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Relativistic Heavy Ion Collider
Magnet Division Procedure

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Class: Acceptance Test Procedure
Title: RHIC DRG Dipole Magnet Warm and Cold Measurements in Magcool Horizontal Test Bay

- Prepared by: Signature on File
- Cognizant Engineer/Scientist: Signature on File
- Electrical Systems Section: Signature on File
- Q. A. Approval: Signature on File
- ES&H Review: Signature on File

REVISION RECORD

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1. Scope:

This procedure describes the operations for warm and cold tests and measurements during the production process for RHIC Arc Dipole Magnets (DRG) in Magcool Horizontal test bays.

2. Applicable Documents:

RHIC-MAG-Q-1004 "Discrepancy Reporting Procedure"

RHIC-MAG-R-7242: "RHIC Hypot Testing"

RHIC-MAG-R-7320: "RHIC Electrical Resistance Measurement for Collared Individual and Connected Coil Sets"

RHIC-MAG-R-7735: "Replaying/Transferring and Magvaxing Harmonic Data"

RHIC-MAG-R-7736: "Vertical and Horizontal Magnet FFT Ratiometer Test"

RHIC-MAG-R-7752: "Mole Transporter Setup & Operation for Magnetic Measurements in Horizontal Test Bays"

RHIC-MAG-R-7753: "Horizontal Warm Bore Tube Evacuation and Warm-Up"

RHIC-MAG-R-7754: "RHIC DRG Dipole Magnet Cold Integral Coil Measurements"

RHIC-MAG-R-7755: "Horizontal RHIC Magnet NMR & Hall Measurements"

RHIC-MAG-R-7756: "DC Level Shift Test"

RHIC-OPM-8.1.1.2: "Operation of MAGCOOL 10KA Power Supply for Horizontal Testing"

3. Requirements:

3.1 Materials/Equipment:

3.1.1 The Horizontal Control Room Console (HCR), Horizontal Data Acquisition System (HDA), Lead Heater Control Rack and the Dual 5K HTF Power Supplies

(MPS1 & MPS2). This equipment is custom built and permanently installed in Building #902 Magnet Test Facility.

3.1.2 Horizontal Quench Antenna (3- or 5-array antenna).

3.1.3 Electrical Test Cart.

3.2 Safety Precautions:

3.2.1 This procedure shall be carried out by an Authorized Magnet Test Group Control Room Operator. A list of these operators is available from the Magnet Test Group Control Room Supervisor (extension 2544 page 4132).

3.2.2 Ensure that the Magnet Test Facilities Power Supplies (MPS1 & MPS2) are disconnected from the magnet at the DC distribution box except where noted in this procedure. If necessary to disconnect the power supplies, refer to OPM 8.1.1.2: "Operation of MAGCOOL 10KA Power Supply for Horizontal Testing".

3.2.3 The technicians shall be qualified 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 RHIC ES&H Coordinator and the RHIC Training Coordinator.

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 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 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.

3.2.6 The technicians connecting and disconnecting power leads shall have Lock Out Tag Out training and be trained and certified for the equipment specific requirements by the Cognizant Engineer or Technical Supervisor.

3.3 Procedure:

3.4 Performance tests and measurements of Dipole magnets in Magcool Test Bays:

CAUTION: Magnet coil damage could result if it is powered while under vacuum. Verify with the HTF cryogenics operator that the magnet is at $ 5 atmospheres (73.5 psi) before applying any power to a warm magnet.

CAUTION: Physical contact with energized power leads can result in injury. Observe proper Lock-out/Tag-out procedures when configuring the power supply distribution box.

3.4.1 Verify the 10KA Horizontal Test Facility Power Supply Distribution Box (located due West of Bay"D" lead can) is disconnected from the test bay by checking the boxes' configuration sheet.

3.4.2 Install the six Hypertronics instrumentation connectors into the bay (magnet under test) interface box. Perform the DC Level Shift test if required by the cognizant phycisist (indicated in the traveler). Refer to RHIC-MAG-R-7756: "DC Level shift Test".

3.4.3 Perform a FFT Ratiometer test as outlined in RHIC-MAG-R-7736: "Vertical and Horizontal FFT Ratiometer Test". Sign off appropriate step on traveler and insert printout.

3.4.4 Install either the 3- or 5-array quench antenna. Connect the antenna signal cable. Seal and evacuate the Warm Bore Tube as described in RHIC-MAG-R-7753: "Horizontal Magnet Warm Bore Tube Evacuation and Warmup". Slide the antenna to the "Z" position specified by the physicist. Do not install the non-lead end blast can. Sign off traveler.

3.4.5 Open the appropriate return valve, then the supply valves on the main lead water manifold (south side of the HTF Distribution Box). Sign the appropriate space on the traveler.

3.4.6 Energize the five lead heaters located in a rack near the Lead Can of the magnet under test. Confirm each heater controller is set to 100^0F. Check each thermocouple temperature display for normal operation. Sign on the traveler.

3.4.7 Connect the lead and non-lead end "MAGNET ON" lights by plugging their line cords into the yellow face-plate outlets. Lead Man should sign traveler and contact the Cryogenics Lead Man to start cooldown.

3.4.8 Perform the cold electrical tests when the magnet is # 6 Kelvin. Refer to RHIC-MAG-R-7242: "RHIC Hypot Testing" and RHIC-MAG-R-7320: "RHIC Electrical Resistance Measurement for Collared Individual and Connected Coil Sets". Check off each OpCode for that OP No. and sign it off.

3.4.9 Perform a cold FFT Ratiometer test as outlined in RHIC-MAG-R-7736: "Vertical and Horizontal FFT Ratiometer Test". Re-configure the database to the magnet under test and verify the monitor page display data is correct. Contact the cognizant technician or engineer if any discrepancies are found. Sign off appropriate step on traveler and attach printout.

3.4.10 Configure the HTF Distribution box links to connect the HTF power supplies to the magnet under test. Energize the HTF power supplies. If the Quench detectors require balancing, then contact the cognizant technician.

3.4.11 Perform the 1000 Amp shutoff as follows:

3.4.11.1 Notify the HTF Cryogenics operator that you are powering the magnet.

3.4.11.2 Set the LeCroy Loggers clock frequency to 0.5Khz. Re-boot the node computers. Arm the loggers.

3.4.11.3 Ramp the magnet up to 1000 Amps. Press the OFF/TEST button on the ÄQD Quench Detector to shut the supply off. Process the data and review the FDL plots on a DEC Workstation. Refer to the "Quench Fast Data Plots Reference Book" if any discrepancies are found. Contact the cognizant technician to analyze and correct the discrepancy before proceeding with testing. Request the lead man to sign off on the verification of this test.

3.4.12 Perform the Quench tests as follows:

3.4.12.1 Set the LeCroy Loggers clock frequency to 5.0Khz. Re-boot the node computers. Arm the loggers. Load the runfile "AUTO_QUE_25_500_1HR.RUN". Notify the HTF cryogenics operator that you are quenching the magnet.

3.4.12.2 Execute the runfile. It will energize the power supply and ramp it up in 500 Amp steps at a ramp rate of 25 Amps a second, then wait at 5500 Amps for one hour. After the wait it continues the 500 Amp step ramp (same ramp rate) until the magnet quenches.

3.4.12.3 Process the data and review the FDL plots on a DEC Workstation. Refer to the "Quench Fast Data Plots Reference Book" if any discrepancies are found. Request the cognizant physicist analyze any discrepancies.

3.4.12.4 Wait one hour for the magnet to recover, then check with the HTF cryogenic operator to ensure it is ready for the next quench.

3.4.12.5 Load the runfile "AUTO_QUENCH_83.RUN". Arm the loggers. Execute the runfile. It will energize the power supply and ramp it up to quench at 83 Amps a second. Repeat step 3.4.12.3.

3.4.12.6 Repeat steps 3.4.12.4 through 3.4.12.5 until you obtain a "plateau" of four quenches, all within " 30 Amps. Contact the cognizant physicist if you fail to obtain plateau, or the quench performance is erratic. Request the lead man to sign off on the verification of this test.

3.4.13 Warm-up the Warm Bore Tube. Follow the instructions in RHIC-MAG-R-7753: "Horizontal Warm Bore Tube Evacuation and Warm-Up". Sign off on the traveler.

3.4.14 Remove the quench antenna and install it in the next dipole slated for cold test when the Warm Bore Tube temperature is > 50^0F. Sign off the traveler for both this and the other magnet. Request the lead man to sign off on this test verification.

3.4.15 **CAUTION: Spoiling the WBT insulating vacuum (on a cold magnet) can result in tube distortion from ice formation.**

Note: If the WBT insulating vacuum is spoiled by the introduction of room air restore the vacuum pump immediately, increase the Nitrogen purge heater temperature to 120^0F, and inform the HTF cryogenics operator of the incident. Monitor the WBT temperature closely until it is safely above freezing then reset the Nitrogen purge heater temperature to 70^0F. If equipment malfunction prevents vacuum restoration or safe CVI pumpout fitting removal then contact the cognizant

vacuum group person. If the WBT temperature fails to rise contact the cognizant engineer and physicist. Pivot the "T" handle on the CVI Pumpout fitting until it is at a right angle (90^0) to the shaft. Push the handle in then rotate it clockwise until it engages. Rotate it until resistance stops you. The T-handle should be close to the body of the pumpout fitting. De-energize the WBT insulating vacuum pump (at non-lead end). Pull the handle out and remove the entire pumpout fitting from the WBT. Shut the WBT heater off then remove the WBT and vacuum gauge cables.

3.4.16 Bolt the blast can onto the Non-lead end can. Re-install the CVI pumpout fitting, connect and energize the WBT insulating vacuum pump, press the T-handle in, engage, and rotate it counter-clockwise until it slips (a slight detent per revolution is felt). Withdraw the handle and tilt it back in-line with the shaft. Re-connect the WBT and vacuum gauge cables. Energize the WBT heater.

3.4.17 **CAUTION: Inaccurate Integral Coil measurements result when the WBT temperature is below 65^0F.**

Install the integral coil and perform the integral field measurements as per RHIC-MAG-R-7754: "RHIC DRG Dipole Magnet Cold Integral Coil Measurements". Wait until the WBT exceeds 65^0F before installing the coil. Sign off on the traveler.

3.4.18 **CAUTION: Mishandling or exposure to liquids will damage the mole.**

NOTE: Handle the mole carefully. Avoid exposure to liquid. Remove the mole from the magnet and set it on its die table when the last magnetic measurement is complete. Cover it with plastic when storing it under cryogenics system pipes.

Set-up the mole transporters in place under the guidelines in RHIC-MAG-R-7752: "Mole Transporter Setup & Operation for Magnetic Measurements in Horizontal Test Bays". Obtain a current Z position sheet from the Control Room files and move the mole into Z position #1. Perform the Z scans as follows and sign off on each operation on the traveler.

3.4.18.1 Run the program "MDQ6_7" on the HP 9000 computer (or PC, "MDQ6.7"). Zero the gravity sensor. Take a test read at 25 Amps to check equipment operation.

3.4.18.2 Load and execute the runfile "RHIC_AC_5000.RUN" which ramps the power supply to 5000 Amps at 83 Amps a second and returns it to 25 Amps. Manually ramp to 660 Amps, wait 5 minutes then take the first measurement.

NOTE: It is unnecessary to repeat the AC cycle prior to the Z scan at 1450 Amps or 5000 Amps unless the power supply is shut off or ramped down during or after each Z scan. If the supply is ramped down to 25 Amps after the Z scan at 5000 Amps (and NOT shut off) then an AC cycle prior to the DC Loop to 6000 Amps is unnecessary also.

3.4.18.3 Move the mole to the next Z position using the transporter control menu in the HP (or PC) program. Observe the transporter video monitor to check transporter operation and actual Z position. Zero the gravity sensor and take the second measurement.

3.4.18.4 Repeat step 3.4.18.3 for the remaining eight positions. After the measurement at position 10 move the mole back to position #1. Zero the gravity sensor.

NOTE: Transfer the data over the Novell network and run the program "CHKRUN" at the first opportunity after each magnetic measurement. Print out the CHKRUN summaries and attach them to the traveler.

3.4.18.5 Ramp the power supply to 1450 Amps at a rate of 16 Amps per second. Wait 5 minutes, open a new run on the HP (or PC) computer and take a measurement. Repeat step 3.4.18.3 to 3.4.18.4.

3.4.18.6 Ramp the power supply to 5000 Amps at a rate of 16 Amps per second. Wait 5 minutes, open a new run on the HP (or PC) computer and take a measurement. Repeat step 3.4.18.3 to 3.4.18.4 EXCEPT move the mole to position #5 (center of magnet) when complete. Ramp the power supply down from 5000 Amps to 25 Amps for the DC Loop.

3.4.19 Perform the DC Loop as follows:

3.4.19.1 Zero the gravity sensor at position #5. Exit the HP (or PC) program, re-load it and select "VAX<>HP" mode. Enter an "HPINIT" command on the workstation to establish the communication link. Reboot the node computer ADD002 if the proper message fails to appear on its monitor and repeat the "HPINIT" command.

Check the workstation for proper coil number, NUMREV, and MAXREC. Open a run on both computers from the workstation.

3.4.19.2 Load the runfile "DCLP_6K_RHIC.UP". After an 8 minute wait execute the runfile. Note that the runfile will ramp the supply to selected currents and take a measurement at that current.

3.4.19.3 At 6000 Amps wait for the runfile to stop and return the workstation to a prompt. Load the runfile 'DCLP_6K_RHIC.DN", close the data file, and open a new data file. Execute the runfile. Shut the power supply off upon completion of the run.

3.4.20 Perform the AC Loop Measurement if required (see traveler and/or consult with cognizant physicist). Set-up the equipment as in step 3.4.21.2 except after the 8 minute wait ramp to 6000 Amps at a rate of 83 Amps a second, then down to 25 Amps again at the same rate. Opening a data file of 36 records for the complete up/down ramp is sufficient. Sign off on the traveler.

3.4.21 Perform the Sextupole vs Time at 660 Amps if required (see traveler and/or consult with cognizant physicist) as follows:

3.4.21.1 Quench the magnet prior to this test. Ensure that the WBT is at room temperature and the mole is parked at position #11. Perform one quench only, following the operations in step 3.4.12.5 then 3.4.12.3. Allow the magnet 1 hour recovery.

3.4.21.2 Move the mole back to position #5 and zero the gravity sensor. Set-up the HP300 computer and the HP3458 DMM's next to the mole electronics rack (North of NL end of Bay A). Disconnect the IEEE from the mole rack's top two HP3457A DMM's then connect the remaining HP3457A to the HP3458 DMM's and HP300. Load the program "M66RP" on the HP300 and open a data file. Set the addresses on the DMM's as per HP300 instructions. Set NUMREV to 1. Perform an AC Cycle to 5000 Amps. Wait 8 minutes. Start taking HP readings continuously then ramp the power supply up to 660 Amps at 16 Amps a second.

3.4.21.3 Take measurements continuously for 10 minutes, then ramp the supply down and shut it off.

3.4.22 Perform the Sextupole vs Time at 5000 Amps if required (see traveler and/or consult with cognizant physicist) as follows:

3.4.22.1 Repeat the operations in step 3.4.21.1 through 3.4.21.3, EXCEPT measure for 10 minutes at 5000 Amps.

3.4.23 Perform the NMR/Hall measurements if required (see traveler and/or consult with cognizant physicist) as per RHIC-MAG-R-7755: "Horizontal RHIC Magnet NMR & Hall Measurements". Extract the mole from the lead end, mate the tethers, and recoil the Non-lead end until the tether connectors emerge.

3.4.24 Perform the Hall measurements if required (see traveler and/or consult with cognizant physicist). The measurements are done by the Short Sample Group who request the Control Room Operator to ramp the magnet as per their instructions. Check that they sign off the traveler.

3.4.25 Have the lead man sign off on all these tests. Request the Magnet Test Group Control Room Supervisor sign off on the traveler. Notify the Cryogenics lead man that the magnet is ready for warm-up. Ensure the traveler is complete and pass it to the Cryogenics leadman.

3.4.26 Re-configure the distribution box to disconnect the magnet from the power supplies. Remove the mole transporters and spool the cables off the floor. Disconnect the "MAGNET ON" lights.

4. Quality Assurance Provisions:

4.1 Insure that all inspection and test operations have been verified and signed on the production traveler by the cognizant operator and that all discrepancies have been recorded in accordance with RHIC-MAG-Q-1004.

4.2 The Quality Assurance Provisions of this procedure require compliance with the procedural instructions contained herein.

4.3 Calibration:

4.3.1 Verify that current calibration labels have been affixed to the HP 3457A DMM's used in testing.

5. Preparation for Delivery:

N/A