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MEMORANDUM

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From: Jim Strait

Date: August 16, 1990

Subject: DC0301 (PCM#2) Collaring Data

DC0301 (PCM#2) was keyed on 7/30/90. Due to deformation of the upper press beam, the keys were not fully inserted in the neighborhood of the strain gage pack nearer the lead end. The collared coil was moved several feet in the press and the keying operation was repeated on 7/31/90, resulting in full key insertion. In this note, I give a brief analysis of the strain gage and collar deflection data.

The usefulness of the strain gage data is limited for two reasons. First, the gages were calibrated at Fermilab before the calibration procedures were fully understood. As a consequence, the calibrations are probably not correct. Wayne has looked at BNL supplied calibrations of about a dozen gages and finds that they all agree within +/- 10-15% and are significantly different from the Fermilab supplied calibrations of the gages in DC0301. In this note, I present the strain gage data analyzed both with the "actual" calibrations and with a "generic " calibration of 8.6 psi/$\mu\varepsilon$ obtained from a linear fit to the average of Wayne's BNL calibrations.

The second problem with the strain gage is that for unknown reasons, about half the gages from time to time show large (~4 Ω or 6000$\mu\varepsilon$ or 50 kpsi) shifts in resistance. Such a shift occurred between the first and second pressings, making analysis of the final keying operation difficult. Two inner gages are unusable for other reasons (one is open and the other shows a large initial negative strain change, followed by the usual positive change with coil compression) leaving only two usable inner gages for the final keying operation. Two estimates (for each calibration type) were obtained for the final prestress. One is the average of the 6 usable gages; the other is gotten by taking the change in stress from the 6 usable gages and adding that to the average stress after the first keying attempt.

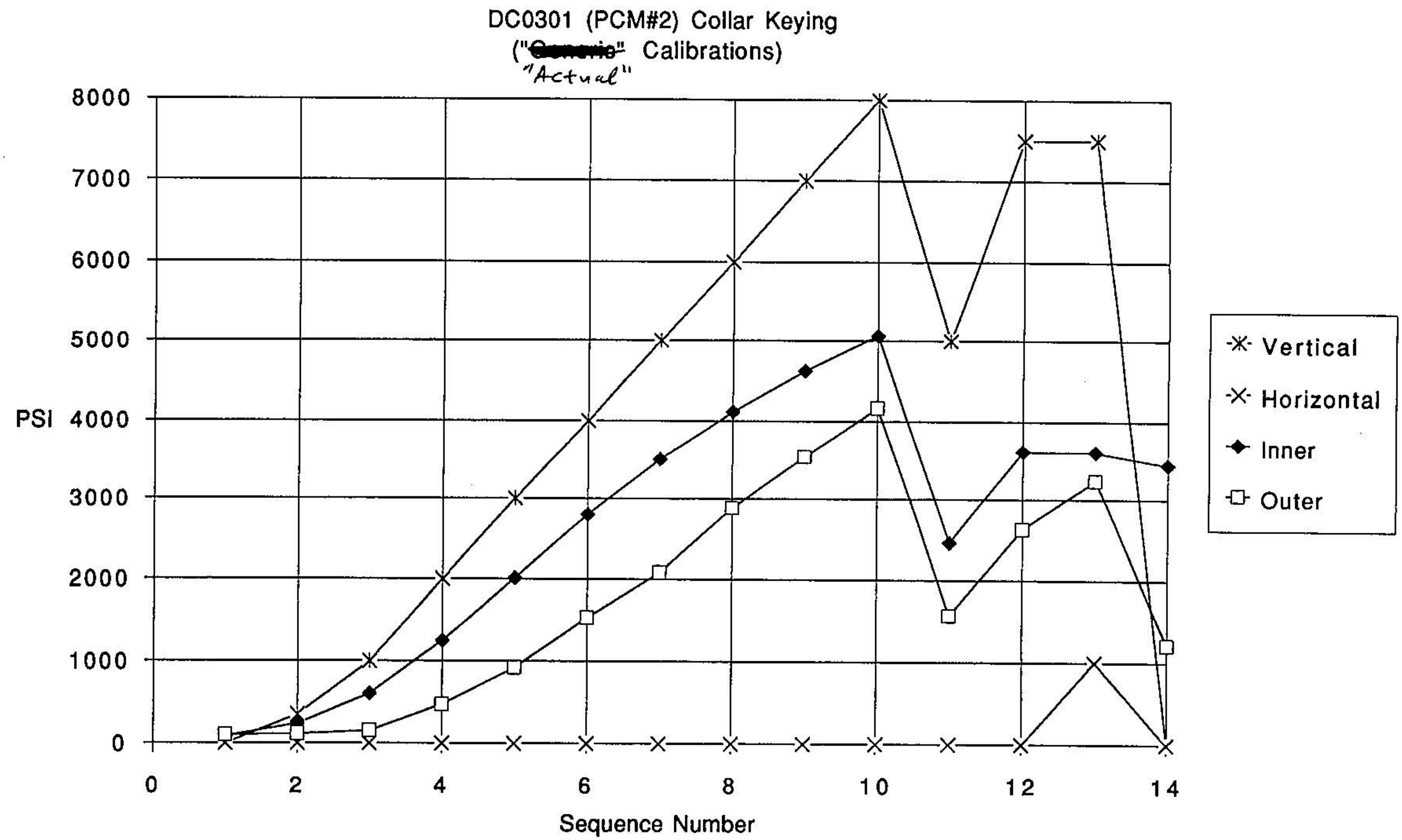
Figures 1 and 2 show the strain gage data for the first keying attempt using the "actual" and "generic" calibrations respectively. The final inner and outer prestress are 2.9 and 1.2 kpsi using "actual" calibrations and 10.0 and 5.3 kpsi using "generic" calibrations. Following the second pressing, the averages of the two usable inner and four usable outer gages give 5.5 (13.2) and 1.6 (6.3) kpsi with "actual" ("generic") calibrations. The differences with the second pressing are 1.3 (2.0) and 0.5 (1.3) kpsi respectively. When the differences are added to the stresses from the first keying, the resultant inner and outer stresses are 4.2 (12.0) and 1.7 (6.6) kpsi. I believe that the last estimate, using the "generic" calibrations, is the most reliable, but obviously significant uncertainty (~ +/- 30%) exists.

A feature of the first keying sequence that is worth noting is that the vertical press pressure increased monotonically to 8 kpsi, then dropped to 5 kpsi, and then went back up to 7.5 kpsi. Neither the inner not the outer coil stress recovered all of the stress decrease resulting from the press pressure decrease. Presumably, this results from the large frictional hysteresis in the system.

Figure 3 shows the slope $d\sigma/dP$ (where σ is the average coil stress and P is the press hydraulic pressure) for the monotonically using part of the first keying operation. If all of the press load is reacted by the coil and the load is fully transmitted to the pole, the expected slope would be 2.2. Recent experience with the short magnets (and BNL experience) shows that about 2/3 of the load appears to be transmitted to the pole. Thus the expected slope is around 1.4-1.5. This slope should appear at low loads and will tend to decrease with increasing press pressure as the tooling closes. If "generic" calibrations are used, the expected shape is observed but the slope is somewhat larger than expected.

Figure 4 shows the collared coil vertical diameter as a function of position along the magnet. The positions of the strain gage packs are indicated by the small brackets above the data. Position number 1 is at the lead end and, except at the strain gage packs, the sizes are measured at 12 inch intervals. On the right hand scale the average coil stress deduced from the collar deflection is shown. The undeflected collar vertical diameter is assumed to be 4.364 inches, the same as for the collars used in the short magnets. (The design radius is 2.181, the collars as punched have a radius of 2.180, and the key size and placement generates a 2 mil vertical radical ovality.) The average vertical diameter is 4.3667 inches implying an average prestress of only 2.4 kpsi. For comparison, the average vertical diameters of DS0309 and DS0310 are 4.3725 and 4.3734 inches respectively. This is consistent with the prestress measured with the strain gages using the "actual" calibrations, which were previously argued probably to be incorrect. The upshot is that I do not understand the prestress in this magnet.

JBS/net:JBS001


DC0301 (PCM#2) Collar Keying
("[redacted]" Calibrations)
"Actual"
PSI
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7000
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
14
Sequence Number
Vertical
Horizontal
Inner
Outer

FIGURE 1

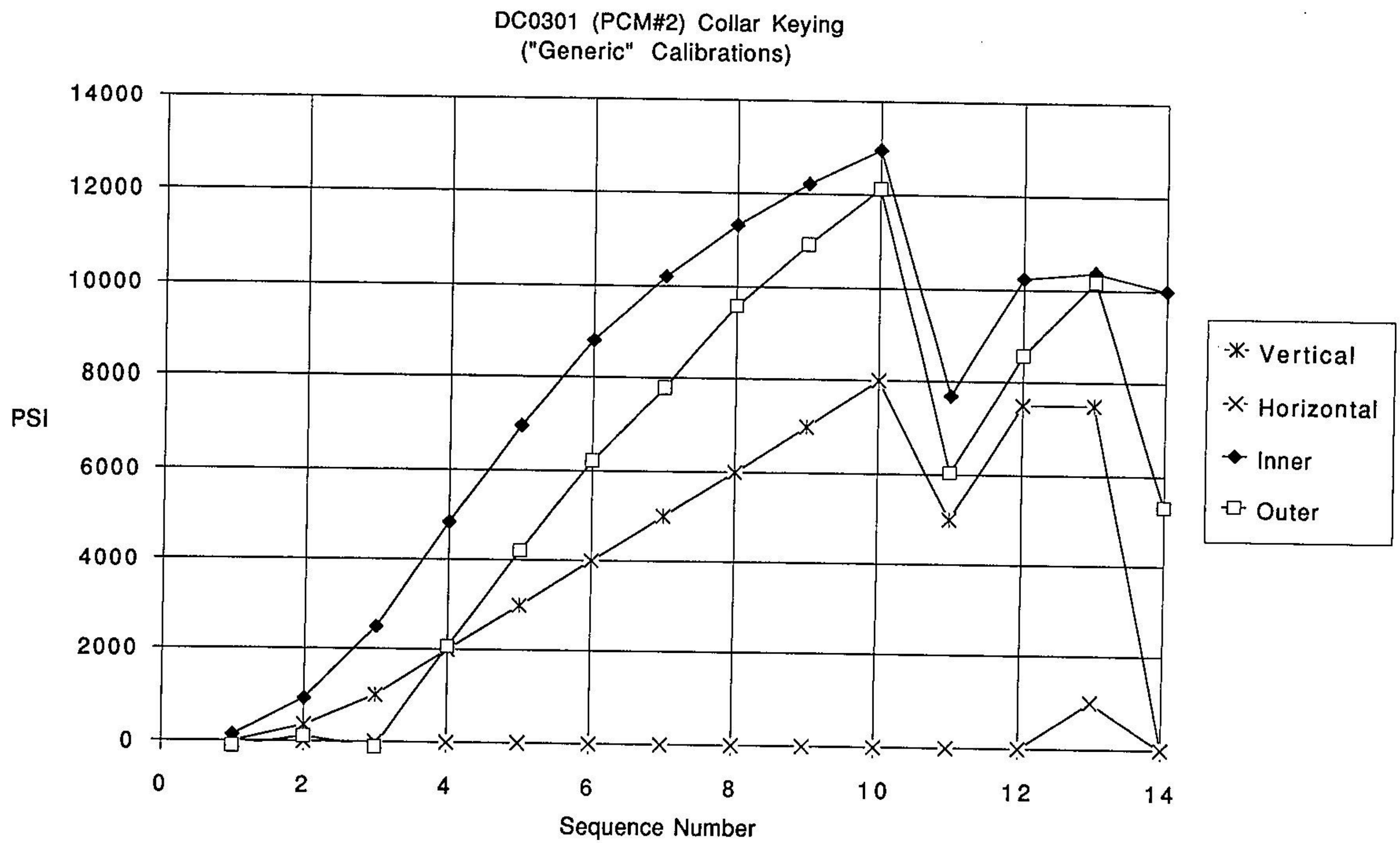
DC0301 (PCM#2) Collar Keying
("Generic" Calibrations)
PSI
14000
12000
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
12
14
Sequence Number
Vertical
Horizontal
Inner
Outer

FIGURE 2

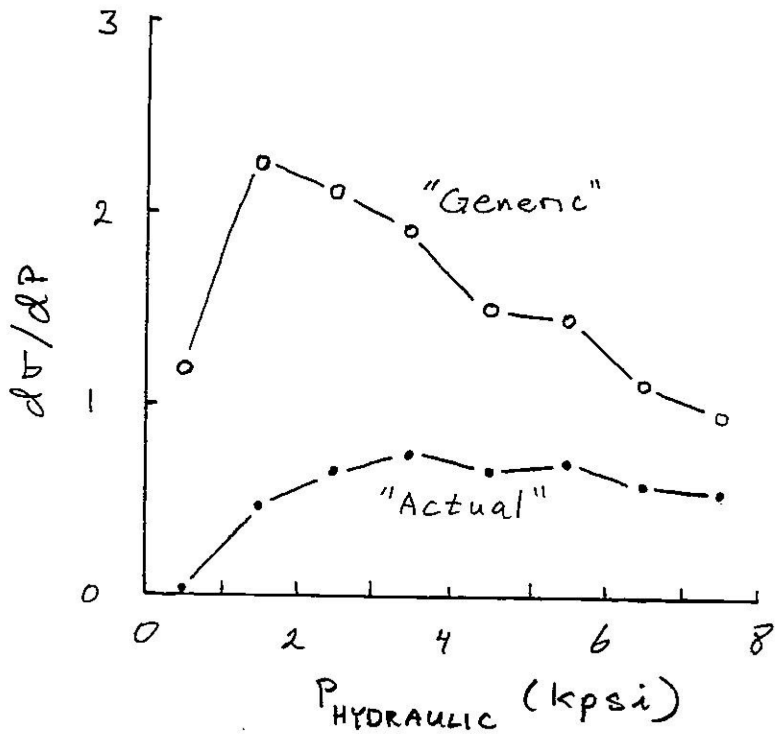

Figure 3

PCC #2 DIM B-1 VERT

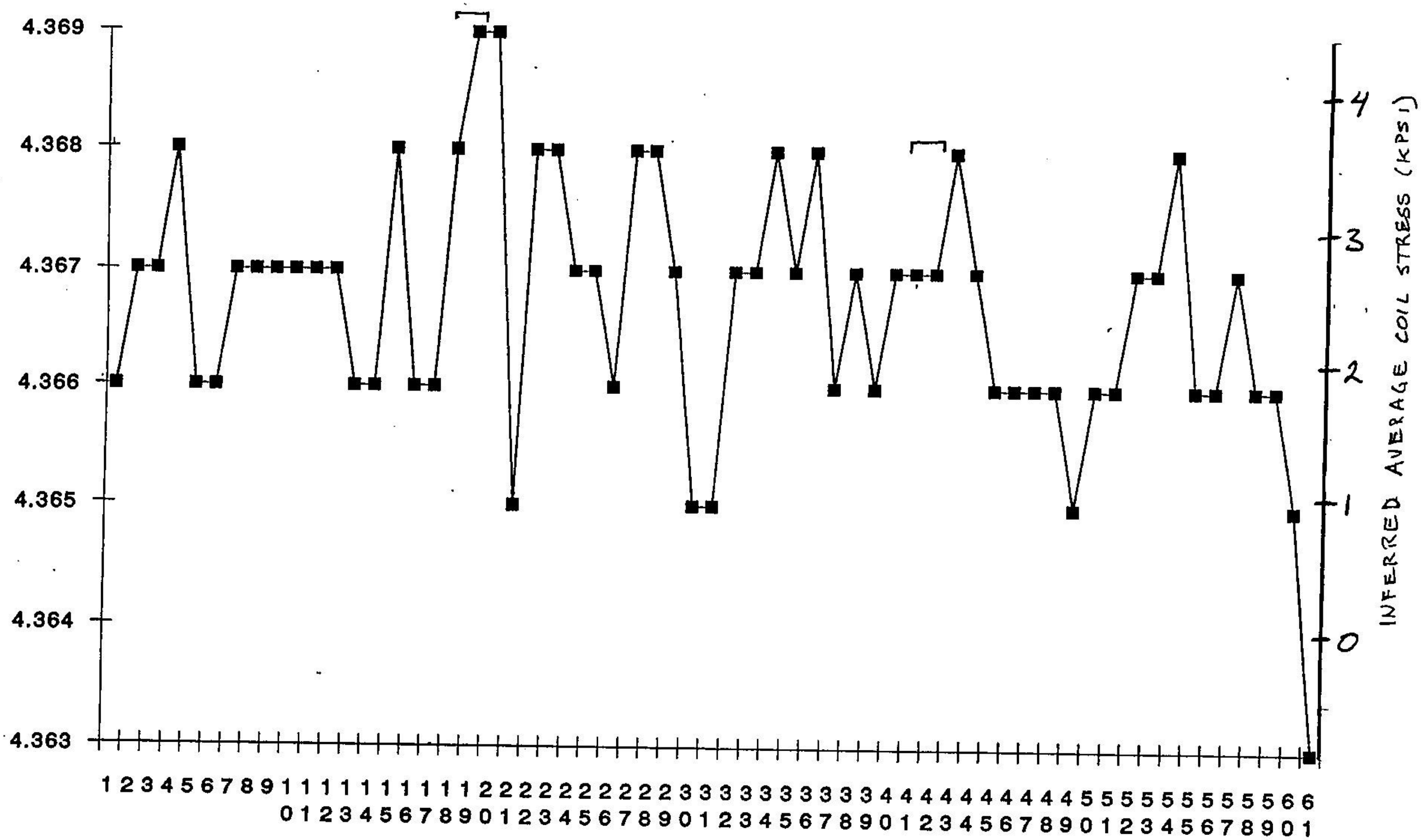

FIGURE 4