Person: Nelson, Rick (nelson@jlab.org)
Org: EESRFS

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Jefferson Lab
Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Review and Approval Form # 87312
(See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for Instructions)

Type:	***OSP*** Click for OSP/TOSP Procedure Form Click for LOSP Procedure Form		
Serial Number:	***ENG-19-87312-OSP***		
Issue Date:	***7/10/2019***		
Expiration Date:	***5/10/2022***		
Title:	***LERF LINAC CPS and HPA Systems***		
Location: (where work is being performed) Building Floor Plans	***18 - Low Energy Recirculator Facility (LERF) - 214***	Location Detail: (specifics about where in the selected location(s) the work is being performed)	
Risk Classification: (See ES&H Manual Chapter 3210 Appendix T3 Risk Code Assignment)	Without mitigation measures (3 or 4):	***4***	
	With mitigation measures in place (N, 1, or 2):	***N***	
Reason:	This document is written to mitigate hazard issues that are : ***Determined to have an unmitigated Risk code of 3 or 4***		
Owning Organization:	***EESRFS***		
Document Owner(s):	***Nelson, Rick (nelson@jlab.org)*** Primary ***Gelhaar, David (gelhaar@jlab.org)***		

Supplemental Technical Validations

50V or Greater: De-energized Work (Bill Rainey, Bob May)
50V or Greater: Diagnostic Type Operations (Bill Rainey, Bob May)
Mode 1: Class 1, 2, and 3 Electrical Equipment (Bill Rainey, Bob May)
Lock, Tag, Try (Paul Powers, Todd Kujawa)
Radio Frequency (Imani Burton, Jennifer Williams)

Document History

Revision	Reason for revision or update	Serial number of superseded document
7	***Previous document expired. equipment and procedures remain unchanged***	

Lessons Learned	Lessons Learned relating to the hazard issues noted above have been reviewed.
Comments for reviewers/approvers:	***Equipment and procedures unchanged.***

Attachments

Procedure: ***LERF HPA-CPS OSP.pdf***
THA: ***LERF HPA-CPS THA.pdf***
Additional Files:

Review Signatures

Subject Matter Expert : Electricity->50V or Greater: De-energized Work	**Signed** on 6/19/2019 2:38:29 PM by Bill Rainey (wrainey@jlab.org)
Subject Matter Expert : Electricity->50V or Greater: Diagnostic Type Operations	**Signed** on 6/19/2019 2:38:34 PM by Bill Rainey (wrainey@jlab.org)
Subject Matter Expert : Electricity->Mode 1: Class 1-> 2-> and 3 Electrical Equipment	**Signed** on 6/19/2019 2:38:39 PM by Bill Rainey (wrainey@jlab.org)
Subject Matter Expert : Lock-> Tag-> Try	**Signed** on 6/19/2019 2:33:54 PM by Todd Kujawa (kujawa@jlab.org)
Subject Matter Expert : Radio Frequency	**Signed** on 6/20/2019 11:50:11 AM by Jennifer Williams (jennifer@jlab.org)

Approval Signatures

Division Safety Officer : EESRFS	**Signed** on 7/10/2019 3:59:47 PM by Harry Fanning (fanning@jlab.org)
Org Manager : EESRFS	**Signed** on 6/20/2019 11:51:54 AM by Rick Nelson (nelson@jlab.org)
Safety Warden : Low Energy Recirculator Facility (LERF) - 214	**Signed** on 6/20/2019 1:19:02 PM by Joe Gubeli (gubeli@jlab.org)

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Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Form

(See ES&H Manual Chapter 3310 Appendix T1 Operational Safety Procedure (OSP) and Temporary OSP Procedure for instructions.)

Click For Word Doc

Title:	Lockout of LERF LINAC CPS and HPA		
Location:	Building 18, Room 214	**Type:**	☒ **OSP** ☐ **TOSP**
Risk Classification (per Task Hazard Analysis attached) (See *ESH&Q Manual Chapter 3210 Appendix T3 Risk Code Assignment*.)		**Highest Risk Code Before Mitigation**	4
		Highest Risk Code after Mitigation (N, 1, or 2):	1
Owning Organization:	Engineering	**Date:**	6/13/19
Document Owner(s):	R. Nelson, D. Gelhaar		

DEFINE THE SCOPE OF WORK

1. Purpose of the Procedure – Describe in detail the reason for the procedure (what is being done and why).

The purpose is to create safe working conditions for this equipment by performing LTT and discharging high voltage systems.

2. Scope – include all operations, people, and/or areas that the procedure will affect.

This document covers maintenance and safety procedures for the LINAC High Power Amplifiers (HPA) including klystrons, Cathode Power Supply (CPS) and RF waveguide systems. Securing of hazardous energy sources : AC, DC, and RF.

3. Description of the Facility – include building, floor plans and layout of the experiment or operation.

The LERF, building 18, and equipment located room 214 includes power supplies, klystrons, supporting electronics, and waveguide that delivers RF to cryomodules in the the LERF vault, room 107. Multiple identical systems are located in this facility. The facility and its equipment are used to accomplish various experimental activities and testing.

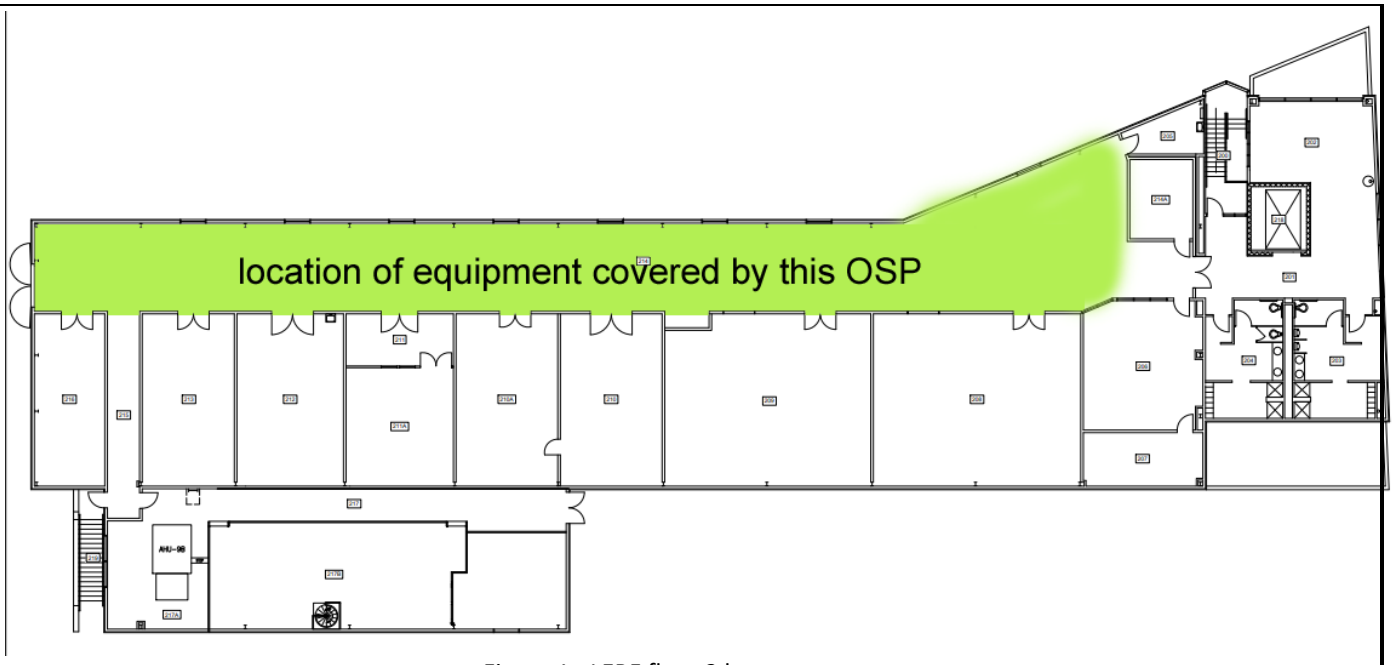

Figure 1 - LERF floor 2 layout

ANALYZE THE HAZARDS and IMPLEMENT CONTROLS

4. Hazards identified on written Task Hazard Analysis

High Voltage DC (up to -15 kV), AC (480 V, 208 V, and 120 V), non-ionizing radiation (RF to 8 kW @ 1497 MHz).

5. Authority and Responsibility:

5.1 Who has authority to implement/terminate

R. Nelson, D. Gelhaar

5.2 Who is responsible for key tasks

R. Nelson, D. Gelhaar

5.3 Who analyzes the special or unusual hazards including elevated work, chemicals, gases, fire or sparks (See ES&H Manual Chapter 3210 Appendix T1 Work Planning, Control, and Authorization Procedure)

n/a (no unusual hazards for this equipment)

6. Personal and Environmental Hazard Controls Including:

6.1 Shielding

Hazardous voltages and RF energy are safely contained:

- Within metal enclosures with interlocked doors
- Within shielded and interlocked waveguide
- Inside the access-controlled LERF vault

6.2 Barriers (magnetic, hearing, elevated or crane work, etc.)

n/a

6.3 Interlocks

Normally accessed doors and panels are interlocked (dual/redundant switches) and designed to terminate high voltage and RF when breached. Waveguide is interlocked via air pressure and pressure switch. Loss of pressure will result in termination of high voltage and RF.

6.4 Monitoring systems

Equipment is equipped with a Voltage Verification Unit (VVU) to aid in verification of the absence of 480 VAC. Automatic grounding relays discharge stored energy/HV, and manual grounding sticks are also used for this purpose. HV metering shows presence of high voltage.

6.5 Ventilation

n/a

6.6 Other (Electrical, ODH, Trip, Ladder) (Attach related Temporary Work Permits or Safety Reviews as appropriate.)

7. List of Safety Equipment:

7.1 List of Safety Equipment:

PPE required during these LTT procedures:

- Long sleeve shirt and long pants, both of non-melting material or untreated natural fiber
- Safety glasses
- Leather gloves

7.2 Special Tools:

n/a

8. Associated Administrative Controls

LTT

9. Training

9.1 What are the Training Requirements (See List of Training Skills)

- SAF104 – Lock, Tag & Try
- SAF603A – Electrical Safety Awareness
- SAF603S – Switching of Electrical Equipment
- Equipment specific training this system

DEVELOP THE PROCEDURE

10. Operating Guidelines

Prior to performing maintenance activities, ensure an ATLis has been written and approved.
Turn off affected equipment prior to performing LTT.

11. Notification of Affected Personnel (who, how, and when include building manager, safety warden, and area coordinator)

12. List the Steps Required to Execute the Procedure: from start to finish.

This Procedure may only be performed with two qualified individuals present.

Safe the CPS

1. The person performing the LTT procedure shall be dressed in appropriate PPE:

a. Long sleeve shirt and long pants, both of non-melting material or untreated natural fiber
b. Safety glasses
c. Leather gloves

2. Using the VVU attached to the CPS:
   a. Verify the 3 green LEDs are illuminated
   b. Verify the VVU meter displays normal line voltages for all 6 phase-phase and phase-neutral switch positions.

Figure 2 – VVU (Voltage Verification Unit)

3. Open the main circuit breaker (lower the actuator handle) located on the front of the CPS.
4. Using the VVU attached to the CPS:
   a. Verify the 3 green LEDs are *NOT* illuminated – they must be off.
   b. Verify the VVU meter displays zero voltage for all 6 phase-phase and phase-neutral switch positions.
5. Apply a hasp and your personal safety lock to the locking mechanism of the circuit breaker. The circuit breaker can only be locked in the OFF position. Each individual who is expected to perform work on the system must also place his personal lock unless a group lockout will be used.
6. These systems are equipped with additional security in the form of a Kirk Key system. Rotate the key located in the block adjacent to the circuit breaker, extending the bolt and firth inhibit actuation of the circuit breaker. The key is only removable in this positon.

Figure 3 – Main Circuit Breaker and Locking Systems

7. Remove the key and insert it into the main Key Transfer Block containing (located between the

two front equipment access doors).

8. Rotate the key just inserted to release the other keys in the block.
9. Remove 2nd from the topmost key and unlock the right door.
10. Verify that the main control panel now shows LEDs indicating interlock faults are now present.
11. Prior to removing the grounding stick, visually inspect the electrical connections on it. The cable must be attached to both the hook and ground.
12. While still wearing PPE, remove the ground stick by grasping the plastic handle it at the end farthest from the metal hook.
13. Touch the metal hook to the point labeled “Hi-Z”.
14. Touch, and then hang, the metal hook to the point labeled “Lo-Z”.

Figure 4 - Location of Lo-Z grounding point in CPS

15. If no access will be made to the HPA cabinet, the process is complete. If work will be done in the HPA cabinets, continue making the HPA safe.

Safe the HPA

The CPS must first be made safe by executing the above sequence before continuing to the HPA. While no HV will be present in the HPA when the CPS is properly locked out, the following procedure provides additional protection and insures no voltage will be present.

16. On the main Kirk Transfer Block, locate and remove the key associated with the HPA door you need to open.
17. Unlock the Kirk Block on the door using this key.
18. Unlock the HPA door using the HPA door key attached to the Kirk Key.
19. Repeat steps 16-18 for each door to be opened.

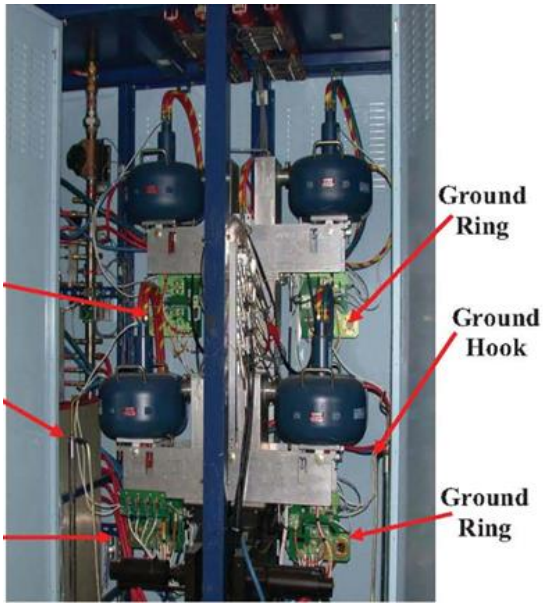

Figure 5 - Location of Grounding in HPA

20. Prior to accessing any compartment, visually inspect the electrical connections on the grounding hook located in that compartment prior to removing the hook. The cable must be attached to both the hook and ground.
21. Remove the ground hook from its holder, grasping the handle at the end farthest from the hook, and hang it on the grounding ring on either circuit board below the klystrons. If this is the back door, hang the hook on the grounding ring provided there.
22. If you will be removing the center front panel to gain access to filament and modulating anode boards, also unplug and secure the two AC power cables that supply 120 and 208 VAC to this compartment and the equipment located inside.

13. Back Out Procedure(s) i.e. steps necessary to restore the equipment/area to a safe level.

If any step in the LTT process fails to return the expected response, close the door and contact the System Expert before continuing. The back-out is the reverse of the LTT procedure.

14. Special environmental control requirements:

14.1 List materials, chemicals, gasses that could impact the environment (ensure these are considered when choosing Subject Mater Experts) and explore EMP-04 Project/Activity/Experiment Environmental Review below

none

14.2 Environmental impacts (See EMP-04 Project/Activity/Experiment Environmental Review)

none

14.3 Abatement steps (secondary containment or special packaging requirements)

n/a

15. Unusual/Emergency Procedures (e.g., loss of power, spills, fire, etc.)

n/a

16. Instrument Calibration Requirements (e.g., safety system/device recertification, RF probe calibration)

n/a

17. Inspection Schedules

18. References/Associated/Relevant Documentation
19. List of Records Generated (Include Location / Review and Approved procedure)

Submit Procedure for Review and Approval (See ES&H Manual Chapter 3310 Appendix T1 OSP & TOSP Instructions – Section 4.2 Submit Draft Procedure for Initial Review):

- Convert this document to .pdf
- Open electronic cover sheet: https://mis.jlab.org/mis/apps/mis_forms/operational_safety_procedure_form.cfm
- Complete the form
- Upload the pdf document and associated Task Hazard Analysis (also in .pdf format)

Distribution: Copies to Affected Area, Authors, Division Safety Officer
Expiration: Forward to ESH&Q Document Control

Form Revision Summary

Revision 1.5 – 04/11/18 – Training section moved from section 5 Authority and Responsibility to section 9 Training
Revision 1.4 – 06/20/16 – Repositioned "Scope of Work" to clarify processes
Qualifying Periodic Review – 02/19/14 – No substantive changes required
Revision 1.3 – 11/27/13 – Added "Owning Organization" to more accurately reflect laboratory operations.
Revision 1.2 – 09/15/12 – Update form to conform to electronic review.
Revision 1.1 – 04/03/12 – Risk Code 0 switched to N to be consistent with 3210 T3 Risk Code Assignment.
Revision 1.0 – 12/01/11 – Added reasoning for OSP to aid in appropriate review determination.
Revision 0.0 – 10/05/09 – Updated to reflect current laboratory operations

ISSUING AUTHORITY	FORM TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	REVIEW DATE	REV.
ESH&Q Division	Harry Fanning	04/11/18	04/11/21	1.5

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Task Hazard Analysis (THA) Worksheet

(See ES&H Manual Chapter 3210 Appendix T1
Work Planning, Control, and Authorization Procedure)

Click For Word

Author:	R. Nelson	**Date:**	6/13/19	**Task #:** If applicable	

Complete all information. Use as many sheets as necessary

Task Title:	Lockout of LERF LINAC CPS and HPA System			**Task Location:**	Building 18, Room 214
Division:	Engineering	**Department:**	RF	**Frequency of use:**	As needed for repair operations
Lead Worker:	R. Nelson				
Mitigation already in place: Standard Protecting Measures Work Control Documents					

Sequence of Task Steps	Task Steps/Potential Hazards	Consequence Level	Probability Level	Risk Code (before mitigation)	Proposed Mitigation (Required for Risk Code >2)	Safety Procedures/ Practices/Controls/Training	Risk Code (after mitigation
1	Energizing/de-energizing CPS and HPA. 480V Hazards, Arc flash from Disconnect	H	M	4	• Long sleeve shirt and long pants, both of non-melting material or untreated natural fiber • Safety glasses • Leather gloves	General Electrical training • SAF603A – Electrical Safety Awareness • SAF603S Switching of Electrical Equipment • SAF104 Lock, Tag & Try	1

Highest Risk Code before Mitigation:		**Highest Risk Code after Mitigation:**	

When completed, if the analysis indicates that the Risk Code before mitigation for any steps is "medium" or higher (RC≥3), then a formal Work Control Document (WCD) is developed for the task. Attach this completed Task Hazard Analysis Worksheet. Have the package reviewed and approved prior to beginning work. (See ES&H Manual Chapter 3310 Operational Safety Procedure Program.)

Jefferson Lab
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Task Hazard Analysis (THA) Worksheet

(See ES&H Manual Chapter 3210 Appendix T1
Work Planning, Control, and Authorization Procedure)

Form Revision Summary

Periodic Review – 08/29/18 – No changes per TPOC
Periodic Review – 08/13/15 – No changes per TPOC
Revision 0.1 – 06/19/12 - Triennial Review. Update to format.
Revision 0.0 – 10/05/09 – Written to document current laboratory operational procedure.

ISSUING AUTHORITY	TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	REVIEW DATE	REV.
ESH&Q Division	Harry Fanning	08/29/18	08/29/21	0.1

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By signing this page, you testify that you have read, understand, and agree to abide by the procedure specified in the above referenced work control document:

Serial Number: ENG-19-87312-OSP

Title: LERF LINAC CPS and HPA Systems

Name	Signature	Date