If you are using a printed copy of this procedure, and not the on-screen version, then you MUST make sure the dates at the bottom of the printed copy and the on-screen version match. The on-screen version of the Collider-Accelerator Department Procedure is the Official Version. Hard copies of all signed, official, C-A Operating Procedures are available by contacting the ESSHQ Procedures Coordinator, Bldg. 911A

C-A OPERATIONS PROCEDURES MANUAL

15.5.72 Procedure for C-AD Vacuum Ion Pump Maintenance or Cable Repair

Attachments

Text pages 2 through 4

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Approved: _____***Signature on File***_____ _____
Collider-Accelerator Department Chairman Date

L. Smart

15.5.72 Procedure for C-AD Vacuum Ion Pump Maintenance or Cable Repair

1 Purpose

1.1 This procedure is to be used when performing repair or maintenance work on ion pump cables, and any time when high voltage connectors are to be disconnected at the ion pump. This procedure applies to ion pumps in the AGS, Booster, NSRL, and RHIC.

1.2 The ion pump controllers have two separate high voltage outputs. In some instances, the outputs power pumps in different vacuum sectors. In RHIC, one of the outputs powers a pump in a blue sector, while the other output powers an ion pump in a yellow sector. In AGS and Booster, the two outputs typically power pumps in the same sector. The outputs are normally operated at 5000 Vdc.

2 Responsibilities

2.1 The Vacuum Group Technical Supervisor and Cognizant Engineer shall train technical staff in this procedure.

2.2 Authorized Vacuum Group personnel are responsible for the execution of this procedure.

3 Prerequisites

3.1 All personnel working on any electrical system or equipment in the C-AD shall be familiar with BNL SBMS Electrical Safety, BNL SBMS Lockout/Tagout (LO/TO), C-A-OPM 1.5, "Electrical Safety Implementation Plan", C-A-OPM 1.5.3 "Procedure to Open or Close Breakers and Switches and Connecting/Disconnecting Plugs", C-A-OPM 2.36, "Lockout/Tagout for Control of Hazardous Energy". C-AD will provide on-site/work specific training to individuals in the electrical safety aspects of their job functions and assignments.

3.2 All authorized personnel performing this procedure shall wear personal protective equipment (PPE) as required in the SBMS PPE for Electrical Safety Subject Area while verifying LOTO (section 5.1.7).

3.2.1 Class 1 or Class 2 Rubber Insulating Gloves shall be worn when disconnecting the connector at the ion pump and when performing the high voltage probe test. Class 2 gloves may be worn without leather protectors for better finger dexterity.

3.2.2 Safety glasses shall be worn while performing zero voltage check and while repairing cable.

3.3 Digital Voltage Meter (DVM) shall be type Cat III.

3.4 High Voltage Probe shall be an NRTL listed FLUKE model 80K-40 HV probe or equivalent.

3.5 Insulation Continuity Meter shall be a Seaward IR800.

4 Precautions

4.1 Electrocution Hazard Warning

WARNING
The ion pump controller presents an electrocution hazard (7500 Vdc max, 400 mA max). Failure to comply with the ion pump controller manufacturer's instructions or these directives may result in injury.

5 Procedure

5.1 Test high voltage probe using Seaward IR800 Insulation Continuity Meter on Insulation Resistance Measurement setting.

5.1.1 Inspect rubber insulating gloves to verify they are in good condition.

5.1.2 Connect the high voltage probe banana plug to the Cat III DVM.

5.1.3 Connect the high voltage probe tip to the read lead of the IR800 meter, and connect the ground to the black lead of the IR800.

5.1.4 Set the meter to 1000 V test voltage setting.

5.1.5 Don Class 1 or higher rubber insulating gloves.

5.1.6 Push and hold the TEST button.

5.1.7 Verify that both the IR800 and the Fluke DMM read 1000 Vdc.

5.2 De-energize equipment before cable is disconnected from pump at the tunnel end.

5.2.1 Turn off high voltage to ion pump through the front panel, leaving the controller in LOCAL control mode. Note that each controller operates two pumps. Be sure to select the correct pump by checking the cable label.

5.2.2 Unplug the high voltage connector from the rear of the controller.

5.2.3 Using a known working meter and high voltage probe, verify that the voltage is zero between the cable center conductor and the shield before performing cable repair. If voltage is present, observe voltage decay to less than 20 Volts.

5.2.4 Short the center conductor to the cable shield as specified by the cognizant engineer.

5.2.5 Apply Lockout/Tagout (LOTO).

5.2.6 Identify cable end in tunnel. Don insulating gloves and disconnect connector from ion pump.

5.2.7 With a known working meter and high voltage probe, verify that the voltage is zero between the cable center conductor and the shield before performing cable repair.

5.2.8 Re-test high voltage probe and meter using IR800 meter.

5.3 Perform cable repair or ion pump maintenance work.

5.4 Re-energize equipment after cable repair.

5.4.1 Re-connect tunnel end of cable to pump.

5.4.2 Remove LOTO.

5.4.3 Remove short from controller end of cable and re-connect cable to ion pump controller.

5.4.4 Turn on high voltage and observe readings for normal operation.

5.4.5 Restore controller to Remote Communication mode.

6 Documentation

None

7 References

7.1 SBMS Subject Area Electrical Safety
7.2 SBMS Subject Area LOTO
7.3 SBMS Subject Area PPE for Electrical Safety
7.4 C-A-OPM 1.5, "Electrical Safety Implementation Plan".
7.5 C-A-OPM 1.5.3 "Procedure to Open or Close Breakers and Switches and Connecting/Disconnecting Plugs".
7.6 C-A-OPM 2.36, "Lockout/Tagout for Control of Hazardous Energy".
7.7 SBMS Electrical Safety.
7.8 SBMS Lockout/Tagout (LOTO).

8 Attachments

8.1 FLUKE 80K-40 High Voltage Probe Instruction Sheet.
8.2 SEAWARD IR800 Insulation Continuity Meter Instruction Manual.

Maintenance

Performance Test

Verify the probe accuracy by measuring a 25 kV dc ±0.25% voltage source. When used with a compatible dc voltmeter, the probe should measure the source with ±1% accuracy. No calibration adjustments are provided.

Cleaning

Use a soft cloth dampened in distilled water to clean the 80K-40. Never use solvents or abrasive cleaners. Make sure the 80K-40 is dry before reuse.

LIMITED WARRANTY & LIMITATION OF LIABILITY

Each Fluke product is warranted to be free from defects in material and workmanship under normal use and service. The warranty period is one year and begins on the date of shipment. Parts, product repairs and services are warranted for 90 days. This warranty extends only to the original buyer or end-user customer of a Fluke authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Fluke's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Fluke warrants that software will operate substantially in accordance with its functional specifications for 90 days and that it has been properly recorded on non-defective media. Fluke does not warrant that software will be error free or operate without interruption.

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To obtain warranty service, contact your nearest Fluke authorized service center or send the product, with a description of the difficulty, postage and insurance prepaid (FOB Destination), to the nearest Fluke authorized service center. Fluke assumes no risk for damage in transit. Following warranty repair, the product will be returned to Buyer, transportation prepaid (FOB Destination). If Fluke determines that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, Fluke will provide an estimate of repair costs and obtain authorization before commencing the work. Following repair, the product will be returned to the Buyer transportation prepaid and the Buyer will be billed for the repair and return transportation charges (FOB Shipping Point).

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5/94

FLUKE®

80K-40
High Voltage Probe

Instruction Sheet

Introduction

The Model 80K-40 is a high voltage accessory probe designed to extend the voltage measuring capability of an ac/dc voltmeter up to 40,000 volts Overvoltage Category I. This means the probe can only be used to make measurements on energy limited circuits within equipment. Examples include high voltage within televisions or photo copy machines. DO NOT use this probe to measure high voltages on power distribution systems. The probe is a precision 1000:1 voltage divider formed by two matched resistors. The unusually high input impedance offered by these resistors minimizes circuit loading and thereby, optimizes measurement accuracy. A special plastic body houses the divider and provides the user with isolation and protection from the voltage being measured.

Specifications

The 80K-40 will achieve rated accuracy when used with a voltmeter (ac or dc) having an input impedance of 10 MΩ ±1.0%.* Specifications for the probe are as follows:

†Voltage Range: 1 kV to 40 kV dc or peak ac, 28 kV rms ac

Input Resistance: 1000 MΩ

Division Ratio: 1000: 1 (1000X attenuator)

Accuracy DC:

20 kV to 35 kV: ±1% at 20°C to 30°C; add 1% at 10°C <20°C and >30°C to 45°C. (For total measurement accuracy add accuracy specification of voltmeter being used.)

0 kV to <20 kV and >35 kV to 40 kV: ±2%.

Accuracy AC: 60 Hz, ±5%.

Safety: Meets IEC 1010-2-031:1993, Type B, 40 kV dc or, peak ac, 28 kV rms ac, Overvoltage Category I (voltages derived from limited energy transformer).

* The input impedance of Autoranging Fluke handheld digital multimeters varies as a function of range. The only range that deviates significantly from 10 MΩ is the 3V (Models 21, 23, 25, 27, 70, 73, 75, 77) or 4V (Models 10, 11, 12, 29, 79, 83, 85, 86, 87, 88) range where the impedance is 11.11 MΩ. To enhance the measurement accuracy when using this range, apply a correction factor of 0.99, i.e. multiply the displayed reading by .99.

† This probe is intended for low energy applications such as CRT and similar circuits. Above 2000 meters altitude, and up to 5000 meters, derate linearly the working voltage from 40 kV peak to 28 kV peak, and derate linearly the transient overvoltage from 80 kV peak to 57 kV peak. Transient overvoltage refers to micro-second duration impulses caused by lightning or load switching. See International Electrotechnical Commission Publication 664-1980, Clause 3.9 Table II, and Appendix A.

Measurement Considerations

Before attempting to use the 80K-40, the following paragraphs should be read and understood. Particular attention should be given to Operator Safety.

PN 481978
January 1978, Rev.9, 3/97

Operator Safety ⚠

⚠ Indicates the operator must refer to an explanation in this manual.

⚠ Indicates terminals at which lethal voltages may exist.

Warning

- **To avoid damage or electric shock:**
  - **Use within ratings and under dry (no condensation) conditions.**
  - **The 80K-40 user should be familiar with, and exercise, all possible high voltage safety practices.**
  - **When making a measurement, never make body contact with the probe tip or the red portion of the probe. Always hold the probe by its black handle.**
  - **Before making a measurement, make sure that the tab side of the output connector is connected to the voltmeter's low input terminal.**
  - **The clip lead must be attached to earth ground.**

Voltmeter Compatibility

Accuracy of the meter is not included in the accuracy of the probe, and must be added to the probe accuracy to determine system accuracy.

The 80K-40 is mechanically compatible with any ac or dc voltmeter or multimeter capable of accepting a standard spaced, 0.75" (19mm) double, banana plug, having standard, .160" (4mm) plugs.

The 80K-40 probe is electrically compatible with any ac or dc voltmeter or multimeter that has an input impedance of 10 MΩ ±1%. Voltmeters or multimeters with other input impedances require the use of an external shunt or a correction factor to obtain an accurate measurement. Higher impedance voltmeters or multimeters should be equipped with a shunt, and lower impedance voltmeters or multimeters should be assigned correction factors. Applicable formulas follow:

a. The following formula is used to determine the value of an external shunt resistor (meter impedance >10 MΩ):

$$Rs = \frac{Rm \times 10}{Rm - 10}$$

Where: Rs = Shunt resistance in MΩ
Rm = Voltmeter input impedance in MΩ (>10 MΩ)

Example: If RM = 20 MΩ,

$$Rs = \frac{20 \times 10}{20 - 10} = \frac{200}{10} = 2.0 M\Omega$$

b. Use the following formula to calculate a correction factor (meter impedance <10 MΩ):

$$Cf = \frac{1.11 + Rm}{1.11 \times Rm}$$

Where: Cf=Correctionfactor (multiplier for meter reading)
Rm = Voltmeter input impedance in MΩ

Example: If Rm = 1 MΩ,

$$Cf = \frac{1.11 + 1}{1.11 \times 1} = \frac{2.11}{1.11} = 1.901$$

Therefore: A meter reading of 0.526 volts represents an input of: 0.526 x 1.901 = 1 or 1 kV.

Circuit Loading

The 80K-40 represents a 1000 MΩ load to the circuit being measured, or 1 μA per 1 kV. Table 1 shows the circuit loading and input/output characteristics of the probe over its measurement range.

Table 1. 80K-40 Circuit Loading and Input/Output Characteristics

Input Voltage	Loading Current	Output Voltage
10V	10 nA	10 mV
100V	100 nA	100 mV
1 kV	1μA	1V
10 kV	10 μA	10V
20 kV	20 μA	20V
30 kV	30 μA	30V
40 kV	40 μA	40V

Operation

Use the following procedure to operate the 80K-40:

1. Select and energize a compatible voltmeter.
2. Equip the voltmeter with a suitable shunt, if required.
3. Select an appropriate voltage range (1 volt reading per 1000 volt input. See Table 1).
4. Connect the probe's output leads to the voltmeter input terminals.
5. Connect the probe's clip lead to ground. See OPERATOR SAFETY.
6. Connect probe tip to circuit being measured and observe voltmeter reading. Apply correction factor to reading when necessary.

Theory Of Operation

The 80K-40 High Voltage probe, is designed to extend the voltage measurement range of an ac/dc voltmeter up to 40,000 volts. Electrically, the probe is a passive attenuator as shown in Figure 1. Its high input impedance (1000 MΩ), as well as its accuracy and stability characteristics are achieved through the use of special thick film resistors. When the probe is connected to a voltmeter with a 10 MΩ input resistance the probe becomes an accurate 1000:1 divider. Notice that the divider depends upon a ground lead to complete the low side of the circuit path. Therefore, this connection must always be secure before attempting a voltage measurement. Otherwise, instrument damage or a shock hazard will result.

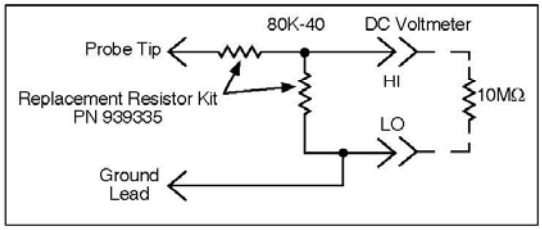

Figure 1. 80K-40 Simplified Circuit Diagram

IR800 INSULATION CONTINUITY METER

289A910

289A911

CONTENTS

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154-289 289A550

Safety Precautions
Specific warning and caution statements, where they apply, will be found throughout the manual.
A Warning identifies conditions and actions that pose hazard(s) to the user.
Use of the instrument in a manner not specified, may impair safety.
Read the following safety information carefully before attempting to operate or service the instrument.
Symbols used on the Meter and in this manual are explained in the next table.

ϟ	Risk of electric shock
⚠	See explanation in manual

⚠ WARNING

To avoid electric shock or fire, do the following:
- **Inspect the test leads for damage.**
- **Damaged leads must be replaced.**
- **Do not use the Meter if it looks damaged.**
- **When using the probes, keep your fingers away from probe contacts.**
- **Place test leads in proper input terminals.**
- **Disconnect the Live test lead before disconnecting the Neutral test lead.**
- **Do not use the Meter with any parts or cover removed.**
- **Do not use the Meter around explosive gas, vapour or dust.**

Using the Meter
Auto shut-off
The Meter will automatically shut off after 10 minutes, or 30 minutes under locked conditions. The Meter will automatically "wake-up" when you press a button, turn the rotary switch, or when a voltage of 30V AC or DC or greater is sensed at the inputs.

Measuring Insulation Resistance

⚠ WARNING

Measuring the insulation resistance requires the application of potentially dangerous voltages to the circuit. This may include exposed bonded metalwork.

1. Select the test voltage.
2. Connect the probes to the circuit to be measured. If a voltage is present on the probes, the voltage is displayed. A repetitive beep and the flashing high voltage symbol ϟ warns the user if the voltage is more than 30V AC or DC.
3. Press and hold the TEST button. The upper left display shows the actual test voltage applied to the circuit under test. The main display shows the resistance. The Meter beeps when the reading is stable.
4. Release the TEST button but keep the probes on the test points. The circuit now discharges through the Meter, while the main reading shows the decreasing voltage. Keep the probes on the test points until the circuit is completely discharged (main display shows - - - -).

Measuring Low Resistance
1. Zero out the test lead resistance. Connect the probes tips together. Press and hold the zero until the meter beeps. The main display will indicate 0.00. and the zero icon will be displayed.
2. Connect the probes to the circuit to be measured. If a voltage is present on the probes, the voltage is displayed. A repetitive beep and the flashing high voltage symbol ϟ warns the user if the voltage is more than 30V AC or DC. In that case remove the voltage from the circuit under test before proceeding with the next step.
3. Press and hold the TEST button. A single beep indicates a stable reading. The main display shows the resistance. If the resistance is higher than 20Ω, **>20Ω** is displayed.
4. After releasing the TEST button, exchange the Red (+) and the Black (-) probes to reverse the polarity of the test current and repeat steps 3 and 4. The reading should be the same as the previous. This test is useful to detect corroded connections, which can cause different readings for both polarities.

Measuring Resistance
1. Connect the probes to the circuit to be measured. If a voltage is present on the probes, the voltage is displayed. A repetitive beep and the flashing high voltage symbol ϟ warns the user if the voltage is more than 30V AC or DC. In that case remove the voltage from the circuit under test before proceeding with the next step.

2. Read the resistance from the main reading. If the resistance is approximately 30Ω or less, the Meter beeps. To turn off the beeper, press the beeper button. If the resistance is higher than 2000Ω, **>2000Ω** is displayed.

Measuring Voltage
1. Connect the probes to the circuit to be measured.

2. Read the voltage from the main reading. If the voltage is higher than 1000 V, **>1000 V** is displayed.

⚠ WARNING

The Meter will indicate either AC or DC voltage. If the voltage being measured has both an AC and DC component, the Meter will display only the largest component of the measured signal.

LOCK Function
The LOCK function is used to hold the test voltage on for Insulation tests. For low resistance the LOCK function continuously supplies the test current. Use LOCK to make longer duration measurements without having to push and

hold the TEST button.

1. Press the TEST button, then press the LOCK button, then release both simultaneously.

⚠ WARNING

For the Insulation test, LOCK mode causes a potentially dangerous voltage to be continuously applied to the probes. In this mode, if the probes are disconnected from the circuit, the Meter cannot discharge any potentially dangerous capacitive voltages left on the circuit.
In this mode the Meter cannot indicate if the circuit is live. Ensure that the circuit is de-energized before connecting the test probes in this mode or the fuse may blow.

Note: To reduce the beep rate to once every 30 seconds, press the beeper button.

2. To disengage the lock function press LOCK or TEST.

Checking the Battery

This function tests the battery under simulated load. Disconnect all test leads from any circuit. If a voltage is present on the probes, the voltage is displayed and the Battery Check function is disabled.

Replacing the Batteries

⚠ Warning

To avoid electric shock, disconnect the test leads from the inputs before opening the Meter for battery replacement.

To avoid false readings, which could lead to possible electric shock or personal injury, replace the batteries as soon as the battery empty indicator appears.

This Meter contains Alkaline batteries. Do not dispose of these batteries with other solid waste. Used batteries should be disposed of by a qualified recycler or hazardous materials handler.

1. Turn the rotary switch to the OFF position and disconnect the test leads.
2. Loosen the two screws with a flat-blade screwdriver and remove the lid.
3. Replace the AA cells. Observe the battery polarity shown in the battery compartment.
4. Secure the battery access lid back in position with the two screws.

Replacing the Fuse

⚠ Warning

To avoid electric shock, personal injury or damage to the Meter, use specified fuse ONLY, and in accordance with the following procedure.

1. Follow Steps 1 and 2 as described under "To replace the Batteries".
2. Unscrew the bottom cover and replace the fuse.
3. Refit the bottom cover, batteries and access lid

Replacement Parts and Optional Accessories

REPLACEMENT PART	PART #
Test Lead set	44B090
Fuse	27B098

Specifications

SAFETY SPECIFICATIONS	
Electrical Safety	Meets all requirements of EN61010-1, 1995 and EN61557, 1997
Maximum Operating Voltage	1000V AC or DC between any terminal and earth ground
Protection Levels	CAT III, 600V, and CAT II, 1000V Pollution Degree 2 per EN61010-1
ELECTROMAGNETIC COMPATIBILITY (EMC)	
Immunity	EN 61326-1
Emissions	EN 61326-1

ELECTRICAL SPECIFICATIONS	
Battery	AA Size 1.5V Alkaline, IEC-LR14 (6 pieces)
Fuse	6 mm x 32 mm (0.25 x 1.25 inch), 0.5 A 1000V, Fast Acting, 30 kA Minimum Interrupt rating
VOLTAGE MEASUREMENT	
Range	1000V AC/DC to 400 Hz
Resolution	1V
Accuracy	2% + 2 counts
Analog Bar Graph	0 to 1000V
Bar Graph Accuracy	10%
Visible Warning	≥ 30V AC / DC at Inputs
INSULATION RESISTANCE MEASUREMENT	
Auto Ranges	2.000 MΩ, 20.00 MΩ, 200.0 MΩ, 2000 MΩ
Resolution	0.001 MΩ on 2.000 MΩ range, maximum
Accuracy	2% + 2 digits, 2MΩ, 20MΩ, 200MΩ Ranges 6% + 2 digits on 2000 MΩ Range
Analog Bar Graph	0 to 1GΩ and infinity
Bar Graph accuracy	10%
Test Voltages	250V, 500V, 1000V
Accuracy	+20%, -0%
Nominal Current	1 mA
Number of Measurements per EN615577-2	2,500
Input Protection	1000V
Circuitry Protection	test inhibited if ≥ 30V AC or DC at inputs

LO Ω	
Range	20.00Ω
Accuracy	2% + 2 digits
Resolution	0.01Ω
Analog Bar Graph	0 to 100Ω and infinity
Open Circuit Voltage	4V dc nominal
Short Circuit Current	>200 mA 0-2Ω
Test Leads Zero	Zero up to 10Ω
Number of Measurements per EN61557-4	2,500
Input Protection	1000V
Circuitry Protection	test inhibited if ≥ 30V AC or DC at inputs
RESISTANCE MEASUREMENT	
Range	2000Ω
Accuracy	5% + 2 digits
Resolution	1Ω
Analog Bar Graph	0 to 10 kΩ and infinity
Bar Graph Accuracy	10%
Beeper	On at ≈30Ω or less
Test Current	25µA nominal

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