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Magnet Division Procedure

Procedure: SMD-AGS-3003

Revision: A

AGS Snake Magnet Inner & Outer Coil Machining and Pinning

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Revision History

Rev A: Initial Release 4/26/04

1 Scope:

This procedure describes the final machining and assembly of inner and outer helical coil sub-assemblies for the AGS Snake magnet. The operations include machining coil overwraps to size, adding spiral grooves to the overwraps, and insertion, registration, and pinning of the inner coil to the outer. Also included are all appropriate inspections and testing.

2 Applicable Documents:

RHIC-MAG-Q-1000	Procedure for Control of Measurement Test Equipment
RHIC-MAG-Q-1004	Discrepancy Reporting Procedure
RHIC-MAG-R-7227	Electrical Resistance Measurements
RHIC-MAG-R-7228	Coil Inductance & Q Measurements
RHIC-MAG-R-7242	Hypot Testing
RHIC-MAG-R-8853	Hypot Testing – Helical Coil Insulation Assembly
BNL Dwg. 22010017	Inner Coil Machined Cooling Channels
BNL Dwg. 22010018	Outer Coil Machined Cooling Channels

3. Requirements:

3.1 Material & Equipment

Black Felt Tip Pen	BNL Stock No. S-23757
Tie Wrap	BNL Stock No. A-59829
Insulated Gloves	BNL stock No. K-63028

High Efficiency Particulate Air (HEPA) filter equipped vacuum cleaner.
Dial Indicator

3.2 Safety Precautions:

3.2.1 Operators shall wear:

- Insulated gloves when handling machined epoxy/fiberglass overwrapped coil assembly to prevent skin irritation.
- Latex gloves while handling acetone or ethanol.

NOTE

Latex gloves only give marginal protection to most solvents used and should only be considered as protection from incidental contact/exposure. If the glove is contaminated, it should be removed and a new glove put on.

3.2.2 Operators shall wear safety glasses with side shields or goggles while performing machining operations.

3.2.3 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.

3.2.4 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.

3.2.5 Hypot testing poses 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 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.

3.2.6 Entanglement with rotating machinery/moving parts can occur if loose fitting clothing or hanging jewelry is worn or if long hair is not tied up.

3.2.7 Do not use machines if a test of interlocks was not performed within the last six months and the dated Interlock Test Form is not posted near machines.

3.2.8 Specific steps of this procedure contain electrical and mechanical assembly operations that impact the environment. Prior to performing these steps, personnel shall complete the applicable facility specific environmental training.

4 Procedure:

4.1 Coil Machining

CAUTION

Process generates airborne epoxy particulate. Adequate ventilation and personal protective equipment must be used. See ES&H Coordinator/FS Representative for determination.

4.1.1 Mount coil sub-assembly in lathe.

4.1.2 Secure leads inside tube or on hub to prevent damage during coil rotation. Check clearances by rotating coil by hand before powering machinery.

NOTE

Do not kink leads. They must extend straight out from tubes, then be coiled individually into a 3.0" min. diameter coil and secured with tie wraps. Cover with plastic bag.

4.1.3 Machine coil sub-assembly to proper OD dimension (inner coils: dwg. 22010017; outer coils: dwg. 22010018).

4.1.4 Remove overwrap from non-lead end for 1.0 inch to expose keyways in aluminum tube. Non-lead end plate must engage keyways in both tubes.

4.1.5 Inspect machined coil OD while on lathe (done by machine operator).

- INNER & OUTER coils: Measure OD of coil in vertical and horizontal axes starting at a point 1.0" from the lead end. Repeat measurement every 3.0".

- OUTER COILS only: Measure ID and circularity of aluminum tube in vertical, horizontal, and 45° axes (4 planes) starting at a point 1.0" from the lead end. Repeat measurement using bore gage every 3.0 inches to maximum depth of gage. Repeat at non-lead end of tube.

4.1.6 Inspect machined coil straightness (done by machine operator).

4.1.7 Evaluate whether sufficient clearance exists to insert inner coil into outer. Notify cognizant mechanical engineer if further machining is required on OD of inner coil to allow insertion.

4.1.8 Remove coil sub-assy from lathe. Install in the Awea machining center that was used to create the helical winding slots and vent holes in the bare aluminum tubes. Index the tube the same way as originally oriented.

CAUTION

The subsequent drilling operations will create vent holes through the overwrap down to the coil surface. These new holes must be coaxial with the vent holes already existing in the aluminum coil tubes. The conductor in the winding slots can be DAMAGED PERMANENTLY and IRREPARABLY if the program for drilling the overwrap holes does not place the drill point at the same location as originally machined in the tubes.

4.1.9 Determine the proper IGES file programming to be used for re-drilling/extending the vent holes through the overwrap. Refer to file **22010008.iges** for the inner coil; file **22010009.iges** for the outer coil.

4.1.10 Test programming using marker or similar non-destructive indicator to be certain of proper functioning before drilling. Remove marker and insert drill bit.

4.1.11 Cautiously drill the first six vent holes indicated as holes #1 through #6 on the drawing:

- one hole at the longitudinal center at the top.
- two more holes 28.738 inches to either side of the first at the top.
- three other holes at same longitudinal positions but at bottom of tube.

The final depth of each hole should be enough to slightly pierce the aluminum surface yet leave no residue within the hole.

4.1.12 Verify that all six vent holes just drilled are concentric with the previously existing vent holes in the aluminum tube.

CAUTION

DO NOT PROCEED if test holes do not properly align with existing vent holes, and notify cognizant mechanical engineer.

4.1.13 Proceed to drill all remaining vent holes in the tube.

4.1.14 Drill the four pinning holes at the lead end (90° apart) through the overwrap down to the tube surface.

4.1.15 Prepare machine to cut helical vent grooves in overwrap; machine the grooves.

4.1.16 Return coil to Magnet Division technicians.

4.1.17 Cap off ends of coil tube. Blow pressurized air through tube to clear vent holes of any debris.

CAUTION

Wear personal protection equipment to protect eyes, face, and lungs.

4.1.18 Inspect Coil Diameters.

- INNER & OUTER coils: Measure OD of coil in vertical and horizontal axes starting at a point 1.0" from the lead end. Repeat measurement every 3.0".
- OUTER COILS only: Measure ID and circularity of aluminum tube in vertical, horizontal, and 45° axes (4 planes) starting at a point 1.0" from the lead end. Repeat measurement using bore gage every 3.0 inches to maximum depth of gage. Repeat at non-lead end of tube.
- OUTER COILS only: Fit-check lamination over finished coil.

4.1.19 Inspect coil straightness. Notify cognizant mechanical engineer if straightness of either coil sub-assy or OD of inner sub-assy might impair insertion of inner coil into outer.

4.1.20 Perform electrical testing per Appendix 1.

4.2 Inner / Outer Coil Registration & Pinning

4.2.1 Clean inner surface of outer coil, and outer surface of inner coil as required.

4.2.2 Insert inner coil into outer, making certain to locate the registration pins at the lead end 180° apart as shown on dwg. 22010001. (Note: with pins 180° apart, inner coil will be inserted upside down into outer)

4.2.3 Place assembly on suitable cradle rests.

4.2.4 At the non-lead end, temporarily insert the four keys into the keyways to align and center the coils with respect to each other. Identify and mark the locations of

the keys relative to the top of the outer coil for later re-installation into the same slots.

4.2.5 With keys engaged at non-lead end, firmly insert temporary shims (~.001 - .005 thick) between inner and outer tubes at the lead end to make tubes concentric.

4.2.6 Enlarge the four radial registration holes through both tubes at the lead end by transfer drilling. Ream holes for precision pin (.2497" dia.).

4.2.7 Drive four alignment pins into reamed holes. Remove temporary alignment shims at lead end. At non-lead end make sure keys are unambiguously identified for later re-installation into same slots, then remove keys.

4.3 End Plate Installation

4.3.1 Remove plastic bag from leads and uncoil.

4.3.2 Support lead end plate. Orient end plate so that top is at top of outer coil. This will place outer coil pin into end plate hole, and inner coil pin in slot.

4.3.3 Route main power leads and quench heater leads through kidney-shaped cut-outs in end plate.

4.3.4 Attach lead end plate to coil sub-assy "loosely", engaging outer and inner coil alignment pins in hole and slot, respectively. Only hand tighten the screws.

4.3.5 Align and install non-lead end plate onto coil sub-assy using four keys attached to end plate. Keys must be installed into same keyways as marked on coil.

4.3.6 Install four support feet on shell welding fixture in two sets; each set is to be 90.5 inches apart, outside to outside.

4.3.7 Transfer sub-assy to shell welding fixture, with end plate notches resting on feet.

4.3.8 Check alignment of end plates to each other using feeler gages between support feet and support notches. There should be no detectable gaps at any of the four supports.

4.3.9 Securely tighten screws holding lead end plate to coil sub-assembly while aligned on feet. Torque to 100 in-lbs.

4.4 Lead Potting

4.4.1 Remove non-lead end plate. (keys can remain with end plate. If removed, they must be relocated into same slots)

4.4.2 Install up-ending/lifting/stacking tool (25-1905.01-5) into coil sub-assy from non-lead end.

4.4.3 Up-end sub-assy, lead end up.

4.4.4 Insert leads through G-10 insulators. Leads must be properly grouped: the two power leads of each block (+lead w/stabilizer, -lead w/stabilizer) along with the two leads for the quench heaters are inserted into one hole. This will be a total of six wires per hole.

4.4.5 Using 5 minute epoxy (P/N 12040120), create a "dam" within the end plate cut-out around the leads down to the surface of the coil. The dam should be about .13 to .19 deep as measured from coil end surface to top of the dam within the cut-out. Refer to drawing 22010522, Detail D.

4.4.6 Immediately seat the G-10 insulators into this dam by inserting them into the end plate cut-out. The leads must not be allowed to kink but can bend, making a gentle transition from the coil end through the insulator. The insulators must press into the dam all around. If this is not the case, remove insulator and build up 5 minute epoxy in low areas.

4.4.7 After 5 minute epoxy has set, "pot" leads into holes in insulators using 2850FT epoxy (P/N 12055014-02). Fill up to or slightly below surface of insulator. Allow epoxy to set for 12 hours at room temperature.

5 Quality Assurance Provisions

5.1 The Quality Assurance provisions of this procedure require that the technician 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

The up-ending/lifting/stacking tool (25-1905.01-5) inserted from the non-lead end should remain in the assembly. It will be used in this position in a subsequent procedure.

Appendix 1 - Electrical Testing

NOTE

Pay particular attention to safety requirements included in individual electrical test procedures.

- Measure coil temperature and the RLQ for each coil block. Perform test in accordance with RHIC-MAG-R-7227 & RHIC-MAG-R-7228.

NOTE

If Coil has previously been cold tested, contact Cognizant Electrical Engineer before proceeding.

- Measure the leakage current of each coil block in accordance with RHIC- MAG-R-7242. Hypot voltage is 1000 V (see caution note above). Max acceptable leakage is 50 μA.

- Perform electrical test of quench protection heaters to ground and to coils. Hypot voltage is 1000 V. Max acceptable leakage is 50μA.

- Cognizant Electrical Engineer to review test data and sign-off "OK to proceed".