

ACCELERATOR DIVISION DEPARTMENTAL PROCEDURE

RF DEPARTMENT

ADDP-RF-2016-0005 Rev C

RF DEPARTMENT MODULATOR LOCKOUT/TAGOUT PROCEDURE

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1.0 PURPOSE AND SCOPE

The purpose of this Accelerator Division Department Procedure (ADDP) is to outline and detail the conduct of LOCKOUT/TAGOUT (LOTO) for the maintenance of the Booster radio frequency Anode **Modulators**. This equipment needs to be locked out when working on the modulator or the power amplifier (tunnel).

2.0 PERFORMANCE OF MAINTENANCE ACTIVITIES

The Anode Modulators in the Booster East equipment gallery, are located at periods 14 through 17. The anode modulators in the West Booster equipment gallery, are located at periods 20 through 24.

This equipment has lockable, 480 V. breakers mounted on the **back** wall at the rear of the equipment. **The anode power supply must have LOTO performed anytime access to the modulator's HV compartment is required, a Power Amplifier change, or internal RF cavity work is performed.**

Follow the **Booster Anode Power Supply Loto procedure** (ADDP-EE-9933) to **isolate** the sources of energy feeding the Anode Power supply. **If needed, follow Booster Modulator isolating procedure** to correctly isolate the Booster Anode Supply High Voltage Source from a Booster RF station's Modulator

For an overall view of this system, refer to the block diagram on Attachment 2. The dark, outlined area is the equipment this procedure is describing.

The Anode Power Supply lock/tagout procedures must be documented. The forms are located at each of the Galleries Lockout center.

3.0 AUTHORIZED PERSONNEL

An Accelerator Division employee is authorized to perform this LOTO procedure if he/she has necessary **knowledge** and **current training**.

Lists of employees who are authorized to perform this procedure are to be maintained by the RF Department Head.

4.0 THE NECESSITY OF WRITTEN LOTO PROCEDURE

This requires a written procedure because:

1. There are two energy sources
2. Possible stored energy.
2. A single lockout device won't lock out the equipment

5.0 THE STEPS OF LOCKOUT/TAGOUT PRIOR TO MAINTENANCE ACTIVITY

The authorized employee performs the following steps prior to performance of 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.

- 5.2 **Notify:** The authorized employee should, as necessary, notify affected area personnel of the LOTO and maintenance activity. Affected personnel include those who might normally use the equipment or who would be affected by the unavailability of the equipment. Maintenance activities in the Accelerator Division normally require notification of the Crew Chief in the Main Control Room (x3721).
- 5.3 **Shut Down:** The authorized employee shall shut down or turn off the equipment or system by using the normal stopping procedure.
- 5.3.1 From the Console turn modulators to HV off from page B-25 or locally by placing modulator in local mode and toggling the HV off switch.
- 5.3.2 From the Console Turn Ferrite Bias Supply (FBS) to off from page B-25 or locally by placing Ferrite Bias Supply control units in local mode and pushing the contactor open button.
- 5.3.3 From the Console Turn Solid State Driver Amplifier's Gate Bias to off from page B-25 or locally by placing Solid State Driver Amplifier control unit in local mode and turning OFF the Gate Bias Switch.
- 5.3.4 **Anode power supply (APS) Turn off Sequence:** This can be accomplished one of two ways, either locally or remotely through the Controls Console B25 page.
- 5.3.5 **Locally:** Place Anode Power Supply Control Panel in local mode, turn HV OFF by pushing the **Red OFF** Button. **Continue to Step #7**
- 5.3.6 **Remotely:** By using a Controls console, go to page B-25 turn OFF the Anode Power Supply.
- 5.3.7 Place Anode Power Supply Control Panel in local mode. Disconnect all modulators from Anode Power Supply by using the Anode Power Supply Display Panel under **Subpage Switches**. Actuate the HV switches by pushing on the disconnect icon button for each Station. **Note: Disconnecting/connecting of the Switches can only be Done Locally! This prevents any possible back feed from a modulator deck to the common HV bus in the anode power supply**
- 5.4 **Isolate:** The authorized employee shall isolate the energy sources from the Anode Power Supply using the **Anode PS Lotto Procedure** (ADDP-EE-9933)
- 5.4.1 Pull disconnect handle to the off position for the appropriate anode power supply while standing to the side of the inspection window. **Anode PS Lotto Procedure** (ADDP-EE-9933) **Shut Down 5.4.**
- 5.4.2 Follow **Booster RF Modulator Shutdown Procedure** to power down the modulator.
- 5.4.3 Locate the 480 V. breaker associated with the modulator and move the handle to the off position(see list Attachment 1). Install Lock & Tag
- 5.4.4 **Alternate LOTO for isolating 480 Volt power to the modulator is to: Disconnect the modulator's 480-volt Crouse-Hinds plug from the socket located above the modulator. This gives line of sight for the Crouse-**

Hinds plug and completely isolates the modulator from the 480-volt power source. Note: Step 5.4.3 above must still be followed.

5.5 **Lock and Tag Out:** The authorized employee shall lock and tag out the energy isolating devices. The locks installed shall be red in color and have only one key. The authorized employee shall keep the single keys in his/her exclusive control at all times from application until return to service or shift change. Approved DANGER - DO NOT OPERATE tags, properly filled out, and should be securely attached to the locks.

5.6 **Relieve/Restrain Stored Hazardous Energy:**

Take the ground stick from the inside door of the modulator and touch the stick to the B+ (Anode of tube), the HV .1uF capacitor, and the deck of the modulator. Appropriate PPE must be worn which includes: face shield, long sleeve cotton shirt and pants, and leather insulating gloves. Leave one grounding stick on the Anode and a second ground stick on the .1uF capacitor, and the third ground stick on the HV deck.

5.7 **Verify:** The authorized employee shall check by conclusive test that the sources of energy have been isolated from the equipment and that the equipment is inoperable. Use the verify procedure in (ADDP-EE-9933) to make sure that the anode supply is disconnected. Make sure the ground sticks are attached as described in 5.6. At the end of the verification step, return all controls to the neutral or off position.

For work inside the floating deck chassis, Verify, by use of a DVM, that the +/- 750-volt DC power supply inside the deck chassis is at zero volts. Required PPE for verification is insulated grooves, long sleeve cotton shirt and pants, and safety glasses. Reminder, DVM operation must be verified before verification of zero voltage and again after verification of zero voltage.

The equipment is now locked out and tagged out. Service and maintenance activity may begin.

6.0 **SPECIAL REQUIREMENTS FOR SHIFT/PERSONNEL CHANGE**

N/A

7.0 **THE FIVE STEPS FOR RETURN TO SERVICE**

The authorized employee must perform the following five steps prior to returning the equipment to service after service or maintenance activity.

7.1 **Check Equipment:** Check the equipment and the immediate area around it to ensure that nonessential items and tools are cleared and that the equipment is ready for safe operation. Remember to unhook the ground stick, store it on top of the modulator, and close the front door.

7.2 **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.

- 7.3 **Verify:** Verify that all controls for the equipment are in the neutral or off position.
- 7.4 **Remove Padlocks and Tags and Reenergize:** The authorized employee who installed the locks and tags shall remove them and reconnect the equipment to the energy sources from which it was isolated. Note that this action, for some equipment, may result in the immediate operation of the equipment.
- 7.5 **Notify:** The authorized employee should, as necessary, notify affected area personnel of the completion of maintenance and LOTO activity. 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.

This completes the requirements for returning the equipment to service.

8.0 **PROCEDURE TRAINING REQUIREMENTS**

Authorized employees are required to have had LOTO training (Level 1 and Level 2), and have read and understood this LOTO procedure. Personnel using this procedure shall be trained on the job. After reviewing this document, the employee shall perform the steps accompanied by an authorized employee with previous experience.

9.0 **PROCEDURE DISTRIBUTION**

A single controlled copy of this procedure shall be assigned and distributed to:

- The Accelerator Division Operations Department Head.

Booster R.F. Modulator Breaker Locations and Designations

Booster Modulator 480 Volt Breaker Locations

Booster East Gallery		Panelboard	Located at end of Transfer Hall to Booster East Gallery	
Station #		PHP-BE-6		
1	✓	1-3-5		
2	✓	2-4-6		
3	✓	7-9-11		
4	✓	8-10-12		
5		13-15-17		
6		14-16-18		
20		26-28-30		
19		25-27-29		
7		19-21-23		
8		20-22-24		

Booster West Gallery		Breaker/Disconnect Located behind the RF Stations		Bias Supply Circuit Breaker
Station #				Booster West gallery FBS Outdoor Yard Breakers 225 Amp
17		G20-RF-SS-1	Parallel feed from Ferrite Bias 480 V disconnect	80-82-84
18		G20-RF-SS-4	Parallel feed from Ferrite Bias 480 V disconnect	74-76-78
9		G21-RF-SS-1	Parallel feed from Ferrite Bias 480 V disconnect	13-15-17
10		G21-RF-SS-3	Parallel feed from Ferrite Bias 480 V disconnect	19-21-23
11		G22-RF-SS-3	Parallel feed from Ferrite Bias 480 V disconnect	25-27-29
12		G22-RF-SS-2	Parallel feed from Ferrite Bias 480 V disconnect	31-33-35
13		G23-RF-SS-2	Parallel feed from Ferrite Bias 480 V disconnect	50-52-54
14		G23-RF-SS-9	Parallel feed from Ferrite Bias 480 V disconnect	56-58-60
15		G24-RF-SS-1	Parallel feed from Ferrite Bias 480 V disconnect	62-64-66
16		G24-RF-SS-5	Parallel feed from Ferrite Bias 480 V disconnect	68-70-72

Booster West Gallery		Panelboard	Located in Equipment Room	
Station #		DHP-L4-1-2		
21		20-22-24		
22		26-28-30		

Booster RF Anode Supply Loto Check List

- | | |
|--------------------------|---|
| <input type="checkbox"/> | 1. Notify MCR Crew Chief for unscheduled maintenance. |
| <input type="checkbox"/> | 2. Turn HV off on all Modulators from B25 or locally. |
| <input type="checkbox"/> | 3. Turn off anode power supply from B-25 or locally. |
| <input type="checkbox"/> | 4. Turn off all Solid-State Drivers Bias Gates from B-25 or locally. |
| <input type="checkbox"/> | 5. Disconnect modulators from the anode power supply by actuating HV switches to the disconnect position. |
| <input type="checkbox"/> | 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. |
| <input type="checkbox"/> | 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. |
| <input type="checkbox"/> | 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. |
| <input type="checkbox"/> | 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. |
| <input type="checkbox"/> | 10. Use grounding stick to enter DC cabinet. Follow grounding procedure below. |
| <input type="checkbox"/> | 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). |
| <input type="checkbox"/> | 12. With Resistive grounding stick, touch "R1" and "R2" secondaries of the transformer. |
| <input type="checkbox"/> | 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). |
| <input type="checkbox"/> | 14. With Hard grounding stick, touch "R1" and "R2" secondaries of the transformer. |
| <input type="checkbox"/> | 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" |
| <input type="checkbox"/> | 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). |
| <input type="checkbox"/> | 17. LOTO POINT C: With RESISTIVE grounding stick, touch "LOTO C" for at least 2 seconds. With HARD grounding stick, touch "LOTO C". |
| <input type="checkbox"/> | 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", |
| <input type="checkbox"/> | 19. For 13.8KV AC cabinet work, call FACILITY OPERATIONS and request a duty electrician for fuse removal in S&C disconnect. |
| <input type="checkbox"/> | 20. Anode supply or local RF station is now ready for maintenance. |

LOTO COMPLETED BY _____
Date _____

Signature 1 _____

Returned to service date _____

Signature 2 _____

East Anode power supply

West Anode power supply

Change Log

2-18-2019 Rev C - Added 5.4.4

Alternate LOTO for isolating 480 Volt power to the modulator is to: Disconnect the modulator's 480-volt Crouse-Hinds plug from the socket located on the wireway above the back of the modulator. This gives line of sight for the Crouse-Hinds plug and completely isolates the modulator from the 480-volt power source. Note: Steps 2 & 3 above must still be followed.

2-18-2019 Rev C - Modified 5.3.3

Turn off the Solid-State Driver RF Amplifier.

2-18-2019 Rev C - Added 5.7 Verity

For work inside the floating deck chassis, Verify, by use of a DVM, that the +/- 750-volt DC power supply inside the deck chassis is at zero volts. Required PPE for verification is insulated gloves, long sleeve cotton shirt and pants, and safety glasses. Reminder, DVM operation must be verified before verification of zero voltage and again after verification of zero voltage.