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C-A OPERATIONS PROCEDURES MANUAL

2.6.9 LINAC RF LOTO

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Hand Processed Changes

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Collider-Accelerator Department Chairman Date

V. LoDestro

2.6.9 LINAC RF LOTO

1. Purpose

This procedure provides Operators and Facilities & Experimental Support (FES) with the necessary steps to safely enter the LINAC 50 kV supplies, capacitor banks, modulator cabinets and the 7835 power amplifier cavities.

2. Responsibilities

It is the responsibility of each Operator or FES Technician to follow this procedure exactly to ensure safe access.

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 PPE must be worn by all personnel while performing portions of this procedure.

4. Precautions

4.1 *All personnel shall ensure their own safety by following the standards, safety rules, and the training they receive. In general, all energy sources must be locked out and tagged. Working on or near energized sources, "Working Hot", is not permitted unless a valid working hot permit has been issued. Personnel shall utilize tools, instruments, equipment (e.g., proper connectors and proper ac line cords), etc., that are safe and proper for the job. If any part of a job appears unsafe to any individual, it is their duty to discontinue work and inform the supervisor, manager, ESH Coordinator, or the C-A ESHQ Division Head, of the unsafe condition.*

4.2 The LINAC 50 kV power supply, capacitor bank and modulator provide the plate voltage to the 7835 RF amplifier. This combination of devices is an extremely high voltage, high stored energy system. The capacitor bank may hold 50,000 joules of energy. This system must be serviced and maintained by skilled and trained technicians. Technicians must use grounding sticks to ensure safety.

5. Procedure

5.1 General Requirements

5.1.1 The power supply, capacitor bank, modulator and 7835 cavity employ a Kirk Key safety grounding system.

5.2 50 KV Power Supply Entry Procedure

To de-energize the supply:

5.2.1 At the Local Control Station (LCS) of each RF module is an Allen Bradley Redi Panel. Push the button labeled **LOCAL**.

5.2.1.1 Set the capacitor bank voltage to zero by pushing the button labeled **ZERO KV**

5.2.1.2 On the Redi Panel is a column of buttons for the 50 kV supply. Push the button labeled **Standby**. Ensure that the power supply voltage has dropped to zero kV by reading the meters at the power supply.

5.2.3 Push the button labeled **OFF** for the 50 kV supply.

5.2.4 Open the 400 amp fused disconnect. This disconnect is on the right hand side of the power supply facing the meters.

5.2.5 Turn and remove the leftmost Kirk Key of the 400 amp fused disconnect, locking the disconnect in the open, (off), position. At the Redi Panel confirm the power supply will not re-energize.

5.2.6 At the capacitor bank, close the ground switch by depressing the button and turning the handle down to the ground position.

Warning:

WEAR SAFETY GLASSES BEFORE OPENING THE 50 KV PS DOOR.

5.2.7 At the 50 KV power supply, insert the Kirk Key removed in step 5.2.5 in the door on the side opposite the disconnect switch; open the door. Apply the ground stick to the high voltage terminal. Check the physical condition of the ground stick and braid before applying the stick. Remove the second Kirk Key from the disconnect switch if access to the AC controls through the aisle side door is required. Verify that all AC power is off before beginning work.

To re-energize the supply:

- 5.2.8 Remove the ground stick from the high voltage terminal in the high voltage supply. Close and lock both cabinet doors. Install both Kirk Keys into the locks at the power supply disconnect switch.
- 5.2.9 Close the 400 amp disconnect
- 5.2.10 Place the capacitor bank ground switch in the **LIVE** position.
- 5.2.11 Push the Redi panel button for the 50 kV supply to **Standby**. This button may have to be pressed again after 15 seconds to clear the **Cooling** fault (cooling fan air flow interlocks).
- 5.2.12 Push the Redi panel power supply **On** button. Internal shorting switches will lift. Adjust voltage to desired level of Capacitor Bank operation.

5.3 Capacitor Bank Entry Procedure

To de-energize:

- 5.3.1 At the Local Control Station (LCS) of each modulator is an Allen Bradley Redi Panel. Push the button labeled **LOCAL**.
 - 5.3.1.1 Set the capacitor bank voltage to zero by pushing the button labeled **ZERO KV**.
- 5.3.2 On the Redi Panel is a column of buttons for the 50 kV supply. Push the button labeled **Standby**. Ensure that the power supply voltage has dropped to zero kV by reading the meters at the power supply.
- 5.3.3 Push the button labeled **OFF** for the 50 kV power supply.
- 5.3.4 At the 50 KV power supply open the 400 amp fused disconnect.
- 5.3.5 Turn the leftmost Kirk Key of the 400 amp fused disconnect, locking the disconnect in the open, (off), position and remove a key. Attempt to re-energize the power supply, verify that it does not come back on. Keep possession of the key until your work is complete or you transfer responsibility to a system specialist. **At your discretion, the key may remain in the lock in the safe position, as long as you do not leave the site of the work.**

- 5.3.6 At the capacitor bank, close the ground switch by depressing the button and turning the handle. With the capacitor bank in the grounded position, remove the extreme left hand Kirk key.

Warning:
WEAR PPE BEFORE OPENING THE CAPACITOR BANK DOOR

- 5.3.7 Check the physical condition of the ground stick and braid before applying the stick. Open the door of the capacitor bank and apply the ground stick to the high voltage terminal.

To re-energize:

- 5.3.8 Remove the ground stick from the high voltage terminal of the capacitor bank. Close and lock all the doors. Install the Kirk Keys into the locks on the side of the cabinet.
- 5.3.9 Place the capacitor bank ground switch in the live position.
- 5.3.10 Reinstall the Kirk Key(s) in the 50 KV power supply disconnect switch.
- 5.3.11 Close the 400 amp disconnect.
- 5.3.12 Push the Redi panel button to **Standby** for the 50 KV power supply. This button may have to be pressed again after 15 seconds to clear the **Cooling** fault (fan interlocks).
- 5.3.13 Push the Redi panel power supply **On** button. Internal shorting switches will lift. Adjust voltage to desired level of Capacitor Bank operation.

5.4 Modulator Entry Procedure

To de-energize:

- 5.4.1 At the Local Control Station (LCS) of each modulator is an Allen Bradley Redi Panel. Push the button labeled **LOCAL**.
- 5.4.1.1 Set the capacitor bank voltage to zero by pushing the button labeled **ZERO KV**.
- 5.4.2 On the Redi Panel is a column of buttons for the 50 kV supply. Push the button labeled **Standby** Ensure that the power supply voltage has dropped to zero kV by reading the meters at the power supply.
- 5.4.3 Push the button labeled **OFF** for the 50 kV supply.

- 5.4.4 At the capacitor bank, close the ground switch by depressing the button and turning the handle to the ground position.
- 5.4.5 At the modulator depress the **OFF** button on the local AC Logic Chassis or modulator **OFF** button on the LCS Filament Control Chassis. If the system has been converted to PLC controlled turn the modulator off from the LCS Panel View screen.
- 5.4.6 At the modulator, close the ground switch by depressing the button and turning the handle to the ground position. With the modulator in the grounded position, remove the extreme left hand Kirk key.

Warning:
WEAR PPE BEFORE OPENING THE MODULATOR DOOR

- 5.4.7 Open the door on the modulator and apply the ground stick to all the high voltage terminals as indicated on the inside of the door. Check the physical condition of the ground stick and braid before applying the stick to the terminal.

To re-energize:

- 5.4.8 Remove the ground stick from the high voltage terminal of the modulator. Close and lock all the doors. Install the kirk keys into the locks on the side of the cabinet.
- 5.4.9 Place the modulator ground switch in the live position.
- 5.4.10 Place the capacitor bank ground switch in the live position.
- 5.4.11 Turn the modulator back ON from the same location you turned it off from, local control or LCS. The modulator will go into process and will take 3-5 minutes to switch to the ON state.
- 5.4.12 Push the Redi panel button for the 50 kV supply **Standby**. This button may have to be pressed again after 15 seconds to clear the **Cooling** fault (fan interlocks).
- 5.4.13 Push the Redi panel power supply **On** button. Internal shorting switches will lift. Adjust voltage to desired level of Capacitor Bank operation.

5.5 Entrance Procedure, 7835 Power Amplifier Cavity

To de-energize:

- 5.5.1 At the Local Control Station (LCS) is an Allen Bradley Redi Panel. Push the button labeled **LOCAL**.
 - 5.5.1.1 Set the capacitor bank voltage to zero by pushing the button labeled **ZERO KV**.
- 5.5.2 On the Redi Panel is a column of buttons for the 50 kV supply. Push the button labeled **Standby** Ensure that the power supply voltage has dropped to zero kV by reading the meters at the power supply.
- 5.5.3 Push the button labeled **OFF** for the 50 kV supply.
- 5.5.4 At the modulator depress the **OFF** button on the local AC Logic Chassis or modulator **OFF** button on the LCS Filament Control Chassis. If the system has been converted to PLC controlled, turn the modulator off from the LCS Panel View screen.
- 5.5.5 At the modulator, close the ground switch by depressing the button and turning the handle to the ground position.
- 5.5.6 At the capacitor bank, close the ground switch by depressing the button and turning the handle to the ground position.
- 5.5.7 At the 7835 Cavity, close the ground switch by depressing the button and turning the handle to the ground position.
- 5.5.8 At the 7835 Cavity filament PS depress the **OFF** button on the local AC Logic Chassis or 7835 filament **OFF** button on the LCS Filament Control Chassis. If the system has been converted to PLC controlled, turn the 7835 filaments off from the LCS Panel View screen.
- 5.5.9 Remove the nitrogen gas feed to the cavity and open the bleed valves located at the top and bottom of the cavity.

Caution:

THE CAVITY IS NORMALLY PRESSURIZED TO 40 PSI, DO NOT REMOVE ANY ACCESS PLATES UNTIL THE PRESSURE GAUGE READS ZERO.

It is now safe to remove all inspection ports on the cavity and high voltage box.

To re-energize:

- 5.5.10 Reinstall all access ports, close nitrogen bleed valves and reconnect 7835 cavity to the nitrogen feed line.
- 5.5.11 Place the 7835 ground switch into the live position.
- 5.5.12 Place the capacitor bank ground switch in the live position.
- 5.5.13 Turn the modulator back ON from the same location you turned it off from, local control or LCS. The modulator will go into process and will take 3-5 minutes to switch to the ON state.
- 5.5.14 Turn the 7835 filament PS back ON from the same location you turned it off from, local control or LCS. The 7835 filament PS will go into process and will take 3-5 minutes to switch to the ON state.
- 5.5.15 Push the Redi panel button for the 50 kV supply **Standby**. This button may have to be pressed again after 15 seconds to clear the **Cooling** fault (fan interlocks).
- 5.5.16 Push the Redi panel power supply **On** button. Internal shorting switches will lift. Adjust voltage to desired level of Capacitor Bank operation.

6. Documentation

None

7. References

- 7.1 7.1.1 NFPA-70E.
- 7.2 7.1.2 PPE for Electrical Workers.
- 7.3 [C-A-OPM 1.5, "Electrical Safety Implementation Plan"](#).
- 7.4 [C-A-OPM 1.5.3 "Procedure to Open or Close Breakers and Switches and Connecting/Disconnecting Plugs"](#).
- 7.5 [C-A-OPM 2.36, "Lockout/Tagout for Control of Hazardous Energy"](#).
- 7.6 [SBMS Electrical Safety](#).
- 7.7 [SBMS Lockout/Tagout \(LOTO\)](#).

8. Attachments

None