67	DJY
2	Good	Lead Sheet, .0625" 1/16"X28"X88 3/8"	85.25	170.50	1.1.3.9.2	11.66	DJY
5	Good	Lead Sheet, .0625" 1/16"X34"X88 3/8"	85.25	426.25	1.1.3.9.2	11.66	DJY
0	Good	Cut Lead Sheet, 99.9% Pure Lead, Thickness Tol. +-.003, Width .0625, length +-.125	0.00	0.00		0.00	
0	Good		0.00	0.00		0.00	
0	Good		0.00	0.00		0.00	
Requisition Total:			1,705.00				

±.003
ABOUT 3%

Comments:

074



Contact Sonya Wright for Purchasing questions (sonya@fnal.gov, (630) 840-4591)
 Contact Jerry OConnell about the operation of this form. (jpoconnell@fnal.gov, (630) 840-3704)

Last Updated: 26-Aug-97

Queries

GETLINEITEMS (Records=9, Time=31ms)

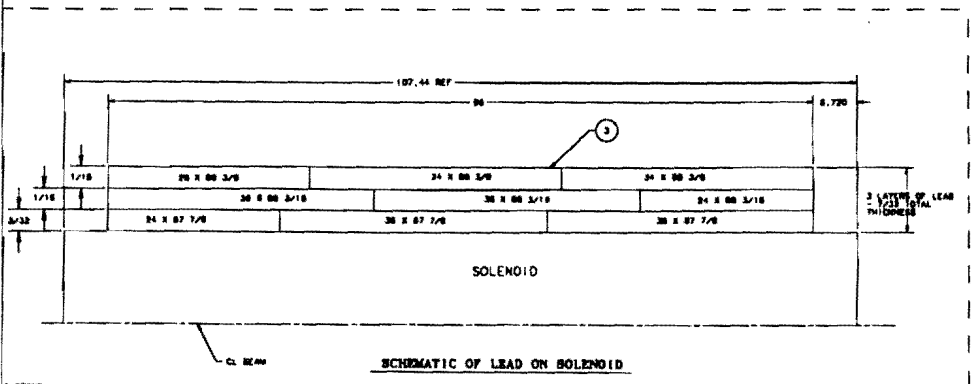
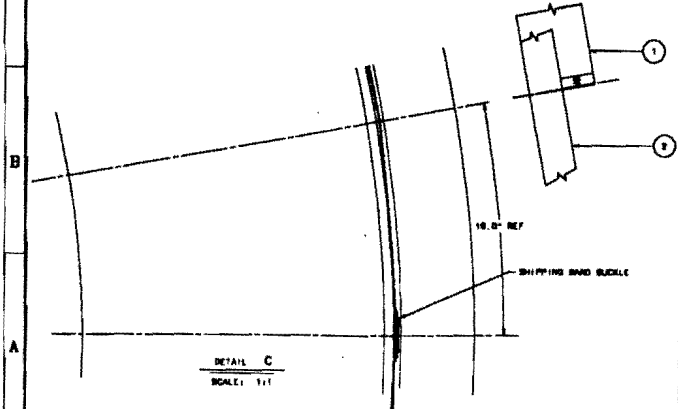
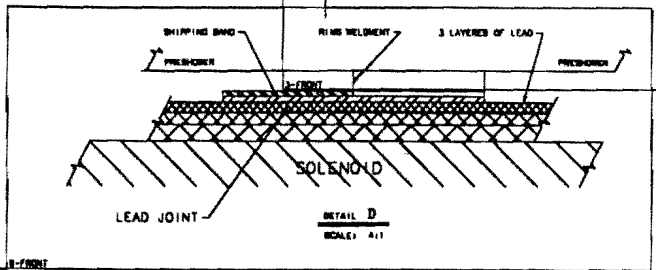
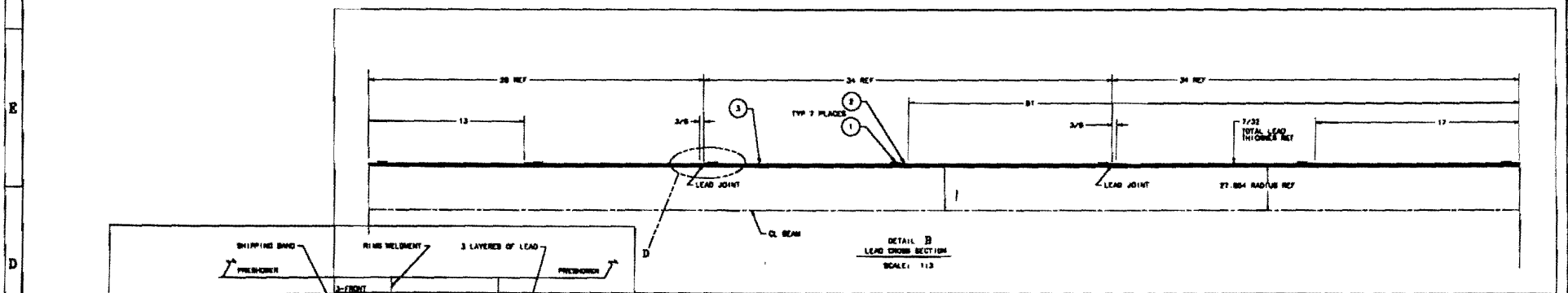
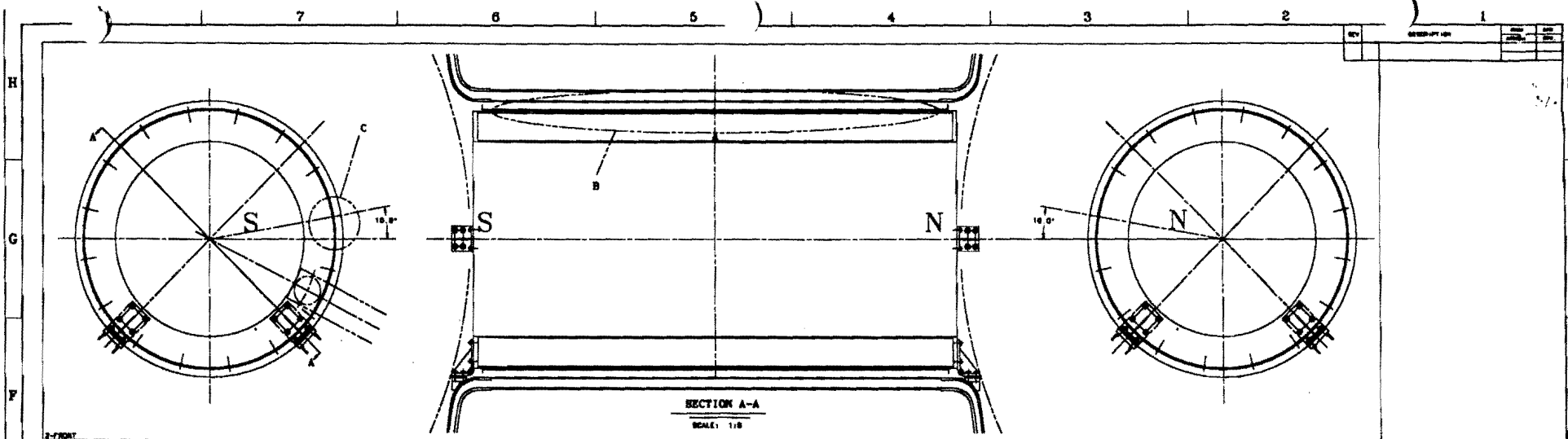
SQL =

```
select LINE_NUM, QUANTITY, PO_LINE_CATAGORY, DESCRIPTION, PRICE, WBS_CODE, BUDGET_CODE, PE
from po.req_line_items
WHERE REQUESTOR_ID = 'D0986365'
```

Handwritten notes and calculations:

27 354^{0.} rev.
 .125
 3823.114 -
 + .0915"
 ME - 358 028

Diagram showing a bracketed area with values: .0915", .0905, .0900, .0900.



ITEM NO.	DESCRIPTION	QTY	UNIT
3	ME-317888	1	ASSEMBLY PLAN
2	CON-L	7	US 1/2\"/>

ITEM NO.	DESCRIPTION	QTY	UNIT
1	NO-SHARDED RING WELDMENT	7	

PARTS LIST	
3	ME-317888
2	CON-L
1	NO-SHARDED RING WELDMENT

REV	DESCRIPTION	DATE
1	ISSUED FOR FABRICATION	7-1-57

DO UPGRADE
PRESHOWER LEAD
LEAD AND AIR SPACER ASSEMBLY

SCALE: 3823.114-ME-356028

PRE SHOWER LEAD THICKNESS CALC.

$$t = \frac{P}{\rho W L}$$

WHERE P = LEAD WT.
W = LEAD WIDTH
L = LEAD LENGTH

ρ = DENSITY = $11.35 \frac{g}{cm^3} = 0.40974 \frac{lb}{in^3}$ (FUNCTIONS HEAT & MASS XFER)
 $711 \frac{lb}{ft^3} = .41146 \frac{lb}{in^3}$ ROLLED LEAD, PACKET Ref. ISBN 09622359-03

ERROR ANALYSIS

$$S_E = \frac{P}{\rho W L} \sqrt{\left(\frac{S_P}{P}\right)^2 + \left[\frac{S_{PWL}}{\rho W L}\right]^2}$$

R.G.F. ENGINEERING MEASUREMENTS P. 543 ERROR PROPAGATION

$$S_{PWL} = W \cdot L \cdot \rho \sqrt{\left[\frac{S_W}{W}\right]^2 + \left[\frac{S_L}{L}\right]^2 + \left[\frac{S_\rho}{\rho}\right]^2}$$

WHERE: S - ERROR ASSOCIATED WITH THE SUBSCRIBED VARIABLE

GIVEN: $S_W = S_L = \frac{1}{16}'' = .0625$ in.
 $S_P = 0.5$ lbs

EXAMPLE WITH FICTITIOUS DATA;

SAM PC 1A; W = 36" L = $87 \frac{3}{16}''$ WT = 120.6 lbs.

$$S_{PWL} = (36)(87.1875)(.40974) \sqrt{\left(\frac{.0625}{36}\right)^2 + \left(\frac{.0625}{87.1875}\right)^2 + \left[\frac{.002 \frac{lb}{in^3}}{.40974}\right]^2}$$

$$S_{PWL} = 6.726 \frac{lb}{in.}$$

$$S_E = \frac{120.6 \text{ lbs}}{(.40974)(36)(87.1875)} \sqrt{\left[\frac{(.5)}{120.6}\right]^2 + \left[\frac{6.726 \frac{lb}{in.}}{(36)(87.1875)(.40974)}\right]^2}$$

$$S_E = .0006 \text{ IN}$$

CONCLUSION: BY THE PROPOSED METHOD, THE AVERAGE LEAD THICKNESS CAN BE CALCULATED TO ± 1 MIL.