Fermilab

April 26, 1990

MEMO TO: Rodger Bossert, John Carson, Wayne Koska, Paul Mantsch, Gale Pewitt

FROM: Jim Strait

SUBJECT: Analysis of collaring data from DS0307 With and Without Brass Shoes

In the most recent collaring of DS0307 the outermost 5 mils of Kapton ground insulation was replaced with 5 mils of brass. The ground insulation configuration is shown in Fig. 1. The measured prestress on magnets DS0307, 8 and 9 have been lower than expected from the component sizes and a possible explanation is that the Kapton ground insulation may be extruding into the collar die break. If this effect is important, the coil preload should go up significantly when brass is placed between the Kapton and the collars. Interpretation of the experiment is made less straightforward, however, by the fact that the coil stress is measured by non-laminated strain gage load cells. Stress changes seen with the strain gages are sensitive mainly to the flow of Kapton along the radial ground surfaces. The deflection of the collars in regions away from the strain gages should give a measure of the change in prestress due to Kapton flow at the coil poles.

In this note I compare the coil stresses and collar deflections between this assembly and the previous one without brass. In both cases the coils were covered with plumbers Teflon tape burnished into the coil surfaces. In the all Kapton case, a 6 mil radial shim was used between the collars and the tooling and in the Kapton and brass case a 3 mil radial shim was used. The strain gage data from the two assemblies are shown in Table I and Figs. 2 and 3. The collar vertical diameters are shown in Table II and Fig. 4. Table III compares the predicted prestress with the various measurements. The strain gage data indicate a small prestress increase in the inner coil and a 1.7 kpsi decrease in the outer coil with the addition of the brass. The collared coil vertical diameter is, on the average, 1.5 mils larger with the brass, corresponding to about 1.3 kpsi more prestress. More striking is that with the brass the diameter varies by only a mil, while without brass the full range is 5 mils with a clear trend from one end to the other.

The difference between the all Kapton and Kapton and brass cases is relatively small and in both cases the prestress, measured with the strain gages or inferred from the collar deflections, is smaller than that predicted. The significance of the differences in collar deflections with and without brass is unclear to me. What is clear is that the conjectured flow of Kapton into the die break can explain at most a small fraction of the discrepancy between the predicted and measured prestress.

There is another difference between the two assemblies. In the all Kapton case, a 6 mil radial shim was used between the collars and the tooling, and in the Kapton and brass case a 3 mils shim was used. In the former case the keys were observed to be fully seated, but in the latter case they were not fully inserted in all places. This suggests that at least in the second case the tapered keys were partially driven in, not just placed in. In both collaring operations (and all others we have done to date) the coil stress is observed to increase when the side hydraulic cylinders are energized. The increase is larger in the second case (3 mil shim) than the first (6 mil shim) and the "spring-back" loss is less. (See Table IV.) Both of these indicate that the tapered keys were supplying a larger fraction of the collar closure when the smaller shim was used. This may result from the larger outward bending of the collars that occurs with the smaller shim. I have not checked what other shims were used between the press and the tooling so another explanation may be that the press was more fully closed when the 6 mil shim was used.

Table II

	Collared Coil Diameter		Inferred Prestress (kpsi)	
Pos #	All Kapton	Brass + Kapton	All Kapton	Brass + Kapton
0	4.366	4.369	5.4	8.0
1	4.365	4.369	4.5	8.0
2	4.365	4.369	4.5	8.0
3	4.367	4.369	6.3	8.0
4	4.366	4.369	5.4	8.0
5	4.367	4.369	6.3	8.0
6	4.367	4.369	6.3	8.0
7	4.367	4.369	6.3	8.0
8	4.367	4.369	6.3	8.0
9	4.368	4.370	7.1	8.9
10	4.368	4.370	7.1	8.9
11	4.368	4.370	7.1	8.9
12	4.368	4.370	7.1	8.9
13	4.369	4.370	8.0	8.9
14	4.369	4.370	8.0	8.9
15	4.368	4.370	7.1	8.9
16	4.369	4.370	8.0	8.9
17	4.369	4.370	8.0	8.9
18	4.368	4.370	7.1	8.9
19	4.368	4.370	7.1	8.9
20	4.369	4.370	8.0	8.9
21	4.369	4.370	8.0	8.9
22	4.369	4.370	8.0	8.9
23	4.368	4.369	7.1	8.0
24	4.369	4.369	8.0	8.0
25	4.368	4.369	7.1	8.0
26	4.369	4.369	8.0	8.0
27	4.369	4.369	8.0	8.0
28	4.368	4.369	7.1	8.0
29	4.369	4.369	8.0	8.0
30	4.369	4.369	8.0	8.0
31	4.370	4.370	8.9	8.9
32	4.369	4.369	8.0	8.0
33	4.367	4.369	6.3	8.0
34	4.367	4.369	6.3	8.0
Average	4.3679	4.3694	7.1	8.4

Table III

Measured Prestress

Ground Insulation	Predicted Prestress Inner	Outer	Average	Strain Gages Inner	Outer	Average	Collar Defl Average
All Kapton	11.5	10.4	10.9 kpsi	2.7	9.2	5.9 kpsi	7.1 kpsi
Kapton + Brass	11.5	10.4	10.9 kpsi	2.9	7.5	5.2 kpsi	8.4 kpsi

Table IV

Prestress Changes

Step	6 mil radial shim Inner	Outer	Average	3 mil radial shim Inner	Outer	Average
Close Press	+4.8	+13.5	+9.1 kpsi	+4.6	+10.6	+7.6 kpsi
Insert Keys	+0.4	+ 0.9	+0.6 kpsi	+0.7	+ 1.4	+1.1 kpsi
Open Press	-2.1	- 5.1	-3.6 kpsi	-2.0	- 4.5	-3.2 kpsi

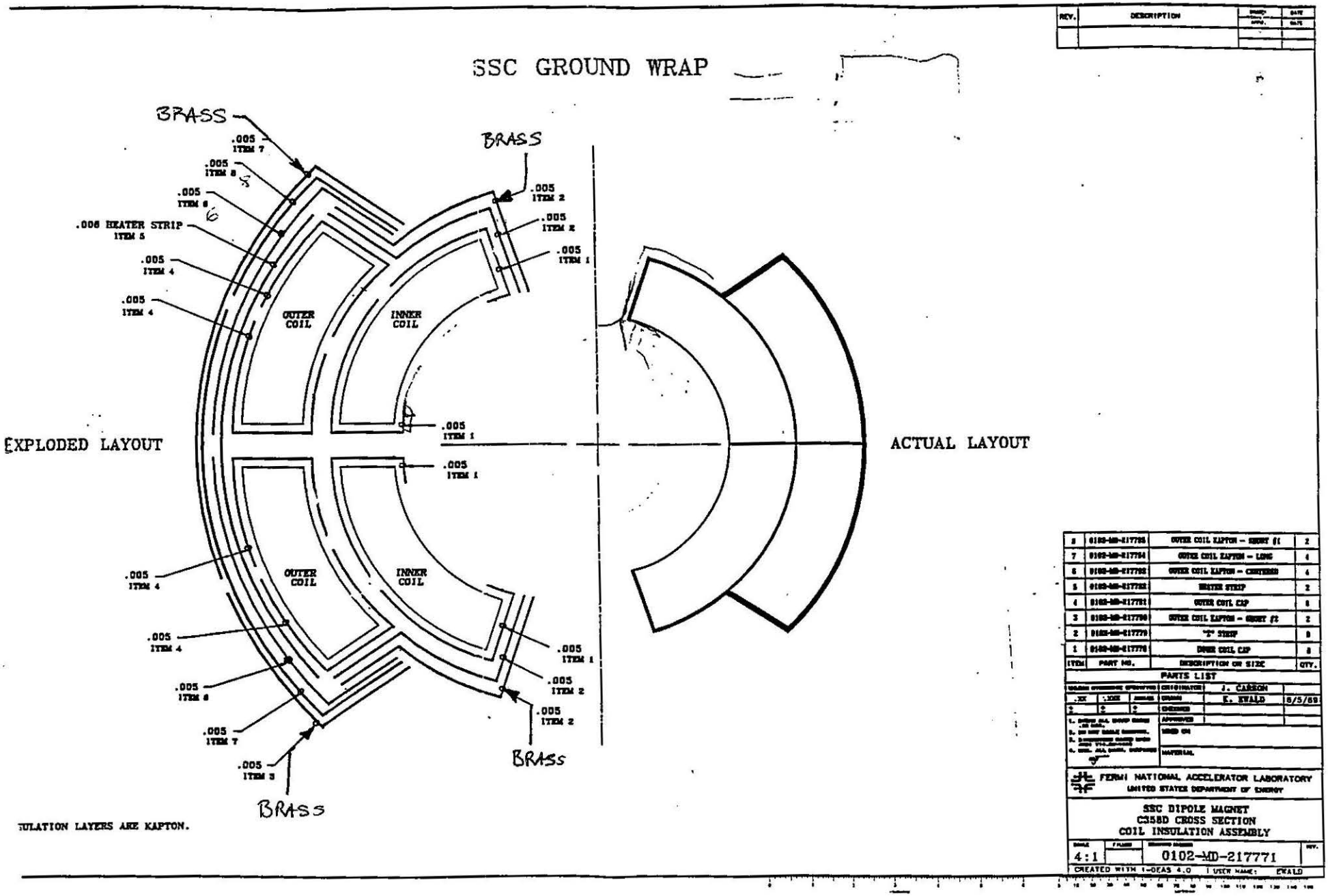
SSC GROUND WRAP
BRASS
.005 ITEM 7
.005 ITEM 8
.005 ITEM 6
.006 HEATER STRIP ITEM 5
.005 ITEM 4
.005 ITEM 4
OUTER COIL
INNER COIL
BRASS
.005 ITEM 2
.005 ITEM 3
.005 ITEM 1
.005 ITEM 1
EXPLODED LAYOUT
ACTUAL LAYOUT
.005 ITEM 1
.005 ITEM 4
.005 ITEM 4
.005 ITEM 8
.005 ITEM 7
.005 ITEM 3
BRASS
.005 ITEM 1
.005 ITEM 2
.005 ITEM 2
BRASS
ULATION LAYERS ARE KAPTON.
OUTER COIL KAPTON – SHEET #1 2
OUTER COIL KAPTON – LONG 4
OUTER COIL KAPTON – CENTERED 4
HEATER STRIP 2
OUTER COIL CAP 8
OUTER COIL KAPTON – SHEET #2 2
"C" STRIP 8
INNER COIL CAP 8
ITEM PART NO. DESCRIPTION OR SIZE QTY.
PARTS LIST
J. CARSON
E. EWALD 8/5/89
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY
SSC DIPOLE MAGNET
C358D CROSS SECTION
COIL INSULATION ASSEMBLY
4:1
0102-MD-217771
CREATED WITH I-DEAS 4.0
EWALD

Fig. 1

	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX
149	PUMP PSI 3/22/90 8.30/ AM.KEVING	Press psi (V)	Press psi (H)	#169 3/I	#198 4/I	#184 4/O	#186 3/O	#1005 1/I	#1004 2/I	#183 1/O	#168 2/O	Inner	Outer	All	Inner	Outer	All
150	Teflon on Coils, 6 mil radial shim													0	0	0	0
151	0 V	0	0	-147	-574	-60	-167	-326	-558	6	-28	-401	-62	-232			
152	Line V	400	0	595	-236	786	1816	81	-135	1916	2940	76	1864	970	1.19	4.82	3.01
153	1000 V	1000	0	1026	22	1460	2791	427	147	3115	4495	406	2965	1686	0.55	1.83	1.19
154	2000 V	2000	0	1955	626	2846	4702	1085	736	5313	7438	1100	5075	3088	0.69	2.11	1.40
155	3000 V	3000	0	2821	1202	4153	6330	1698	1282	7314	9816	1751	6903	4327	0.65	1.83	1.24
156	4000 V	4000	0	3638	1857	5531	7974	2298	1805	9102	11825	2399	8608	5504	0.65	1.70	1.18
157	5000 V	5000	0	4456	2469	6802	9443	2940	2348	10906	13901	3053	10263	6658	0.65	1.66	1.15
158	6000 V	6000	0	5337	3187	8223	11091	3570	2915	12658	15787	3752	11940	7846	0.70	1.68	1.19
159	7000 V	7000	0	6030	3780	9422	12340	4175	3433	14305	17521	4355	13397	8876	0.60	1.46	1.03
160	7000 V/400 H	7000	400	6319	4050	9922	12938	4423	3619	14902	18164	4603	13982	9292			
161	7000 V/1000 H	7000	1000	6461	4208	10214	13121	4578	3724	15257	18575	4743	14292	9517			
162	3000 V/1000 H	3000	1000	4930	3035	8000	10651	3506	2656	12488	15285	3532	11606	7569			
163	0	0	0	3760	2501	6140	8349	2604	1850	10064	12153	2679	9176	5928			
164																	
165				coil psi	coil psi	coil psi	coil psi	coil psi	coil psi	coil psi	coil psi	Average Stress			d(stress)/dPv		
166	PUMP PSI 4/17/90 12.30/pm.KEVING	Press psi (V)	Press psi (H)	#169 3/I	#198 4/I	#184 4/O	#186 3/O	#1005 1/I	#1004 2/I	#183 1/O	#168 2/O	Inner	Outer	All	Inner	Outer	All
167	Teflon on Coils, 3 mil radial shim, brass																
168	0 V	0	0	-144	-577	-126	-216	-274	-531	-36	-83	-382	-115	-248			
169	Line V	400	0	799	-306	-38	333	125	-279	983	1480	85	689	387	1.17	2.01	1.59
170	1000 V	1000	0	1227	-70	283	541	377	-94	1967	3098	360	1472	916	0.46	1.30	0.88
171	2000 V	2000	0	2047	384	1235	1454	987	393	3943	5604	953	3059	2006	0.59	1.59	1.09
172	3000 V	3000	0	2978	915	2302	2557	1663	928	5938	7680	1621	4619	3120	0.67	1.56	1.11
173	4000 V	4000	0	3864	1473	3518	3749	2334	1488	7771	9501	2290	6135	4212	0.67	1.52	1.09
174	5000 V	5000	0	7064	1946	4463	4699	2911	1965	9275	11143	3471	7395	5433	1.18	1.26	1.22
175	6000 V	6000	0	5460	2599	5845	6047	3604	2567	11115	13012	3558	9005	6281	0.09	1.61	0.85
176	7000 V	7000	0	6246	3197	6994	7205	4298	3166	12812	14906	4227	10479	7353	0.67	1.47	1.07
177	7000 V/400 H	7000	400	6587	3472	7549	7857	4529	3405	13406	15480	4498	11073	7786			
178	7000 V/1000 H	7000	1000	7046	3913	8273	8439	4967	3758	14608	16349	4921	11917	8419			
179	3000 V/1000 H	3000	1000	5729	3029	6446	6885	4016	2914	12224	13503	3922	9765	6843			
180	0	0	0	4430	2124	4566	5149	3129	2085	9477	10634	2942	7457	5199			

Table I

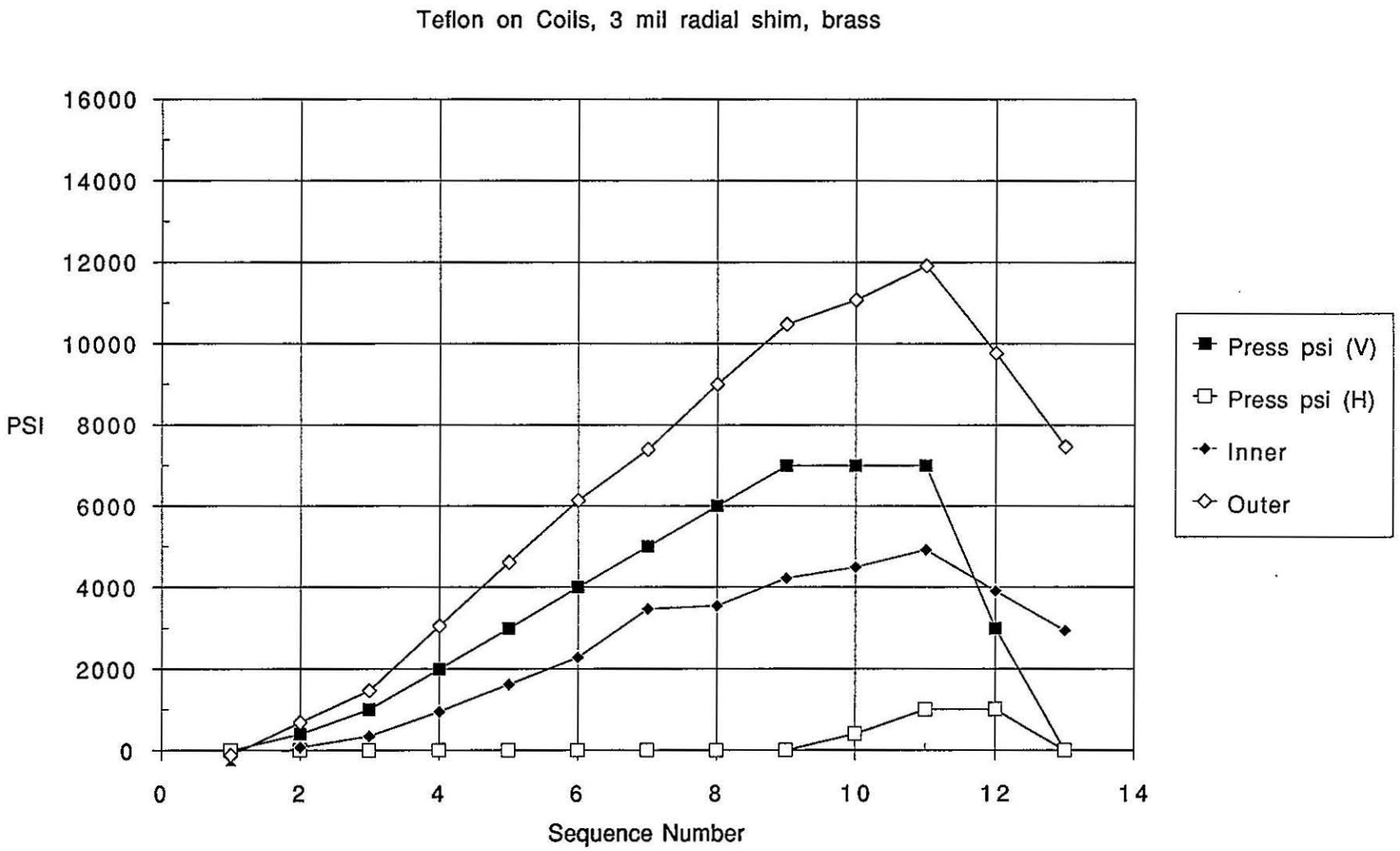
Teflon on Coils, 3 mil radial shim, brass
16000
14000
12000
10000
8000
6000
4000
2000
0
PSI
0
2
4
6
8
10
12
14
Sequence Number
Press psi (V)
Press psi (H)
Inner
Outer

Fig. 3

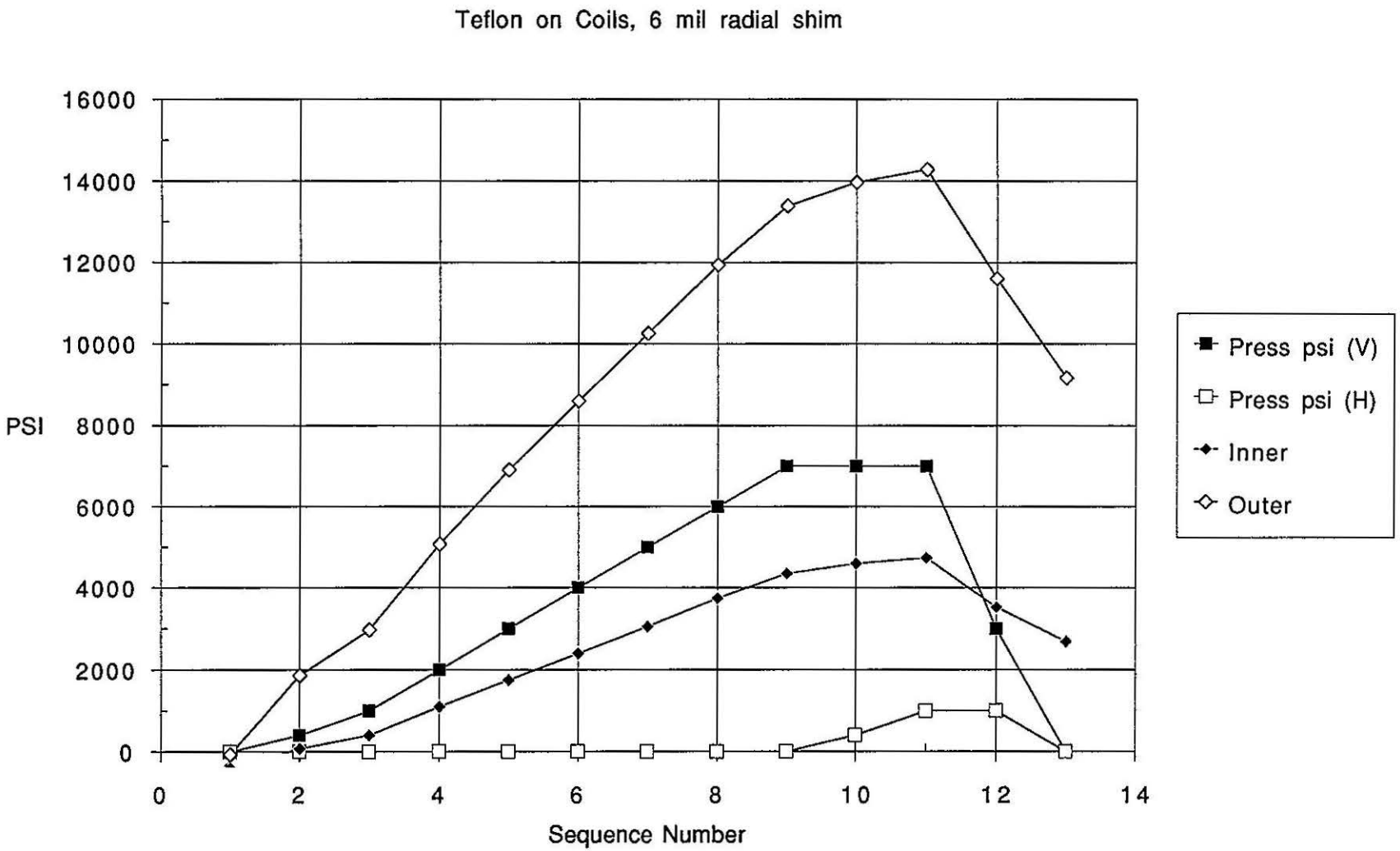
Teflon on Coils, 6 mil radial shim
16000
14000
12000
10000
8000
6000
4000
2000
0
PSI
0
2
4
6
8
10
12
14
Sequence Number
Press psi (V)
Press psi (H)
Inner
Outer

Fig. 2

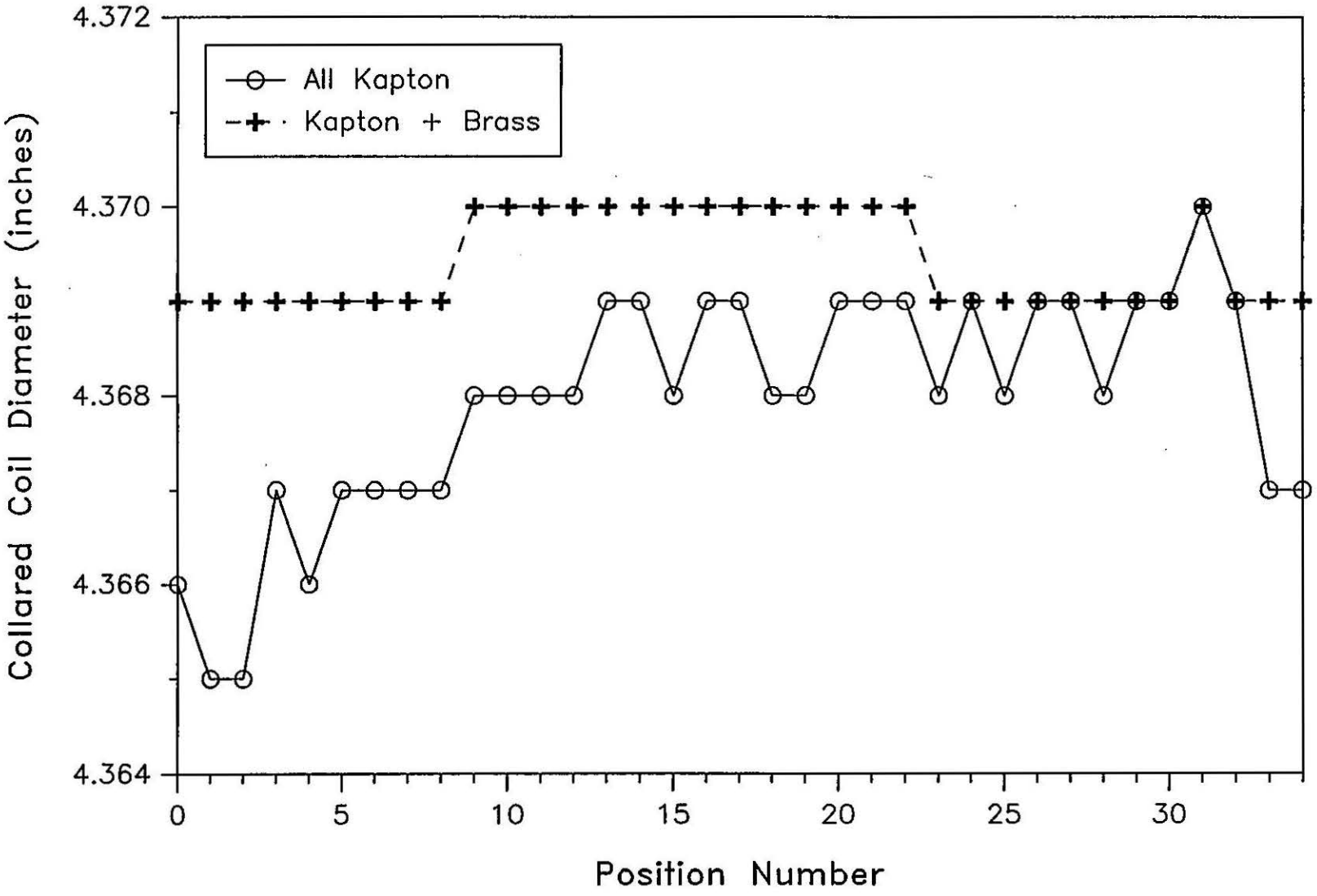
All Kapton
Kapton + Brass
Collared Coil Diameter (inches)
4.372
4.370
4.368
4.366
4.364
0
5
10
15
20
25
30
Position Number

Fig. 4