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Subj: Yoke density

TS-SSC 92-049

We have spent a little time reviewing our yoke stacking procedures and what we really know about the density of our yokes. Apparently the information Mike Gordan gave you that indicated that we only know the weight of each 135.25" pack to +/-10 lbs is not correct. As a cross-check the yoke pack is weighed after assembly with a scale whose least count is 20 lbs. However, the yoke is stacked by weighing sets of 101 laminations (100 regular and 1 slotted lamination) on a scale whose least count is 0.002 lbs. 22 of such packs are weighed and stacked, the weight is added up, and the required number of laminations are added to bring the total weight to 1875 lbs. These are then compressed on horizontal stacking table to a length so that the final assembly, after removal from the stacking table, is 135.25". The resulting yoke density is estimated to be 99.0+/-0.5% of solid iron. (The error bar of +/-0.5% is the uncertainty in the calculation, based on a combination of two different estimates of the yoke lam cross-sectional area and two different values of the density of iron that we found in the literature. It does not represent an estimate of the pack-to-pack density variation -- see below.)

While the technicians doing the stacking recorded the weights of each sub-pack that went into each 135.25" pack, they did not record the total weight. Mike Gordan has added up the recorded weights of the individual sub-packs for the 8 135.25" packs that are in DCA318 (a "randomly" selected magnet) and finds that all are within +/-2 lbs of 1875 lbs. (Most are within +/-1 lb.) Assuming that the same accuracy applies to all magnets (the same procedure was used for all*) then the possible left-right yoke half density difference is < (+/-4 lbs)/(1875 lbs) = +/-0.2%. Ramesh's calculation seem to require a 5 times bigger difference to generate the observed saturation b1 of up to 0.5 units and a 15 times bigger difference to generate the observed remnant field b1 of up to 10 units. I have no suggestion as to what the real cause(s) of the observed b1 (and a0) effects is (are), but to the best of our knowledge, it is not poor control of yoke density.

As a final check we are trying to locate somewhere on site a scale which will with better resolution than 20 lbs with which (assuming we find one) we will weigh the packs for DCA320-323.

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*The lead tech for the yoke stacking says that for the last several magnets (from DCA320 or 321, I think) they eliminated the weighing of sub-packs because they found that all 135.25" packs, when stacked to the required weight, took the "same" force on the stacking table to bring to the design length. Therefore, as I understand it, they began to stack to a length and compressive force, rather than length and weight, since that simplified the procedure. I am not entirely comfortable with this since I have not been shown documentation on the correlation among assembly force, length and weight to justify this change of procedure. However, all packs for all long magnets have now been made and we cannot easily "go back."