Are the End Cans "On" for DCA310 - DCA313?

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Introduction: Figure 1 shows a measurement specified in the traveller[1] for full length SSC dipoles of the end surfaces of the four quadrant insulators relative to the end surface of the end can just after installation. The purpose of this measurement is to insure that the can is in fact "on."

The nominal measurement should be 30 mils[2]. The 40 mil maximum tolerated value comes from consideration of the tolerances in the length measurements of the insulators and end cans, which are both ±5 mils.

Discrepancy Reports 156 and 165 refer to cases in which the measured value is out of the tolerance specified in the traveller in the case of one or more quadrants. Both DR's were generated by processing on magnet DCA313.

Data: Table 1 shows the actual lead and return end measurement values for all of the magnets processed so far. The values shown are the average and RMS over the four quadrants, as well as the maximal value. It is seen that in six out of eight installations, the mean measured value is 40 mils or greater, while individual quadrant measurements of as great as 52 mils have been recorded.

	DCA310	DCA311	DCA312	DCA313
Lead End	40 ± 5 mils (45 mils max.)	43 ± 5 mils (48 mils max.)	38 ± 5 mils (45 mils max.)	42 ± 7 mils (52 mils max.) *45 ± 9 mils* *(55 mils max.)*
Return End	38 ± 2 mils (40 mils max.)	37 ± 0 mils (37 mils max.)	41 ± 3 mils (45 mils max.)	42 ± 6 mils (47 mils max.) *42 ± 6 mils* *(47 mils max.)*

Table 1. Measurements of Lead and Return End Insulator Surfaces Relative to End Can End Surface (30 mils nominal) for Full Length SSC Collider Dipole Magnets

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[1]Steps 2.19 and 4.18 of traveller 0102-ES-298290 revision C (End Clamp Assembly).

[2]8.345" - 8.315" from drawings 0102-MB-292085 (end insulator) and 0102-MB-292205 (aluminum end clamp can.)

The numbers in italics for DCA313 were obtained by Ed Chang, who usually works on model magnets. The idea was to compare the readings taken in Industrial Building 3 and in Industrial Center Building, to check for any systematic errors. There is no apparent discrepancy between the IB3 and ICB numbers.

Only two model magnets, DSA324 and DSA326 have so far had G10CR insulators installed with aluminum end cans. The values for these magnets are shown in Table 2.

	DSA324	DSA326
Lead End	not recorded	35 ± 1 mils (37 mils max.)
Return End	34 ±1 mils (35 mils max.)	35 ± 1 mils (35 mils max.)

Table 2. Measurements of Lead and Return End Insulator Surfaces Relative to End Can End Surface (30 mils nominal) for Model SSC Dipole Magnets

Discussion: Comparing the numbers in Table 1 and Table 2, we see that in the model magnet program, the end cans have appeared to be "more on" than in the full length magnet program. Any analysis of the correct "closure" criterion has to take this systematic difference into account.

It could be that the model magnet technicians "push harder" before taking the end clamp installation fixture apart, thus pushing the can surface closer to the G10 insulator surfaces. (When to stop pushing is dictated by the somewhat subjective criterion that the can has "stopped moving.") The maximum hydraulic pressure before the closed position is reached has tended to be higher for IB3 than for ICB, and this might be the reason.

It has also been observed that the cans installed in ICB have a tendency to slide OFF after the installation fixture is removed. (In one case, the can came completely off while technicians watched in amazement.) This would seem to indicate the the lubrication job done in ICB is somewhat more effective than the IB3 treatment. If the can has a greater tendency to relax in ICB, the Table 1 values would be expected to be greater than the Table 2 values.

Putting aside for the moment the discrepancy between the model and full length program results, there are several possible sources of divergence from the nominal 30 mils in this measurement, including:

Poisson Stretching: Some stretching of end insulators is expected due to the radial pressure exerted by the end clamp. The radial elastic modulus of the G10CR material ("azimuthal G10") is ~2 Mpsi. The Poisson value for this material is ~.25. Therefore, the expected stretching for a radial pressure P_{rad} on an insulator with nominal length (8.750") is

$$d(\text{length}) \sim .25 \times 8.750" \times (P_{rad} / 2\ \text{Mpsi}) \qquad (1)$$

The exact radial pressure inside the end clamp is not known. However, Fuji Prescale pressure-sensitive film tests show that the average pressure on the midplane and pole coil surfaces is 8 - 10 kpsi.

For a radial pressure of 8 kpsi, equation (1) gives d(length) = 9 mils. This could help explain why the nominal 30 mils becomes closer to 40 mils. (The grand average value from Table 1 is 40 mils.)

If there is more friction in the IB3 installations, the expected stretching of the G10 insulators would be smaller and the numbers in Table 2 smaller than those in Table 1.

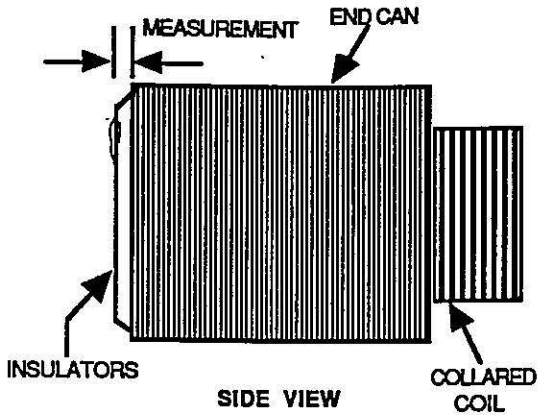
Vydax Lubricant Build-up: Vydax lubricant build-up on the closure surfaces of the end can and insulators, and on the surface of the insulators being measured could add some mils to the measurement. In fact, there is scatter in the depth gage results from a single insulator quadrant of several mils, presumably due to this effect and intrinsic irregularities in the insulator end surface.

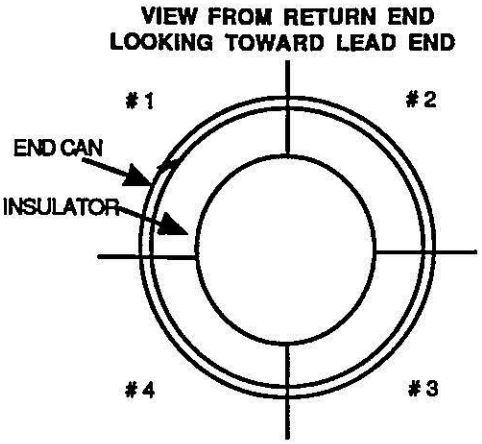
Installation Misalignment: An additional source of variations in this measurement is misalignment of the threaded rods of the end clamp installation assembly, which may have caused the largest value so far (52 mils from quadrant I of the lead end of DCA313.)

Recommendation: Since all of the end load is applied to a region near the center of the end cap, it is more important that the saddle surfaces of the inner and outer coils be made as flat as possible (currently done with "green putty") than that the insulator surfaces be exactly level with each other.

We expect the insulators to "stretch" by about 10 mils. It is not understood why the model magnets show values much closer to the nominal 30 mils than the full length magnets. Thus, the maximum tolerated value for this measurement should be increased to at least 50 mils. Adding 5 mils for further variations, 55 mils seems reasonable. A traveller change has been requested to bring this about.

2.19 Before removing End Squeezer Assembly, measure the distance between the outer end of each Collet and the End Can, using a Depth Gauge.





Quadrant #1_____ Quadrant #2_____

Quadrant #3_____ Quadrant #4_____

NOTE: IF THE MEASUREMENT OF ANY QUADRANT IS GREATER THAN 40 MILS, STOP AND CONSULT RESPONSIBLE AUTHORITY/PHYSICIST.

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Technician(s) Date

FIGURE 1

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