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1. Scope:

This procedure describes the methods used in curing an 8cm Dipole coil in the BNL long curing press. Appendix A provides the basic data used to program the BNL computer for the automatic curing cycle operation.

2. Applicable Documents:

BNL Dwg. No. 14010010	8cm Dipole Coil Winding & Curing Assembly
RHIC-OPM 8.1.1.28	Operation of Automated Long Coil Curing Press
RHIC-MAG-Q-1004	Discrepancy Report Procedure

3. Requirements:

3.1 Material/Equipment - The following process materials are referenced for use in this procedure and shall be controlled for procurement, use, storage and handling by the documents or catalog descriptions listed below. Substitutions require prior approval by the Cognizant Engineer.

<u>Procedure Reference</u>	<u>Technical Reference</u>	<u>Source/Control</u>
Degreaser	LPS Contact Cleaner	LPS Industries Inc. Tucker, GA
	Zepspre	ZEP, Inc., GA
Frekote 700	Frekote Release Interface	Frekote Products Bulletin 700
Teflon	Film Type 200PH (.002 in.-thick x 6 in.-wide)	E.I. DuPont Co., Inc. Fabricated Products Dept.

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<u>Procedure Reference</u>	<u>Technical Reference</u>	<u>Source/Control</u>
Kapton	Tape ½ in.-wide 0.0005 in.-thick; 0.0005 in.-thick Silicone Adhesive	R.H. Carlson P.O. Box 1687 Greenwich, CT Part No. K104
Non-conducting Marker	Staedtler Permanent marker #317 WP4	BNL Stock #S-23755
Velcro Straps	Velcro Strap 24 x 5/8	Gleicher Manufacturing 851 Jeraselem Rd. Scotch Plains, NJ
Scouring pad	Scotch Brite	3M Company
Towels	Kim Wipes Precision Wipes	Kimberly Clark Corp. Scott Towel Corp.
Tack rag	Gerson Tack Cloth	Gerson Co., Inc. Middleboro, MA
Gaussmeter	Gaussmeter	Magnetic Analysis Corp. Mt. Vernon, NY
Degausser	BNL Dwg. No. 25-953.01-5	
Tie wraps	BNL Stock No. A-59827	
Coil Transporter	BNL Dwg. No. 25-1796.01-5	

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3.2 **Safety Precautions:**

- 3.2.1 Operators shall be qualified by their cognizant technical supervisor in the safe operation of the coil curing press, RHIC-OPM 8.1.1.28.
- 3.2.2 Hard hats are required during crane operations.
- 3.2.3 All lifting and handling operations requiring overhead crane operations shall be performed by personnel who are holders of valid Safety Awareness Certificates and who have been trained and certified for the lifting device being used by the Cognizant Engineer or Technical Supervisor.
- 3.2.4 Proper eye protection (safety glasses, goggles) shall be worn while the hydraulic system is in use.

3.3 Cure Procedures:

3.3.1 FIXTURE CLEANING AND PREPARATION FOR CURE:

- 3.3.1.1 Record the serial number of coil in the traveler.
- 3.3.1.2 Inspect all parts including; end pushers, fasteners and formblock, for magnetization using the gaussmeter. Demagnetize any tooling which reads greater than 10 gauss using the degausser.
- 3.3.1.3 Clean formblock and all tooling parts using scouring pads and degreaser to remove all foreign matter from surfaces to contact coil. Vacuum entire formblock including threaded hole locations.
- 3.3.1.4 Inspect all tooling surfaces to contact coil for burrs or scratches. Deburr if necessary using vacuum to remove chips.
- 3.3.1.5 Wipe formblock and tooling parts using degreaser and towel. Follow up with a clean tack rag.
- 3.3.1.6 Place coil end pushers in formblock against fully retracted threaded hydraulic cylinder rods. Be sure that lead end and non-lead end pusher bars are placed at proper end locations.

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3.3.1.7 Apply Frekote 700 mold release to the inside surface of the formblock. Let dry for five minutes.

3.3.1.8 Remove clamp assemblies from coil ends.

CAUTION: Hardhats are required when overhead crane is in use. Failure to observe this caution may result in head injury.

3.3.1.9 Carefully lower mandrel/coil/blade assembly into the formblock using overhead crane and strongback assembly. The mandrel should be positioned using alignment pins on the ends of the formblock assembly.

3.3.1.10 Bolt the coil down into the formblock using through holes in the blade assembly and mandrel.

3.3.1.11 Torque each bolt three times minimum to assure the mandrel is seated properly. Use a spiral pattern starting with the center bolt. Torque 5/16" bolts to 300 in-lbs. 1/2" bolts to 825 in-lbs.

3.3.1.12 Remove blade holders from blade assembly. Cut away the Teflon from top of the blade surface where the blade holders were located.

3.3.1.13 Place a 3 mil shim and a layer of 1 mil Kapton tape on top of blades at lead and non-lead ends where blade holders were, only where Teflon has previously been removed (do not add to existing Teflon).

3.3.1.14 Install thermocouples. Be certain that mandrel thermocouple wires are routed thru slots in the blades and not on top of the blade surface.

3.3.1.15 Attach mandrel hot oil lines.

3.3.1.16 Set the pusher bar system to seat the end saddles against coil by manually pushing on end pushers.

3.3.1.17 Extend threaded hydraulic cylinder rods until they contact the end pusher bars. Insert shims if necessary.

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3.3.1.18 Lower locking bar to allow formblock to enter press.

CAUTION: Stand behind the formblock and use handles to move the formblock. Ensure no one is standing at the front of the formblock when it is moved. Failure to observe this caution may result in personnel injury.

3.3.1.19 Roll formblock assembly into press.

3.3.1.20 Raise locking bar and pin in place.

3.3.1.21 Check all hot oil lines for correct attachment.

3.3.1.22 Open all hot oil valves.

3.3.1.23 Check all nitrogen tank levels. Set regulators @ 5 psig.

3.3.1.24 Inspect the fan cooled heat exchanger and piping system for leaking Therminol 59. Repair and report to the cognizant supervisor any leaks found. Continue to inspect hourly during the cure program.

3.3.1.25 Start up the press as per RHIC-OPM 8.1.1.28.

3.3.2 CURE CYCLE:

NOTE: The parameters for the automatic cure cycle and an explanatory sheet are given in Appendix A.

3.3.2.1 Start the automatic cure cycle. Follow the instructions as they are given on the computer screen.

3.3.2.2 When the cure cycle pauses after gap measurements are taken at 135⁰C, determine the correct shim size based on a memo from the cognizant engineer.

3.3.2.3 Select/assemble the cure shims. Verify the thickness of both with a micrometer and install them in the press.

3.3.2.4 Resume the automatic cure cycle.

3.3.2.5 When the cure cycle is complete, shut down the press as per RHIC-OPM 8.1.1.28.

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3.3.2.6 Print computer cure summary sheet and attach to traveler.

3.3.3 CURED COIL REMOVAL:

3.3.3.1 Remove stop bar and roll formblock assembly out of press.

3.3.3.2 Remove thermocouples from mandrel only.

3.3.3.3 Turn off mandrel hot oil valves and disconnect hot oil lines. Cap all hot oil lines.

3.3.3.4 Unbolt mandrel from formblock.

CAUTION: Hardhats are required when overhead crane is in use. Failure to observe this caution may result in head injury.

3.3.3.5 Using the overhead crane, (2) ½ in. screw eyes and 6 ft. slings, carefully move curing mandrel and coil onto the winding machine.

3.3.3.6 Start up short coil winder following the “Start the Winder” procedure, section 5.4 of the RHIC-OPM8.1.1.19, “Operation of Short Winder”.

3.3.3.7 Press “Reset” on the Unidex 400 controller, then [F5] “machine”, [F5] “slew” to enter “joystick/manual” mode. Position the mandrel drive and carriage to allow the mandrel to be installed onto the winding machine.

CAUTION: Do not rotate the mandrel until the blades are removed.

3.3.3.8 Attach mandrel rotating supports and (2) straight section cable clamps to the centerpost. Lower the mandrel and cured coil onto winding machine, lining up journals with thru holes. Insert shoulder bolts and tighten.

CAUTION: Care must be taken when using a razor blade. Failure to observe this caution may result in personal injury.

3.3.3.9 Run razor blade horizontally along the top of the blades to cut the Teflon wrap. Do not cut against the blades; this might cause chips to be formed and damage the coil and blades.

3.3.3.10 Peel the Teflon wrap off the coil.

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- 3.3.3.11 Using the hand held blade holders, remove the blades from the mandrel and place on the blade cart.
- 3.3.3.12 Attach mandrel rotating supports to the blade spacer on the side opposite the centerposts.
- 3.3.3.13 Rotate mandrel so that the centerposts are facing up. Remove rotating supports and straight section cable clamps from the centerposts.
- 3.3.3.14 Tighten the lead #1 and non-lead #5 center post mounting screws. Remove centerposts #3 & #4. Of the remaining centerpost mounting screws, remove the screws that are in straight thru holes.
- 3.3.3.15 Remove the straight section locating pins. Remove centerpost #2, then slowly loosen the remaining centerpost screws. Remove centerposts #1 & #5.
- 3.3.3.16 Remove coil end force rings form saddles at each end.
- 3.3.3.17 With 2 Technicians, carefully lift coil off mandrel and transfer to coil assembly area.
- 3.3.3.18 Using a non-conductive green marker, record coil serial number, part number and revision letter on the inside diameter of the non-lead end coil end saddle.
- 3.3.3.19 Secure midplane and pole leads to coil with velcro straps.
- 3.3.3.20 Using a fine cut file, remove the flashing from the coil end saddles. To avoid damaging the coil leads, temporarily fold them back and secure them with velcro straps.
- 3.3.3.21 Roll up the coil excess leads and secure with tie wraps.
- 3.3.3.22 Enter all data into the Magnets Database.

4. Quality Assurance:

- 4.1 Insure all inspection and test operations have been verified and signed on the production traveler by the cognizant operator and that all discrepancies have been reported as per RHIC-MAG-Q-1004.

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4.2 Calibration:

Verify the calibration for the following equipment is current.

- Pressure Gauges
- Temperature Gauges
- Gaussmeter

5. Preparation for Delivery:

N/A

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APPENDIX A-1
Explanation of Cure Cycle Program

1. Program Steps:

00 HEAT to 135 ⁰ C	Heat the fixture to bring it from 25 ⁰ C to 135 ⁰ C while holding the coil under medium pressure (cycling).
01 1st Sizing Step @ 135 ⁰ C	Close the mold and hold the coil under high pressure while at 135 ⁰ C for 30 minutes to size the coil.
02 HEAT to 225 ⁰ C	Unload the coil completely and heat the fixture to bring it from 135 ⁰ C to 225 ⁰ C.
03A MOLD @ 225 ⁰ C	Hold the fixture @ 225 ⁰ C for 5 minutes while holding the coil under low pressure to bond the cable turns together.
03B Begin Cooling	Cool the fixture for 5 minutes while holding the coil under low pressure.
04 COOL to 135 ⁰ C	Unload the coil completely and cool to 135 ⁰ C.
05 2nd Sizing Step @ 135 ⁰ C	Same as Step 01.
06 COOL to 25 ⁰ C	Cool the fixture to 25 ⁰ C while holding the coil under high pressure (cycling).

NOTE: All temperatures listed are average mandrel temperatures.

2. Hydraulic System Commands:

The hydraulic system is turned off for specific time intervals in minutes (Hyd. Disengaged). Otherwise the hydraulics remain on for the time intervals shown (Hyd. Engaged). Turning off the hydraulic system allows release of stresses produced by non-uniform thermal expansion or contraction of the coil and curing fixture components.

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3. Valve and Fan Operation:

Various valves control the secondary flow of oil to the curing fixture (formblock and mandrel), the oil heater or to heat exchanger with cooled oil. The fan in the external heat exchanger is used for cooling. When the ambient temperature is high, a water-cooled heat exchanger is also used.

4. Computer Control Cure Cycles:

The following table shows the BNL Cure Cycle Program.

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APPENDIX A-2
Cure Cycle Program

STEP #	HEAT 00	SIZE 01	HEAT 02	MOLD 03	COOL 04	SIZE 05	COOL 06
MANDREL VALVE OPEN (MIN.)							
FORMBLOCK VALVE OPEN							
HYD DISENGAGED (MIN.)	(1-1/2)*	-	√	-	√	-	(1-1/2)*
HYD ENGAGED (MIN.)	(2-1/2)*	√	-	√	-	√	(5-1/2)*
PUMP ON							
HEAT VALVE OPEN							
COOL VALVE OPEN							
FAN ON							

*Indicates cycling times.