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C-A OPERATIONS PROCEDURES MANUAL

15.3.1.1 Procedure for Testing the Insulation of AGS Main Magnet Coils when they are Out of the Magnet Steel & Magnet Tests after Rebuild

(Booster/AGS Ring Power Supply Systems Group Procedure EPS-A-001)

Note: This document was formerly a C-A Group Procedure. The content of the group procedure was reviewed by the Technical Supervisor. All approvals and/or issue dates of the original group procedure are maintained for present use.

Hand Processed Changes

<u>HPC No.</u>	<u>Date</u>	<u>Page Nos.</u>	<u>Initials</u>
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Approved: _____ *Signature on File* _____
 Collider-Accelerator Department Chairman Date

M. Bannon

Booster/AGS Ring Power Supply Systems
Group Procedure EPS-A-001
Revision 00

1. Purpose:

This procedure shall be used by trained MMPS operators or PSG techs to determine the insulation integrity of the AGS Main Magnet Coils before mounting them into a magnet assembly.

2. Responsibilities:

The supervisor of the MMPS Group or his designee shall train the operators in the following procedure. If techs have performed these tests before and feel confident in performing this procedure then test will proceed without any additional training and the data files for all tests performed on the AGS MM Coils shall be added to the results book after each coil is completely tested. Also make copies for the mechanical group (Dan Lehn) and 1 additional copy to the mechanical engineer who placed the order for the coils.

3. Prerequisites:

The personnel performing these tests shall be trained in electrical safety and this specific training.

4. Precautions:

- 1.1 This procedure requires two people at all times.
- 1.2 One person as a safety watch one person doing test.
- 1.3 This area must be fenced off for testing purposes
- 1.4 A sign that test is in progress with contact personnel list on sheet.
- 1.5 Safety glasses are to be worn at all times.
- 1.6 High voltage gloves are required.
- 1.7 Proper PPE required.
- 1.8 Ground stick is required.
- 1.9 No loose conductive jewelry may be worn.

5. Procedure:

Do tests on the main magnet evaluation sheets and record data.

- 1.1 Coil manufacture, serial # and type.
- 1.2 Coil visual inspection.
- 1.3 Coil hydrostatic test. (This is to be completed by the pump room after all electrical tests are completed and coil has passed all other testing.)
- 1.4 Coil low resistance biddle meter test.
- 1.5 Coil inductance test.
- 1.6 Coil turn to turn short test.(Ring test)
- 1.7 The coil insulation test is done by wrapping aluminum foil around the coil then laying some 6" aluminum channel on top of the aluminum foil weighted down so a more accurate test can be done. On old coils the area most in question is where the beam pipe crossed the coil. This area has seen the most radiation damage of any other part of the magnet.
- 1.8 After coil is wrapped in aluminum foil, megger test coils insulation @ 1000vdc and 5000vdc and record data.

- 1.9 After each coil has passed the megger test then it is time to hipot each coil to 20kv if coils are new or 3kv if coils are used. (possible 3kv if coils are used and old).
Note: new coils should read microamp leakage current while used coils we have decided that if coil leakage exceeds 1 milliamp the coil has failed.

6. Equipment Needed:

- 1.) LECROY SCOPE WITH PRINTER
- 2.) TEKTRONIC P5200 DIFFERENTIAL PROBES
- 3.) CAUTION SIGNS (TEST IN PROGRESS)
- 4.) FENCE AREA FOR TESTING
- 5.) FLASHING LIGHT (TEST IN PROGRESS)
- 6.) GROUNDING STICK
- 7.) HIGH VOLTAGE GLOVES (20KV)
- 8.) SAFETY GLASSES
- 9.) TEMPERATURE/HUMIDITY METER
- 10.) LOW RESISTANCE BIDDLE METER
- 11.) PULSE TESTER (RINGER)
- 12.) MEGGER 5000V
- 13.) HIPOT 20KV
- 14.) ALUMINUM FOIL
- 15.) RUBBER FOR UNDERNEATH COILS
- 16.) 2 EACH -6 INCH ALUMINUM CHANNEL THE LENGTH OF COIL
- 17.) LEAD BRICKS TO PLACE ON TOP OF 6" CHANNEL

5.1 Coil Data

Manufacturer _____

Serial # _____

Coil Dwg # [] D36-M-668-5 Long Coil

[] D36-M-669-5 Short Coil

New Coil []

Used Coil []

Refurbished []

5.2 Visual Inspection

No voids, cracks, de-lamination, damage detected [] by _____

Voids, cracks, de-lamination, damage detected (cuts, etc.) [] by _____

Explain: _____

Is coil worth testing any further Yes [] No [] because the physical damage does not warrant us saving.

by _____

5.3 Coil Hydrostatic Test

Coil should hold pressure for at least 15 mins. @ 300 psig

Initial pressure (psig) _____ by: _____

Final pressure (psig) _____

Record temp. _____

On leaks [] Leaks []

Explain _____

Flow Rate: _____ gpm Diff. Pressure _____

Expected Flow is ~ 1.4 to 1.6 GPM with a Diff. Press. of 50

Electrical Testing

- 5.4 Biddle Low Resistance Meter: _____ Milliohms by: _____
- 5.5 Inductance Measurement _____ by: _____
- 5.6 Turn to turn short test (Ring Test)

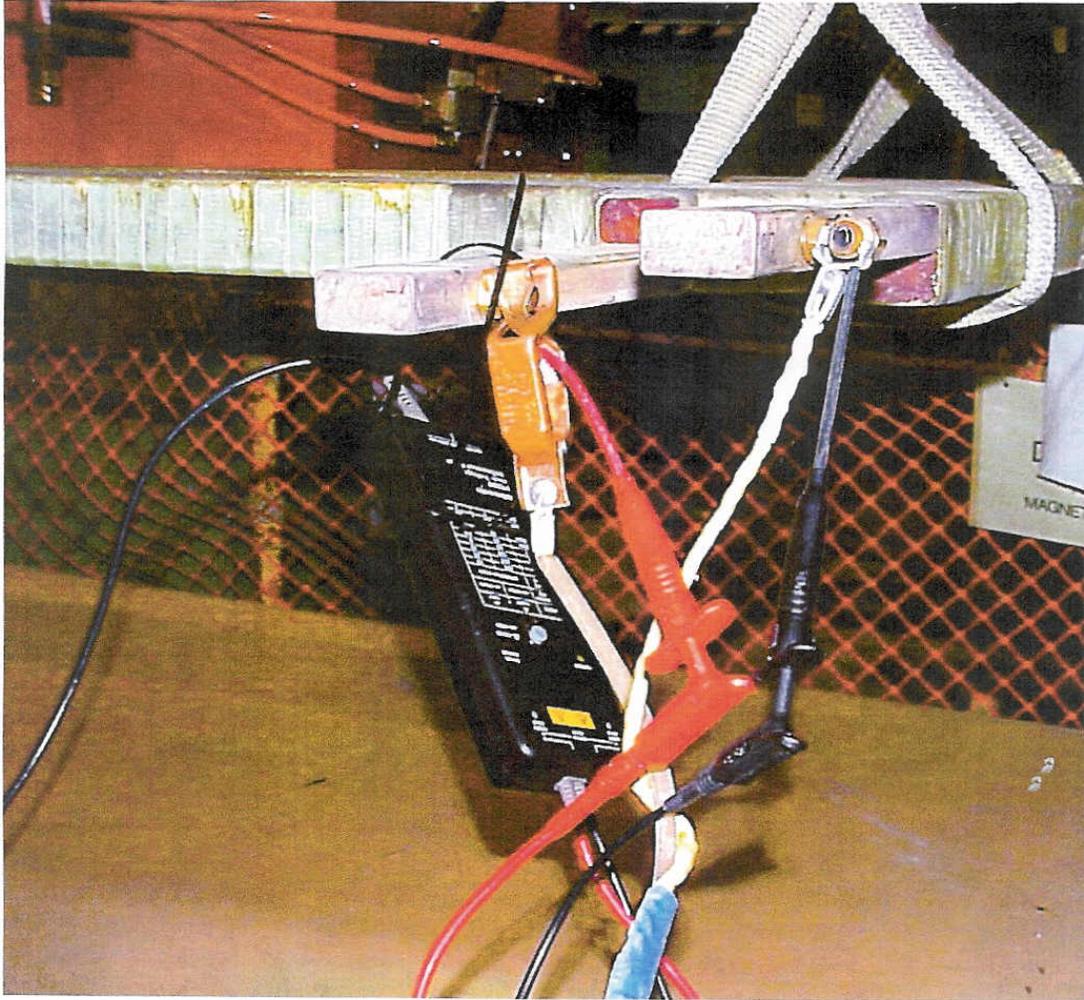
NOTE:
THE NEXT (RINGING OF COIL TEST) SHALL BE DONE WITH COIL AWAY FROM ANY STEEL OR GRANITE TABLE. THIS TEST IS BEST DONE WHILE IT IS HELD BY NYLON STRAPS IN THE AIR WITH THE OVERHEAD CRANE. REFER TO PAGER 5 & 6

Turn to turn short check pulse check (ringing magnet) apply a 4000 volt peak-peak voltage across coil terminals. The resulting waveform of a good coil should look like FIG. 2a. A bad coil will look like FIG. 2b.

Passed [] Failed []

Using Lecroy Scope with printer and isolation probes capture and print the ringing results. Attach print to this paperwork.

After ring test of coil is completed, ground coil for approx. 1 min. before any other test of coil is started.



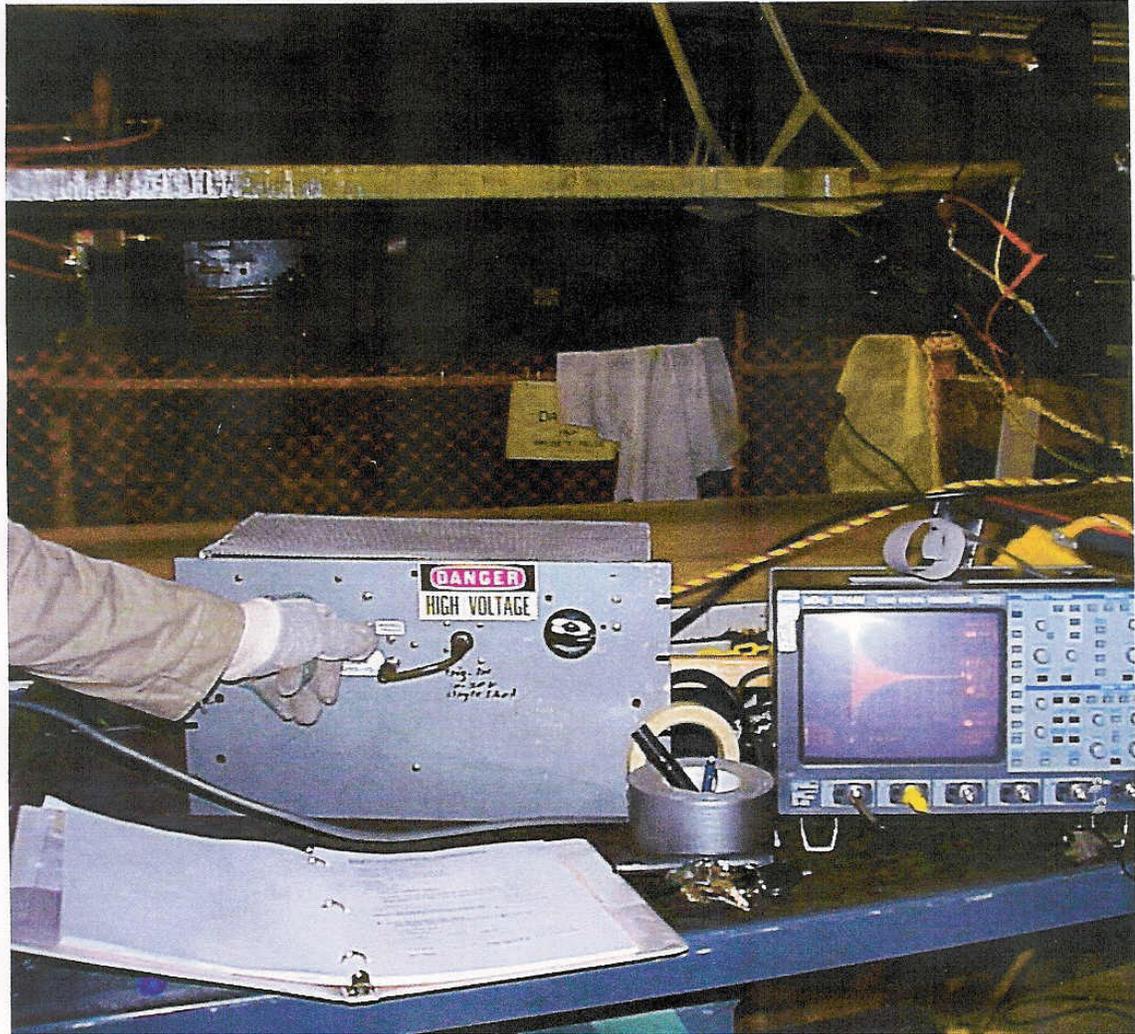


FIG. 2A

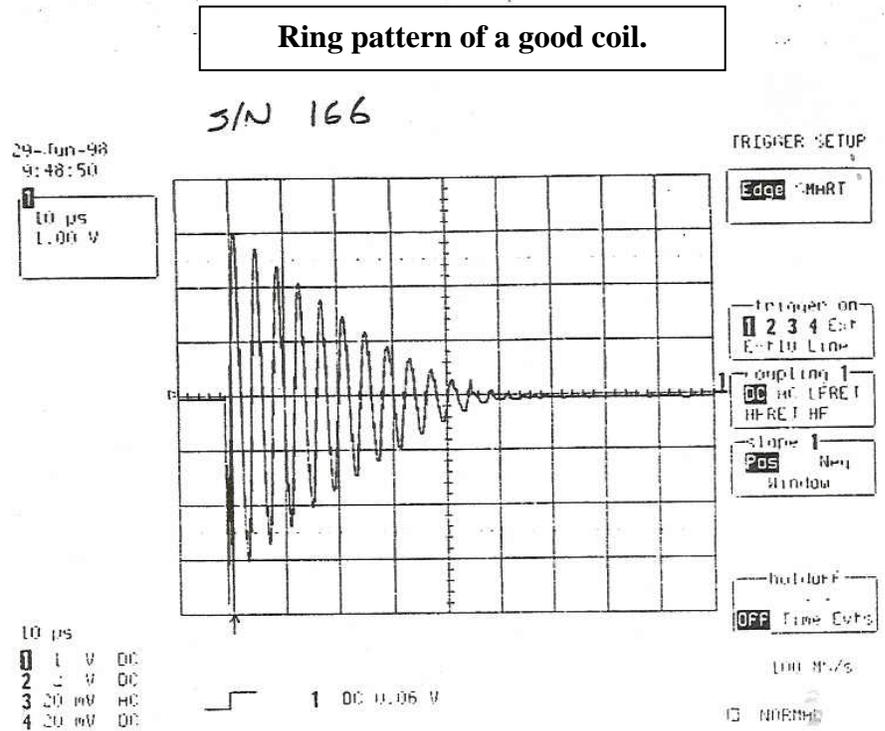
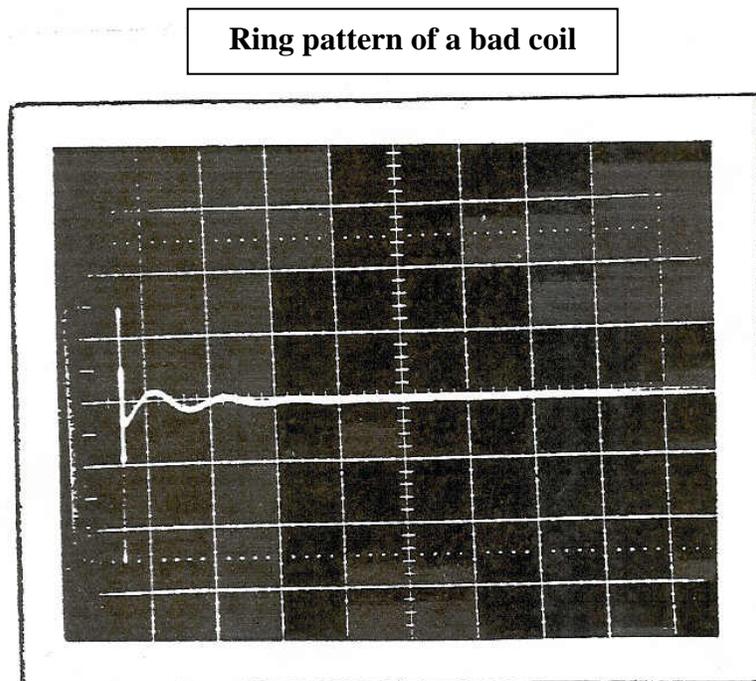


FIG. 2B



5.7 Coil Insulation Test – Wrapping Coil in Aluminum Foil

Procedure: Put a soft layer of rubber on top of steel table and a layer of aluminum foil on top of rubber. Then lower coil on top of Al. foil then wrap coil tightly with Al. foil (refer to pictures) After coil is completely wrapped with Al. foil lay 2 piece of Al. channel on the top of Al. foil and lay some lead bricks (anything with weight) on the top of the channel so you feel confident the Al. foil is tight against the coil.

Note

Aluminum foil must be approx. 1 ½” to 2.0” from the end where copper leads come out of insulation otherwise it will arc at this point during hipot testing.

Refer to pictures on the following pages (pages10 thru 16)

Note

No manipulation is allowed while hipot testing is being performed, also a minimum distance of 3 ft must be maintained at all times during hipot testing.

5.8 Megger test coil after it has been wrapped with aluminum foil

- 1) Put the ground stick on the coil.
- 2) Put the ground from the megger test equipment on the aluminum foil.
- 3) Short both ends of the coil together.
- 4) Attach the high voltage lead of the megger on the coils copper.
- 5) Turn on the warning light signifying coil is under test.
- 6) High voltage 20 kv gloves and proper PPE (flame retardant clothing and blast suit jacket)along with safety glasses.

@ 1000 vdc _____ record resistance

@ 5000 vdc _____ record resistance

After megger test of coil is completed, ground coil for approx. 1 min. before any other test of coil is started.

If coil passes megger test proceed to Hipot testing.

5.9 HIPOT TEST

- 1) Put the ground stick on the coil.
- 2) Put the ground from the hipot test equipment on the aluminum foil.
- 3) Short both ends of the coil together.
- 4) Attach the high voltage lead of the hipot on the coil copper.
- 5) Turn on the warning light signifying coil is under test.

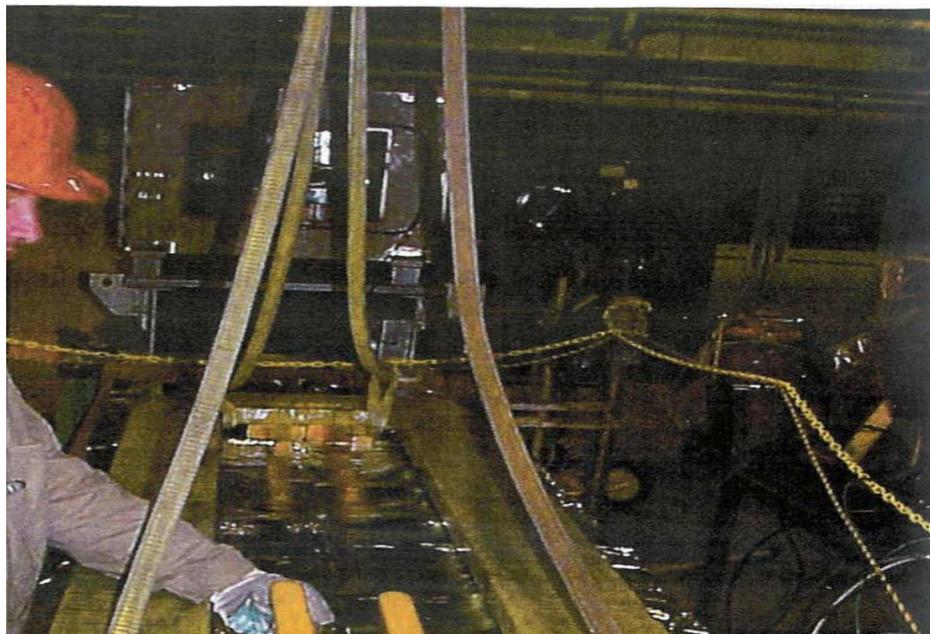
- 6) High voltage 20 kv gloves and proper PPE (flame retardant clothing and blast suit jacket) along with safety glasses.
- 7) Turn on hipot and record the leakage current at the following voltages after being at that voltage for 1 min
- 8) After test is completed run the hipot test equipment to zero volts, turn off and let coil decay for 5 min. then apply ground stick before handling any of the test equipment.
- 9) After test is complete then the gloves and suit can be removed.
- 10) Record all data on text page.

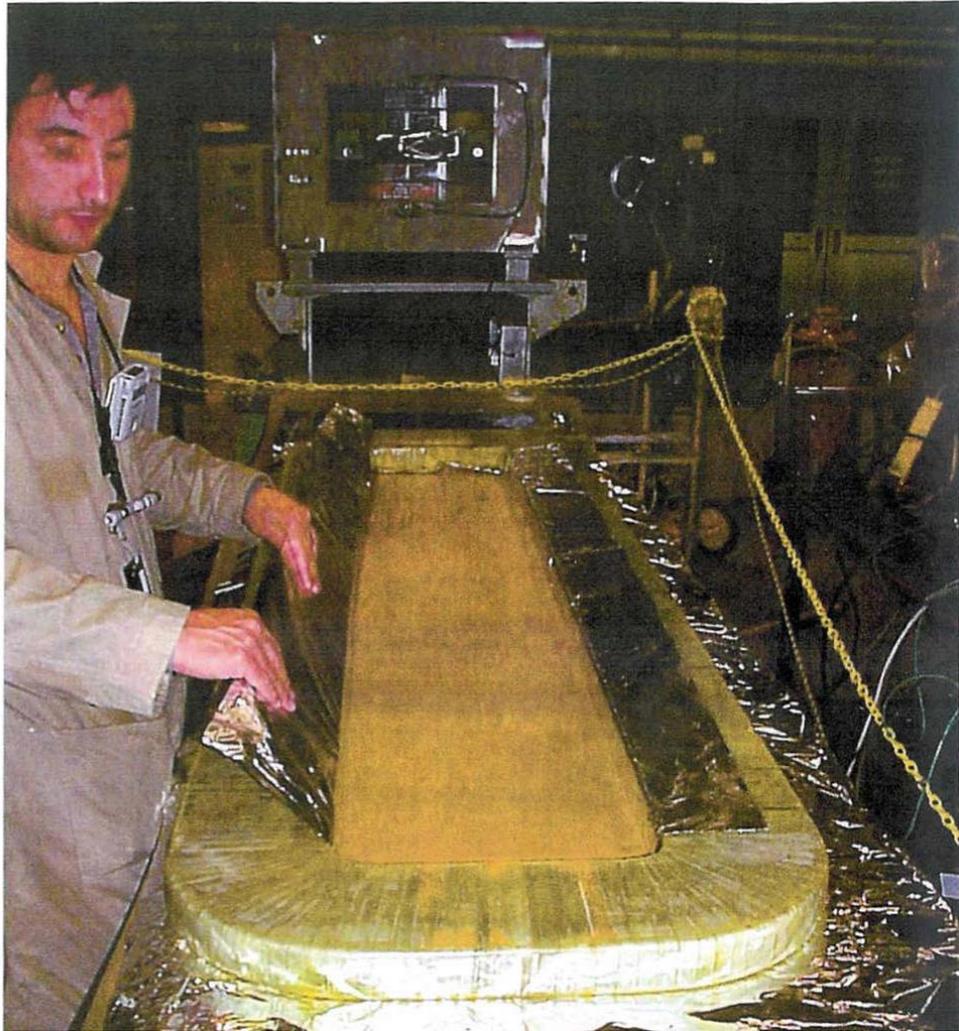
INSULATION EVALUATION TEST AS PER NEXT SHEET

Note
Coil leakage current must not exceed 1 ma or coil has failed.

Coil
Record the current at each step after 1 min.

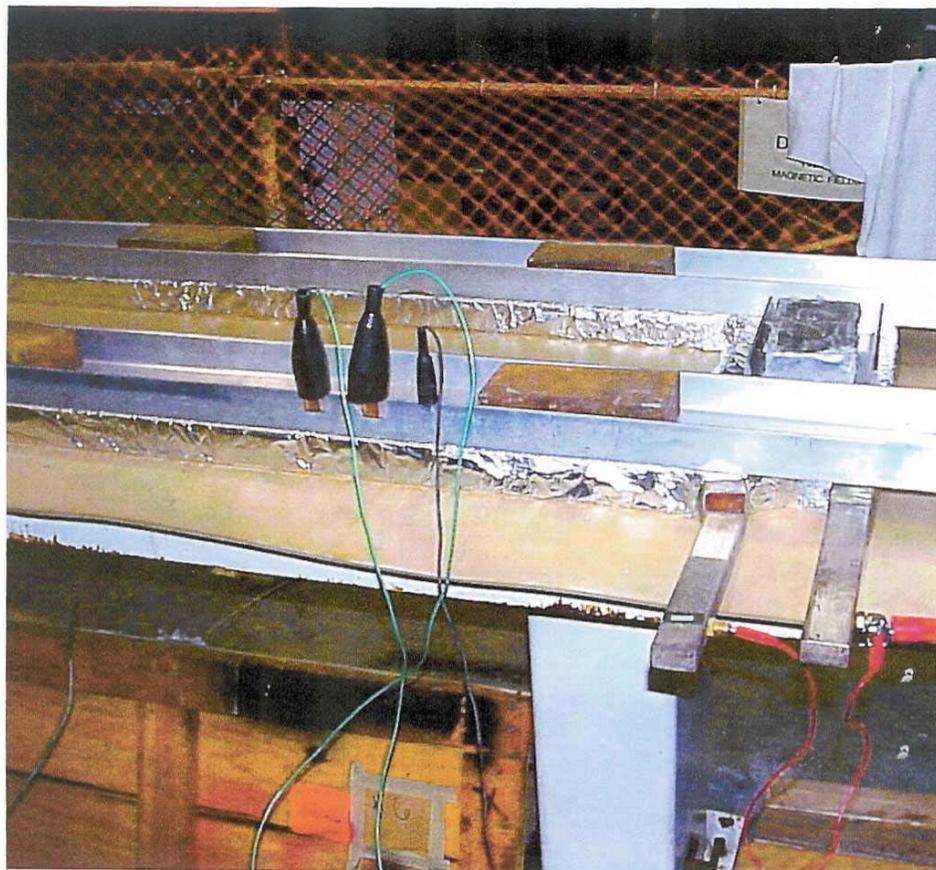
KVdc	CURRENT
0	
1.0	
2.0	
3.0	
4.0	
5.0	
6.0	
7.0	
8.0	
9.0	
10.0	
11.0	
12.0	
13.0	
14.0	
15.0	
16.0	
17.0	
18.0	
19.0	
20.0	











Main Magnet Test After Rebuild

Magnet Location: _____ Date: _____

Tested By: _____

Magnet Type: long [] short [] Open [] Closed []

Original Coils:

Coil #1 s/n _____

Coil #2 s/n _____

Coil #3 s/n _____

Coil #4 s/n _____

New Coils

s/n _____

s/n _____

s/n _____

s/n _____

With the magnet separated from the main magnet bus do the following tests:

- Coil resistance check with biddle meter:
coils 1 & 2 _____ milli-ohms coils 3 & 4 _____ milli-ohms

Note
Resistance readings should be approx. 1.989 milli-ohms for a long magnet and 1.72 milli-ohms for a short magnet)

- Record the temperature and humidity when doing the megger and hi-pot tests.
Temp. _____ Humidity _____
- Megger coils 1 & 2 to frame @ 5000v _____
Megger coils 3 & 4 to frame @ 5000v _____

Note
Coils 1 & 2 should be tied together and coils 3 & 4 tied together.

- If coils passed megger test tie all the coils together and hi-pot the magnet up to 10 kv and record current.

Note
After magnet has been rebuilt it should only read a few micro-amps leakage current to ground if not something is wrong.

KVdc	CURRENT (ua)
0	
1	
2	
3	
4	
5	
6	
7	
10	

Main Magnet Checklist After Rebuild

- 1. High field BLW replaced: _____ by: _____ awg
wire _____
- 2. Low field BLW replaced as per sht _____ by: _____ # of cond. _____ awg. _____
- 3. BLW terminal block replaced _____
- 4. High & low field BLW supports replaced: _____
- 5. All micarta shims removed and replaced with G10 _____
- 6. Coil jacks micarta removed and replaced with G10 _____
- 7. Kapton used in shim area. _____
- 8. All aluminum brackets cleaned and sprayed with krylon _____
- 9. Jacks for coils replaced _____ repaired then re-used _____
- 10. Jack coil wedges replaced. _____
- 11. All wedges replaced: _____
- 12. Woodsmetal buttons and mircoswitches installed: _____
- 13. Isolation transformer installed and in good shape: _____
- 14. Beam pipe installed. _____
- 15. RC network installed and beam pipe not grounded. _____
- 16. End brackets installed and insulated from coils. _____
- 17. AGS correction Dipole installed on face of magnet. _____
- 18. Proper water fittings on coils. _____
- 19. Covers reinstalled. _____
- 20. Resistor installed across upper and lower coils and its wiring in good shape
60 ohms across coils 1 & 2 ; 3 & 4 for long magnets _____
50 ohms across coils 1 & 2 ; 3 & 4 for short magnet _____

Note:
short magnets 1-2-9-10-11-12-19-20 / long magnets 3-4-5-6-7-8-13-14-15-16-17-18 / open magnets 1-2-5-6-9-10-11-12-15-16-19-20 / closed magnets 3-4-7-8-13-14-17-18

When magnet is put back on the girder

- 21. Bus reinstalled and insulated _____

Note:
If any bus was knicked, tape up with glass tape then glyptal.

- 22. Water hoses reconnected & flow checked each coil: _____
 coil 1 gpm: _____ coil 2 gpm: _____ coil 3 gpm _____ coil4 gpm _____
- 23. All water turned back on, check 2,3 magnets on either side of magnet that was rebuilt to insure all water was turned back on. _____
- 24. Vacuum group reseal beam pipe. _____
- 25. PUE's reinstalled _____
- 26. Woodsmetal wiring reattached _____
- 27. Low field wiring reattached as per sht. _____
- 28. High field reinstalled _____
- 29. Other _____
- 30. _____
- 31. _____
- 32. _____
- 33. _____
- 34. _____
- 35. _____
- 36. _____
- 37. _____

