The only official copy of this file is the one on-line on the Superconducting Magnet Division website. Before using a printed copy, verify that this is the most current version by checking the document issue date on the website.

SMD Operations Procedures Manual

8.1.1.41 TEST OF SAFETY INTERLOCKS FOR THE SHORT SAMPLE TEST FACILITY, MAGNET POWER SUPPLY

Text Pages 1 through 10
Attachment 1,2

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Revision No. 03 Approved:

Signature on File 1/14/2009
Division Head Date

Preparer(s): P. Ribaudo

Test of Safety Interlocks for the Short Sample Test Facility, Magnet Power Supply

1.0 Purpose and Scope

1.1 To provide a procedure for testing the Kirk Locks, electrical door interlocks, "crash" push buttons, DC Overcurrent protection circuits, and warning lights associated with the Short Sample Magnet Test Power Supply.

2.0 Responsibilities

2.1 The Cognizant Engineer for the Short Sample Magnet Test Power Supply, or the Electrical Systems Section Head, shall:

A. designate those persons authorized to perform the procedure;

B. establish and maintain a list of authorized persons;

C. appoint a Cognizant Technician for the interlock test database;

D. review the completed "Check List for Safety Interlock Test" (Attachment 1) and sign the "Interlock Test Approval Form" (Attachment 2).

2.2 The Cognizant Technician shall:

A. complete the "Check List for Safety Interlock Test";

B. establish and maintain a paper database for the interlock test;

C. arrange for the "Interlock Test Approval Form" to be posted at the required locations.

2.3 The Authorized Operator shall:

A. initiate the procedure, when required;

B. perform the main actions of the procedure.

3.0 Prerequisites

3.1 The Authorized Operator shall:

A. be instructed by the Cognizant Engineer;

B. be trained as a "Authorized Employee", as per SBMS Subject Area, "Lockout/Tagout (LOTO)".

C. Operator must be trained in NFPA 70E Personal Protective Equipment Requirements and Arc Flash Hazards.

D. Operator LOTO OJT Training on Power Supply System must be current.

E. Operator must follow SMD-OPM 8.1.1.44 Generic LOTO Procedure.

4.0 Precautions

4.1 Personal Protective Equipment must be worn as defined in NFPA 70E for verifying LOTO, 480V is a category 2 hazard. Only when LED Meter UPA-100 and AC Panel Meters monitoring each AC Phase to ground are installed on the 480V Disconnect is the Hazard Category is reduced to (–1), operator can then follow PPE requirements for the lower classification. See Attachment 3 – Interpretation by the Laboratory Electrical Safety Committee – June 2005.

4.2 The procedure requires that the Kirk Lock system be bypassed, or "defeated", during some tests. The Kirk Lock system shall be restored to full working order after the procedure is completed.

4.3 All doors that were unlocked for the purpose of testing the interlocks shall be locked when the procedure is completed.

5.0 Procedure

Note 1: *The test should be performed every six months.*

Note 2: *Use the Check List (Attachment 1) as a guide in locating each safety device. As each device is tested successfully, check it off.*

Note 3: *If a device fails, stop work and immediately notify the Cognizant Engineer and the ES&H Coordinator.*

Note 4: *Remote operation can be performed using either control panel buttons or computer control.*

Kirk Key Lock Mechanical Interlock

Note: ***This procedure should be performed concurrently with OPM 8.1.1.7, Test of Safety Interlocks of the Short Sample Test Facility, Twin 15 kA Power Supplies.***

OVERVIEW

Note: ***The safety Kirk lock system of the Short Sample Test Facility was designed to accommodate multitasking within in the various stages of setup and testing of Superconducting magnet cable. Below is explanation of each integrated part.***

Within each test dewar their are three set of safety enclosures that protect the power leads used to energize superconducting test cable and a magnet coil. Each positive and negative power lead and magnet coil has an independent cover with the following designation. S4+, S4-, M4, S5+, S5-, M5, S6+, S6-, M6.

Each dewar test cage entry door has a Kirk lock installed on them designated as G4, G5, and G6. Dewars cage entry doors G4 and G5 have two doors that share the same Kirk key.

In the Short Sample control room there is three banks of four Kirk key locks. These are designated as the Magnet Cover Safety Kirk key Interlock Logic Panel. Next to that panel is four banks of five Kirk Key locks. This is called the Power Supply Safety Kirk Key Interlock Logic Panel.

On each power supply main disconnect switch is a Kirk Key lock labeled PS, PSS, PM and PSM. Kirk Keys PS and PM are the final results after all the correct Kirk Key logic has been satisfied in the Short Sample control room. Then each main power switch can be activated to each Short Sample power supply to conduct cable testing. The PSS and PSM Kirk keys are used to gain entry to the power supply doors for periodic maintenance. These Kirk keys in conjunction with the PS and PM Kirk key can gain entry to the Short Sample Link Box.

SEQUENCE OF OPERATION OF THE KIRK KEY SAFETY INTERLOCK SYSTEM

To perform a superconducting cable test, the Short Sample control room operator must insure that all safety covers on both test dewars that are not in used be secured and have Kirk key inserted in the proper designated Kirk locks (Magnet Cover Safety Kirk Key Interlock Logic Panel). Once this condition is satisfied, the Magnet Supply key (MS#) can be removed and inserted into the Power Supply Safety Kirk Key Interlock Logic Panel along with the gate key from the dewar facility be used for the cable test.

When all these conditions have been satisfied in the Power Supply Safety Kirk Key Interlock Logic Panel, both the Power Supply Short Sample Key (PS#) and Power Supply Magnet (PM#) can be removed. These Kirk Keys can now be inserted into their respective Kirk locks to activate the main power supply to conduct superconducting cable testing.

5.1 The Kirk Key Lock Mechanical Interlock is tested by performing the following steps:

5.1.1 Use PM key from the Short Sample Control Room, Power Supply Safety Kirk Key Interlock Logic Panel to open the Kirk Lock magnet power supply electrical current feed Panel F.D.S. 48.

5.1.2 Place the Switch in the ON position.

5.1.3 Attempt to turn the keys to remove the PM and PSM. Verify that this cannot be done.

5.1.4 Place the Switch in the OFF position.

5.1.5 Use the PSM key to unlock the Control Cubicle door on the left side of the Power Supply.

5.1.6 Attempt to remove the key while the door is unlocked. Verify that this cannot be done.

5.1.7 Re-lock the door and remove the key.

<u>Electrical Door Interlocks</u>

Note 1. *An authorized control room technician for this test must operate the Supply.*

Note 2. *An Authorized Cognizant Technician may assist the control room technician by tripping the interlocks while the technician monitors and controls the Supply.*

Note 3. *Refer to Attachment 1 ("Check List for Test of Safety Interlocks") for locations of all of the Door Interlocks. Interlocks on doors with Kirk Locks are noted as such on the Check List.*

5.2 Performing the following steps to test the electrical Door Interlocks on those doors with Kirk key locks:

5.2.1 Defeat the captive key lock permitting access with power on to MPS-1.

5.2.2 Leave the door open enough to activate the Interlock switch.

5.2.3 Place the Input Disconnect Switch F.D.S. 48 in the ON position. Check both door switch interlocks.

5.2.4 On the Power Supply front panel, depress the RESET pushbutton to clear faults.

5.2.5 Place the REMOTE/LOCAL switch in the REMOTE position.

5.2.6 Through control panel, attempt to reset faults. Verify that the panel display indicates a fault and that the "DOOR" LED on the control rack is lit. The LED is located on the card labeled POWER SUPPLY CONTROL CARD.

5.2.7 Attempt to turn the Supply on through panel command. Verify that this cannot be done.

5.2.8 Place the Input Disconnect Switch in the OFF position.

5.2.9 Close the door and lock the Kirk key lock.

5.2.10 Place the Input Disconnect Switch in the ON position.

5.2.11 Through computer command, reset faults. Verify that the "door" fault resets.

5.2.12 Place the Input Disconnect Switch in the OFF position.

5.2.13 Repeat steps 5.2.1 to 5.2.12 for all electrical Door Interlocks on those doors with Kirk key locks.

DC Overcurrent

5.3 The DC Overcurrent interlock of each power supply is tested by performing the following steps:

5.3.1 On the Power Supply DC Overcurrent Relay, locate the meter labeled "D.C. AMPS". Two red needles should be visible on the meter.

5.3.2 Record the setting of the red needles.

5.3.3 Adjust the needle setting to lowest setting.

5.3.4 Place the Input Disconnect Switch in the ON position.

5.3.5 On the Power Supply front panel, depress the RESET pushbutton to clear faults.

5.3.6 Place the REMOTE/LOCAL switch in the REMOTE position.

5.3.7 Through panel command, reset faults and place the Supply in the ON state.

5.3.8 Command an output of 1000 amps and a ramp rate of 50 amps/second.

5.3.9 Verify that the Supply shuts off when an output of 500 amps is reached.

5.3.10 Set the two red needles to its original setting.

Crash Buttons

5.4 Performing the following steps to test the crash buttons:

5.4.1 Place the Input Disconnect Switch in the ON position.

5.4.2 On the Power Supply front panel, depress the RESET pushbutton to clear faults.

5.4.3 Place the REMOTE/LOCAL switch in the REMOTE position.

5.4.4 Through computer command, reset faults and place the Supply in the ON state with an output of zero amps. A small idle current will be present.

5.4.5 Depress a crash button. Verify that the Supply shuts off by observing the meters on the front panel of the Supply. All meters should indicate zero.

5.4.6 Repeat steps 5.4.2 to 5.4.5 for the other crash buttons to be tested as listed on the check list.

"PS ON" Warning Lights

5.5 The "PS ON" Warning Lights are tested by performing the following steps:

5.5.1 Place the Input Disconnect Switch in the ON position.

5.5.2 On the Power Supply front panel, depress the RESET pushbutton to clear faults.

5.5.3 Place the REMOTE/LOCAL switch in the REMOTE position.

5.5.4 Through computer command, reset faults and place the Supply in the ON state.

5.5.5 Verify that all of the warning lights listed on the CheckList are flashing.

5.5.6 Turn off the Supply.

5.5.7 Verify that the warning lights extinguish.

<*Authorized Person:*

5.6 Complete, date, and sign the checklist.

<*Cognizant Engineer:*

5.7 Review the checklist and, if approved, sign the "Interlock Test Approval" form (Attachment 2).

<*Cognizant Technician:*

5.8 Post a copy of the signed "Interlock Test Approval" form on the Control Rack.

5.9 File one copy of the checklist and one copy of the Approval Form.

6.0 Documentation

6.1 Check List for Test of Safety Interlocks

6.2 Interlock Test Approval Form

7.0 References

7.1 SBMS Subject Area, "Lockout/Tagout (LOTO)".

7.2 OPM 8.1.1.44, Generic LOTO Procedure Incorporating UPA-100 Led Meter and AC Panel Meters.

7.3 NFPA 70E.

7.4 System Specific SMD LOTO OJT Training.

8.0 Attachments

1. Check List for Test of Safety Interlocks

2. Interlock Test Approval Form

3. Interpretation by the Laboratory Electrical Safety Committee (LESC).

Attachment 1

CHECK LIST FOR TEST OF SAFETY INTERLOCKS
Short Sample Test Facility, Magnet Power Supply

DESIGNATION	DESCRIPTION	U
DTF KL-1	Kirk lock on F.D.S. 48 Disconnect Switch	
DTF KL-2	Kirk lock on power supply control cubicle door	
UT-100	Verify LED Meter UPA-100 goes to zero	
DTF DIL-1	Door Interlock on power supply control cubicle door (w/ Kirk Lock)	
DTF DIL-2	Power supply front panel Interlock (screws will have to be removed to activate)	
DTF DCO-1	DC overcurrent interlock for power supply	
DTF CB-1	Crash button on power supply	
DTF CB-2	Crash button in Cryo CR	
DTF CB-3	Crash button Short Sample CR	
DTF WL-1	Warning light over power supply	
DTF WL-2	Warning light over Link Box	

Test date ____________ Tested by _______________ Life# _______________

Tested by _______________ Life# _______________

Cognizant Engineer _______________ Life # _______________

Notes:

The only official copy of this file is the one on-line on the Superconducting Magnet Division website. Before using a printed copy, verify that this is the most current version by checking the document issue date on the website.

Attachment 2

Safety Interlock Test Approval
The safety interlocks of the Short Sample Test Facility Magnet Power Supply System have been tested and approved

Approval Date_______________

The approval is valid until the expiration date shown. DO NOT OPERATE THE SHORT SAMPLE TEST FACILITY MAGNET POWER SUPPLY AFTER THE EXPIRATION DATE.

Expiration Date______________

Approval Signature ____

Post on Control Rack near power supply

==

Safety Interlock Test Approval
The safety interlocks of the Short Sample Test Facility Magnet Power Supply System have been tested and approved

Approval Date_______________

The approval is valid until the expiration date shown. DO NOT OPERATE THE SHORT SAMPLE TEST FACILITY MAGNET POWER SUPPLY AFTER THE EXPIRATION DATE.

Expiration Date______________

Approval Signature ____

Post on remote Control Rack (in CR)

==

Safety Interlock Test Approval
The safety interlocks of the Short Sample Test Facility Magnet Power Supply System have been tested and approved

Approval Date_______________

The approval is valid until the expiration date shown. DO NOT OPERATE THE SHORT SAMPLE TEST FACILITY MAGNET POWER SUPPLY AFTER THE EXPIRATION DATE.

Expiration Date______________

Approval Signature ____

Post on power supply

==

Safety Interlock Test Approval
The safety interlocks of the Short Sample Test Facility Magnet Power Supply System have been tested and approved

Approval Date_______________

The approval is valid until the expiration date shown. DO NOT OPERATE THE SHORT SAMPLE TEST FACILITY MAGNET POWER SUPPLY AFTER THE EXPIRATION DATE.

Expiration Date______________

Approval Signature ____

File copy

==

Attachment 3

Interpretation by the Laboratory Electrical Safety Committee – June 2005

Engineered Voltage Monitoring Solutions for Lockout/Tagout

Properly engineered and installed voltage monitoring can simplify operations by providing a method of implementing lockout/tagout without requiring the use of personal protective equipment.

When used according to approved procedures, the systems described in this document can establish that system voltage has been reduced to levels where subsequent zero-voltage tests may be made using a hand-held meter and wearing safety glasses, and without additional personal protective equipment. In some engineered configurations, the installed devices will serve to indicate zero voltage without the need for further tests.

The Importance of Procedure and Timeliness

Zero-voltage verification during electrical lockout/tagout follows an A-B-A sequence. A hand held meter is tested on a known voltage source, the equipment voltage is measured to confirm a zero-voltage state, and the meter is tested once again on a known voltage source.

Timely performance of this sequence is required, with the A-B-A steps performed within minutes of one another. It is not sufficient to believe that the meter worked in the past, to measure the equipment, and to start work on the equipment intending to verify meter operation at a later time. The principle of timeliness is vital in considering alternative methods of assuring a zero-voltage state.

If a technician arrived at equipment with front panel voltage-indicating devices and observed the devices indicating zero voltage, it would not be clear if power were truly removed or if the measuring devices were simply defective. On the other hand, if the devices indicated the equipment was being powered, and when power was removed the devices responded in a timely manner to indicate zero voltage, then the device indication can be trusted to show the true condition of the equipment. In an operational situation, if a technician called to fix a piece of equipment arrived to find panel-mounted devices indicating voltage, and the equipment was then turned off and the devices indicated zero voltage, the technician could complete lockout/tagout while using safety glasses and without additional personal protective equipment and work could begin. If the technician arrived to find the devices already indicating zero voltage, the technician would have no way of knowing if the equipment were powered down or if the voltage-indicating devices were defective. In the latter case, direct contact measurement would have to be made to execute lockout/tagout, while wearing full appropriate PPE in accordance with the NFPA 70E tables appearing in the SBMS Personal Protective Equipment Manual.

Interpretation by the Laboratory Electrical Safety Committee – June 2005

Engineered Voltage-Monitoring Systems

1. Front Panel Meters

Front panel meters, commonly used on equipment handling large amounts of power, can be used to confirm a zero-voltage state. Meters used for this purpose should be wired so they directly monitor the source of power. Meter switches, if used, should be industrial-grade devices intended for this service, such as GE type SB switches.

2. Voltage Indicators

A UPA-100 "Universal Power Alert," a UL listed voltage indicator, is available from STC (Automatic Timing and Controls, Lancaster, PA). The voltage indicator can be used in the same way as front panel meters, to assist in confirming a zero-voltage state. The indicators may be wired to monitor ac or dc power, and LED lamps are lighted whenever the device senses voltage more than 40 volts. The single design operates to 600 volts and has four leads, one for each phase and one for connection to ground. This arrangement allows the device to be used on single phase and three phase circuits, and even on direct current circuits. A data sheet on the UPA-100 is attached to this document.

The device works reliably with grounded systems. Some facilities on a site have ungrounded power distribution systems designed to enhance operational reliability. These systems actually have high-resistance grounding due to the equipment continually monitoring for ground faults on any phase. The UPA-100 has a 470-k ohm resistor in each leg, and will operate properly on less than a tenth of a milliampere. Since the voltage indicator requires minimal current for proper operation, the high-resistance grounding is adequate for proper operation of the indicator.

As noted, the LED lamps are lighted whenever the device senses voltage more than 40 volts. While deployment of the UPA-100 does not permit voltage verification to zero volts, use of this device allows access to the equipment for further testing using a hand-held meter with no requirement for personal protective equipment since the voltage has been established through use of the device as below 50 volts.

3. Voltage Test Points

Personnel protective equipment (PPE.), including voltage-rated gloves and leather glove protectors, must be used when measurements are made on circuits normally energized at voltages greater than 50 volts. Aside from safety glasses, no additional PPE. is required for measurements on power-limited voltage sources less than 50 volts. If voltage step-down devices are designed into equipment normally operating more than 50 volts, and with the reduced voltages available at test points, then the zero-voltage lockout/tagout confirmation measurements can be made at the test points while using safety glasses and without using additional PPE. Preferably, the test points would be available at the equipment front panel.

A voltage step-down can be achieved using transformers. Three transformers would be required for three-phase power supply circuits.

A voltage step-down can also be achieved using resistive voltage dividers. The disadvantage of this approach is that heat would be continually released into the enclosure. Resistors chosen for this application should be wire-wound or equivalent in reliability (not metal film). They should have identical power ratings, selected as at least three times the anticipated continuous power dissipation as if the test point were connected to a solid ground. A 10:1 divider is suggested for this application, so that a 120-volt source would present 12 volts to a test point.

Level of Safety

Commercially off-the-shelf (COTS) components are used to assemble electrical equipment. These COTS components have all been examined by a Nationally-Recognized Testing Laboratory (NRTL) and are labeled or listed. Finally, when the COTS components are assembled into their final configuration, all systems must be reviewed and accepted by a representative of the Authority Having Jurisdiction (AHJ). It is by use of labeled or listed components such as switches, fuses, circuit breakers, and similar devices that safety of the electrical installation is assured.

Use of engineered voltage monitoring solutions for lockout/tagout follows the same safety pathway. ATC's UPA-100 "Universal Power Alert" is a commercial off-the-shelf device listed by UL, an NRTL. When installed under engineering control, and with the installation (and associated procedures) reviewed and accepted by a representative of the Authority Having Jurisdiction, the device is equal to switches and circuit breakers and conduits in affording personnel protection.

Installation of other means of engineered voltage monitoring solutions for lockout/tagout, including installed metering and voltage test points, follows a similar pathway. The major issue with these alternate devices is that they are not labeled or listed like the UPA-100 and therefore more engineering controls and AHJ reviews are required.

The initial topic in this document discussed *The Importance of Procedure and Timeliness*. Using procedures discussed under the second topic, *Engineered Voltage-Monitoring Systems*, the techniques discussed in this document are classified as Hazard Severity Category IV. This category is shown in the table below, which has entries typical of many versions of the same material available in the military and civilian sectors. Aside from the engineered aspects of each installation and the fact that the UPA-100 is UL listed if this is the chosen device, the basic reason lies in procedures. Since verification of voltage must occur first, followed by removal of power and timely verification that voltage has been removed, the devices are, in effect, being tested each and every time they are used. Further, no periodic testing is required since they are repeatedly tested at each use. No other component of an electrical system is periodically tested, except for items like insulation tests for transformers and large motors.

Hazard Severity		
Category	Descriptive Word	Potential Consequences
I	Catastrophic	May cause death or system loss
II	Critical	May cause severe injury, severe occupational illness, or major system damage
III	Marginal	May cause minor injury, minor occupational illness, or minor system damage
IV	Negligible	Will not result in injury, occupational illness, or system damage

Routine Voltage Testing on De-Energized Equipment

It should be noted that careful technicians routinely apply meter leads to test for voltage on parts they know to be de-energized, such as equipment which has been unplugged or locked and tagged. While safety glasses are required for this and all electrical work, the technicians do not need additional PPE for this operation.