Measurements of Molded 2850FT Stycast End Insulators for Short SSC Dipoles*

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Automated and hand measurements have been made to compare the molded Stycast 2850FT[1,2] end insulator pieces with the G10 models. The automated measurements were made in the Quality Assurance Lab on the Cordax 1808 apparatus. The hand measurements were performed using a blade micrometer.

The Stycast return end pieces were molded in the Materials Development Lab from a single G10 model. The lead end pieces were molded from two G10 models, corresponding to drawings 0102-MC-217769 and 0102-MC-217770. Two of each of these are required in the lead end insulator assembly. The molds were cast from polyurethane.

Since mold shrinkage is expected to be quite small for Stycast 2850FT cured at room temperature with catalyst 24LV[3], we might expect the dimensions of the Stycast pieces to match closely the G10 dimensions. Actual measurements show that while some characteristics of the Stycast pieces follow the G10, other features arise which have no immediately obvious correlation with the G10.

Cordax Measurements. Table 1 shows the departure from the specified value of the inner diameter for G10 and molded Stycast return and lead end parts. Only two of the four G10 pieces were measured. The Stycast pieces depart from the specified inner diameter by nearly twice as much.

Table 1. Departure from Specified Inner Diameter (mils) [Cordax 1808]

Quadrant Number	1	2	3	4
Stycast Return End	-59	-47	-42	-54
G10 Return End	-28			
Stycast Lead End	-43	-50	-62	-59
G10 Lead End	-29			

* The Stycast collet pieces described in this report were molded and prepared under the supervision of Jay Hoffman at the Fermilab Materials Development Lab. Dave Muniz assisted with the preparation of the Stycast epoxy, and the pieces were given final machine finishing by Bill McCaw. Bill Pritchard of the Quality Assurance Lab performed the Cordax measurements.

Table 2 shows other deviations of the G10 and molded Stycast insulator parts from dimensions specified on the drawings. The column numbers in this table refer to various specified lengths and diameters on the appropriate drawings, and are used here only to group the measurements for comparison between G10 and Stycast.

Table 2. Departure from Specified Lengths and Outer Diameters (mils) [Cordax 1808]

Length	#1	#2	
G10 Lead End	OK	+5	
Stycast Lead End	-5,-6,-4,-7	-8,-9,-9,-16	
G10 Return End	OK	+1	
Stycast Return End	All OK	+2,OK,OK,+1	
Outer Diameter	#1	#2	#3
G10 Lead End	-27	-29	-22
Stycast Lead End	-18,-19,-27,-22	-32,-18,-32,?	-30,-43,-28,-20
G10 Return End	-18	?	-23
Stycast Return End	-24,-25,-19,-24	-14,-19,-7, -15	-21,-19,-12,-19

In general, the Stycast pieces appear to be smaller in their linear dimensions than the G10 pieces. Mold shrinkage, and a defect in molded material due to whatever separator is used in molding may play a role. Also, the ends of the Stycast pieces were smoothed after molding, causing removal of material from the ends, which might enhance the departure from specified length. The outer diameter measurements show the Stycast pieces smaller in general also, with some exceptions.

Hand Micrometer Measurements. Micrometer measurements were made of the thickness of the Stycast and G10 insulator pieces at four positions along each side. The positions are 1", 3", 5", and 7" from the thickest end of the insulator piece. (The outer surface of the insulator pieces tapers by 2 degrees.)

Figure 1 shows the differences between micrometer measurements taken on two different days. This gives some indication of the precision of the measurements. The horizontal axis shows the position index of the measurement. This is the same for all the plots that follow. The worst point shows a 10 mil change in the measurement.

Figures 2a and 2b show the thicknesses of the G10 lead and return end pieces for the 8 measurement positions. The slopes of the two sets of four points correspond to the 2 degree taper in the thickness of each insulator.

Figures 3a and 3b show the thicknesses of the Stycast lead and return end pieces. Two things should be noticed. First, the Stycast return end pieces show scatter in their thicknesses at each measurement position greater than either the G10 pieces or the Stycast return end pieces. Second, there is a pronounced asymmetry in the measured thicknesses of the Stycast return end pieces corresponding to a "thick side" and a "thin side." None of the G10 return end pieces shows such an asymmetry.

Figure 4 shows the average asymmetry between positions 1 and 5, 2 and 6, 3 and 7, 4 and 8 for Stycast and G10 lead and return ends. Again, the most pronounced asymmetry is in the Stycast return end pieces. A smaller asymmetry may be present in the Stycast lead end pieces.

The last two figures, 5a and 5b show the Stycast - G10 difference in thickness for two pairs of lead and return end pieces. In general, the thick side of the Stycast is thicker than the G10 piece, and the thin side thinner.

Measurements of Assemblies. A set of measurements were made of the Stycast lead and return end insulator pieces assembled within their stainless steel end cans, with shimming between each pair of pieces to hold them firmly in place. (41 mils of shimming per quadrant were needed for the return end pieces, and 46 mils for the lead end peices.) Measurements of the inner diameter of the lead and return end "cylinders" were made as shown in Figure 6. The results of the measurements are shown in Table 3.

Table 3. Micrometer Measurements of Stycast Insulator Assemblies (Inner Diameter of Cylinder in inches)

Measurement Position	AA	BB	CC	DD	EE	FF
Return End	3.200	3.200	3.175	3.205	3.176	3.204
Lead End	3.215	3.219	3.200	3.199	3.201	3.206

Two kinds of distortion are present in the Stycast pieces. These are the deviation from the specified inner cylindrical diameter ("bowing"), which is expected since the Stycast pieces were molded from G-10 pieces which have the same distortion. The other is the thin-thick asymmetry in the return end pieces mentioned in the previous section.

The BB and AA diameters are higher than the design value of 3.198 inches, indicating the bowing. The low values at CC and EE are between thick sides, and the high values at DD and FF are between thin sides. The lead end pieces don't show the thin-thick asymmetry between CC-DD and EE-FF, but do show the bowing effect (AA and BB larger than the other measurments.)

Conclusions. The molded Stycast end insulators show almost twice the G10 defect in inner radius (bowing.) Furthermore, there is a pronounced asymmetry in the Stycast pieces between the thickness of the two sides, especially in the return end parts. In general the Stycast pieces are somewhat smaller than the G10 models.

References and Notes

1. TS-SSC 90-053, Preliminary Report on Stycast 2850FT.

2. TS-SSC 90-060, Report on Thermal Contraction of Some Materials Including Stycast 2850FT.

3. Jay Hoffman, private communication.

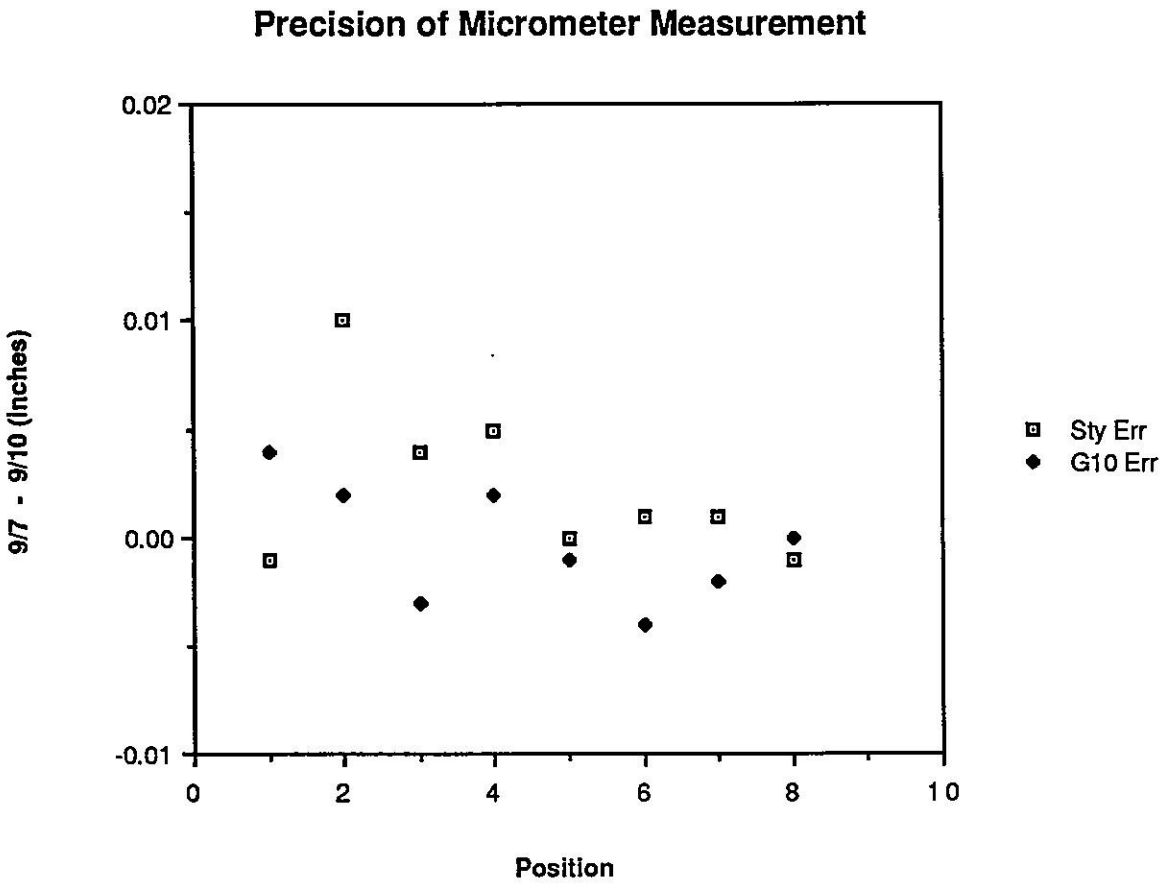
Precision of Micrometer Measurement
0.02
0.01
0.00
-0.01
9/7 - 9/10 (Inches)
0
2
4
6
8
10
Position
Sty Err
G10 Err

Figure 1

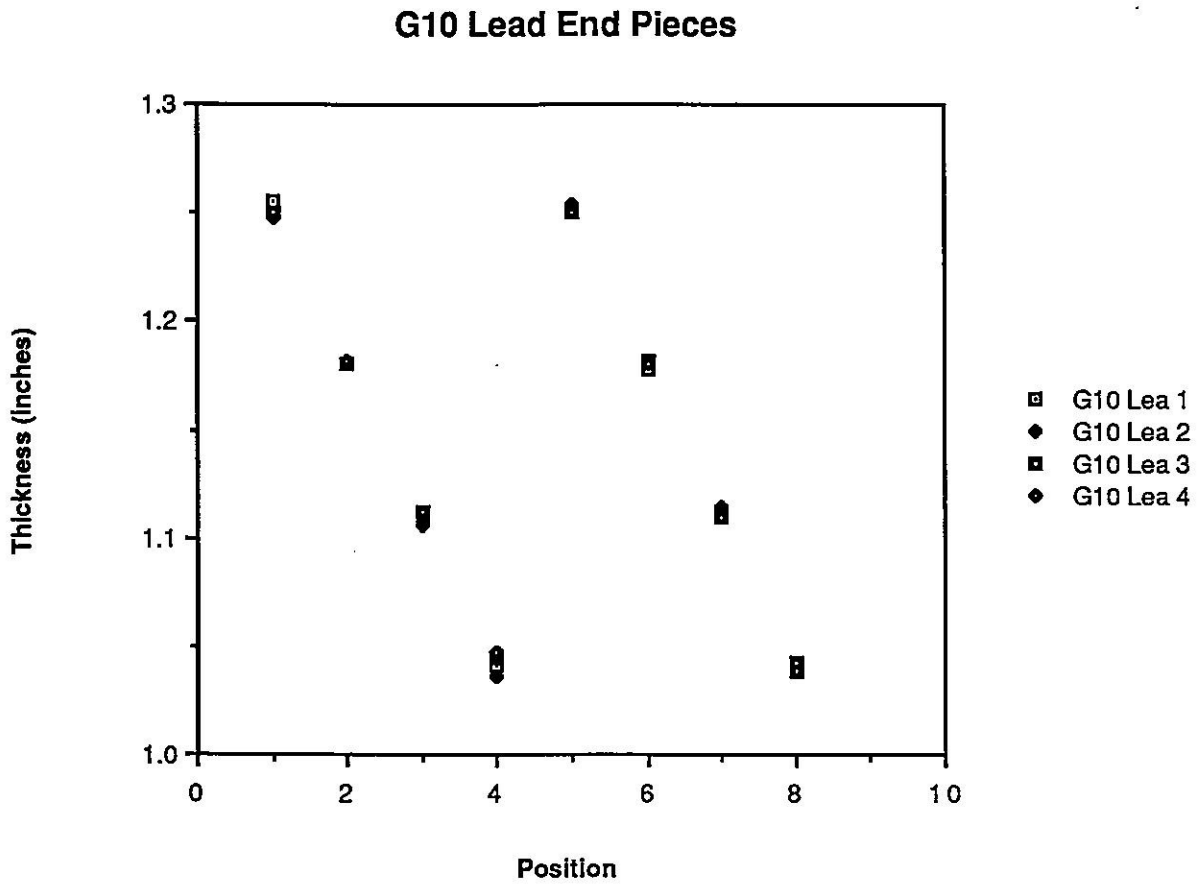
G10 Lead End Pieces
1.3
1.2
1.1
1.0
Thickness (Inches)
0
2
4
6
8
10
Position
G10 Lea 1
G10 Lea 2
G10 Lea 3
G10 Lea 4

Figure 2a

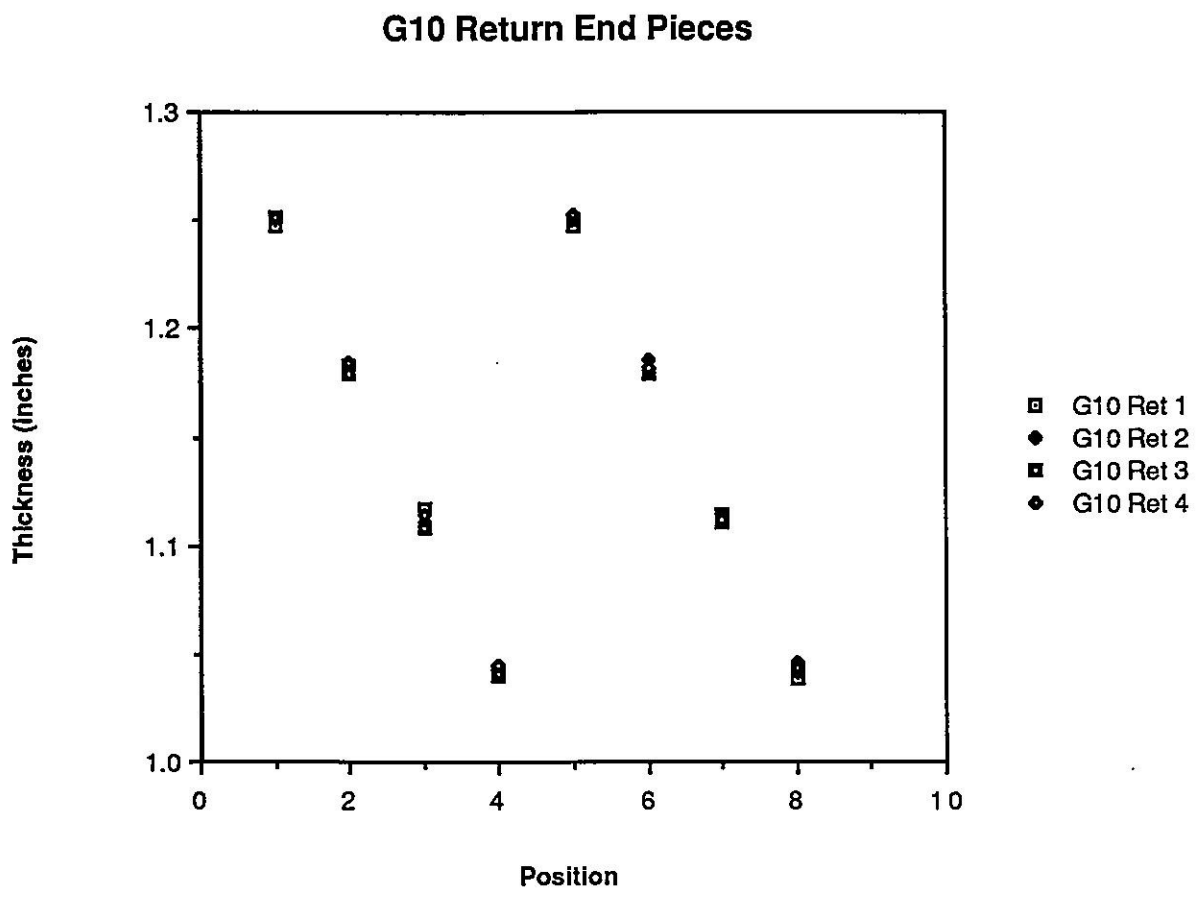
G10 Return End Pieces
Thickness (inches)
1.3
1.2
1.1
1.0
0
2
4
6
8
10
Position
G10 Ret 1
G10 Ret 2
G10 Ret 3
G10 Ret 4

Figure 2b

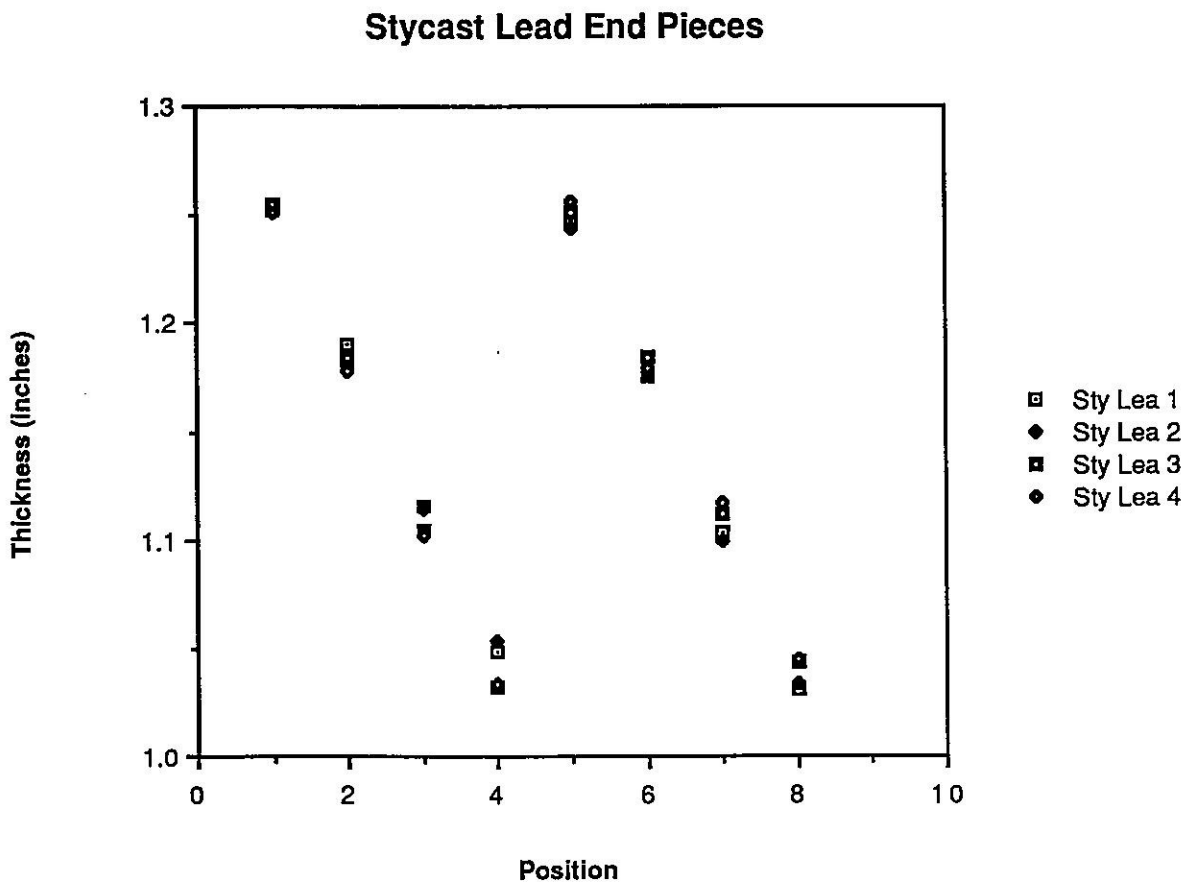
Stycast Lead End Pieces
1.3
1.2
1.1
1.0
Thickness (Inches)
0
2
4
6
8
10
Position
Sty Lea 1
Sty Lea 2
Sty Lea 3
Sty Lea 4

Figure 3a

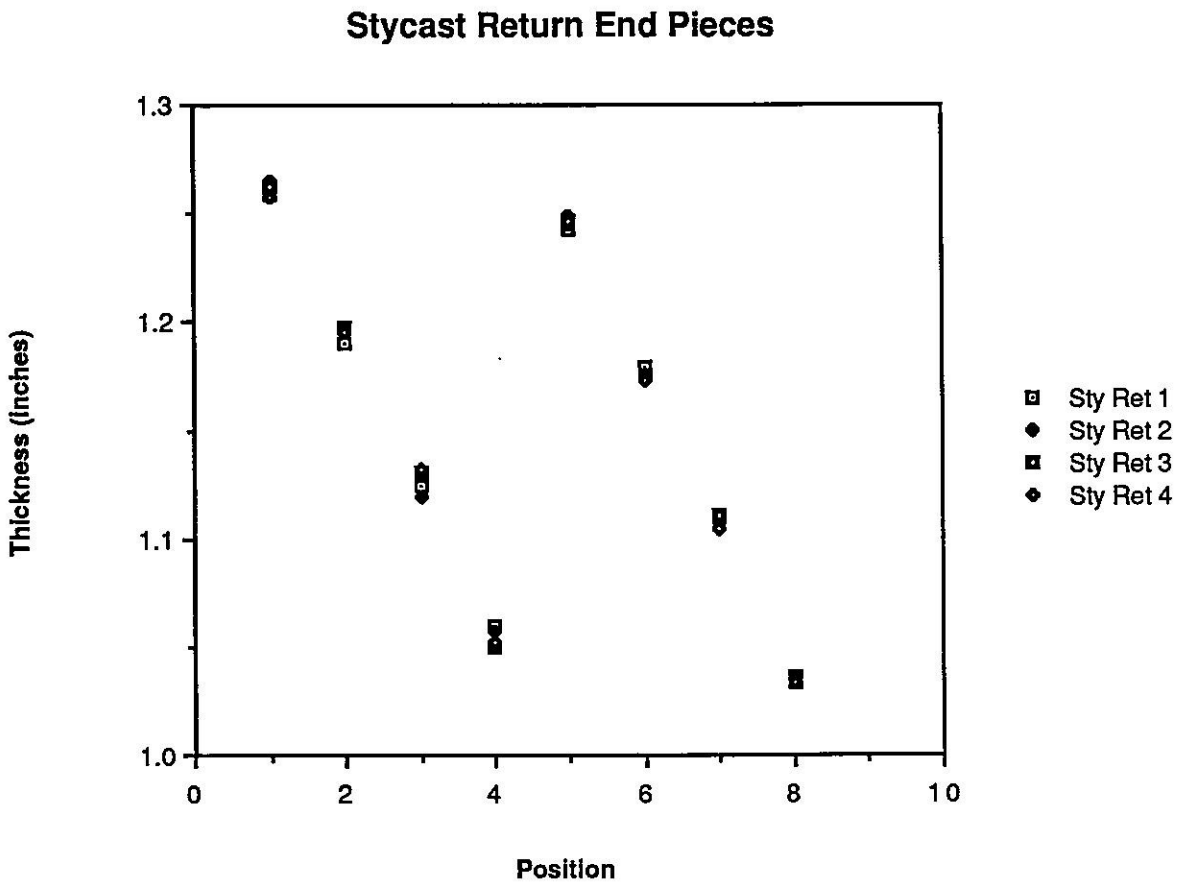
Stycast Return End Pieces
1.3
1.2
1.1
1.0
Thickness (inches)
0
2
4
6
8
10
Position
Sty Ret 1
Sty Ret 2
Sty Ret 3
Sty Ret 4

Figure 3b

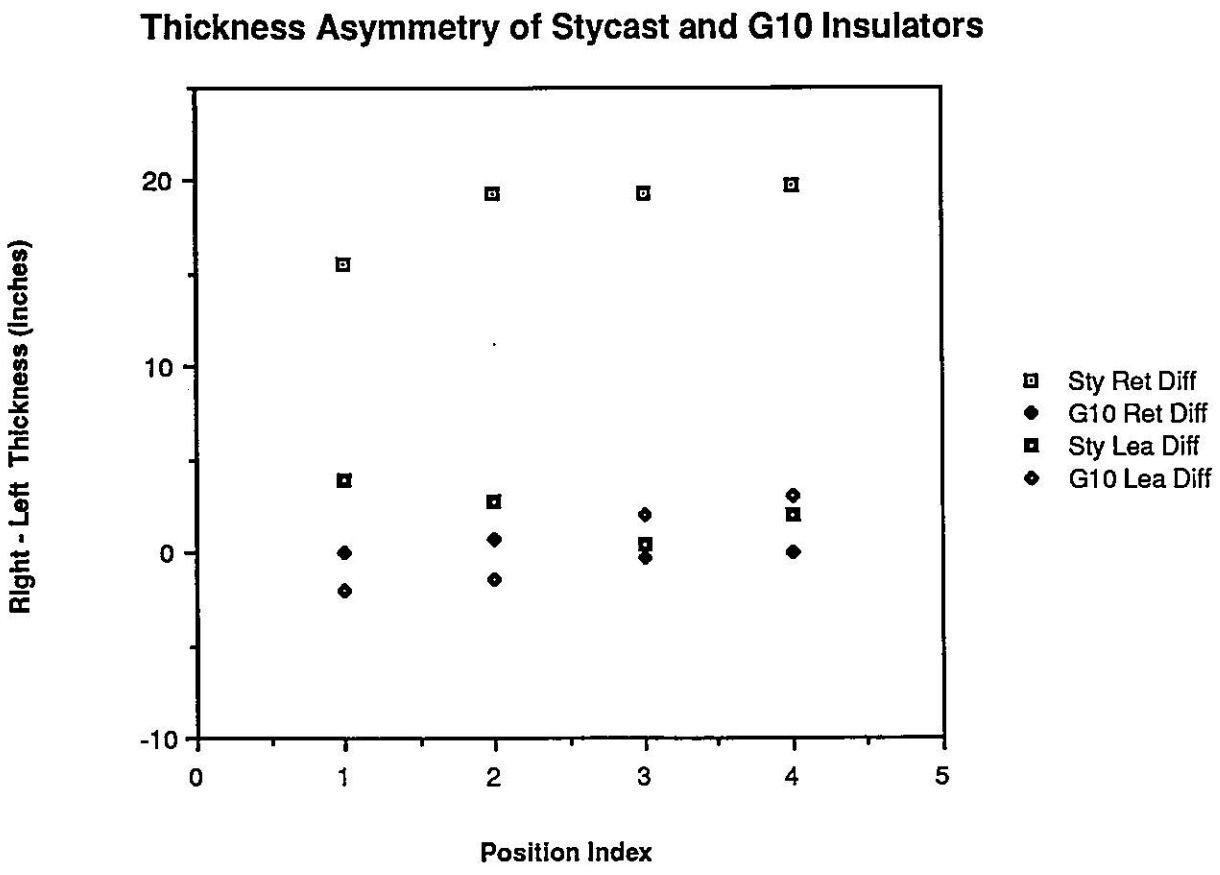
Thickness Asymmetry of Stycast and G10 Insulators
Right - Left Thickness (Inches)
20
10
0
-10
0
1
2
3
4
5
Position Index
Sty Ret Diff
G10 Ret Diff
Sty Lea Diff
G10 Lea Diff

Figure 4

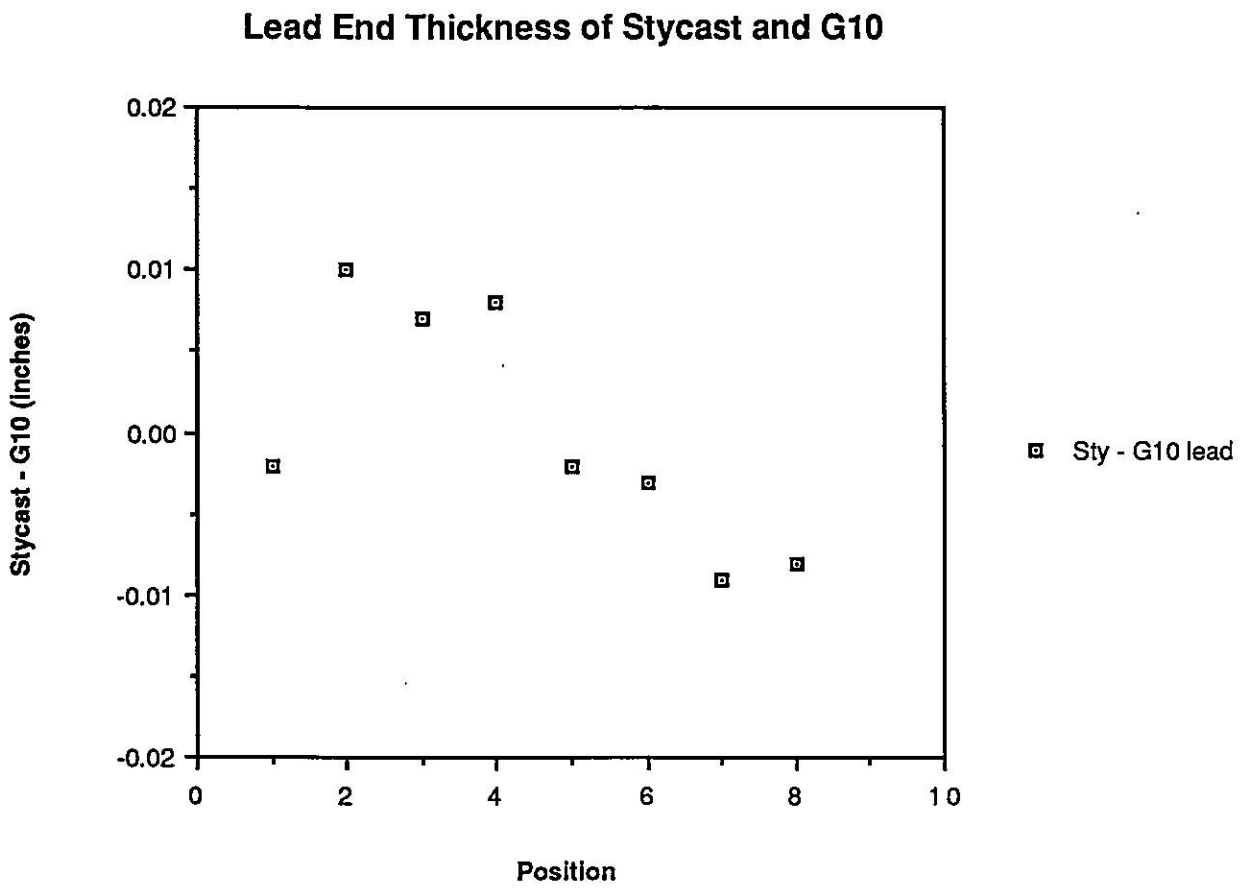
Lead End Thickness of Stycast and G10
0.02
0.01
0.00
-0.01
-0.02
Stycast - G10 (inches)
0
2
4
6
8
10
Position
Sty - G10 lead

Figure 5a

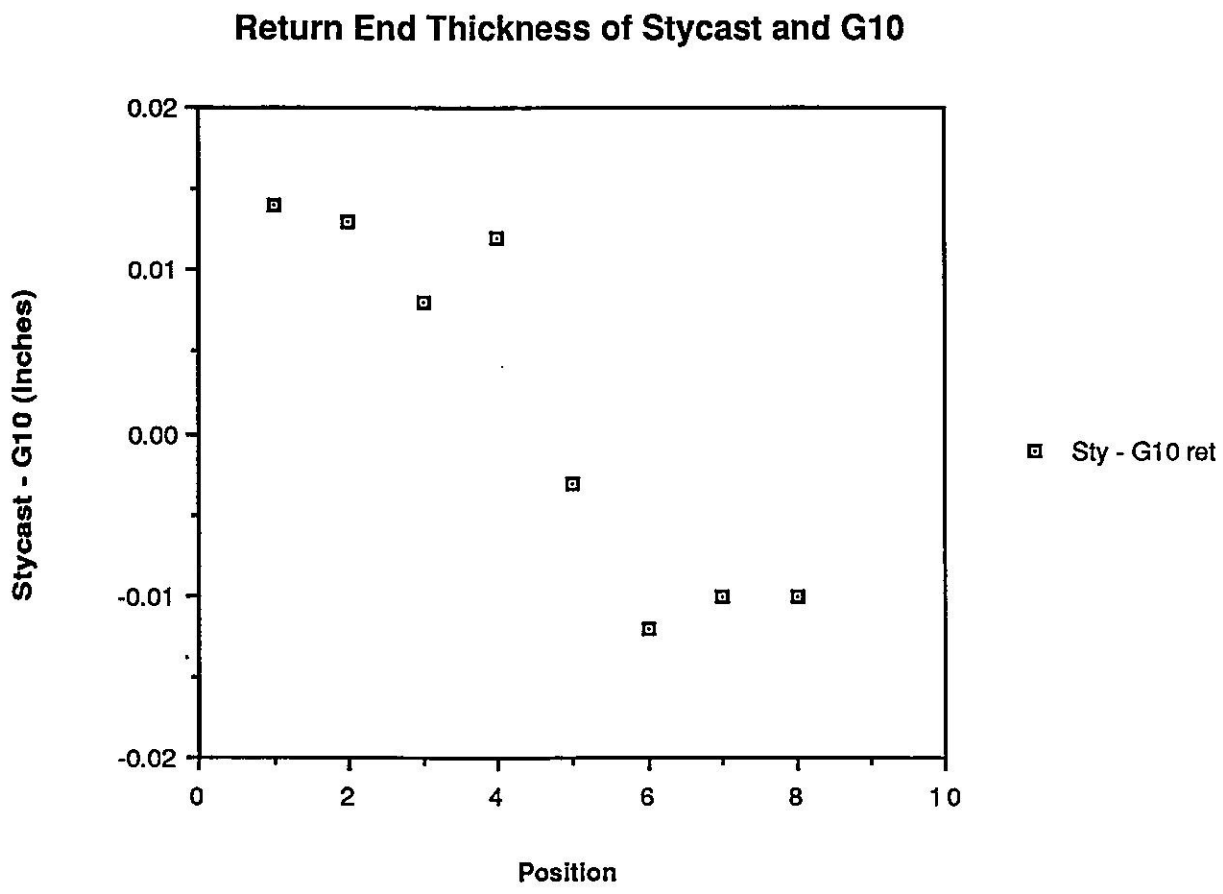
Return End Thickness of Stycast and G10
0.02
0.01
0.00
-0.01
-0.02
Stycast - G10 (Inches)
0
2
4
6
8
10
Position
Sty - G10 ret

Figure 5b

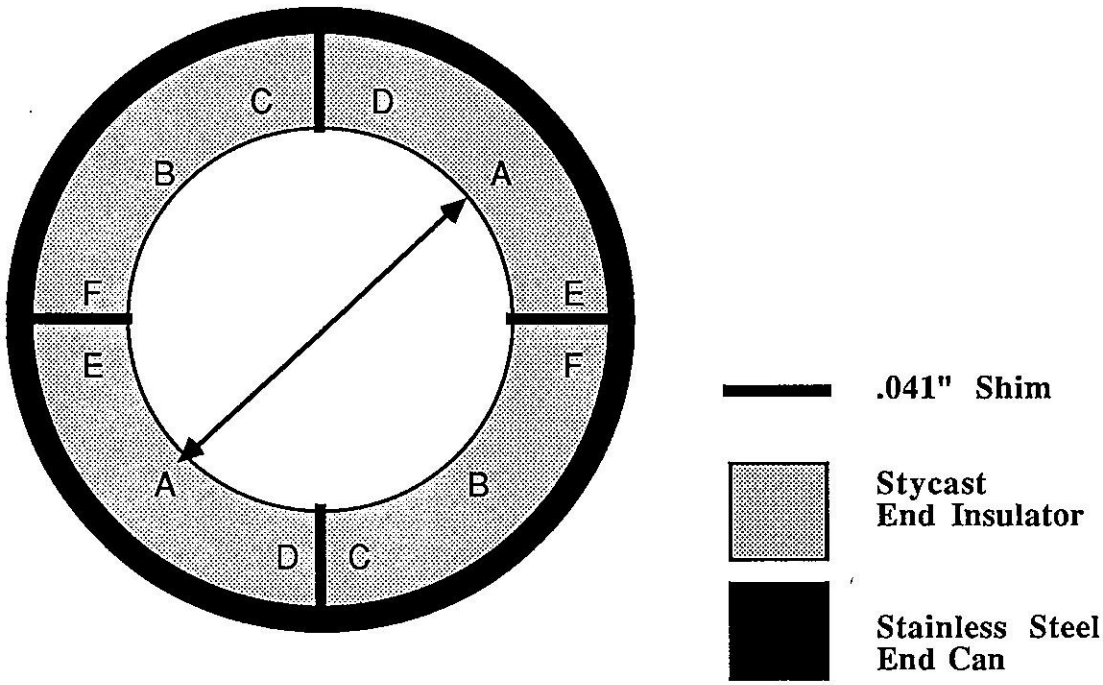

Figure 6. Assembled Insulator Inner Diameter Measurements

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