Fermilab

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SUBJECT: **Muon Design Note #37**
(Power Up Check Out Procedure)

The attached Design Note #37 describes in detail how the individual interlock trip points will be verified and how the individual interlock circuits will be exercised.

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MUON CRYOSYSTEM DESIGN NOTE 37

SUBSYSTEM: X CCM _____ CVM _____ Cryoplant

TITLE: **Power Up Check Out Procedure**

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DATE: October 21, 1986

Objective

To insure that all the electrical interlocks are functioning and properly set.

Required Equipment

a) Power Supply 0-50 volts d.c.
b) Hypot Tester
c) 0-10 psi Pressure Gauge
d) Low Pressure Gas Bottle Regulator
e) Helium Gas Bottle
f) Stop Watch

There are two distinct steps to this power up check out procedure: a) checking out the set interlock trip points and b) exercising the interlock electrical circuitry. The below procedures are to be done before each engineering and physics run of the Chicago Cyclotron Magnet.

Table 1 shows all the interlocks which are part of the Chicago Cyclotron Magnet electric protection system.

Table 1

Interlock Checklist for the Chicago Cyclotron Magnet

	Item	Trip Set Point	Actual Trip Set Point	Trip Y/N	Initials
1)	Helium Level 1	_____	_____	_____	_____
2)	Helium Level 2	_____	_____	_____	_____
3)	Probe 1 (I)	62.9 ma	_____	_____	_____
4)	Probe 2 (I)	62.9 ma	_____	_____	_____
5)	Imbalance Voltage	±75 mv	_____	_____	_____
6)	Imbalance Voltage Magnet Trip Inhibit Set Point	0-325 Amp	_____	_____	_____
7)	Magnet GND Current	2.5 amps	_____	_____	_____
8)	Lower Lead Voltage	~50 mv	_____	_____	_____
9)	Upper Lead Voltage	~50 mv	_____	_____	_____
10)	Over Current Relay	905 amps	_____	_____	_____
11)	Over Current Shunt	895 amps	_____	_____	_____
12)	Rev. Switch Door	On/Off	_____	_____	_____
13)	Diode Cooling	On/Off	_____	_____	_____
14)	Power Trip	On/Off	_____	_____	_____
15)	Magnet Cryostat Pressure	5 psi	_____	_____	_____
16)	Low Gas Flow 1	50 scfh	_____	_____	_____
17)	Low Gas Flow 2	50 scfh	_____	_____	_____
18)	Imbalance Voltage Trip Turn-On Delay Time	0-25 sec.	_____	_____	_____
19)	Magnet Vacuum	1 micron (1×10^{-3} torr)	_____	_____	_____
20)	Over Current (dump)	930 amps	_____	_____	_____

Trip Point Check Out Procedure

The trip points for the interlocks numbered 1 through 7 can be verified by using the 18 position rotary analog monitoring selector switch, trip point switch and the DVM (Digital Volt Meter) display which is right below the magnet current DVM display.

The trip points for the interlocks numbered 8 through 10 can be verified by visually accessing the location of a mechanical pointer on an analog display.

The trip points for the interlocks numbered 11 through 20 cannot be verified without exercising the protection circuitry.

Exercising Interlock Circuitry Check Out Procedure

Interlocks 1 and 2 (Helium Level) can be tested only when there is liquid helium in the reservoir. Reset the interlocks making sure that the helium level status lights are green. This means that the helium level is above the low trip point. Slowly increase the low trip point on helium level 1 until its status light goes red. This should be at or just below the actual helium liquid level in the reservoir. Return the low trip point to its original setting. Repeat for helium level 2.

Interlocks 3 and 4 (Probe Current) can be tested any time. Reset the interlocks making sure that the probe current status lights are green. Now disconnect the probes at the magnet chimney, wait five minutes. If either status light remains green, this indicates a malfunction. Repair the circuit as required. Connect the probes once everything is in order.

Interlock 5 (Imbalance Voltage) can be tested by disconnecting the Vmag cable from the interlock chassis. Reset the interlocks making sure that the imbalance voltage status light is green. Now apply d.c. voltage and to the banana plugs that are normally used to measure the voltage drop across the coils during cooldown. Slowly increase the d.c. voltage until the status light goes red. Adjust trip point as required. Don't forget to reconnect the Vmag cable.

Interlock 6 (Imbalance Voltage Magnet Current Trip Inhibit Set Point) can only be tested when the magnet has accumulated liquid helium and after all the other interlocks have been tested out successfully. Reset the interlocks making sure all the status lights are green. Reduce the quench voltage to $\pm$ 10 mv. Slowly raise the magnet current to 330 amps; if the magnet dumps, the interlock is functioning properly. If the magnet does not trip, check to see if the imbalance voltage is between 10 mv and -10 mv. If so, decrease the imbalance voltage below this level, and if the magnet dumps, the interlock is functioning properly. If the imbalance voltage is above 10 mv and below -10 mv, then the current set point needs to be adjusted or there could be a malfunction.

Interlock 7 and 8 (Lead Voltage) can be tested by resetting the interlocks making sure that the lead voltage status lights are green and applying 60 millivolts (check to see that meter is reasonably accurate) across the input terminals. If the status lights go red, the circuit functions properly. If status light stays green, repair the circuit as required. Don't forget to plug the lead signal voltage cable back into the interlock chassis.

Interlock 9 (Over Current Relay) can be tested by removing the signal wires from the shunt which is located near the dump resistor and applying 1000 millivolts d.c. to the signal wires. Check the accuracy of the power supply. Reset the interlocks making sure that the over current relay status light is green, apply the voltage. If the status light goes red, the circuit functions properly. Repair circuit as required, if status light remains green.

Interlock 10 (Magnet GND Current) can be tested by first disconnecting the ground resistor from ground. Check to see that the resistor is not damaged and has a resistance of 20 ohms. Reset the interlocks making sure that the magnet ground current status light is green. Check the accuracy of the power supply. Apply 50 volts to the ground resistor. If status goes red, the circuit functions properly. If status light remains green, repair as required.

Interlock 11 (Over Current Shunt) can be tested by disconnecting the shunt signal wires and applying voltage to the signal wires. Reset the interlocks making sure that the over current shunt status light is green. Check accuracy of the power supply. Apply 90 millivolts d.c. to the signal wires, if the status light goes red, the circuit functions correctly. Repair circuit as required if status light stays green.

Interlock 12 (Reversing Switch Door) can be tested by resetting the interlocks making sure that the reversing switch door status light is green. Now open the door. The status light should go red. If not, repair as required.

Interlock 13 and 14 (Diode Cooling and Power Trip) can be tested by turning on the power to the power supply, resetting the interlocks and making sure that the diode cooling and power trip status are green. Now turn the power off to the EMI power supply. If both status lights go red, the circuit functions properly. Repair as required.

Interlocks 16 and 17 (Lead Flow) can be tested after the helium reservoir has some liquid in it. Open the lead flow control flow EVCCML and the lead flow flow meters full open. Turn on the hastings flow meter readout and put its channel selector switch on channel 1. Reset the interlocks making sure the lead flow status lights are green. Reduce the flow through lead 1 while having some one else watch the hastings flow meter readout and the status lights. Once the status light for lead flow 1 goes red, record the flow indicated by the hastings flow meter. Repeat for lead number two. Adjust the trip point as required.

Interlock 15 (Magnet Cryostat Pressure) can be tested by closing MV-604-H, disconnecting the pressure switch from its signal line and connecting it to a helium gas bottle. Reset the interlock making sure that the magnet pressure status light is green. Slowly increase the pressure using the gas bottle until

the above status light goes red. Adjust the trip point as required. Open MV-604-H. Purge the instrument line before connecting the pressure switch to its signal line.

Interlock 18 (Imbalance Voltage Trip Turn On Delay Time) will be tested by timing how long it takes for the circuit to trip the magnet when the quench voltage is applied by a direct current power supply. Before starting the test, reset the interlocks making sure the quench voltage status light is green. Adjust as required.

Interlock 19 (Magnet Vacuum) is tested by resetting the interlocks making sure the magnet vacuum status light is green and the televac read out unit is on. Turn off the televac unit and watch the status light and record the vacuum reading which caused the above status light to go red. Adjust as required.

Interlock 20 (Over Current) can only be tested by running over 930 amps through the transducer. This will not be done because of the risk involved. The magnet is already protected from over current by interlocks 9 and 11. During the 1985 Chicago Cyclotron Magnet test run, this circuit was tested by directly connecting the power supply to it. Circuit was found to function properly.

Hypotting

Hypot the Chicago Cyclotron Magnet to 500 volts with the magnet center tap signal cable disconnected from the interlock chassis making sure that the connector is not shorting to anything. If there is a lot of leakage current, find the cause and correct it.

Reviewed By R Hofman Date Oct 27, 1986