



BNL-104518-2014-TECH

AGS/AD/Tech Note No. 85;BNL-104518-2014-IR

# TESTS OF BRACKET AND COIL INSULATION - MAGNETS A-1, B-1, G-10, AND G-11 AFTER APRIL 1971 SHUTDOWN

E. J. Rutan

June 1971

Collider Accelerator Department  
**Brookhaven National Laboratory**

**U.S. Department of Energy**

USDOE Office of Science (SC)

Notice: This technical note has been authored by employees of Brookhaven Science Associates, LLC under Contract No.AT(30-1)-16 with the U.S. Department of Energy. The publisher by accepting the technical note for publication acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, world-wide license to publish or reproduce the published form of this technical note, or allow others to do so, for United States Government purposes.

## **DISCLAIMER**

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Accelerator Department  
BROOKHAVEN NATIONAL LABORATORY  
Associated Universities, Inc.  
Upton, New York

AGS DIVISION TECHNICAL NOTE

No. 85

E.J. Rutan

June 11, 1971

TESTS OF BRACKET AND COIL INSULATION - MAGNETS A-1,  
B-1, G-10, AND G-11 AFTER APRIL 1971 SHUTDOWN

(Continuation of Study Recommended  
AGS Tech Note No. 70, 1969)

During the routine inspection of the bracket insulation of magnet A-1, the micarta at the upstream bracket was found to be carbonized. This condition has occurred in the past. This type of failure of the micarta has resulted in charring of the magnet coil insulation and necessitated replacement of the magnet coil. Similar failures had been reported most recently in AGS Tech Note No. 70, and recommendations for replacement of the micarta with mica-Kapton had been made.

In November 1969, a trial installation of three mica sheets (NEMA grade 9) with two films of Kapton, (polyimide) between the mica sheets, was substituted for the micarta. These materials were selected because of high radiation resistance, good electrical insulation, and fire resistance. This assembly was installed on the end and front brackets of G-11 magnet. This magnet is in a high radiation area. The reading on June 3rd near this magnet was 3100 MR over a month after shutdown. The mica-Kapton sandwich under the upstream bracket was removed for inspection and test. After 1-1/2 years service, visual inspection showed no changes. Electrical tests showed it to be as good as new micarta. All tests are reported in the Appendix.

Coil 283 at A-1 had a charred area about 1 in. by 3-1/2 in. under the micarta at the upstream bracket. Tests were made on the coil insulation in place and on the micarta after removal. These are reported in the Appendix. Compared with magnet B-1, the A-1 coils were very low in insulation resistance.

The results of the above inspections and tests were reviewed by Messrs. Czaja, Dryden, Gefers, Grisoli, Plotkin and Rutan, and the following recommendations are being put into effect:

- 1) The bracket insulation on magnets for possible high radiation areas shall be mica sheet Kapton film (a sandwich built up of three sheets of 35 mil NEMA No. 9 mica sheet with inorganic binder, with two films of Kapton--polyimide--between).
- 2) This insulation shall be installed at the upstream bracket and the first two brackets along the side of the magnet.
- 3) These sheets shall be cut larger than the present micarta so as to provide, if possible 3/4 in. additional creepage, on all sides, to the metal pad.
- 4) When making up the sandwich, the separate sheets shall be wiped clean and inspected for holes or foreign particles.
- 5) After the coils have been assembled on the magnet, surface and volume insulation resistance tests shall be measured following the procedure on Fig. 2 and Sheet No. 1 in the Appendix. The tests shall be made at locations 1A and B, 2, 5, 8A and B Fig. 1. This will serve as a bench mark for later after service tests.

APPENDIX

In this Appendix the test procedures for insulation resistance and results of recent tests are included.

The tests of surface and volume insulation resistance were adopted in 1965 (Figs. 1 and 2) as a convenient procedure to quickly determine the approximate condition of the magnet coil insulation on coils installed on magnets and in place in the ring. It is a rough test, but will usually indicate degraded insulation. These tests have the advantage that the electrodes are small and the megger is portable.

On Sheet No. 1 tests of two coils on magnet A-1 are compared with two coils on magnet B-1. The differences are very marked. Although at present we do not have a definite value for rejecting magnet coils in service, the fact that the surface of coil 283 was burned prompted the decision to remove and replace these coils.

Work will be done to determine if standards can be established so that the serviceability of the other coils can be decided.

On Sheet No. 2 the data of tests on micarta, unused, from service (G-10), burned A-1, and the mica-Kapton trial insulation, is reported. The exceptionally high insulation resistance tests of the mica after a year and a half in service in a high radiation area showed it equivalent to the unused micarta, and also the micarta from G-10 from a relative low radiation area. These results prompted the recommendations in the early part of this report.

Distr: Administration Group  
Those mentioned in this report

BY *SW* DATE 10/69

SUBJECT SCHEMATIC COIL MOUNTING - MAIN MAGNET - BRACKET INSULATION SPACERS

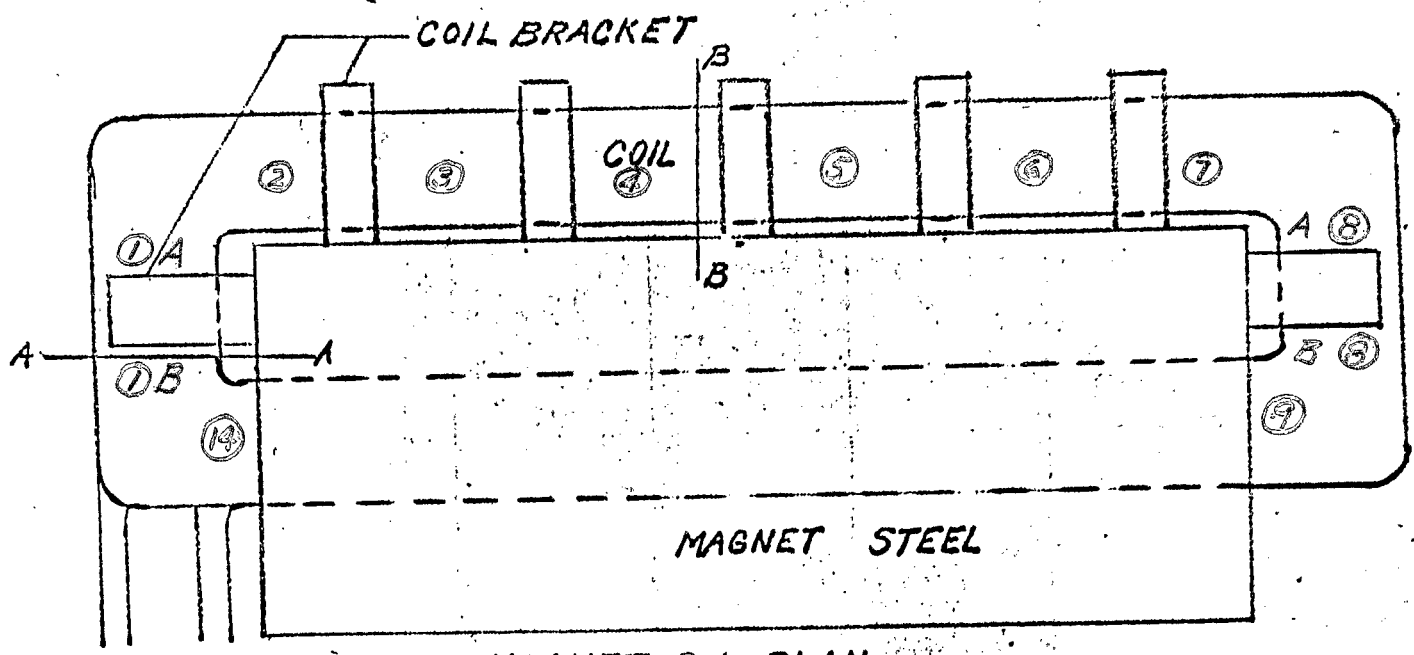
SHEET NO. .... OF .....

CHKD. BY ..... DATE .....

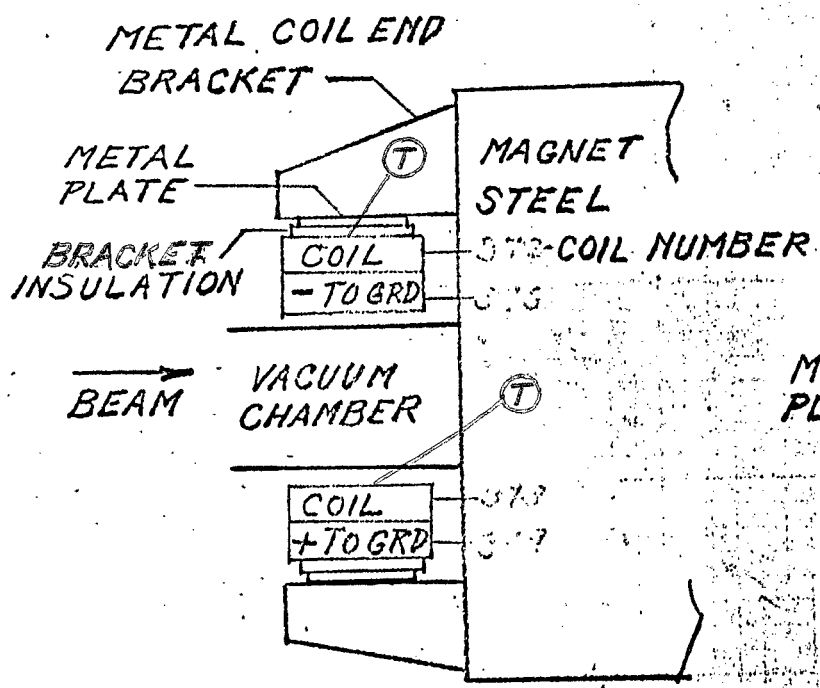
DEPT. OR PROJECT LATION SPACERS

JOB NO. ....

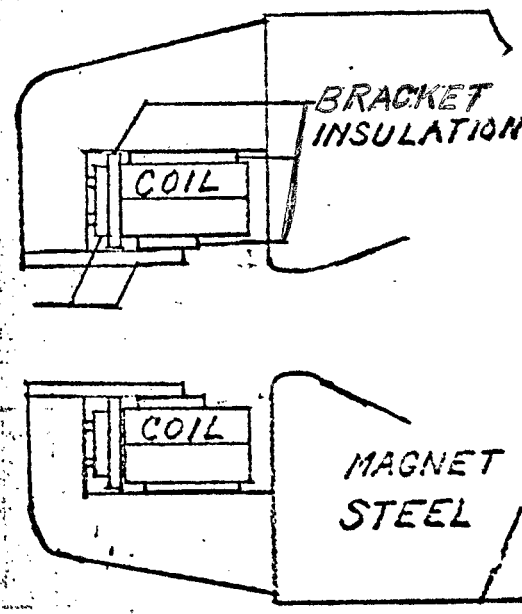
TEST LOCATION ①, ① - WHEN COILS ARE ASSEMBLED - TOP SURFACE OF TOP COIL AND TOP SURFACE OF TOP LOWER COIL



MAGNET COIL PLAN

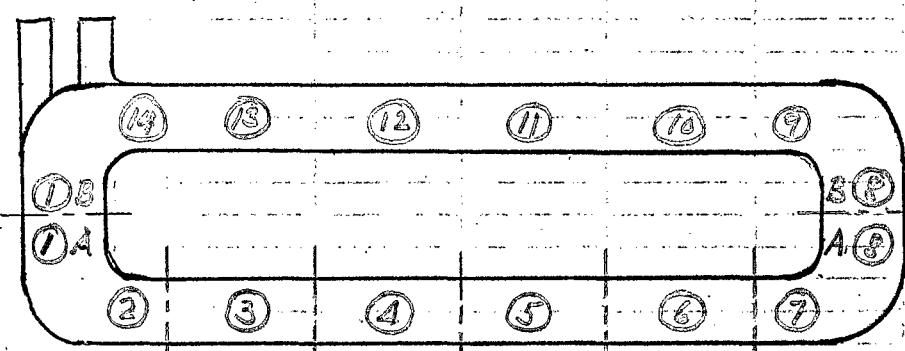
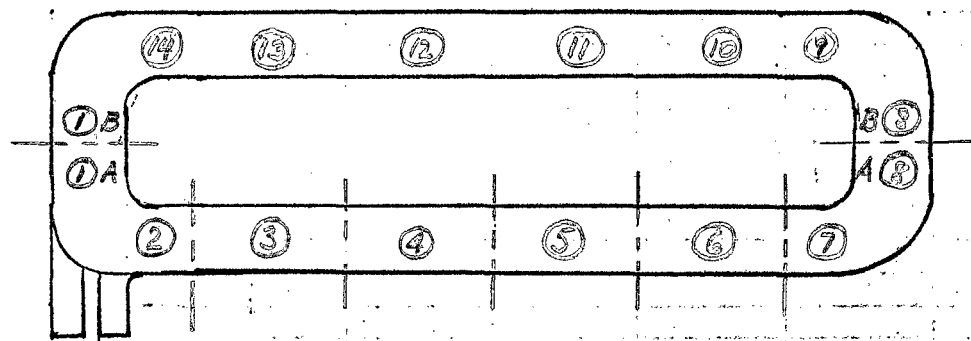


ELEVATION AT A-A



ELEVATION AT B-B

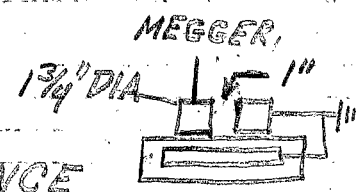
INSULATION TEST - MAIN MAGNET COILS  
LOCATION OF TEST ELECTRODES - ①  
WHEN COILS ARE NOT ASSEMBLED ON MAGNET  
LIST COIL NO., - POSITION, - SURFACE (TOP OR BOTTOM)



PROCEDURE - SURFACE INSULATION RESISTANCE

VOLUME INSULATION RESISTANCE

TEST - MEGGER - 1000, 2500, 5000 VOLTS

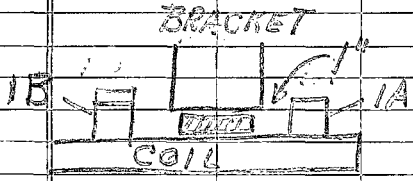
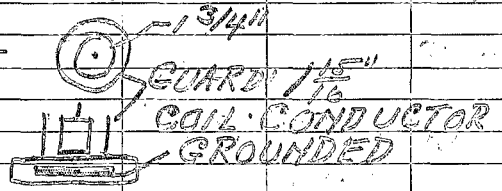


INSULATION RESISTANCE - MAGNET COILS - MAGNETS A-1 & B-1

PROCEDURE - SURFACE RESISTANCE -



VOLUME RESISTANCE -



COIL NO	TEST LOCATION (SEE FIG 1)	SURFACE RES			VOLUME RES		
		1000V	2500V	5000V	1000V	2500V	5000V
A-1 283	1A	.4	.4	.3	4.0	2.6	2.7
NO MICARTA	2	1.2	.8	.6	2.5	3.7	3.0
TOP OF TOP	1B	.4	.3	.25	2.0	2.1*	2.4*
	14	60.	7.	3.3	9.0	7.0	5.0*
A-1 300	1A	.5	.3	.2*	2.0	1.7	2.5
TOP OF BOTTOM	2	1.2	.3	.3*	3.0	3.0*	2.7*
	1B	.3	.2	.2*	3.0	2.2	2.5
	14	.4	.35	.25	4.8	3.7*	3.0*

\* VISIBLE SPARKING AT ELECTRODE OR GUARD

COIL 283  
 BURNED AREA ABOUT 1" x 3/8" ON TOP EDGE UNDER MICARTA UPSTREAM  
 END MICARTA ALSO BURNED (SEE DATA SHEET NO 2) COIL SURFACES  
 BROWNED  
 A-1 HAD BEEN IN A FORMER RADIATION AREA B-1 NOT A HOT AREA

FOR COMPARISON

B-1 518	1A	8000	25000	45000	8000	17000	27000
TOP OF TOP	14				10000	20000	30000
	1B	10000	15000	27000	15000	20000	30000
B-1 526	1A	8000	17000	15000	8000	12000	7500
TOP OF BOTTOM	2	10000	25000	50000			
	1B	1200	350	75			
	14				9000	22000	30000

B-1 COIL SURFACE VERY GOOD NO DISCOLORATION

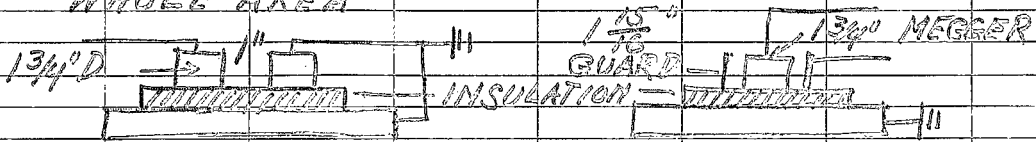
RADIATION LEVEL 6/3/71 COIL 283 - 35 MR  
 B-1 MAGNET 20 MR

LITHOGRAPHED IN U.S.A. - ADDISON-WESLEY PUBLISHING COMPANY, INC., READING, MASS. 01061



TESTS OF BRACKET INSULATION PADS

INSULATION MOUNTED ON GROUNDED PLATE COVERING WHOLE AREA



SPECIMEN	SURFACE RESISTANCE			VOLUME RESISTANCE		
	1000V	2500V	5000V	1000V	2500V	5000V
	MEG OHMS			MEG OHMS		
UNUSED MICARTA - LONG - 1/8" THICK						
TEST AT CENTER	∞	∞	26,000	∞	∞	30,000
ALONG EDGE	15,000	12,000	22,000			
SHORT-AT CENTER 1/8"	∞	50,000	17,000	∞	100,000+	25,000
A-1 UPSTREAM BRACKET COIL 283 - BURNED SIDE IN CONTACT WITH COIL CENTER	400	400	380	1400	1200	1200
SURFACE IN CONTACT WITH BRACKET - CENTER	∞	∞	100,000	∞	∞	100,000
NEAR BURNED CORNER				∞	100,000	50,000+
	* SPARKING AND SMOKING AT 5000V					
MICARTA - FROM G-10 UPSTREAM - TEST AT CENTER	∞	∞	100,000	∞	∞	∞
NEAR EDGE	∞	∞	45,000	∞	∞	100,000
MICA-KAPTON - G-11 UPSTREAM IN SERVICE SINCE NOV 1969						
CENTER	∞	∞	100,000+	∞	∞	100,000+
NEAR EDGE	∞	∞	100,000+	∞	∞	100,000+
MICA-KAPTON - SURFACE NO NOTICEABLE CHANGE						

RADIATION MEASUREMENTS JUNE 3, 1971

A-1	35 MR
B-1	20 MR
G-10	30 MR
G-11	3100 MR
G-1	600 MR