Fermilab

TS-SSC 92-039
3/18/92
J. Strait

DCA320 Turn-to-turn Short

DCA320 has developed a turn-to-turn short either during or immediately after the coller keying operation. The short is in the uninstrumented portion of the lower inner coil. Table I summarizes the inner coil resistance measurements recorded in the Traveler. From before to immediately after keying the lower inner coil resistance decreased 6 milliohms relative to the upper inner coil. This, however, is within the range of variation observed among earlier measurements and did not cause immediate alarm. By the next day, however, it had lost another 13 milliohms, and it became evident that there is a problem.

Table II and Figure 1 show the upper and lower half coil resistances during the keying operation. It is evident that the lower coil resistance dropped about 5 milliohms when the vertical press hydraulic pressure was brought from 6500 to 7000 psi. (No increase in coil stress was observed by the strain gauges at this step, however.) This represents only a 0.2% change in the lower-upper coil difference which is below the alarm threshold of 0.5%. As the press was opened, the lower-upper coil difference returned to its original value. In retrospect, of course, this change indicated the presence of a short; unfortunately no one was looking closely enough.

Table III gives the voltage tap series check data from the Traveler. Also indicated are 1) z, the estimated cable length, in inches, from tap 19B to each tap, 2) dz, the distance from the indicated tap the the previous one, and 3) $\langle z \rangle$, the average z of the cable segment defined by the indicated tap and the previous one. Vraw is the measured voltage from the Traveler. Vnorm is that voltage normalized to make the voltage at 13A match the "standard" voltage listed in the Traveler of 313.5 mV. dVnorm is the normalized voltage difference between the one tap and the previous tap. The data in the collared (pre-keyed) and keyed states are compared at the right. Within the instrumented portion, the normalized voltage at each tap differs between the two sets by at most 0.1 mV, which corresponds to the least significant digit recorded in the Traveler. However, the the normalized voltage across the uninstrumented portion is 17 mV lower after keying. This corresponds to a 19 milliohm decrease in resistance.

There is no further information about the location of the short that can be obtained without disassembling the magnet. Therefore we should begin disassembly as soon as the standard post-keying inspection has been completed. To aid in the location of the short, all 4 keys should be pryed out together down the length of the magnet and the upper inner and lower inner coil resistances should be monitored as the keys are pryed out. The resistances should be recorded after every 2 feet of the keys has been removed from the key slots.

Distribution:
R. Bossert, J. Carson, S. Delchamps, W. Koska, E.G. Pewitt, M. Wake,
DCA320 Traveler, Discrepancy Report, D. Smith

1022 Vtaps Keyed-Collared

Table I

		Inner Coils			
		Rupper	Rlower	Rl-Ru	Δ(Rl-Ru)
1/31/92	Post Cure	1148	1137	-11	0
2/7/92	Pre-Assembly	1147	1142	-5	6
2/18/92	Post-Assembly	1148	1139	-9	2
3/10/92	Pre-Collared	1148	1137	-11	0
3/12/92	Post-Collared	1153	1142	-11	0
3/17/92	Post Keyed	1146	1129	-17	-6
3/18/92	Post Keyed	1149	1119	-30	-19

Table II

Keying Sequence

Vert	Horiz	Rupper	Rlower	Rl-Ru	Δ(Rl-Ru)	Δ/R
-1.0	-1.0	2974	2960	-14	0	0.00%
357.0	8.0	2972	2961	-11	3	0.10%
2514.0	7.0	2973	2960	-13	1	0.03%
4522.0	7.0	2972	2957	-15	-1	-0.03%
6545.0	7.0	2971	2959	-12	2	0.07%
7048.0	7.0	2970	2950	-20	-6	-0.20%
7049.0	6.0	2969	2950	-19	-5	-0.17%
7027.0	506.0	2969	2950	-19	-5	-0.17%
7030.0	1016.0	2969	2950	-19	-5	-0.17%
7042.0	1524.0	2969	2950	-19	-5	-0.17%
7035.0	2032.0	2968	2952	-16	-2	-0.07%
4078.0	1976.0	2970	2956	-14	0	0.00%
14.0	6.0	2969	2955	-14	0	0.00%

Table III

1022 Vtaps Keyed-Collared

Coil 15M-50-1002 (DCA320 Lower Inner)

	Cable			Collared (3/12/92)					Keyed (3/18/92)					Keyed - Collared.	
Vtap	z (in)	dz	<z>(in)	Vraw (mV)	Vnorm (mV)	dVnorm (mV)	dV/dz (µV/in)	Vtap	Vraw (mV)	Vnorm (mV)	dVnorm (mV)	dV/dz (µV/in)	Vtap	Vnorm (mV)	dVnorm (mV)
19 B	0.0			0.0	0.0			19 B	0.0	0.0			19 B	0.0	
19 A	11.5	11.5	5.8	0.5	0.5	0.5	44.9	19 A	0.5	0.5	0.5	45.1	19 A	0.0	0.0
19 C	585.3	573.8	298.4	26.1	26.1	25.6	44.6	19 C	26.6	26.1	25.6	44.6	19 C	0.0	0.0
19 D	596.6	11.3	590.9	26.5	26.5	0.4	35.4	19 D	27.0	26.5	0.4	39.1	19 D	0.0	0.0
18 B	1171.1	574.5	883.8	52.1	52.1	25.6	44.6	18 B	53.0	52.1	25.6	44.5	18 B	0.0	-0.1
18 A	1182.4	11.3	1176.7	52.6	52.7	0.5	44.3	18 A	53.6	52.7	0.6	52.2	18 A	0.0	0.1
18 C	1757.6	575.3	1470.0	78.2	78.3	25.6	44.5	18 C	79.7	78.4	25.7	44.6	18 C	0.1	0.0
18 D	1767.4	9.8	1762.5	78.6	78.7	0.4	40.9	18 D	80.1	78.8	0.4	42.1	18 D	0.1	0.0
17 B	2343.4	576.0	2055.4	104.3	104.4	25.7	44.7	17 B	106.2	104.4	25.6	44.5	17 B	0.0	-0.1
17 A	2353.2	9.8	2348.3	104.7	104.8	0.4	40.9	17 A	106.7	104.9	0.5	50.2	17 A	0.1	0.1
17 C	2930.0	576.8	2641.6	130.4	130.5	25.7	44.6	17 C	132.7	130.5	25.6	44.3	17 C	-0.1	-0.2
17 D	2938.3	8.3	2934.1	130.7	130.8	0.3	36.2	17 D	133.1	130.9	0.4	52.1	17 D	0.1	0.1
16 B	3515.8	577.5	3227.0	156.3	156.4	25.6	44.4	16 B	159.2	156.5	25.6	44.4	16 B	0.1	0.0
16 A	3525.0	9.2	3520.4	156.8	157.0	0.5	54.4	16 A	159.7	157.0	0.5	53.4	16 A	0.0	0.0
16 C	4103.2	578.3	3814.1	182.5	182.7	25.7	44.5	16 C	185.8	182.6	25.6	44.3	16 C	0.0	-0.1
16 D	4111.8	8.6	4107.5	182.8	183.0	0.3	34.9	16 D	186.2	183.0	0.4	43.4	16 D	0.0	0.1
15 B	4690.8	579.0	4401.3	208.5	208.7	25.7	44.4	15 B	212.3	208.7	25.7	44.4	15 B	0.0	0.0
15 A	4699.4	8.6	4695.1	208.9	209.1	0.4	46.6	15 A	212.7	209.1	0.4	45.7	15 A	0.0	0.0
15 C	5276.2	576.8	4987.8	234.6	234.8	25.7	44.6	15 C	238.8	234.8	25.7	44.5	15 C	-0.1	-0.1
15 D	5289.3	13.1	5282.7	235.2	235.4	0.6	45.8	15 D	239.4	235.4	0.6	45.8	15 D	-0.1	0.0
14 B	5863.8	574.5	5576.5	260.7	260.9	25.5	44.4	14 B	265.4	260.9	25.6	44.5	14 B	0.0	0.0
14 A	5876.9	13.1	5870.3	261.3	261.6	0.6	45.8	14 A	266.0	261.5	0.6	46.5	14 A	0.0	0.0
14 C	6452.1	575.3	6164.5	286.9	287.2	25.6	44.5	14 C	292.1	287.1	25.6	44.5	14 C	-0.1	0.0
14 D	6463.7	11.6	6457.9	287.4	287.7	0.5	43.1	14 D	292.6	287.6	0.5	44.1	14 D	-0.1	0.0
13 B	7039.7	576.0	6751.7	313.0	313.3	25.6	44.5	13 B	318.6	313.2	25.6	44.4	13 B	-0.1	0.0
13 A	7051.3	11.6	7045.5	313.5	313.8	0.5	43.1	13 A	319.2	313.8	0.6	50.8	13 A	0.0	0.1
0 A	22476	15425	14764	999.7	1000.7	686.9	44.5	0 A	1000.2	983.3	669.5	43.4	0 A	-17.4	-17.4

584 Straight sect lgth
1.8 End lgth (turn 18)
3.6 End lgth (turn 15)

Vnorm = Vraw*313.8mV/V(13A)

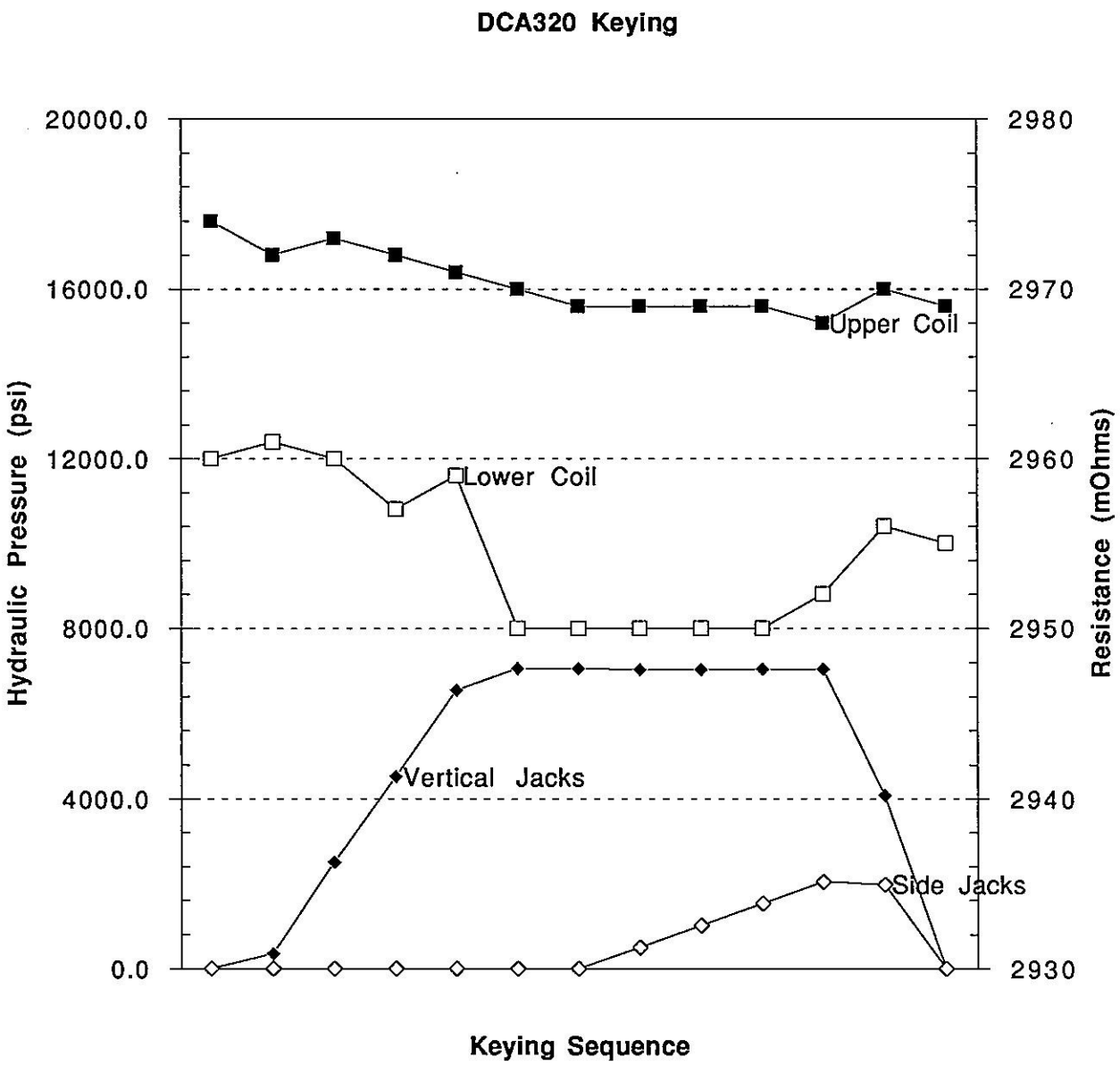
DCA320 Keying
20000.0
16000.0
12000.0
8000.0
4000.0
0.0
2980
2970
2960
2950
2940
2930
Hydraulic Pressure (psi)
Resistance (mOhms)
Upper Coil
Lower Coil
Vertical Jacks
Side Jacks
Keying Sequence

Figure 1