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Magnet Division Procedure

Procedure: SMD-RHIC-3001

Revision: B

Helical Magnet Coil Assembly

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Revision History

Rev A: Initial Release 10/4/02
Rev B: Changes per ECN MG2129 5/22/03

1 Scope:

This procedure describes the fabrication of Inner & Outer Helical Coil Assemblies for spares. This includes insulating the tubes, stabilizing and potting leads, 1st wrapping and curing, and 2nd wrapping and curing. It also includes final machining, and 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-8553	Hypot Testing – Helical Coil Insulation Assembly
BNL Dwg. 12011002	R.H. & L.H. Inner & Outer Coil Wrapping Curing.
BNL Dwg. 12011004	R.H. & L.H. Inner & Outer Coil Insulation
BNL Dwg. 12011005	R.H. Inner Coil Winding & Curing Assy.
BNL Dwg 12011006	R.H. Outer Coil Winding & Curing Assembly
BNL Dwg 12011199	L.H. Inner Coil Winding & Curing Assembly
BNL Dwg 12011200	L.H. Outer Coil Winding & Curing Assembly
BNL Dwg. 12011114	R.H. Inner & Outer Coil Lead Stabilizing
BNL Dwg. 12011115	L.H. Inner & Outer Coil Lead Stabilizing
OPM 8.1.1.16	Operation of Corrector Coil Overwrap Machine
OPM 8.1.1.33	Operation of the Beam Tube Curing Oven

3. Requirements:

3.1 Material & Equipment

Black Felt Tip Pen	BNL Stock No. S-23757
PVC Gloves	BNL Stock No. K-62649 (large)
Latex Gloves	BNL Stock No. K-62856 (ex large)
Tie Wrap	BNL Stock No. A-59829
Insulated Gloves	BNL stock No. K-63028
KEVLAR Yarn KM2	
TEFLON Plumbers tape	BNL stock No. I-40674
VELCRO Straps	
Brush	BNL Stock No. I-56400
Non-conductive Black Marker	BNL Stock No. S-23757
Paper Container	BNL Stock No. I-80300

High Efficiency Particulate Air (HEPA) filter equipped vacuum cleaner.
Coil Over wrap machine
Curing oven
Dial Indicator
Hand Grinder
Heat Gun
Insulated gloves
Lathe
Orangewood sticks
Oven
Over wrap Template
Scale
Solder pot
Soldering Iron
Teflon lined steel clamps
Tension Gauge
Test Rack ETS-001
Vented Hood
Vibration table
Web Straps

3.2 Safety Precautions:

3.2.1 To avoid the possibility of static build-up 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.

3.2.2 Operators shall wear:

- Insulated gloves when handling heated coil assembly or soldering operation.
- PVC gloves while handling epoxies.
- Latex gloves while handling epoxies
- Latex gloves while handling acetone, ethanol or type FT & MT epoxies.

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.

3.2.3 Operators shall wear safety glasses with side shields, or goggles while using the over-wrap machine or epoxy.

3.2.4 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.

3.2.5 The operator shall be instructed by the cognizant Technical Supervisor in the safe operation of the Coil Over wrap Machine.

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 This 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.

3.2.8 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.

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

3.2.10 Specific steps of this procedure contain Electrical & Mechanical Assembly operations that impact the environment. Prior to performing these steps, personnel shall complete the applicable facility specific environmental training.

3.2.10.1 Epoxy Usage Form (Appendix 3) shall be filled out at the end of the workday, recording the weight of all epoxies/agents used. The form shall remain posted in a jacket on the side of the machine until removed by the ESH Coordinator.

3.2.10.2 The ESH Coordinator shall report to the Laboratories Environmental Services Division epoxy usage based on Appendix 3 for Title V compliance (once the information on the information form has been reported to ESD, Appendix 3 is no longer required to be retained).

3.2.11 Ensure ventilation is aligned to the machine in use (Curing Oven or Overwrap Machine). Exhaust dampers for only the machine in use (Curing Oven – 3, Overwrap Machine – 2) shall be open, and adjoining machine closed.

4 Procedure:

4.1 Preparation for Coil Insulating.

4.1.1 Record serial number of coil support tube. Visually inspect coil assembly for any damage or machining burrs. If necessary deburr any sharp edges with 240 grit sandpaper.

4.1.2 Break sharp edges left from machining on the lead entrance opening of each lead end Coil block, approximately 0.015 +0.015/-.000" radius; use 240 grit sand paper. (See Dwg.12011004).

4.1.3 Clean assembly and wipe out slots with alcohol.

4.2 Insulation Lead End & Non-Lead Ends

4.2.1 Mark around the circumference of the coil support tube 7.53"± 0.12" in from the lead end and non-lead end for Inner Tube Coil Blocks 1-6 & Outer Tube Coil Blocks 1-8. Use black felt tip pen.

4.2.2 Mark around the circumference of the coil support tube 4.00"± 0.12" in from the lead end and non-lead end for Inner Coil Block 7. Use black felt tip pen.

4.2.3 Mark around the circumference of the coil support tube 5.37" ± 0.12" in from the lead end and non-lead end for Outer Coil Block 9. Use black felt tip pen.

4.2.4 Install KAPTON film 12010181-35 in the ends of the coil blocks up to the marks on each coil block. Film must overlap by 50% min. The KAPTON film must also overwrap onto the O.D. of the coil support tube by 0.15" minimum.

NOTE

Insure KAPTON film is pressed firmly along the contour of the slot and in the lower comers.

4.2.5 Trim the KAPTON film on the O.D. of the coil support tube to within 0.15" to 0.25"of slots.

4.2.6 Install KAPTON film (P/N 12010181-43) on the 4 points of the outer most coil block where the two slots meet. Install film on the vertical wall only. The film should extend a minimum of 0.5" back along the vertical walls from the points.

4.3 Cable Spacers

4.3.1 Cut NOMEX cable spacer (P/N 12011192) to the required lengths and quantities per table on drawing.

4.3.2 Install spacers using transfer tape #465. Spacers are installed in lead end and non-lead end of coil block slots where wall thickness transitions to straight section of coil block slot. Start spacer at point where transition radius ends.

4.4 Kapton Liners

4.4.1 Install transfer tape #465 on all 3 sides of the straight section of coil block slot #1. Tape shall overlap KAPTON film at each end of coil block slot by 0.50" ± 0.12''.

4.4.2 Cut KAPTON liner in half along length. Install liner in coil block slot #1. Liner shall overlap KAPTON film at each end of coil block slot by 0.50" ± 0.12". Trim as required.

NOTE

Insure KAPTON film is pressed firmly along the contour of the slot and in the lower corners.

4.4.3 Cover gap between liner halves using KAPTON film (P/N 1201081-43).

4.4.4 Repeat paragraphs 4.4.1 thru 4.4.3 for all remaining coil block slots.

4.5 Hypot Testing

4.5.1 Perform Hypot Testing of Assembly as specified in Procedure RHIC-MAG-R-8853.

4.6 NOMEX Protectors

4.6.1 Fabricate NOMEX Protectors per Drawing. Protectors should be trimmed to butt fit against cable spacers. Apply transfer tape on vertical walls only and install NOMEX protectors. Repeat for all protector locations as specified on drawing.

4.7 Preparation for Coil Winding

4.7.1 Visually inspect insulated coil support tube for any damage to KAPTON insulation. Clean assembly

4.7.2 Enter wire and cable identification numbers for each coil block in table on production traveler

4.8 Spooled Cable Resistance Measurements.

4.8.1 If Spooled cable resistance measurements were not performed during cable handling, then per measurements per appendix 2.

4.9 Incoming [Start] Lead Stabilizer.

4.9.1 Cut 30" lengths of Helical cable (P/N 12000027) as stabilizers.

NOTE

Inner Coils require 7 stabilizers. Outer Coils require 9 stabilizers

4.9.2 Remove insulation from the stabilizers. Solder (Tin) stabilizers using solder pot filled with tin/silver solder . (P/N 12010923) Clean stabilizers with alcohol. Check that all flux residues are removed.

NOTE

Ensure unused solder is recycled or disposed of properly

4.9.3 Remove the Kapton insulation from the first 30" of cable on a spool.

NOTE

Exercise care when cutting insulation to avoid damaging super-conductor wire.

4.9.4 Slide 2" length of 0.063" diameter Shrink tubing (P/N 12040126-03) over end of cable. Insure shrink tubing is slid far enough back so it is not affected by heat from the soldering operation.

4.9.5 Apply flux to the bare cable (of spool) and tin with solder. Apply flux to the pre-tinned stabilizer and tinned cable end and clamp. Solder together using solder. Clean with alcohol.

NOTE

Ensure unused solder is recycled or disposed of properly

4.9.6 Wrap stabilized lead with KAPTON tape (P/N 12010181-35) using half overlap wrap. Wrap should continue approximately 0.5" beyond the stabilized lead.

4.9.7 Slide the 2" length of 0.063" shrink tubing forward on the cable spool until it butts against the stabilized lead and then shrink. See figure 1.

4.9.8 Install 0.125" shrink tubing over the entire length of the stabilized lead. While installing, stretch tube slightly. Overlap the .063" shrink tubing as shown on drawing.

4.9.9 Repeat steps 4.9.3 to 4.9.8 for all the remaining cable spools.

4.10 Temporary TEFLON Cable Spacers

4.10.1 Install temporary TEFLON Cable Spacers in the Lead End & Non-lead End of each support tube prior to winding. Secure spacers to coil outside wall of slot using #465 transfer tape. See Drawing table for part numbers and locations.

4.11 Substrate Pre-Preg Assembly.

NOTE

Check drawing 12011025 for required substrate part numbers for every layer installed. Required part numbers are dependent upon layer and coil block.

4.11.1 Remove protective backing from 3M #465 transfer tape (P/N 12011353) on the fiberglass side and install curved end pieces in the coil block slot with fiberglass side down. Apply pressure to insure contact. Trim if necessary,

4.11.2 Install straight sections of substrate into straight slots. Fiberglass side down, ends of substrate must butt up to the curved end pieces within 0.04". Firmly press on protective backing of transfer tape to set substrate in place.

4.12 NOMEX Lead Protectors

4.12.1 Install NOMEX lead In protector 12011315 as shown on drawing 12011004. Attach in place with #465 transfer tape.

4.12.2 Form the stabilized lead into the lead slot as shown on Drawing - "Start of winding" detail.

NOTE

Minimum bend radius for leads is 0.3"

4.12.3 Bond the start point of the unstabilized cable in the coil block with 5-minute epoxy. See Drawing for location. Bond to bottom of the slot.

4.12.4 Form pieces of Green Putty on both sides of the lead wire using forming tool, and allow to harden. Trim and remove excess putty.

4.12.5 Install NOMEX lead protector 12011366-xx /12011316-xx over cured putty. Attach with transfer tape #465.

4.13 Coil Winding

4.13.1 Starting with the outer most slot (Block 7 for Inner coil, Block 9 for outer coil), wind the first layer of coil block. Check Drawing for the required amount of turns and layers.

4.13.2 Upon completion of turn 12, wrap the cable using half overlap with KAPTON tape (P/N 12010181-35) at transition point (transition point is where the cable rises up to the next higher layer in the coil. See Dwg. for transition locations.

4.13.3 Repeat sections 4.11.1 & 4.11.2, 4.13.1 & 4.13.2, installing substrate and cable until the coil block has the required amount of layers. Install NOMEX lead out protectors (P/N12011317) as shown on Dwg. 12011004. Attach in place with #465 transfer tape.

NOTE

If the height of the coil stack begins to grow excessively during winding, the following clamping procedure should be used (it is also suggested if winding of a block exceeds one day).

After the 3rd & 6th layers are wound, clamp the layer down using steel clamps and multiple pusher blades. Straight sections should be clamped every 4" and the ends every inch. All clamps should be installed and tightened, then removed prior to proceeding to the next layer.

4.13.4 Repeat sections 4.11.1 & 4.11.2, install substrate over top layer of coil. Remove temporary Teflon end spacer.

4.13.5 Trim outgoing cable to a length of 34" past the out going lead exit point. See Dwg. for exit points.

4.13.6 Install the appropriate end press plates (P/N 12011042/43/44-xx) See Drawing and table for part identification and location. Cut and trim plates as necessary.

NOTE

Operations on G10 material that can produce dust (machining, cutting, grinding, sanding) require proper safety practices. Eyes and skin protection and HEPA Filter vacuum required. **See ES&H Coordinator/FS Representative for Questions.**

4.13.7 Slide a length of Teflon tubing over existing lead wires. Label start and finish lead per drawing.

4.13.8 Clamp end plates using Teflon lined steel clamps. Do not over tighten.

4.13.9 Install straight section plates (P/N 12011044-xx) and "Y" slot plates (P/N 12011340/341).

4.13.10 Locate Teflon lined steel clamps every 4" of coil length. These clamps must be installed whenever the coil is not being worked on.

4.13.11 Secure start and finish leads to coil support tube with tape. Minimum bend radius for lead is 0.3".

4.13.12 Repeat steps 4.10.1 through 4.13.11 for all remaining coil blocks.

4.13.13 Inspect coil, insure plates are in proper location, all wires are below press plates, and all lead wires are labeled.

4.13.14 Teflon lined steel clamps should be of uniform torque and distances apart.

CAUTION

Uneven torque and /or spacing of clamps can cause wires to bulge, which will result in unsupported wires. Wires protruding from under press plates may be pinched between plate and tube, resulting in shorts and /or permanent damage.

4.14 Stabilize Outgoing Leads

4.14.1 Cut 30.0" lengths of Helical Dipole Cable (P/N 12000027)

NOTE

Inner Coils require 7 stabilizers. Outer Coils require 9 stabilizers

4.14.2 Remove insulation from 30" lengths of lead wire (surplus stock) and tin using solder pot.

NOTE

Ensure unused solder is recycled or disposed of properly

4.14.3 Install 2.0" piece of 1/16 shrink tubing (P/N 12040126-03) over the outgoing coil lead, do not shrink at this time.

4.14.4 Remove the insulation from all the coil block outgoing leads to within 1.3" from the lead start point. See Drawing 12011114 / 12011115.

NOTE

Exercise extreme care when removing insulation to avoid damaging super Conductor wire.

4.14.5 Clean lead on coil block with scotch-brite pad and wipe clean with alcohol.

4.14.6 Using solder & paste (P/N 12010923-02 /12010069) tin outgoing coil block leads.

NOTE

Ensure unused solder is recycled or disposed of properly

4.14.7 Clamp pre-tinned stabilizer parallel to the entire length of out going lead.

4.14.8 Solder stabilizer and lead together.

NOTE

Ensure unused solder is recycled or disposed of properly

4.14.9 Clean stabilized lead with alcohol to remove excess flux.

4.14.10 Wrap stabilized lead with Kapton tape (p/n 12010181-35). Start the wrap at the lead starting point and wrap using 50% overlap until end is reached.

4.14.11 Slide 1/16" shrink tubing (from step 4.14.3) to butt against stabilizer & shrink.

4.14.12 Install one layer of 1/8" diameter shrink tubing (p/n 12040126-01) for the entire length and shrink. Overlap existing 1/16 shrink tubing as shown on drawing.

4.14.13 Repeat steps 4.14.1 through 4.14.12 for remaining leads.

4.15 NOMEX Lead Wire Liners.

4.15.1 Remove Teflon wrapped press plates and mark section which lines up with channels in coil tube.

4.15.2 Inspect lead wire channel coil crossover locations for high-spots or misplaced wires. Correct or modify as necessary to insure flat placement of lead wires. Label incoming leads for future reference.

4.15.3 Trim slot into end press plates such that the lead channel from the coil tube is continuous across the press plate. Check that the bottom of the slot in the plate is smooth and that it is level with the slot in the coil tube.

4.15.4 Cut NOMEX tube (12050280) to length (full length of outgoing lead to 1/8" inside end of coil tube) and slide over both incoming and outgoing leads. Ensure that wires do not become crossed or twisted.

4.15.5 Locate the appropriate lead wire pair into the wire channel.

4.15.6 Cover exposed sections of wire with NOMEX patch (.015) and re-clamp securely.

NOTE

Minimum bend radius of 0.3” for lead wires.

4.15.7 Install a second layer of 1/8” diameter shrink tubing (P/N 12040126-01) over each incoming and outgoing lead overlapping end of the aluminum coil tube by ¼”.

4.15.8 Bond the lead wires to the channels at each end.

4.15.9 Cut two 1” pieces of red shrink tubing (12011368-01) and slide over incoming lead. Position tubing 1.5” from end of tube, and the other 1” from the end of the start lead. Shrink in place.

4.15.10 Locate two wire labels (12011367) on each wire (start & finish), correctly labeling the identity of the coil block. See Drawing 12011114 /12011115 for locations.

NOTE

Every lead must have 2 wire labels. The start lead for each block must also be identified with red shrink tubing.

4.15.11 Repeat steps 4.15.1 through 4.15.10 for remaining leads.

4.16 Electrical Tests

4.16.1 Perform electrical testing per Appendix 1.

4.17 Preparation for 1st Over wrap

4.17.1 Inspect coil assembly for any damage to wires or KAPTON insulation. Clean assembly.

4.17.2 Install TEFLON tubing sleeve over "finish" lead wires. Secure with tape.

4.18 Preparation for Cure

4.18.1 Inspect G10 end plates and G10 straight section plates. Insure that wires are captured under plates. Gap between plates should measure between .050" - .150" .

4.18.2 Route lead wires between coil blocks and secure to tube with tape.

4.19 Press Plate Clamping

4.19.1 Install coil assembly in the Coil Over wrap Machine.

4.19.2 Remove the TEFLON lined steel clamps near the center of the coil.

4.19.3 Secure TEDLAR film (P/N 12011229) to center of the coil with tape.

4.19.4 Wrap TEDLAR film from center to Non-Lead End using 50% overlap, removing the TEFLON lined steel clamps in the process.

4.19.5 Secure the TEDLAR film at the Non-Lead end with tape.

4.19.6 Secure TEDLAR film to the center of the coil with tape.

4.19.7 Wrap TEDLAR film from center to Lead End using 50% overlap, removing the TEFLON lined steel clamps in the process.

4.20 KEVLAR Wrap

4.20.1 Install KEVLAR yarn KM2 on over wrap machine.

4.20.2 Adjust and set Tension to 5 lbs. Set machine pitch to setting #8.

4.20.3 Mark coil tube around circumference at 8” from each end with a red felt marker.

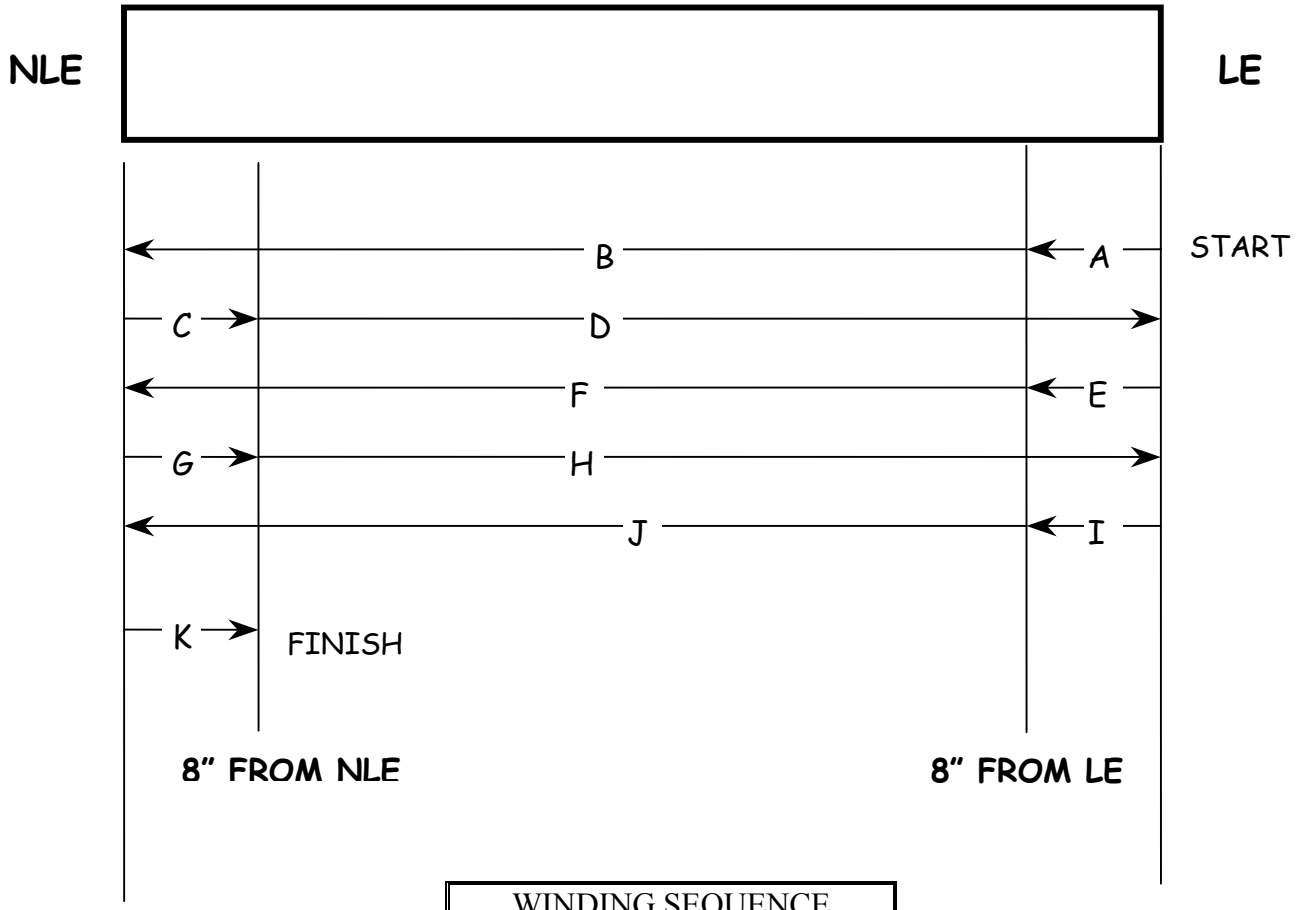
4.20.4 Starting at the lead end of the tube, wrap a couple of turns of yarn to secure the starting point of the caps.

4.20.5 Start the machine and wrap yarn from the LE to a point 8" from the LE. Stop machine. This is Pass A. Do not cut yarn. See figure 1.

4.20.6 Adjust machine settings and perform Pass B.

4.20.7 Perform Pass C thru Pass K, adjusting machine settings as required by Figure 1. After Pass K, stop machine, cut yarn and secure with Kapton tape.

Figure 1 – Coil Wrapping Sequence



WINDING SEQUENCE MACHINE SETTINGS		
PASS	**TENSION (LBS)**	**MACHINE PITCH SETTING**
A	5	4
B	5	25
C	5	4
D	5	25
E	10	4
F	10	25
G	10	4
H	10	25
I	15	4
J	15	25
K	15	4

4.21 Electrical Tests

4.21.1 Perform electrical testing per appendix 1.

4.22 Coil curing

4.22.1 Attach " curing" hubs on each end of the tube assembly.

4.22.2 Install coil in curing oven.

4.22.3 Attach thermocouples to the coil hubs at each end. The thermocouple must be in contact with either the aluminum surface of the coil or the steel "curing" hub.

CAUTION

Ensure Proper Ventilation for Oven. Oven dampers (3) OPEN and Winding Machine Dampers (2) inserted. Fan runs until coil is at room temperature

4.22.4 Set oven temperature to 121 C (250 F), start strip chart recorder and rotation motor.

4.22.5 Allow temperature to come up to cure temperature and remain at that temperature for a minimum of 2 ½ hours.

4.22.6 When the cure is complete, and the coil has cooled down to room temperature, remove the thermocouples.

4.22.7 Allow coil to cool to ambient temperature before electrical testing.

4.22.8 Remove all KEVLAR and TEDLAR wrapping material from the coil.

4.22.9 Remove and save the removable lead end press plates.

4.22.10 Inspect coil, examine lead wires for contact with aluminum support tube.

4.23 Electrical Tests

4.23.1 Perform electrical testing per Appendix 1.

4.24 Epoxy Fill Of Press Plate And Coil Wire Voids.

NOTE

Ensure adequate ventilation while performing all epoxy operations. See ES&H Coordinator/FS Representative for Determination.

4.24.1 Install vibration table under center of coil. Secure coil to table with two web straps. Suspend each end of coil with web straps to reduce excessive weight from vibration table.

4.24.2 Install heat guns in both ends of coil tube and warm up ends.

NOTE

Do not allow coil ends to warm to over 250 F, it is important to Monitor heat during this operation.

4.24.3 Mix batch of 2850 FT epoxy.

NOTE

Pot life is approximately 60 minutes at room temperature and less at elevated temperatures.

NOTE

Fill in weight of epoxy/agents used in Appendix 3.

4.24.4 With coil ends warm, fill the voids in the coil ends and press plates with 2850FT epoxy. Syringes can be used to fill voids.

NOTE

Syringes shall be disposed of per the Regulated Medical Waste Management SBMS Subject area (https://sbms.bnl.gov/standard/0p/0p01d011.htm**).**

4.24.5 Turn on vibration table and refill areas with epoxy as required.

NOTE

The epoxy fill will have to be done in sections. Check that the epoxy has set before rotating to fill another section.

4.24.6 After the last section has set, turn off vibration table and heat guns.

4.24.7 Remove coil from vibration table.

4.24.8 Inspect coil ends, note remaining voids, these are to be filled in with 2850MT (blue).

NOTE

Perform all epoxy operations in front of vented hood.

4.24.9 Mix batch of 2850MT (blue) epoxy.

NOTE

Fill in weight of epoxy/agents used in Appendix 3.

4.24.10 Install heat gun in lead end (non lead end also, if voids were found). Warm up the coil tube end

4.24.11 Fill any remaining void in the press plates or in the lead wire channels. Wrap coil end with Tedlar film and tape. Clamps can be used as hold down.

4.24.12 Turn off heat, allow epoxy to cure.

4.24.13 Remove Tedlar tape and inspect.

4.25 OD Measurement and Coil sizing.

4.25.1 Coil lead wires for protection and secure with Tie Wraps

4.25.2 Install coil assembly in coil over wrap machine.

4.25.3 Zero dial indicator on ends of aluminum coil tube

4.25.4 Rotate coil by hand, pass dial indicator over coil end press plates and suspected high spots. Mark high spots with marker.

NOTE

Allowable maximum height from aluminum coil tube is 0.080”

4.25.5 Grind / sand high spots using hand grinder.

NOTE 1

Operations on G10 material that can produce dust (machining, cutting, grinding, sanding) require proper safety practices. Eyes and skin protection and HEPA Filter vacuum required. See ES&H Coordinator/FS Representative for Questions.

NOTE 2

Care must be taken grinding/ sanding over lead wires to avoid damage to leads.

4.25.6 Inspect coil with dial indicator, verify that high spots are removed.

4.25.7 Inspect lead wires for damage.

4.25.8 Inspect coil, insure wire labels are intact

4.26 Coil Over wrap Machine Setup

4.26.1 Install Teflon disc on lead end of coil, routing leads through holes, coiling and securing with Tie Wrap.

4.26.2 Locate second Teflon disc on Non-lead end receiving hub of Coil Over wrap machine.

4.26.3 Install coil tube assembly onto the over wrap machine.

4.26.4 Seal lead exit holes in Teflon disc with Kapton tape.

4.26.5 Wrap bands of masking tape around outside of the wound coil leads to secure leads from damage during coil rotation. Rotate coil and observe.

4.27 Fiberglass Wrap (dry)

4.27.1 Install 1” wide fiberglass tape (P/N 12040039) on coil over wrap machine.

4.27.2 Set tension to ~5lbs using Tension gauge.

4.27.3 Position tape/Kevlar carriage to starting position at Non-lead end.

4.27.4 Secure end of fiberglass tape at the Non-lead end with kapton tape.

4.27.5 Start over wrap machine and wrap coil with one layer of fiberglass tape, using 50% overlap, machine pitch setting # 24

NOTE

Fiberglass tape should be flush with Teflon discs at both ends.

4.27.6 Stop machine and cut fiberglass tape at Lead end , secure with Kapton tape.

4.28 Kevlar Wrap (dry)

4.28.1 Remove Fiberglass spool from over wrap machine and install KEVLAR spool on over wrap machine.

4.28.2 Measure tension with Tension gauge, and set to 13 ~ 15lbs.

4.28.3 Position over wrap machine carriage to starting position at Non-Lead end. Set pitch to 0.036, (28 cords/in) machine pitch setting #4.

4.28.4 Secure the Kevlar yarn at the Non-lead end with a knot around the coil. Start Kevlar ¼" from Teflon disc.

4.28.5 Start machine and wrap coil with two layers of Kevlar yarn, reversing the carriage motion when the Kevlar reaches the Teflon lead end disc.

4.28.6 Stop machine when Kevlar returns to the starting point at the Non-lead end. Wrap an additional two turns and cut and tie off the Kevlar yarn. Wrap Kapton tape 360 around coil over knots to secure.

4.29 Tedlar Wrap (dry)

4.29.1 Secure start of Tedlar film to the Non-lead end with Kapton tape.

4.29.2 Start machine and wrap coil with one layer of Tedlar film, 50% overlap. Cut film at lead end and secure with kapton tape.

4.30 Fiberglass Wet Wrap

CAUTION

Ensure Proper Ventilation. Oven dampers (3) CLOSED and Overwrap Machine Dampers (2) pulled out. See ES&H Coordinator/FS representative for questions.

4.30.1 Turn Exhaust Hood on.

4.30.2 Install 1" wide fiberglass tape on coil over wrap machine.

NOTE

Inner coils require 4 spools, approximately 1600yds. Outer coils require 6 spools, approximately 2400yds.

4.30.3 Mix equal amounts by weight (1:1 ratio) , Epoxy 815 adhesive (Dwg. no. 12010047) and Epoxy curing agent (BNL Dwg. no. 12010065).

NOTE

Inner coils require approximately 10 pints, mixed epoxy. Outer coils require approximately 14 pints, mixed epoxy.

NOTE

Fill in weight of epoxy/agents used in Appendix 3.

4.30.4 Adjust over wrap machine for 50% over lap, machine pitch setting #24.

4.30.5 Start machine, brush coat Tedlar covered coil assembly with a light layer of epoxy.

4.30.6 Position carriage at Non-lead end starting point , slow machine down and start fiberglass tape. Once started adjust motor speed as desired. Fully wet the fiberglass tape with epoxy applied by brush as coil is being wrapped.

NOTE

Wrap and epoxy must extend from end to end of tube within the Teflon discs.

4.30.7 Reverse carriage direction at lead end, continue this procedure until the OD of the tube meets dimensional requirements on drawing 12011002. Use Template to gage size.

NOTE

Epoxy life is 2 hours at room temperature.

4.30.8 Allow coil to remain rotating for a minimum of 12 hours to allow the epoxy to set.

NOTE

Ensure Overwrap hood doors are fully closed and fan running while epoxy sets.

4.30.9 Remove coil from over wrap machine.

4.30.10 Remove tie wraps from leads and remove Teflon discs.

4.30.11 Remove epoxy “flash” from coil ends with knife.

4.30.12 Inspect wire leads for damage, insure wire labels are intact.

4.31 Electrical Tests

4.31.1 Perform electrical testing per appendix 1.

4.31.2 Loop leads and secure with tie wraps.

4.32 Final Cure

4.32.1 Install coil into curing oven.

4.32.2 Attach thermocouples to the coil hubs at each end. The thermocouple must contact either the aluminum tube surface or the curing hub. Use oven thermocouple which is not attached.

4.32.3 Set oven for 80 C (176 F) and start recorder.

4.32.4 Start cure, allow temperature of oven to come up to temperature and remain at that temperature for 4 hours.

4.32.5 Allow coil to cool after cure, then remove from oven.

4.33 Electrical Tests

4.33.1 Perform electrical testing per appendix 1.

4.34 Preparation For Machining

4.34.1 Remove excess epoxy around lead wires.

4.34.2 Loop and secure lead wires with tie wraps. Cover lead wires with plastic bag and tape.

4.34.3 Tag coil with part number, including dash number, serial number and applicable revision letter. Mark Serial Number n each end of the aluminum support tube with non-conductive permanent marker.

4.35 Coil Machining

CAUTION

Airborne Particulate of Epoxy. Adequate ventilation and Personnel Protective Equipment Must be used. See ES&H Coordinator/FS Representative for Determination.

4.35.1 Machine coil to OD dimension on Dwg. 12011116.

NOTE

Do not bend or kink leads they must extend straight out from tubes and must be coiled individually into a 3.0” min coil and secured with tie wraps. Cover wrap with plastic bag.

4.35.2 Machining shop to inspect machined coil OD:

- INNER COILS ONLY. Measure OD of coil in both x and y axis starting at a point 1.0" from the lead end. Repeat measurement every 3.0".
- OUTER COILS ONLY. Measure OD of coil in both x and y axis starting at a point 4.0" form the lead end. Repeat measurements at points 51.0" and 98.0" from the lead end.

4.35.3 Machining shop to inspect machined coil straightness.

4.35.4 Return coil to magnet division.

4.35.5 Perform electrical testing per Appendix 1.

4.35.6 Inspect Coil Outer Diameter.

4.35.7 OUTER COILS ONLY. Inspect Coil Inner Diameter.

4.35.8 Inspect coil straightness.

4.35.9 INNER COILS ONLY. Add Scribe Mark along centerline of tube Keyway for orientation on Coil Assembly.

4.35.10 OUTER COILS ONLY. Fit check lamination over finished coil and visually inspect coil O.D. for flaws & voids.

5 Quality Assurance Provisions

5.1.1 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.

5.1.2 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.

5.1.3 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:

N/A

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 1000v.

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

Appendix 2 - Cable Spool Measurements

- Measure the Resistance and Temperature of the spooled cable for each coil block.

- Cut a 36" sample from each wire spool. Tag each sample with cable identification number, block number, date and initials. Example of tagged cable shall read:
  - Block # : HCD 5011
  - Cable ID: BNL-14-N-002-A
  - Date: : 3/01/99
  - Initial : RJ

- Route cable samples to the cable test group prior to coil winding. Verify each spool was measured for resistance, weighed, and 36" sample taken.

Appendix 3
EPOXY USAGE FORM

(Fill in Month and weight in grams of items used)

MONTH: _____

Date	Shell Epon Resin 815C	Shell Epi-Cure 3140 Curing Agent	E&C 2850 FT Epoxy	E&C 24 LV Catalyst w/FT Epoxy	E&C 2850 MT Epoxy	E&C 24 LV Catalyst W/MT Epoxy	Additional Solvents*
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2							
3							
4							
5							
6							
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***If solvents were added, list below:**