

BEAMS DIVISION DEPARTMENTAL PROCEDURE

RF DEPARTMENT

ADDP-EE-9933

EQUIPMENT SPECIFIC LOCKOUT/TAGOUT PROCEDURE FOR THE WEST AND EAST
BOOSTER ANODE POWER SUPPLY

PREPARED BY:

Ryan Crawford
Ryan Crawford, Engineer

DATE:

4/1/16

APPROVED BY:

John Reid
J.Reid, Department Head

DATE:

4-1-16

ISSUE DATE: 4/01/16

1. PURPOSE AND SCOPE

The purpose of this document is to outline and detail the conduct of LOCKOUT/TAGOUT for the maintenance of the Booster West and East Anode Power Supplies (hereinafter referred to as WAPS and EAPS respectively). This procedure only covers the DC cabinet work. The WAPS and EAPS are located on outdoor utility distribution substation pads near the East and West Booster galleries.

2. PERFORMANCE OF MAINTENANCE ACTIVITIES

LOTO is always performed on the Anode Power Supply by two trained employees due to the dangerous voltages that may be present.

- 2.1. A check list is to be used for this LOTO procedure and a copy is attached. Check lists are to be stored at the lockout center. Quarterly, all lists will be delivered to the Department Head for storage.
- 2.2. All personnel who replace, access, or work within the described equipment must comply with the specific instructions defined in this document. In cases where unusual circumstances may require deviation from these instructions, the Department Head or his/her designee and all participating personnel shall discuss and agree upon an appropriate course of action.

3. AUTHORIZED PERSONNEL

- 3.1. The E/E Support Department Head maintains a list of department personnel authorized to perform this procedure. This list is accessible on the web via the department's home page under "LOTO Compliance".
- 3.2. In times of emergency the Department Head or their designee may authorize other employees to perform this procedure but only if they are trained and have signed the training document indicating they understand the written procedure.

4. THE NECESSITY OF WRITTEN LOTO PROCEDURE

- 4.1. The specific hazards present in this power supply are:
 - 4.1.1. 13.8 kVAC – 3 phase power inside of step start cabinet
 - 4.1.2. 25.2 kVAC – 3 phase power inside of enclosure
 - 4.1.3. 35 kVDC – inside of enclosure
 - 4.1.4. 208 VAC - 3 phase power inside enclosure and step start cabinet.
 - 4.1.5. Up to 44.1 kJ of stored energy in the capacitor bank
 - 4.1.6. 120 VAC inside enclosure

4.1.7. Persons are not protected by a single lockout device.

4.2. The specific hazards are mitigated by:

- 4.2.1. 13.8 kVAC lockable, fused, windowed load break switch
- 4.2.2. Safety shorting relay across the high voltage output to short the high voltage connections to ground
- 4.2.3. Resistive grounding stick.
- 4.2.4. Non-resistive (hard) grounding stick.
- 4.2.5. Removable grounding straps for grounding capacitor bank and resistors.
- 4.2.6. Bleeder resistors across cap bank.
- 4.2.7. Finger safe terminal blocks and covers on 208Y/120 VAC to prevent incidental contact.

5. THE STEPS OF LOCKOUT/TAGOUT PRIOR TO MAINTENANCE ACTIVITY

The authorized employee must perform the following steps prior to maintenance activity.

5.1. Prepare: The authorized employee shall understand the hazards involved and how to control them. If an authorized employee does not have this knowledge, he/she is not qualified to perform the LOTO procedure or maintenance activity.

NOTE: Proper PPE is required for this procedure. The TWO-PERSON RULE is in effect while executing this procedure.

5.2. Notify: The authorized employee shall, as necessary, notify affected area personnel of the LOTO and maintenance activity. Additionally, if this procedure is being used during operating periods of the accelerator, the Main Control Room shall be first notified of the work. During all other times, the procedure may be used at the discretion of the personnel responsible for the maintenance of the equipment.

5.3. Shut Down:

- 5.3.1. The authorized employee shall shut down or turn off the equipment or system by using the normal stopping procedure.
- 5.3.2. Turn all modulators to HV off from Page B-25 or locally by placing modulator control units in local mode and turning HV switch to off.
- 5.3.3. Turn anode power supply high voltage off from page B25 or locally by placing the anode supply controller in the RCC rack in LOCAL mode using the panel Local/Remote switch and pushing the OFF button.
- 5.3.4. Turn off all Solid State Drivers Gate Bias

- 5.3.5. Check that the primary VCB (ABB) opened by looking at the HMI status.
- 5.3.6. Disconnect modulators from the anode supply by deactivating the switches locally at the anode supply HMI.
- 5.3.7. Remove Kirk key from RCC rack control box (EAST: RE10931 WEST: RE10916). This key must be in possession of the person that will open the 13.8kV fused disconnect switch in step 5.4.
- 5.4. Isolate: Open the 13.8 kVAC fused disconnect switch that is located in front of the EAPS and WAPS wearing the proper Personnel Protective Equipment.
- Note:** When this LOTO procedure was written the proper PPE was Class 2. PPE required clothing: Minimum Arc Thermal Protection Value (ATPV) – 8 cal/cm² FR Coverall Clothing Required – Cotton Clothing under FR Coverall. Additional PPE – Hard Hat, Face Shield, Hearing Protection, Leather Gloves, and Leather Work Shoes.
- 5.5. Verify: Look through the window on the disconnect switch and confirm that all 3 of the knife blades have disengaged.

If Knife blades fail to disengage, contact experts and stop LOTO activities

- 5.6. Lock and Tag: Place LOTO lock on the fused disconnect handle. The anode supplies utilize a KIRK KEY system of safety locks.
- 5.7. Relieve/Restrain Cap Bank Stored Hazardous Energy and Verify:

NOTE: IF sparks are visible at any point, stop LOTO activities and call experts

- 5.7.1. Look through the window that is located on the side of the enclosure and verify that the high voltage shorting relay arm is in the downward position (it is the switch that is illuminated by a spotlight), and the ground connection is intact
- 5.7.2. Open the front doors on the enclosure by placing the previously removed kirk keys (fused disconnect and the relay chassis) in the 3 key kirk lock system. If access is required to the back of the supply, the captured key can be used to open the rear door.
- 5.7.3. Unlatch the ground and resistive sticks from the door
- 5.7.4. Visually verify that both the resistive stick and ground stick have no loose or missing connections
- 5.7.5. With **Resistive** grounding stick, touch the base and the top (only the base is accessible on the back most resistor) of all the water cooled resistors for at least 2 seconds each (start with the bottom of each and then move to the top).
- 5.7.6. With **Resistive** grounding stick, touch “R1” and “R2” secondaries of the transformer.

5.7.7. With **Hard** grounding stick, touch the base and the top (only the base is accessible on the back most resistor) of all the water cooled resistors for at least 2 seconds each (start with the bottom of each and then move to the top).

5.7.8. With **Hard** grounding stick, touch "R1" and "R2" secondaries of the transformer.

LOTO POINT A:

5.7.9. With **HARD** grounding stick, touch "LOTO A".

5.7.10. While holding **HARD** grounding stick on the point marked "LOTO A", clip a hard ground strap to "LOTO A". Use caution to avoid "LOTO B"

LOTO POINT B:

5.7.11. With **HARD** grounding stick, touch "LOTO B".

5.7.12. While holding **HARD** grounding stick on the point marked "LOTO B", clip hard ground strap "B" to "LOTO B".

LOTO POINT C:

5.7.13. Visually inspect the series resistors and wires (6 per bank).

5.7.14. With **RESISTIVE** grounding stick, touch "LOTO C" for at least 2 seconds.

5.7.15. With **HARD** grounding stick, touch "LOTO C".

LOTO POINT D, E, F, G, H, I (eye protection and hearing protection are required at this point):

5.7.16. Repeat the steps of "LOTO POINT C" for "LOTO D", "LOTO E", "LOTO F", "LOTO G", "LOTO H", and "LOTO I"

5.7.17. With **HARD** grounding stick touch the high voltage terminal of each capacitor

5.7.18. Starting with "LOTO D" place the **HARD** grounding stick on "LOTO D" and attach the removable alligator clip to the bus bar

5.7.19. Repeat for "LOTO E", "LOTO F", "LOTO G", "LOTO H", "LOTO

SPECIAL REQUIREMENTS FOR SHIFT/PERSONNEL CHANGE

If the required work continues over a shift or personnel change, the authorized employees involved shall insure that the on-going shift is informed of the present equipment status from the off-going shift.

6. THE STEPS FOR RETURN TO SERVICE

The authorized employee must perform the following steps prior to returning the equipment to service.

- 6.1. Check Equipment: Check the equipment and the immediate area around it to insure that nonessential items and tools are cleared and that the equipment is ready for safe operation.
- 6.2. Check Work Area: Check the work area to ensure that all employees are safely positioned or removed from the area as necessary and/or appropriate.
- 6.3. Verify that all controls for the equipment are in the neutral or off position.
- 6.4. Remove Ground Clips: Remove the grounding clips from "LOTO A", "LOTO B", "LOTO D", "LOTO E", "LOTO F", "LOTO G", "LOTO H", and "LOTO I". Secure them in the cabinet to prevent inadvertent grounding.
- 6.5. Close enclosure doors (the blush bolts located at the top and bottom of one of the doors must be engaged to prevent accidental opening of the APS doors) and return Kirk keys to required kirk locks.
- 6.6. Remove LOTO locks: Each member of the personnel working on the supply must remove her/his lock.
- 6.7. Throw load disconnect to "ON" position:

NOTE: The following action may result in the immediate operation of the equipment.

- 6.8. Return control unit to REMOTE.
- 6.9. The authorized employee should, as necessary, notify affected area personnel of the completion of maintenance and LOTO activity.

NOTE: If the crew chief in the Main Control Room was notified prior to the activity, he/she should be notified of the completion of the activity.

7. PROCEDURE TRAINING REQUIREMENTS

- 7.1. Authorized employees are required to have had LOTO training (Level 1 and Level 2), and have read and understood this LOTO procedure.

7.2. Electrical/Electronic Department Personnel using this procedure shall be trained on the job. After reviewing this document, the employee shall perform the steps accompanied by an employee with previous experience. The authorized employee shall then complete a "Beams Division Electrical/Electronic Department Procedures Review Form" and turn it in to the department secretary.

7.3. Personnel from other departments shall be trained according to the requirements of their department.

8. REVISION HISTORY

None.

9. Appendix A: RF Group Lockout/Tagout Lockbox

A group Lockout/Tagout box is mounted just to the left of each RCC Rack in the Booster East and West Galleries. The high level RF group's lead authorized person will perform the equipment LOTO and place the key from the RED LOTO Lock on the 13.8kV fused disconnect handle into the lock box in which he/she and others will put their locks and tags on. The group lead shall maintain control of the two kirk keys (fused disconnect switch and control box) required for entry into the cabinet. If access is not required to the DC cabinet of the anode supply, both kirk keys shall also be placed in the group lockbox.

BOOSTER RF ANODE SUPPLY LOTO CHECK LIST

1. Notify MCR Crew Chief for unscheduled maintenance.
2. Turn HV off on all modulators from B-25 or locally.
3. Turn off anode power supply from B-25 or locally.
4. Turn off all Solid State Drivers Gate Bias.
5. Disconnect modulators from anode supply by actuating HV switches to disconnect position.
6. At anode supply control unit located in Rack as shown below turn KIRK key to remove. Keep this KIRK key in your possession while performing step 7.
7. Suit up in required PPE (Class 2 Arc Flash protection at the time of writing). Pull handle down on 13.8 KV yard disconnect. Look thru window to verify that the air switch has opened.
8. Turn KIRK key to remove from 13.8 KV disconnect, Place LOTO lock on disconnect handle and place keys either in lock box or door of DC cabinet.
9. Place lock and tag on lock out box where KIRK keys have been placed if no access is being made to anode power supply. If access is being made to DC or AC cabinets one of the captured KIRK keys must be removed and placed in the lock box.
10. Use grounding stick to enter DC cabinet. Follow grounding procedure below.
11. With **Resistive** grounding stick, touch the top and the base (only the base is accessible on the back most resistor) of all the water cooled resistors for at least 2 seconds each (start with the bottom of each and then move to the top).
12. With **Resistive** grounding stick, touch "R1" and "R2" secondaries of the transformer.
13. With **Hard** grounding stick, touch the top and the base (only the base is accessible on the back most resistor) of all the water cooled resistors for at least 2 seconds each (start with the bottom of each and then move to the top).

- 14. With **Hard** grounding stick, touch "R1" and "R2" secondaries of the transformer.
- 15. LOTO POINT A: With **Resistive** grounding stick, touch point "LOTO A" for at least 2 seconds. With **HARD** grounding stick, touch "LOTO A". While holding **HARD** grounding stick on the point marked "LOTO A", clip a hard ground strap to "LOTO A". Use caution to avoid "LOTO B"
- 16. LOTO POINT B: With **RESISTIVE** grounding stick, touch "LOTO B" and the input from the bridge for 2 seconds each. With **HARD** grounding stick, touch "LOTO B". While holding **HARD** grounding stick on the point marked "LOTO B", clip hard ground strap "B" to "LOTO B". Visually inspect the series resistors and wires (6 per bank).
- 17. LOTO POINT C: With **RESISTIVE** grounding stick, touch "LOTO C" for at least 2 seconds. With **HARD** grounding stick, touch "LOTO C".
- 18. LOTO POINT D,E,F,G,H,I: Repeat the steps of "LOTO POINT C" for "LOTO D", "LOTO E", "LOTO F", "LOTO G", "LOTO H", and "LOTO I". With **HARD** grounding stick touch the high voltage terminal of each capacitor. Starting with "LOTO D" place the **HARD** grounding stick on "LOTO D" and attach the removable alligator clip to the bus bar. Repeat for "LOTO E", "LOTO F", "LOTO G", "LOTO H", "LOTO I",
- 19. For 13.8KV AC cabinet work, call FACILITY OPERATIONS and request a duty electrician for fuse removal in S&C disconnect.
- 20. Anode supply or local RF station is now ready for maintenance.

LOTO COMPLETED BY _____ Signature _____

Date _____

Returned to service date _____ Signature _____

East Anode power supply West Anode power supply