Magnet Division Procedure

Superconducting Magnet Division

Proc. No.: SMD-BEPC-3002

Revision: A

AS1 & AS3 Solenoid Winding

- Prepared by: Signature on File
- Cognizant Engineer: Signature on File
- Production Representative: Signature on File
- Production Section Head: Signature on File
- Cognizant Electrical Engineer: Signature on File
- Q. A. Approval: Signature on File
- ES&H Review: Signature on File

Revision History

Rev A: Initial Release

1 Scope:

This MAP describes the procedure used for AS1 & AS3 solenoid winding.

2 Applicable Documents:

RHIC-MAG-Q-1000	Control of Measurement Test Equipment
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
RHIC-OPM-8.1.1.27	Operation of Beam Tube Wrapper
RHIC-MAG-R-7242	RHIC Hypot Testing
RHIC-MAG-R-7227	Electrical Resistance Meas. Individual Coils
RHIC-MAG-R-7228	Magnet Coil Inductance and Q Measurement
SMD-OPM-8.1.1.36	DESY Wiring Machine
21010009	Coil Assembly
12010181	Insulation, Polyimide Film

3 Requirements:

3.1 Material/Equipment

Mounting Clamps	
Acetone	
Insulated Gloves	BNL Stock No. K-63025
PVC Gloves	BNL Stock No. K-62649
Latex Gloves	BNL Stock No. K-62854
Test Cart	ETS-001
Micrometer	

3.2 Safety Precautions

3.2.1 The operator shall be qualified by the Cognizant Technical Supervisor in the safe operation of the DESY Wiring Machine.

3.2.2 The operator shall be qualified by the Cognizant Technical Supervisor in the safe operation of the Beam Tube Wrapper.

3.2.3 Operators shall wear safety glasses with side shields, or goggles.

3.2.4 Operators shall wear insulated gloves when handling heated coil assembly.

3.2.5 Personnel shall wear Nitrile gloves while handling epoxies, acetone, ethanol, or methanol cleaning agents.

3.2.6 The technicians shall be instructed by their cognizant technical supervisor in the operation of the required test equipment and these electrical testing procedures. They shall be familiar with the latest revision of the applicable documents referenced in section 2. In addition, some of these tests require the technician to have special training. A list of qualified personnel shall be maintained with the Training Coordinator.

3.2.7 Some of these electrical test procedures have specific safety requirements. The technicians performing these specific tests shall rigorously follow all the safety requirements listed as well as those prescribed by the BNL ES&H standard. Operators shall wear safety glasses with side shields or goggles.

3.2.8 Hypot and impulse testing pose a Class "C" electrocution hazard. At least two properly trained technicians must be present to perform this testing. When testing, a trained technician shall be stationed at any point where the item under test is accessible to unauthorized people, and barriers shall be set up. Signs shall be posted reading "DANGER HIGH VOLTAGE" and warning lights shall be turned on.

3.2.9 Caution: to avoid the possibility of static build-up during and discharge during coil winding operation, the following grounding must be installed. Attach a ground wire to the coil support tube. Attach incoming lead for coil block being wound to ground. After all the coil blocks are wound remove the ground wires.

3.2.10 When applying epoxy to coil perform operation under exhaust hood and document quantity of epoxy used on “Epoxy Usage Form”

4 Procedure

4.1 AS3 Solenoid Coil Winding

4.1.1 Referring to coil drawing (21010009) position the grooved tooling clamp at the magnet lead end side of where the AS3 coil is to be wound.

NOTE

For AS3 the magnet lead end and the coil lead end are the same side. This will not be the case for AS1.

4.1.2 In area of coil wrap tube with a double wrap of .003" B-stage fiberglass tape.

4.1.3 Approximately 6' in from start of lead, install 2 voltage taps and spot heater.

4.1.4 Loosen tooling clamp and then feed about 6' of conductor through groove in the bottom of the tooling clamp. The voltage tap should be in the area under the clamp. This will be the start lead.

4.1.5 Using the winding machine, machine wind one layer of the coil (from the lead end toward the quad coil). Stop the machining just before the point where the conductor will want to ride up on itself.

4.1.6 Using green putty fill in the gap caused by the conductor pitch angle between the conductor itself and the main quad lead splice ring.

4.1.7 With same green putty from a position about ½" – ¾" before the conductor will "ride up on itself", make a ramp for it to climb to the next layer.

4.1.8 Allow about 45 minutes for green putty to set.

4.1.9 Sparingly apply blue epoxy (2850 ft. [12011227] + 24 LV catalyst [12011228]) to fill in any voids between wires. Squeegee away any epoxy on top of wires while pushing it down between them.

4.1.10 Overwrap coil with 2 layers of .003" B-stage fiberglass tape (2 butt wrap layers are permissible as long as seams are staggered.)

4.1.11 Repeat steps 4.1.5 thru 4.1.10 until 2nd coil layer is complete. Wind toward lead end on even numbered layers, toward quad coil on odd numbered layers.

4.1.12 Repeating step 4.1.5, wind 3rd coil layer.

4.1.13 In the void area (to be filled with green putty), install 2 voltage taps to conductor at the end of the 3rd coil layer.

4.1.14 Route V-taps through hole in tooling clamp.

4.1.15 Overwrap coil with 2 layers of .003" B-stage fiberglass tape (2 layers butt wrap are permissible as long as seams are staggered).

4.1.16 Repeat steps 4.1.5 thru 4.1.10 until all coil layers are complete.

NOTE

Do not overwrap layer #6 with .003" B-stage fiberglass at this point.

4.1.17 Route exit lead in groove on top of tooling flange. Allow about 4 feet of excess for splicing.

4.1.18 Wrap two layers of .003" B-stage fiberglass over the coil.

4.1.19 Wrap coil with triple overlap (66%) wrap of Kapton H-film (12010181-13).

4.1.20 Wrap coil with B-stage epoxy impregnated S-glass roving @28 lbs. tension and 18 turns per inch over full length of coil just wound.

4.1.21 Overwrap coil with 50% overlap wrap of .003" Teflon tape.

4.1.22 Cure at 125^0C for 90 min.

4.1.23 After coil has cooled, remove tooling clamp.

4.2 AS1 Solenoid Coil Winding

NOTE

The lead end of the AS1 coil is at the non-lead end of the magnet.

4.2.1 Referring to coil drawing 21010009, install grooved tooling clamp at lead end of AS1 coil and the plain clamp at its non-lead end.

4.2.2 In area of coil, butt wrap a double layer of .003" B-stage fiberglass tape over the tube.

4.2.3 Spool off about 15' of conductor and start the first layer. Once started, wind the first turn of the coil on itself.

4.2.4 Make a ramp out of green putty starting ½" – ¾" before first turn winds over itself.

4.2.5 Allow about 45 min. for putty to set.

4.2.6 With spooled off end of the conductor wind the first turn of the coil up 4 layers putting .003" B-stage fiberglass between layers.

4.2.7 Install 2 V-taps on lead as it exits the coil.

4.2.8 Clamp conductor in groove on top of tooling clamp.

4.2.9 Using the winding machine, wind one layer of the coil from lead end of coil toward the main quad. (Note: this is the opposite direction as AS3). Stop the machine just before the point where the conductor will want to ride up on itself.

4.2.10 Using green putty, fill in the gap caused by the conductor angle between the conductor itself and the clamp tool.

4.2.11 With the same green putty, from a position about ½" – ¾", before the conductor will "ride up on itself", make a ramp for it to climb to the next layer.

4.2.12 Allow about 45 min for green putty to set.

4.2.13 Sparingly apply blue epoxy (2850 ft. [12011227] + 24 LV catalyst [12011228]) to fill in any voids between wires. Squeegee away any excess epoxy on top of wires while pushing it down between them.

4.2.14 Overwrap coil with a 2 layers of .003" B-stage fiberglass tape. (2 butt wrap layers are permissible as long as seams are staggered).

4.2.15 Repeat steps 4.2.9 thru 4.2.14 until 2nd coil layer is done.

4.2.16 Repeat step 4.2.9 and wind 3rd layer of coil.

4.2.17 In the void area to be filled with green putty install a voltage tap to conductor at the end of the 3rd layer.

4.2.18 Route V-tap out of coil along the start lead of the coil and out of the tooling clamp.

4.2.19 Overwrap coil with 2 layers of .003” B-stage fiberglass tape. (2 butt wrap layers are permissible as long as seams are staggered).

4.2.20 Repeat steps 4.2.9 to 4.2.14 until all six coil layers are done.

NOTE

Layers 5 & 6 have one less turn at the coil lead end. Also, don’t overwrap layer #6 with .003” B-stage fiberglass at this time.

4.2.21 Route exit lead through groove on top of tooling flange and clamp in place. Allow about 6 ft. of excess for lead.

4.2.22 Just before lead exits coil, add a spot heater to lead.

4.2.23 Wrap two layers of .003” B-state fiberglass tape over the coil.

4.2.24 Wrap coil with triple overlap (66%) of Kapton H-film (12010181-13).

4.2.25 Wrap coil with B-staged epoxy impregnated S-glass roving @28 lbs. tension and 18 turns per inch over full length of coil just wound.

4.2.26 Wrap coil with 50% overlap wrap of .003” Teflon tape.

4.2.27 Cure at 125^0C for 90 min.

4.2.28 After coil has cooled, remove both tooling clamps.

4.3 SCB Surface preparation

4.3.1 Install G-10 spacer ring between main quad and AS1 solenoid.

4.3.1.1 Fill in voids with blue epoxy (stycast 2850 ft. [12011227] + 24LV catalyst [12011228]).

4.3.1.2 Wrap area with .003” Teflon tape and cut a small opening in top of the tape to allow any trapped air out.

4.3.1.3 Using a syringe, inject more blue epoxy as required.

4.3.1.4 Allow to cure overnight.

4.3.2 Build up diameters over the AS1 & AS3 solenoids with .003" B-staged fiberglass tape @ 10 lbs tension until they are about even or slightly above the main quad. (This should require about 8 or 9 layers of fiberglass tape.)

4.3.3 Overwrap entire coil assembly with an additional 3 layers of .003" B-stage fiberglass tape at a tension of about 10 lbs.

4.3.4 Overwrap coil with a 50% overlap of .003" Teflon tape.

4.3.5 Cure at 125^0C for 90 min.

4.3.6 Remove Teflon tape.

4.3.7 Machining

4.3.7.1 Taking maximum diameter cuts of .010", machine the coil assembly to the drawing diameter.

4.3.7.2 Examine coil after each cut. If fiberglass roving is seen, contact engineer or if coil does not clean up after 2 cuts, contact engineer.

4.3.7.3 Take diameter measurements and record (data sheet).

4.3.8 Electrical Checks.

4.3.8.1 Perform Coil Hypot

CAUTION

Be sure the "Hypot" and support tube are grounded at all times. Failure to observe this caution may result in electrocution.

- Connect each of the coil sets except the one under test to the coil support tube and to ground. Perform an ohmmeter check of the resistance between the coil set under test and ground following RHIC-MAG-R-7243. Verify that the resistance is at least 20 mega-ohms.

- Perform a 5.0 Kv hypot between the coil set under test and ground per RHIC-MAG-R-7242 and RHIC-MAG-R-7243. The leakage current must be less than 50 µa.

- Repeat for all other coil sets.

4.3.8.2 Measure coil temperature. Measure voltage drop across each coil set at 1 amp DC, following RHIC-MAG-R-7227. Complete the measurements of inductance and quality factor (Q) following RHIC-MAG-R-7228.

5 Quality Assurance Provisions:

5.1 The Quality Assurance provisions of this procedure require that the technician shall be responsible for performing all assembly operations in compliance with the procedural instructions contained herein and the recording of the results on the production traveler.

5.2 The technician is responsible for notifying the technical supervisor and/or the cognizant engineer of any discrepancies occurring during the performance of this procedure. All discrepancies shall be identified and reported in accordance with RHIC- MAG-Q-1004.

5.3 Measuring and test equipment used for this procedure shall contain a valid calibration label in accordance with RHIC-MAG-Q-1000.

6 Preparation for Delivery:

6.1 N/A