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600 A Current Lead Splice Procedure
6-21-04 revision

Purpose: This procedure shall be used by the Cryogenic Feed Box vendor to insure that the splices between the vapor cooled current leads and the busses are prepared in a reproducible, consistent process. This procedure will result in splices that have the required electrical and mechanical properties. In service, the joints will be submersed in liquid helium and will operate at currents up to 600 A.

Materials:

1. The solder shall be Sn62PB36AG02, with a melting point of 180 C. (Dwg. No. 5520-MA-369904).
2. The solder flux shall be chloride-free rosin type (Kester SP-44 or equivalent).
3. Cartridge heaters (Watlow Firerod 9813 J3A112 L12), or equivalent.
4. Thermocouples and readout instrumentation
5. Excess solder/flux catch basin.
6. Disposable flux brushes.
7. Isopropyl alcohol
8. Paper wipes
9. Scotchbrite abrasive pads

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Parts and Drawings:

1. 600 Amp Solder Box Assembly (Dwg. # 25I4913)
2. Solder Box Top Plate 600 Amp (Dwg. # 25I6813)
3. Solder Box 600 Amp (Dwg. #25I6774)
4. 600 Amp Conductor Clamp Assembly (Dwg. #25I4933)
5. Conductor Clamp Top Plate 600 Amp (Dwg. #25I6803)
6. Conductor Clamp 600 Amp (Dwg. #25I6793)
7. 600 Amp Conductor Clamp Stiffener Assembly (Dwg. #25I486)
8. 600 Amp Lead Stiffener Inner Ring (Dwg. #25I487)
9. 600 Amp Lead Stiffener Outer Ring (Dwg. #25I488)

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Specifications. The specifications required for this procedure are:

1. MSDS No. A5214—for Kester Type SP-44 rosin soldering flux.
2. ASTM B32-89 (Sn62PB36AG02 Solder).

Splice procedure

1. Install 600 Amp Conductor Clamp Stiffener Assembly (Dwg. #25I486) prior to soldering leads. Position the clamp stiffener 4" from the bottom of the 600 amp vapor cooled leads.
2. Verify that the 600 amp vapor cooled leads are pre-tinned with Sn 62 solder. If not, pre-tin before proceeding.
3. Perform a trial layout with the superconductor wire to be used in the splice. Have a coworker verify that the correct wire is being used. Mark the wire for pre-tinning and cutting to correct length.
4. Remove the Kapton insulation by careful trimming with a sharp scalpel. (Photo #1)

NOTE: Check continuity before cutting wire to length

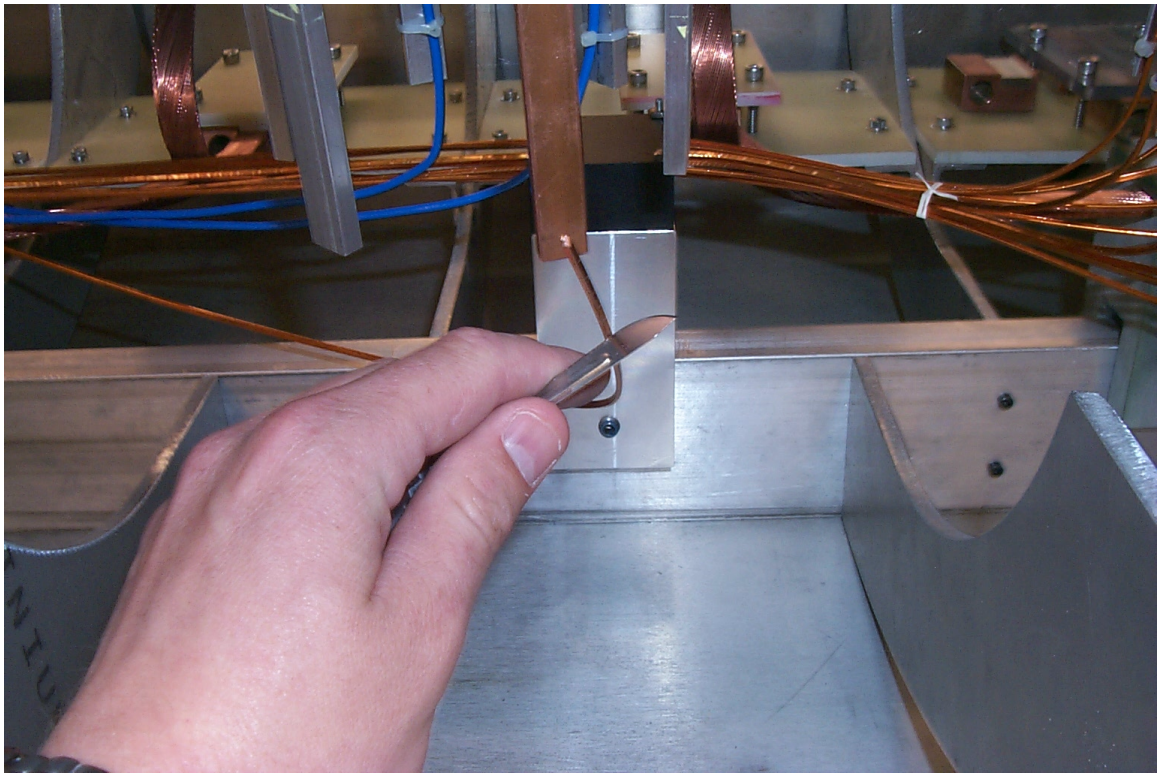

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Photo #1

5. Tin the wire. Tin only the length of wire that will be contained in the 600 amp solder box assembly. Also, the wire shall be tinned at a distance of 100 mm from the end of the solder box assembly, where the voltage tap wires will be mounted.
6. Coat wire and 600 amp lead with flux. Assemble wire and lead in the 600 amp solder box assembly, as shown in Photo #2 & #3. Cut and mount voltage tap wires.

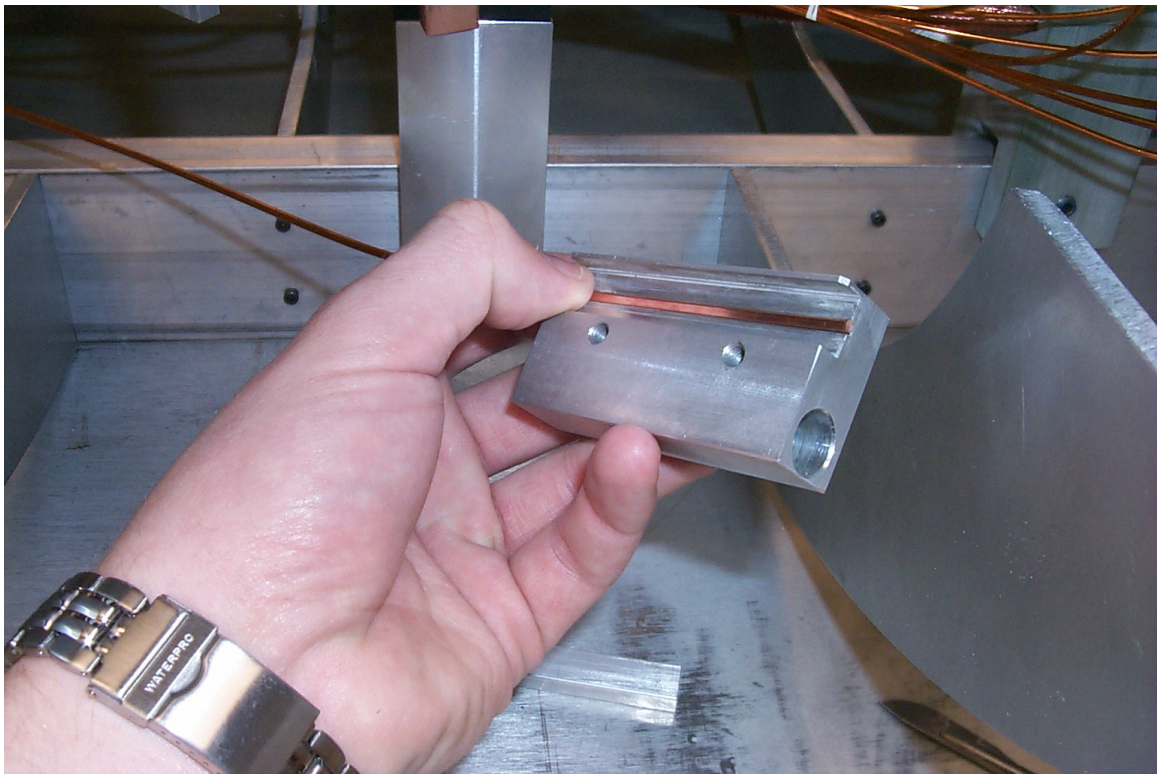

Photo #2

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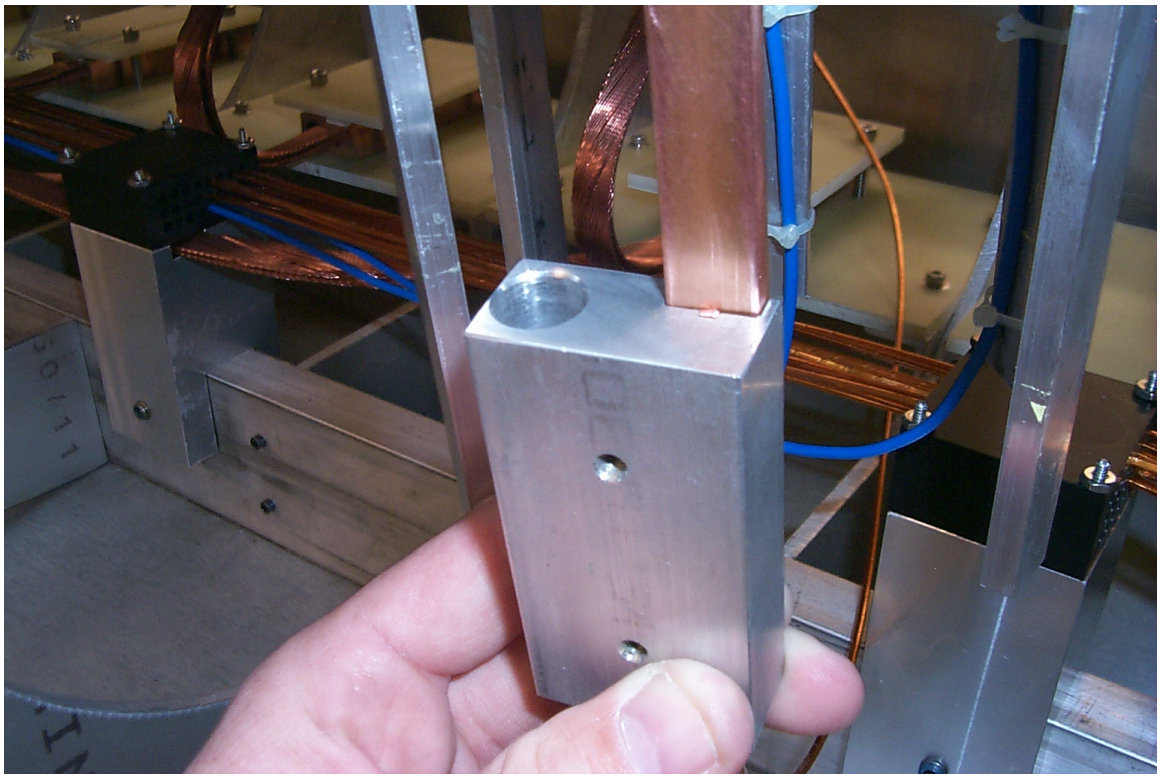

Photo #3

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6. Insert superconducting wire into 600 Amp solder box (Dwg #25I6774) and mount on the 600 amp lead. Install solder box top plate onto 600 amp solder box. Use the hardware that is specified on the drawing (Dwg. #25I4913). Start the four bolts and snug down. This will hold tension on the stack while soldering. (Photo #4)

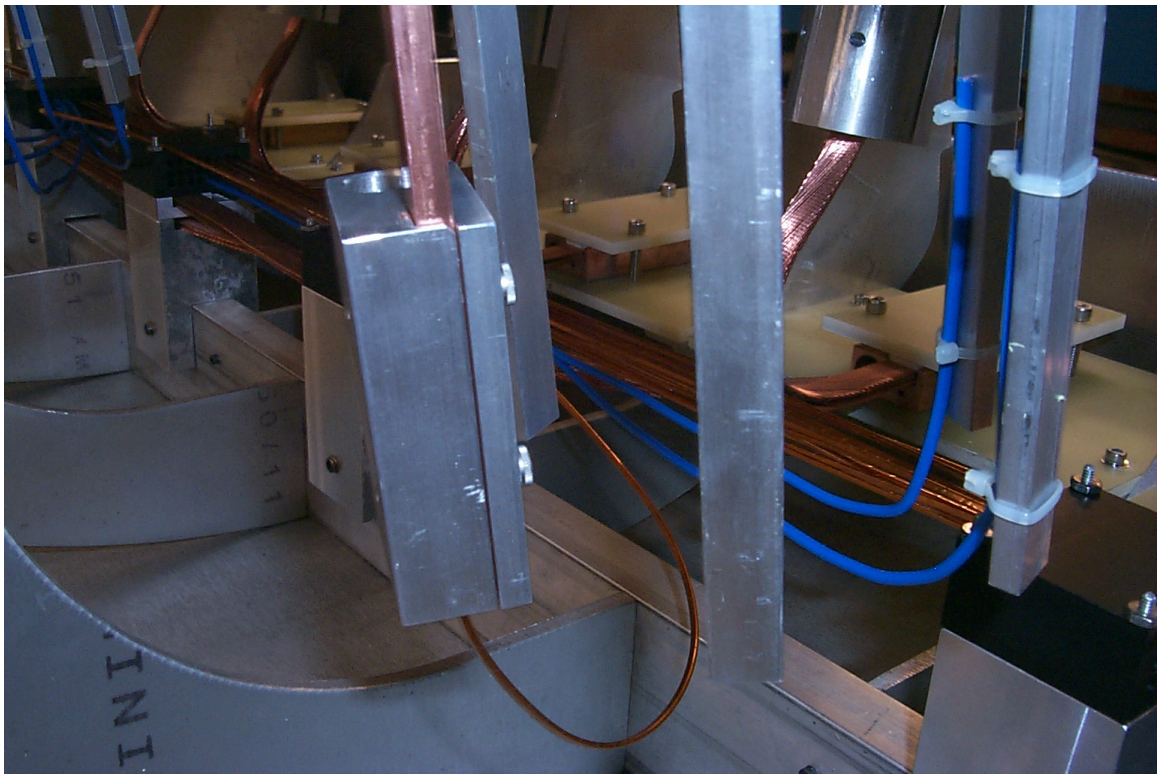

Photo #4

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7. Insert cartridge heater into holder. Plug the heaters into 120 VAC source. Use a Variac to control the voltage so as to not exceed 190C. Turn variac on and monitor the progress of heating the cables with the thermocouple in the holder and by observing when the solder melts. Do not allow the temperature to exceed 190 C. Feed in extra solder when solder reaches melting point. Tighten screws on solder fixture to insure that the excess solder is squeezed out of the joint. Keep feeding solder into the joint until the solder has solidified. (Photo #5)

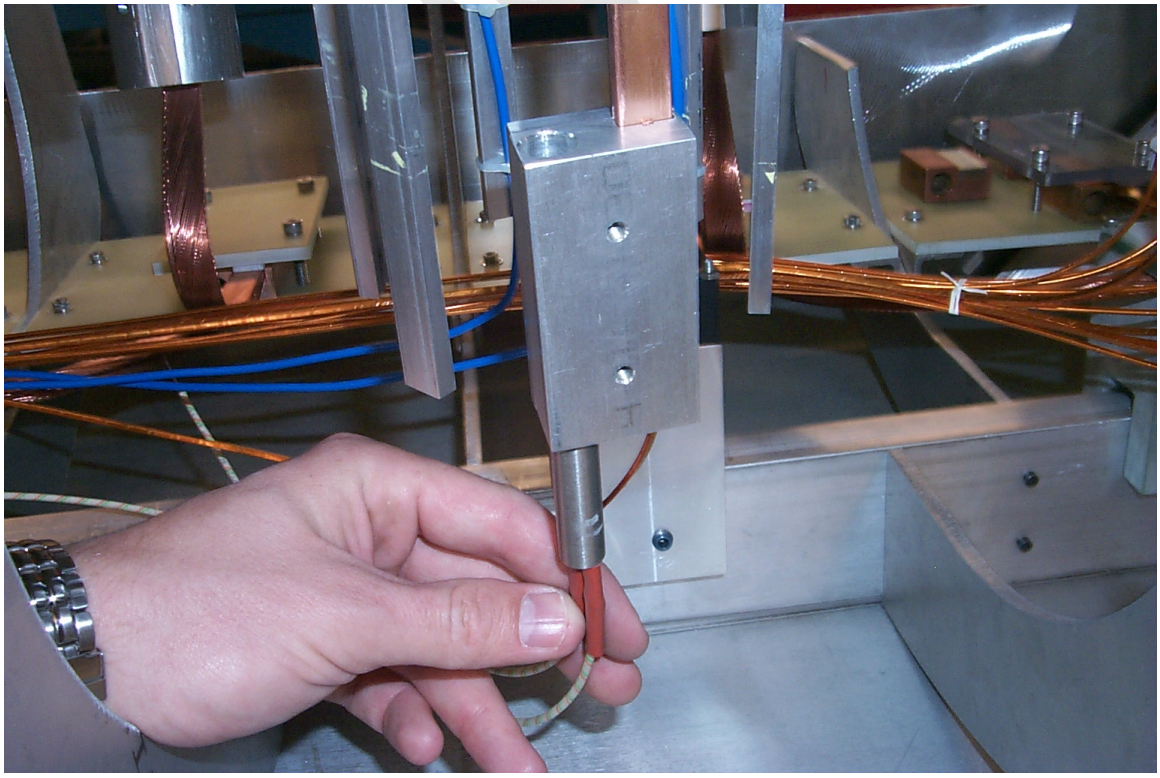

Photo #5

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8. Solder the voltage tap wire to the conductor. Make this joint upstream about 100 mm from the splice block.
9. After the joint cools, remove the clamping plate and push block.
10. Clean up the joint area with Scotchbrite pads and isopropyl alcohol to remove any residual flux and excess solder (Photo #6).

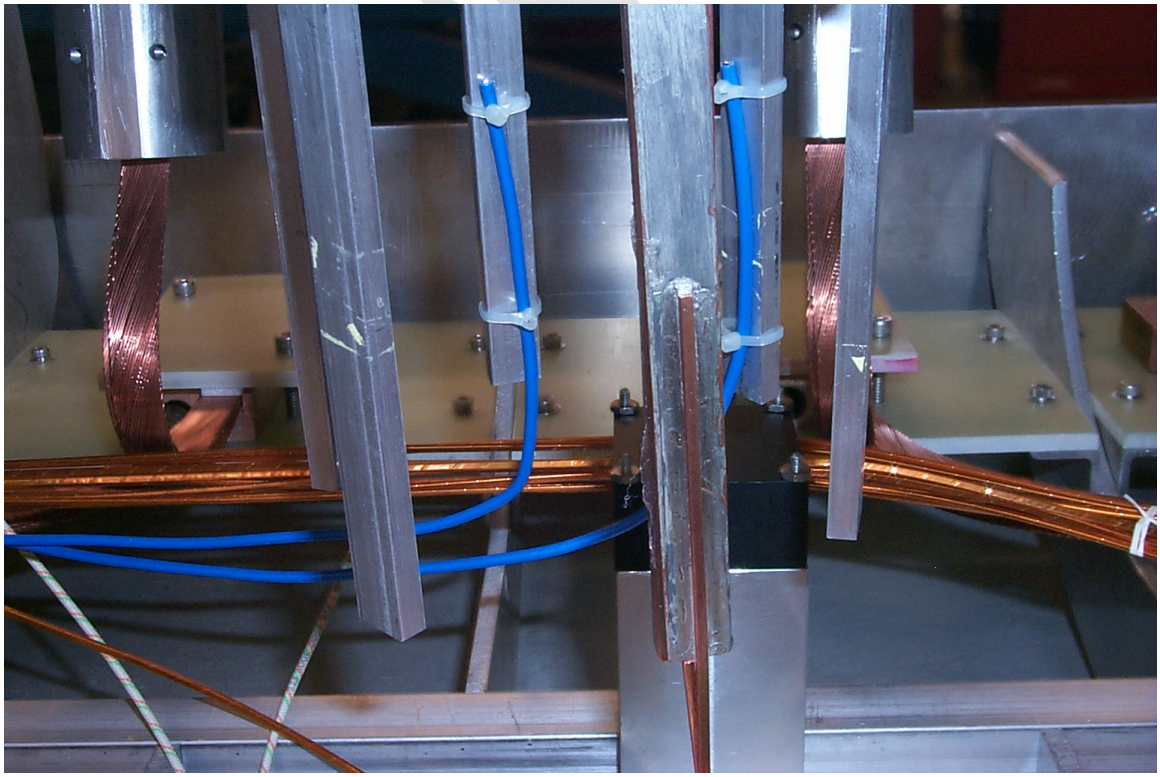

Photo #6

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11. Perform an electrical continuity check to verify that the correct bus wire has been connected to the lead.
12. Install the 600 Amp conductor clamp assembly (Dwg. #25I4933). Tighten up the screws.
13. Install the Kapton film insulation around the voltage tap and splice. Install the voltage tap strain relief.
14. Position 600 Amp Conductor Clamp Stiffener Assembly (Dwg. #25I486) 3.25" to 3.5" from the bottom of the 600 amp vapor cooled leads and tighten.

Electrical Performance Test

After the splices are completed and the insulation applied, the high voltage performance shall be verified by performing a voltage stand-off test (referred to as a "hi-pot" test) following the procedure described below. The completed lead system shall be tested to 2000 volts in air, while the DFBX is held at ground potential.

1. SCOPE:
   This procedure describes the general Hi-Potting process to check the integrity of insulation between electrical components.

2. APPLICABLE DOCUMENTS:
   a. LBNL Health and Safety Manual, PUB 3000, Chapter 8, "Electrical Safety".
   b. High Potter technical manual.

3. REQUIREMENTS:
   3.1 Equipment and Materials:
      a. Hypotronics, Model 306B Hy-pot tester or Bertan Associate Inc. Bin Power Module Model 375X high voltage power supply or equivalent.
      b. Grounding strap 1/6" X 7/16" Wide stranded wire or equivalent

   3.2 Safety Precautions:
      a. Follow all applicable safety precautions called for in PUB-3000.
         a1. Pub 3000 rates this operation as a Class 1B hazard (Low), high voltage very low current. The operation will be performed in a Mode 2 classification, (manipulative operations performed on non-energized system. Energized in close proximity to exposed components).

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b. This test is to be conducted only by qualified technicians who have been trained in the proper use of the equipment and who are knowledgeable in the construction of these components.

c. When testing, insure the area is cordoned off and posted as "DANGER – HIGH VOLTAGE".

d. Notify the supervisor or responsible person that High-potting will be preformed.

e. When performing High Pot testing or when around high voltage and handling test leads it is a good practice to keep one hand in your pocket and keep a safe distance from energized components. Also keep other people away while conducting a high voltage tests.

3.3 PROCEDURE:

3.3.1 Calibration Check:

a. Disconnect all measuring instruments and any source of voltage.

b. Ensure that the Hi-pot meter is off and discharge the D.C. OUT terminal with a ground lead.

c. Use only the SHV test leads provided with the instrument. DO NOT remove the SHV Cable from these instruments. For the Hipotronics tester, plug the BLACK lead to the GROUND terminal and the RED lead to the D.C. OUT terminal.
For the Bertan tester, connect the ground strap to the chassis case. Connect a DVM to the voltage monitor and a second DVM to the current monitor. Set the DVM to DC volts and the current monitor to mV. For the Bertan tester, the voltage monitor reads 10 volts = 10KV the current monitor reads 10V = 1mA

d. Connect the GROUND cable or strap to Earth ground.

e. Connect a 20 MΩ resistor across the GROUND and D.C. OUT terminals for either tester.

f. Move the Hipotronics sensitivity knob to the maximum sensitivity. . The Bertan should be set to the 100μA scale

g. Move the range switch to LOW (1-1.2 KV range) or the turn pot to zero voltage in the case of the Bertan.

h. Turn the main power switch on and increase the voltage to 500 Volts. Note the current reading is 25μA. The Bertan should read ¼ of scale on the 100μA setting. If the meter does not read these values the Hi-pot tester is not working correctly. Turn the tester off and reduce the voltage control knob to zero. Inform the Cognizant Supervisor. If the reading is correct raise the voltage towards 1000V and verify the trip point is approximately 50 μA. The Bertan meter will trip at 80% full scale or 80μA. Accordingly, the voltage for the Bertan will trip at approximately 1600 V.

i. Repeat the test if necessary to verify a trip point of less than 50 μA

j. Record the trip point on the Hi-pot record book.

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k. Turn the Hi-pot off and discharge it by touching the grounding lead to the D.C. OUT terminal and resistor.

l. Disconnect the resistor.

3.3.2 HI-POT TEST:

a. Ground test point prior to connecting the instruments to discharge any stored energy in the device to be tested. Be aware that high pot test can charge up capacitance in the system. Although the calculated energy in these magnets is less than 5 joules, the stored energy in any system is a concern and the primary source of hazard. If in doubt the capacitance can be measured and should be less than 10μF at 1000V.

b. Connect the (+) SHV lead to the magnet or magnet component.

c. Connect the ground strap to EARTH ground, to the ground potential of the respective component, and to the chassis case or ground terminal.

d. Move the sensitivity knob to the maximum setting. For the Bertan the sensitivity setting is 1μA.

e. Move the Voltage control setting to low and the control knob to the minimum position.

f. Move the current meter setting to X100 for the Hipotronics.

g. Turn the High Pot tester power switch on. Turn the VOLTAGE control knob very slowly to raise the voltage until 1000 V (1KV) has been reached. Switch to the high setting and continue to increase the voltage until the specified voltage is reached. The reading should be less than 10μA.

h. Record the reading, inform the cognizant supervisor of any reading is greater than 10 μA.

m. A fault in the insulation or in the test connection will cause the meter to trip off. Turn the Hi-pot tester power switch off, turn the voltage control to the minimum position, and then discharge the component and tester by touching the Ground cable to the positive terminal connection. You can now disconnect the lead.

n. DO NOT REPEAT THIS TEST UNNECESSARILY AS IT MAY CAUSE A CARBON TRACK OR ARC POINT DAMAGE TO A COMPONENT.

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