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From: Jim Strait
Subject: Cause of coil-to-collar short in DSA322 (4th assembly)

During the fourth keying of DSA322 on 3/28/91 a coil-to-collar short occurred. The short appeared with a failure of the pre-keying hi-pot at 3.5 kV resulting in a coil-to-ground resistance of 3 K Ω . Electrical measurements determined that the short was in the upper inner coil in turn 17 (the third turn from the pole, just above the pole-most wedge) at or near the return end of the collared portion.[1] DSA322 has now been uncollared and the cause of the short is quite clear.

Approximately 1/4" from the return end of the collared portion on the outer surface of the upper inner coil in quadrant I there is a gouge in the Kapton which has some carbon deposits associated with it. There is a small amount of carbon on the corresponding location on the collar pack. There is no evidence of any metal chips or other foreign material that might have caused the tear, and the tear is too large to be plausibly caused by a chip. It appears more likely to have been caused by some tool gouging the insulation. There are also tool marks on the return end face of the collar pack, some of which have raised a sharp edge on the last lamination where it contacts the outer surface of the inner coil. There is a small linear slice in at least the outer layer of Kapton at this location, although there is no evidence that there was any electrical breakdown at this point. A similar sharp edge and Kapton damage is present on the inner coil pole surface adjacent to this. In removing the collar pack it was observed to be rather tightly installed between the adjacent pack and the coil end keys. It is likely that a screwdriver or similar instrument was used to try to wedge the collar pack in place, damaging the collar and putting the gouge into the Kapton.

At the lead end of the same collar pack there is a gouge in the Kapton at the outer corner of the outer coil pole turn in quadrant II. The outer layer of Kapton is completely torn and the second layer is damaged, although it is not clear at this point if it was cut through. No electrical breakdown occurred at this point. The brass collaring shoe has a significant dent at this location also. Presumably the collar pack was installed with the lead end inserted all the way and then as return end of the pack was forced in, excessive force was applied which gouged the insulation.

It is clear that using screwdrivers or similar tools to aid installation of collar packs or for any mechanical purpose that might cause them to come in contact with the coil insulation should be avoided. In this case it would have been preferable to remove one or more lamination pairs from the last collar pack to allow it to be inserted easily by hand. There is good experimental evidence that leaving the coil unclamped over a length of a few laminations does not cause degradation of magnet performance, while damaged insulation surely does.

Reference

- [1] J. Strait, Location of coil-to-collar short in DSA322 (4th assembly), TS-SSC 91-057, 4/2/91.

cc: DSA322 Traveler