DCA312 Production Report

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DCA312 is the second SSC 50 mm aperture collider dipole magnet built at Fermilab. It will be the second to be tested in liquid helium. Its assembly followed the baseline as stated in the 50 mm Collider Dipole Magnet Requirements and Specifications Book [1] (the "Yellow Book.") This report will summarize the production history of DCA312 and any discrepancies from the baseline design. References will be made to the Specific Data Summary Traveler (SDST) and to the Fermilab Advanced Magnet R&D Group's technical note series. Notes in the latter series are indicated by the prefix TS-SSC.

DCA312 is the "technology transfer" magnet. Fermilab production personnel supervised and carried out construction, while General Dynamics personnel observed, and in some instances acquired hands-on experience.

Coil Winding and Inspection: Coil winding began on June 4, 1991. Several discrepancy reports were filed during coil winding and inspection. Inner coil 15M-50-1006 had kapton insulator missing when the lead end inner winding key was removed, and varnish was applied [1].

The cable for coil 15M-50-2006 uncabled at the 5309 foot mark during insulation. The decabled portion was fixed by hand, and checked for any damage. Processing continued [2].

Coil 15M-50-2007 was found to have sharp epoxy flash, due to epoxy outflow during cure, on the outside edge of the midplane surface. The excess epoxy was carefully removed with a file [3]. On the same coil, there was torn b-stage and kapton near the lead end, possibly from sizing bar installation or removal. Varnish was applied to the affected area [4]. Finally, a metal chip on the pole surfaced caused a drop in resistance during sizing of this coil. The chip was easily located and removed [5].

Collared Coil Assembly: No pole shims were used in DCA312 [6]. During collaring, some weld flash and contaminants were detected between the collar pack laminations by production personnel. The collar packs were cleaned thoroughly before use [7]. The fixture for collar pack installation was not yet available, so C-clamps were used during pack installation [8]. Some corrosion was detected on the strain gage packs, and was removed with alcohol [9].

There was no step in the Traveller at this time for cutting the end saddles of the coils, and so a procedure was specified which might have resulted in a coil assembly of non-standard length [10].

The return end clamp was installed with two layers of 5 mil kapton shim on the inside of the insulator surfaces [11]. The lead end clamp was installed twice because on the first attempt the G10 insulators were not aligned properly [12]. Two layers of 5 mil kapton shim were used on the lead end [13].

The ball was not available for inspection of the beam tube, and so this test was skipped [14]. The vacuum leak check sticker for the beam pipe was also unavailable [15]. The collared coil assembly magnetic field harmonics were tested with the Brookhaven B2 mole system [16].

Yoking and Shell Welding: During shell pressing, catastrophic chevroning of the yoke packs occurred [17]. Measurements of the end clamps after chevroning indicated that the return end clamp may have slid along the coil surface by as much as 100 mils. Some superficial damage to the collar packs was observed, but measurements showed no permanent distortion of the collar pack diameters, or lenghthening of the coil package.

The yoke packs were removed and replaced with a revised assembly to prevent chevroning in the future [18]. This assembly includes more epoxy-reinforced "monolithic packs" than in the baseline design, as well as an increase in the packing fraction of the standard packs. Measurements performed after shell welding indicated that chevroning is not present in DCA312 [19]. However, measurements of shell diameter on DCA312 and other 50 mm magnets show that the profile is elliptical and not circular [20].

Final Assembly and Cryostatting: The bullet gage bushing screws on DCA312 were adjusted following the procedure written by John Carson on October 11, 1991, designed to produce the appropriate end load after welding of the extension tube / end bell assembly, assuming the same weld procedure was used as in the case of DCA311. Due to miscommunication, this procedure was used even though the extension tube had been modified to reduce the amount of welding required to fix the extension tube to the end plate. The reduction in welding resulted in reduced warpage of the end plate, so that the bullet loading after welding was too low. Therefore, following welding, the bullet bushing screws were tightened to produce final bullet loads of 899, 953, 824, and 890 pounts [21]. The lead end set screws were adjusted to 20 inch-pounds of torque before end bell welding [22].

During cryostatting, weld material splashed onto the 80K multi-layer insulator, creating holes about 1/4 " in diameter all the way through. The layers of insulation were patched individually [23]. The insulating blankets were cut too short due to unavailability of the correct drawing. Short sections (several inches in length) were cut and spliced at both ends of the blanket to correct this [24].

During vacuum vessel final certification, the He was pressurized only to 45 psi and not to 60 psi, because hard seals were not available and it was felt that the rubber seals used could not take 60 psi [25].

The z positions of several flanges relative to the Lead End Beam Tube Flange were found to be out of tolerance [26]. The x and y positions of several tubes relative to the beam tube center were found to be out of tolerance [27]. At the time of this report, efforts are still under way to determine correct tolerances for these measurements and to standardized alignment test procedures [28].

The expansion loop could not be positioned within the tolerance specified in the traveller. This was due to not checking the bus length before installatin in the slot. The tolerance was changed after reconsideration of coldmass thermal contractions showed that the original specification was too tight [29].

The return end cap/extension assembly was .2 inches too short. It was used, and further investigation into the tolerances for this length and ramifications of this discrepancy are under study [30].

The field angle probe measurements on DCA312 showed that significant changes occurred during cryostatting, including a twist of about 1 mrad over a ~200 inch length, and the disappearence of a ~30 inch 3 mrad twisted region [31].

References

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