

ACCELERATOR DIVISION DEPARTMENTAL PROCEDURE

RF DEPARTMENT

ADDP-RF-0008

BOOSTER R.F. POWER AMPLIFIER AND CAVITY LOCKOUT/TAGOUT PROCEDURE

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REVISION NO. A REVISION ISSUE DATE 2-20-2019

CONTROLLED COPY NO. _____

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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 **cavities** (tunnel) and **power amplifiers** (tunnel). The anode power supply (ADDP-EE-9933), anode modulator (ADDP-RF 2016-0005), and the ferrite bias power supply (ADDP-RF 2016-0006) all need to be locked out.

2.0 PERFORMANCE OF MAINTENANCE ACTIVITIES

Both the amplifier and the cavity are in the tunnel at periods 14 through 17, period 19, and periods 21 through 24.

This equipment is the load end of several power supplies.

For an overall view of this system, refer to the block diagram, Attachment 3. The dark, outlined area is the equipment this procedure is describing.

This lockout/tagout procedure must be documented. The forms are near the RF Departments lockout box attached to each of the RCC Racks.

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 is a potential for stored energy
2. There are multiple energy sources
3. 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 an ACNET 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 an ACNET Console turn Ferrite Bias Supplies (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 an ACNET Console turn the Solid-State RF Amplifiers Gate Bias to off from page B-25 or locally by placing Solid State RF Amplifier's control unit in local mode and turning the Gate Bias Switch to off.

At this point the East and West Gallery Modulators should be in a High Voltage Ready state.

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.

Locally: Place Anode Power Supply Control Panel in local mode, turn HV OFF by pushing the **Red OFF** Button. *Continue to Step 5.3.5.*

Remotely: By using a Controls console, go to page B-25 turn OFF the Anode Power Supply.

5.3.5 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 HV 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 will follow the **Booster Anode Power Supply LOTO procedure** (ADDP-EE-9933) to isolate the sources of AC energy feeding the Anode Power supply.

If Applicable the authorized employee shall follow the **Booster Modulator isolating procedure** to correctly isolate the Booster's Anode Supply High Voltage Sources from a given Booster RF station's Modulator.

Note: The Modulator Door Anode Power Supply interlock cable and the HV deck Interface cable to the RCC Rack under no circumstances should ever be removed unless an authorized employee has followed

the Booster Modulator isolating procedure to correctly isolate the Booster's Anode Supply High Voltage Sources from a given Booster RF station's Modulator.

- 5.4.1 The authorized employee **must** follow the **Booster RF Modulator Shutdown Procedure** to power down the modulator under the section **Booster Modulator Shutdown Procedure**.

The authorized employee shall follow the **Booster Modulator LOTO procedure** (ADDP-RF 2016-0005 Rev C) for **isolating the sources of AC energy to the Modulator**.

- 5.4.2 The authorized employee shall follow the **Booster Ferrite Bias Supply LOTO procedure** (ADDP-RF 2016-0006) for **isolating the sources of AC energy to the Ferrite Bias Power Supply**. (See list Attachment 2 for disconnect locations).

- 5.4.3 The authorized employee shall follow the **Booster Solid State RF Amplifier LOTO procedure** (ADDP-RF 2016-0007) for **isolating the sources of AC energy to the SSA's 50 Volt power supply**.

- 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 key in his/her exclusive control always 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:**

That is accomplished with the procedures for the power supplies.

- 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. He/she will use the procedures for the individual power supplies to verify that no power can be applied to the Power Amplifier or cavity. The ferrite bias supply and the solid state rf amplifier do not need to have their control power disconnected to work on the power amplifier or cavity.

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.
- 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.
- 7.4.1 **The authorized employee shall follow the **Booster RF Station Start up procedure for repowering the station.****
- 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. Disconnect Locations and Designations

480 vac

East Booster RF Mod/SSD 480 Volt Distribution

RF Station	Booster Period	FBS Switch	DHP-Y-BE3	DHP-BE6 Cir#40		PHP-BE5
			FBS Breaker #	Modulator Switch	Mod Breaker #	SSD Breaker#
1	14	G14-SS-01	13-15-17	G14-SS-02	01-03-05	01-03-05
2	14	G14-SS-04	19-21-23	G14-SS-03	02-04-06	02-04-06
3	15	G15-SS-01	14-16-18	G15-SS-02	07-09-11	07-09-11
4	15	G15-SS-04	20-22-24	G15-SS-03	08-10-12	08-10-12
5	16	G16-SS-02	26-28-30	G16-SS-01	13-15-17	13-15-17
6	16	G16-SS-04	44-46-48	G16-SS-03	14-16-18	14-16-18
20	16	G16-SS-06	56-58-60	G16-SS-05	26-28-30	26-28-30
19	16	G16-SS-08	50-52-54	G16-SS-07	25-27-29	25-27-29
7	17	G17-SS-02	68-70-72	G17-SS-01	19-21-23	19-21-23
8	17	G17-SS-04	62-64-66	G17-SS-03	20-22-24	20-22-24

West Booster RF Mod/SSD 480 Volt Distribution

RF Station	Booster Period	FBS Switch	DHP-Y-BW1	DHP-L4-1-1		
			FBS Breaker#	Modulator Switch	Mod Breaker #	SSD Breaker#
17	20	G20 RF SS-2	80-82-84	G20 RF SS-1	80-82-84	01-03-05
18	20	G20 RF SS-3	74-76-78	G20 RF SS-4	74-76-78	02-04-06
9	21	G21 RF SS-2	13-15-17	G21 RF SS-1	13-15-17	07-09-11
10	21	G21 RF SS-4	19-21-23	G21 RF SS-3	19-21-23	08-10-12
11	22	G22 RF SS-2	25-27-29	G22 RF SS-1	25-27-29	13-15-17
12	22	G22 RF SS-4	31-33-25	G22 RF SS-3	31-33-25	14-16-18
						DHP-BW-1-1
13	23	G23 RF SS-1	50-52-54	G23 RF SS-2	50-52-54	01-03-05
14	23	G23 RF SS-10	56-58-60	G23 RF SS-9	56-58-60	02-04-06
15	24	G24 RF SS-2	62-64-66	G24 RF SS-1	62-64-66	07-09-11
16	24	G24 RF SS-6	68-70-72	G24 RF SS-5	68-70-72	08-10-12

West Booster BWG-124 RF FBS/Mod/SSD 480 Volt Distribution - Fed From DHP-L4-1

DHP-L4-1-2							
RF Station	Period	FBS Switch	Breaker#	MOD Switch	Breaker#	SSD Swit	Breaker#
21	20	FBS #21	02-04-06	MOD #21	20-22-24	SSD #21	25-27-29
22	20	FBS #22	08-10-12	MOD #22	26-28-30	SSD #22	19-21-23

120vac Tables

East Booster RF FBS/SSD 120 Volt Distribution				
RF Station	FBS BSTR Panel	120 Breaker#	SSD BSTR Panel	120 Breaker#
1	G15-PP-01	#22	G15-PP-06	#25
2	G15-PP-01	#24	G15-PP-06	#27
3	LP-BE-7/G15-PP-02	#30	G15-PP-06	#21
4	LP-BE-7/G15-PP-02	#29	G15-PP-06	#23
5	LP-BE-7/G15-PP-02	#20	G15-PP-06	#13
6	LP-BE-7/G15-PP-02	#19	G15-PP-06	#15
20	G15-PP-06	#20	G15-PP-06	#18
19	LP-BE-7/G15-PP-02	#19	LP-BE7/G15-PP-02	#18
7	LP-BE-7/G15-PP-02	#18	G15-PP-06	#17
8	LP-BE-7/G15-PP-02	#17	G15-PP-06	#19

West Booster RF FBS/SSD 120 Volt Distribution				
RF Station	FBS BSTR Panel	120 Breaker#	SSD BSTR Panel	120 Breaker#
9	LP-BW-7/G23-PP-0	#18	PP-BW-1-1	#01
10	LP-BW-7/G23-PP-0	#17	PP-BW-1-1	#03
11	LP-BW-7/G23-PP-0	#24	PP-BW-1-1	#17
12	LP-BW-7/G23-PP-0	#23	PP-BW-1-1	#19
13	LP-BW-7/G23-PP-0	#30	PP-BW-1-1	#11
14	LP-BW-7/G23-PP-0	#29	PP-BW-1-1	#09
15	LP-BW-7/G23-PP-0	#08	PP-BW-1-1	#15
16	LP-BW-7/G23-PP-0	#06	PP-BW-1-1	#13
17	LP-BW-7/G23-PP-0	#02	PP-BW-1-1	#07
18	LP-BW-7/G23-PP-0	#04	PP-BW-1-1	#05

BWG-124 Booster RF FBS/SSD 120 Volt Distribution				
RF Station	FBS BSTR Panel	120 Breaker#	SSD BSTR Panel	120 Breaker#
21	PP-L4-1-2	#01	PP-L4-1-2	#02
22	PP-L4-1-2	#03	PP-L4-1-2	#04

Booster R.F Anode Power Supply Breaker Locations and Designations

East Anode Power Supplies	13.8 KV	EAPS
	208	G11-PP-02
Anode Power Supplies Water Skid	480	DHP-BE-4 fka G12-PP-05
West Anode Power Supplies	13.8 KV	WAPS
	208	LP-BW-6 fka G02-PP-02
Anode Power Supplies Water Skid	480	DHP-BW4 fka G02-PP-01

Block Diagram



