Fermilab

TS-SSC 92-017
2/3/92
J. Strait

DCA314 Production Report

DCA314 is the fourth complete 50 mm SSC dipole magnet built at Fermilab and the second that was assembled by General Dynamics personnel. It is built according to the specifications in "50 mm Collider Dipole Magnet Requirements and Specifications," Baseline Issue, August 16, 1991 ("the Yellow Book"). It contains no intentional deviations from the baseline design. Coil winding for this magnet began in June, 1991, and assembly was completed in January, 1992. A summary list of all Discrepancy Reports (DRs) that were generated for this magnet or apply to it is attached. This report consists principally of a summary and evaluation of problems that occurred during assembly which could effect the magnet performance.

COIL WINDING AND CURING

Several minor problems occurred during coil winding and curing; all were satisfactorily corrected and are not expected to cause any performance problems. The apparently low epoxy content of the B-stage tape for coil 15M-50-1010 (DR 100) was found to result from a measurement error. The initial attempt at making the preform in coil 15M-50-2011 resulted in a poor quality preform. It was cut off and remade successfully.

In winding coil 15M-50-1010, the upper inner coil, a strand popped out of position while winding the lead end of the third turn (counting from the pole). (DR 102) The turn was backwound slightly and the popped strand was put back in place without disturbing the insulation. The coil was then successfully wound.

Several instances of minor insulation damage were found and repaired. (DR 106, coil 15M-5-2010, the upper outer coil; DR 109, coil 50M-50-1010; DR 112, coil 15M-50-2011, the lower outer coil.) This sort of damage is considered normal, and after these coils it was recommended that further DRs not be generated for minor insulation damage.

After coil curing a small metalic chip was found on the outer surface of the middle wedge of coil 15M-50-1010 (DR 108). The chip was removed. No damage was done to the conductor or its insulation.

Due to a last minute change in the outer coil pole angle[1] the initial production of outer coil end keys were 5 mils per side too small. Through DCA313 this 5 mils was filled with a layer of adhesive backed Kapton. In DCA314 coil 15M-50-2010 the keys were modified by the addition of a 5 mil G-10 shim cemented to the surface, to simulate the later pieces which were made to the proper dimensions. Since the B-stage epoxy in the cable insulation and on the key surfaces was likely to bond more securely to the G-10 than the Kapton

tape, a new procedure for preparing the key surfaces was outlined in DR 105.

Upon removing this coil from the mold some minor damage to several of the end pieces was observed. The shelves on both keys, which were glued on rather than being machined from the same piece as the main body of they key, were broken off (DR 121). These were successfully glued back into place. The ramp shim, which fills the space underneath the splice preform as it ramps away from the radius of the outer coil, also broke loose and was reglued (DR 121). The preform itself and the preform shim, which is cemented into the slot in the key and sits beside the preform, were both partially raised out of the slot and cured into this position (DR 137). These were left in their cured position. Appropriate material was removed from the G-10 end clamp quadrant that is adjacent to the raised preform. Material from the lead end saddle inner radius extruded slightly into the slot at the pole of the winding and curing mandrel (DR 121). It was filed by hand to bring the surface back to the proper radius.

In coil 15M-50-2011 the number of "Koldwelds" noted during coil winding was inconsistent (smaller by one) with the number noted during cable insulating (DR 138).

COIL ASSEMBLY AND INSULATION

Several components were found to damaged or out of specification during coil assembly and insulation, although they had passed inspection (DR 132, DR 133, DR 147, and DR 148). These parts were replaced with ones that satisfied the specifications.

END CLAMP ASSEMBLY

On one of the end clamps the positions at which diameter measurements are made were mis-marked (DR 177). The deflection measurements were made correctly, however. The end clamp deflections, which are taken to indicate the radial prestress on the ends, were somewhat larger than in previous long 50 mm dipoles and are typical of subsequent ones[2]. Some difficulties were encountered in making the electrical inspection after end clamp assembly (DR 202). These were traced to improper temperature compensation of the resistance measurements.

BUS PULTRUSION ASSEMBLY

The initial hi-pot of the bus pultrusion failed due to inadequate procedures (DR 183). A subsequent hi-pot using a better procedure was successful. The wall thickness of the pultrusion sleeve was too great to allow full insertion of the bus assembly into the yoke (DR 255). It was filed to fit. After insertion of the bus the distance from the expansion loop to the end of the yoke was out of tolerance (DR 264). Subsequently the tolerance on this dimension was relaxed.

COLD MASS FINAL ASSEMBLY

Several minor problems were encountered with the assembly of the beam tube at the ends of the cold mass. The procedures for making the various connections were still under final development (DR 270) for this magnet. The beam tube was 0.375 inches too short at the lead end (DR 243). It was allowed to be recessed by this much inside the flange. (This might not be acceptable in a magnet destined for the collider due to RF considerations.) The beam tube flange initially would not fit over the beam tube at the return end (DR 312). (The flanges were designed for custom Nitronic 40 tubes rather than ASTM toleranced tubes.) The flange was machined to have a larger I.D.

The single phase bellows assembly flanges had to be reworked to achieve the required surface finish (DR 316).

CRYOSTAT ASSEMBLY

An out of tolerance anchor slide cradle was delivered to production and rejected by them (DR 311). The liquid helium return line was found to have a small dent, but it was used "as is" (DR 329).

Distortions of the 80 K shield were found to cause compaction of the 20 K MLI blanket at several locations, possibly causing thermal shorts between the two shields (DR 353). A minor re-work, involving rewelding several shield segments, did not completely cure the problem. It was decided, based on a decision by the SSCL regarding a BNL-built magnet with a similar problem, to continue assembly of this magnet. Shields for subsequent magnets will be inspected more carefully to eliminate those with excessive distortions, and the amount of weld material applied during assembly has been reduced.

Several dimensions measured during the final optical survey of the cryogenic piping were found to be out of tolerance (DR 377). It was decided to use the magnet "as is."

REFERENCES

[1] J. Strait, Improved harmonics for 50 mm dipole, TS-SSC 90-066, 7/16/90.

[2] S. Delchamps, End clamp deflections for DCA311 - DCA319, TS-SSC 92-013, 1/29/92.

DCA 314
1-28-92

The following is a total list of Discrepancy Reports (DRs) written during the fabrication and assembly this 50 MM Magnet. If closed the disposition and corrective action to prevent recurrence was verified by Quality Assurance. The effect on Configuration is address by yes or no.

	Config../status		
DR 100	no/closed	Coil 1010	Cable and Wedges with B-Stage Resin % at 11.29.
DR 101	no/closed	Coil 2011	Preform crossovers with lack of uniform solder flow.
DR 102	no/closed	Coil 1010	Wire Strand was out of place.
DR 105	no/closed	Coil 2010	Outer Grouped End Return End Key was not available.
DR 106	no/closed	Coil 2010	Torn B-Stage and spot on the tape.
DR 108	no/closed	Coil 1010	Chip on wedge.
DR 109	no/closed	Coil 1010	Bare Cable showing from torn tape.
DR 112	no/closed	Coil 2011	Torn B-Stage and Kapton.
DR 114	no/closed	Use one coat of Mold Release.	
DR 116	no/closed	Coil 1012	Wooden slivers with Wedges when unpacked.
DR 121	no/closed	Coil 2010	G-10 Repairs needed.
DR 132	no/closed	Scrape on Beam Tube.	
DR 133	no/closed	Kapton was not applied on Beam Tube correctly.	
DR 137	no/closed	Coil 2010	L.E. Preform and shims raised out of G-10 slot.
DR 138	no/closed	Coil 2013	Koldwelds missing from winding map.
DR 147	no/closed	Collaring shoe has kink 6' from R.E.	
DR 148	no/closed	Narrow ground wrap has splice	
DR 177	no/closed	Incorrect End Can markings.	
DR 183	no/closed	Bus Pultrusion failed HI-Pot.	
DR 202	no/closed	Post weld Electrical R is greater than Previous reading.	
DR243	closed/no	L.E. of Beam tube is too short.	
DR 255	no/closed	Power Pultrusion will not insert.	
- DR 264	no/closed	Power Bus Pultrusion loop to outer most edge of skin out of tolerance.	
DR 270	no/closed	Traveler steps will not be preformed in sequence.	
DR 311	no/closed	Anchor Slide Cradle Holes off center.	
- DR 312	no/closed	Bean Tube Flange cannot be inserted on beam Tube.	
DR 316	no/closed	Flange Surface area will not meet Spec. (All reworked)	
DR 329	no/closed	Dent in Liquid Helium Return line.	
- DR 336	no/closed	REPLACE all electrical travelers with Rev. H.	
DR 353	yes/closed	Distortion of 80K Thermal Shields.	
DR 368	no/OPEN	MTF has failed to comply with QA and establish control of measuring and test equipment.	
DR 377	no/OPEN	Optical Survey X,Y,Z out of tolerance. (Tom to resolve)	
DR 378	no/closed	Ring Test not performed at Yoked-Post cutting of the skin.	
DR 385	no/OPEN	MTF - 80K pipe 3/8" out of alignment with test stand pipe.	
DR 397	yes/OPEN	Electrical inspection on test stand shows out of tolerance measurements.	
DR 412	yes/OPEN	Voltage Tap 14B open during Cryogenic Testing.	