Muon Design Note #2

TITLE: CCM Dump Resistor Test

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OBJECTIVE: To demonstrate that the integrity of the dump resistor was not comprised because of the exposure to the elements for the last two years.

EQUIPMENT LIST

Name	Serial No.
1. Racal-Dana Series 6000 microprocessing digital multimeter	40299
2. P=EI power energy industries 150-5 60V 2,500 amp power supply	42284
3. Resistor shunt FNAL ID #MTF SNT03	
4. Tranductor FNAL ID #CS04	

DUMP RESISTOR SPECIFICATIONS:

Resistance - 0.1 ohms per unit

Measured resistance - 0.1 ohms

Amperage - 1,000 amps continuous

Maximum temperature - $650^{O}F$
achieved by the dump resistor
during load is thought to be.

TEST PROCEDURE

The following parameters wll be monitored with time and included in Appendix A.

1. Current
2. Voltage

The following parameter will be monitored with time and the highest value will be reported in Appendix A.

1. Temperature

Before proceeding with the test read the instructions below completely and thoroughly.

1. Slowly raise the current in 100 amps steps every one minute, until a current 1000 amps is reached. Then hold this current for 10 minutes. Slowly decrease the current in 100 amp steps every 1 minute.
2. While the dump resistor is being put under load carefully watch for any arcing. If arcing is seen unload the dump resistor, disconnect the resistor from the supply and correct the problem. After the problem is corrected proceed with the test.

CONCLUSION

The current in the dump resistor was not ramped down in 100 amp intervals, because the time available did not allow for it. There was no arcing heard or seen when the individual dump resistor modules were powered. The maximum temperature reached by any of the dump resistor modules was 726^{o}F, higher than expected. The resistance of the dump resistor modules increased approximately 10%, this would only reduce the time constant slightly. During this test each dump resistor module dissipated approximately twice the magnetic energy stored by the magnet with no problem, therefore the dump resistor is mechanically and electrically sound.

Witness Ronnie L. Dalmasy Date 6/26/85

Witness Howard T. Ward Date 6/27/85

Appendix A
Results of Dump Resistor Test

Dump resistor module without shunt

Time (min)	Current (amps)	Voltage (V)	Resistance (Ω)
0:00	100	10.625	0.106
1:00	200	21.367	0.107
2:00	300	31.887	0.106
3:00	400	42.165	0.105
4:00	500	53.487	0.107
5:00	600	64.461	0.107
6:00	700	75.464	0.108
7:00	800	87.360	0.109
8:00	900	99.829	0.110
9:00	1000	111.436	0.111
19:00	1000	116.034	0.116
19:00	800	91.746	0.116
20:00	600	68.643	0.114
21:00	400	45.307	0.113
22:00	200	22.183	0.110
23:00	0	0.000	

Dump resistor module with shunt

Time (min)	Current (amps)	Voltage (V)	Resistance (Ω)
0:00	100	10.760	0.107
1:00	200	21.296	0.106
2:00	300	32.293	0.107
3:00	400	43.127	0.108
4:00	500	54.097	0.108
5:00	600	65.094	0.108
6:00	700	76.346	0.109
7:00	800	87.808	0.110
8:00	900	99.947	0.111
9:00	1000	112.379	0.112
19:00	1000	117.161	0.117
19:00	800	94.476	0.116
20:00	600	70.564	0.115
21:00	500	56.661	0.114
22:00	400	45.126	0.113
23:00	200	21.945	0.110

Total amount of energy dissipated by each dump resistor module

$E_1 = I^2 R \Delta t$

$= (500)^2 (0.1) (600)$ Energy dissipated during ramp up

$= 1.50 \times 10^7$ J

$E_2 = I^2 R \Delta t$

$= (1000)^2 (0.1) (540)$ Energy dissipated at constant current

$= 5.40 \times 10^7$ J

$E_3 = I^2 R \Delta t$

$= (500)^2 (0.1) (300)$ Energy dissipated during ramp down

$= 7.5 \times 10^6$

$E_T = E_1 + E_2 + E_3$

$= 7.65 \times 10^7$ J

$= 76.5$ MJ

Stored magnetic energy of the Chicago Cyclotron Magnet = 32.5 MJ

Maximum temperature reached by the dump resistor modules

Without shunt $T_{max} = 726^{\circ}F$

With shunt $T_{max} = 583^{\circ}F$