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Org: ACCCIS

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Jefferson Lab
Thomas Jefferson National Accelerator Facility

Operational Safety Procedure Review and Approval Form # 94662
(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 Click for LTT-Individual Information Click for LTT-Group Information	
Serial Number:	***ACC-19-94662-OSP***		
Issue Date:	***11/25/2019***		
Expiration Date:	***10/25/2022***		
Title:	***Gun Studies and Electron Beam Operation at Gun Test Stand (GTS)***		
Location: (where work is being performed) Building Floor Plans	***18 - Low Energy Recirculator Facility (LERF) - 109A*** ***18 - Low Energy Recirculator Facility (LERF) - 217***	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): With mitigation measures in place (N, 1, or 2):	***3*** ***1***	
Reason:	This document is written to mitigate hazard issues that are : ***Determined to have an unmitigated Risk code of 3 or 4***		
Owning Organization:	***ACCCIS***		
Document Owner(s):	***Suleiman, Riad (suleiman@jlab.org)*** Primary		

Supplemental Technical Validations

Lasers Class 3B or 4 (Ultraviolet, Infrared, and Visible Light) (Jennifer Williams, Paul Collins)
Lock, Tag, Try (Bill Rainey, Tim Fitzgerald)
ODH 0 and 1 (Imani Burton, Jennifer Williams)
Controlled Area (David Hamlette, Keith Welch)
Radiological Controlled Area (David Hamlette, Keith Welch)

Document History

Revision	Reason for revision or update	Serial number of superseded document
	Update and Renewal	

Lessons Learned	Lessons Learned relating to the hazard issues noted above have been reviewed.

Comments for reviewers/approvers:	***Serial number of superseded document: ACC-16-63923-OSP***

Attachments

Procedure: ***GTS_OSP_2019.pdf***

THA: ***THA_GTS_OSP_2019.pdf***

Additional Files:

Review Signatures

Subject Matter Expert : Lasers Class 3B or 4 (Ultraviolet-> Infrared-> and Visible Light)	**Signed** on 11/12/2019 11:14:28 AM by Paul Collins (paulc@jlab.org)
Subject Matter Expert : Lock-> Tag-> Try	**Signed** on 11/12/2019 11:50:27 AM by Tim Fitzgerald (tfitzger@jlab.org)
Subject Matter Expert : Oxygen Deficiency Hazards (ODH)->ODH 0 and 1	**Signed** on 11/22/2019 11:16:44 AM by Jennifer Williams (jennifer@jlab.org)
Subject Matter Expert : Radiation - Ionizing->Controlled Area	**Signed** on 11/12/2019 11:14:32 AM by David Hamlette (hamlette@jlab.org)
Subject Matter Expert : Radiation - Ionizing->Radiological Controlled Area	**Signed** on 11/12/2019 11:14:32 AM by David Hamlette (hamlette@jlab.org)

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Safety Warden : Low Energy Recirculator Facility (LERF) - 217	**Signed** on 11/25/2019 8:53:41 AM by Joe Gubeli (gubeli@jlab.org)

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Operational Safety Procedure Form

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

Click

DEFINE THE SCOPE OF WORK

Title:	**Gun Studies and Electron Beam Operation at Gun Test Stand (GTS)**		
Location:	Building 18 (LERF), room 217 (GTS control room) and room 109A (GTS enclosure).	**Type:**	**X 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 (3 or 4):**	3
		Highest Risk Code after Mitigation (N, 1, or 2):	1
Owning Organization:	ACCCIS	**Date:**	November 12, 2019
Document Owner(s):	Riad Suleiman		

Document History (Optional)

Revision:	Reason for revision or update:	Serial number of superseded document
	Update and Renewal	***ACC-16-63923-OSP***

ANALYZE THE HAZARDS

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

The purpose of this OSP is to describe in detail safe operating procedures for conducting electron gun and beam studies in the Gun Test Stand at LERF. Operations & maintenance are conducted by the Center for Injectors and Sources (CIS) personnel.

This operating procedure applies to the area known as the Gun Test Stand (GTS). The GTS is located in the west side of the LERF, Building 18. Room 217 is the control room, Room 109A is the shielded enclosure that is under room 217 and also adjacent to the LERF vault.

The GTS consists of a DC electron gun (gun thereafter) and a beam line, it is considered in the FSAD* to be an accelerator component test stand and does not contain accelerating cavities or components designed to impart energy to the electrons beyond the voltage potential across the gun; a few hundred-kilo electron-Volts (keV). Its principal use is to generate keV electron beam for testing photocathode material performance and electron gun configurations.

There are two types of electron guns that are available at the GTS: a photogun and a thermionic gun. Only one gun can be in use and connected to the beamline at any time. The photogun requires a laser system to generate the electron beam while a heated filament generate the beam with the thermionic gun. The laser system for the photogun is discussed below. For the thermionic gun, a separate OSP describes its operations. To work with the thermionic gun, training is required on both OSPs, the thermionic gun OSP and this OSP.

An electron beam is generated when the biased photocathode inside the photogun is illuminated with a laser beam. The GTS houses the drive laser inside a hutch. The laser is operated remotely from a computer terminal in the GTS control room. The laser transport from the hutch to the gun vacuum chamber laser viewport is enclosed in light-

tight tubing. The hutch doors, drive laser power supply and drive laser shutters (two of different kind for redundancy) are interlocked to the GTS Personal Safety System (PSS). This OSP does not cover drive laser alignment nor work on the drive laser inside hutch. These activities are performed by the laser system owner and qualified personnel prior to electron beam operations and will be covered in a separate LOSP, ACC-18-78924-LOSP.

* Final Safety Assessment Document Rev 8a: https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-4440

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

The GTS is not considered an accelerator; it is not a user facility and does not conduct nuclear physics experiments. Nominal operations are limited to the following modes:

- Tune and viewer limited beam at gun HV up to 350 kV, administratively limited to about 100 nA average current.
- 350 kV at 5 mA CW max limited by the power supply. HV is limited by gun break down at higher voltages (physical HVPS limit is 580 kV)
- 225 kV at 32 mA CW max limited by the power supply (has a power limit of 3 kW)
- 150 kV, 67 mA CW max limited by the power supply

The gun high voltage power supplies, the laser hutch doors, laser shutters and the laser power units are interlocked to the GTS Personal Safety System (PSS). The cathode solenoid coil is not part of the PSS but it interlocked to the sliding concrete door, which is interlocked to the PSS.

3. Description of the Facility – include floor plans and layout of a typical experiment or operation.

The Gun Test Stand is located on the west side of the LERF (Building 18) and consists of a control room (Bldg. 18, room 217) and an enclosure (Bldg. 18, room 109A) with concrete shield walls that is under room 217 and is adjacent to the LERF vault, see Figure 1.

The GTS has a ceiling-mounted hutch with lasers that can illuminate the photocathode. These lasers are described in ACC-18-78924-LOSP.

In addition to the lasers, the GTS houses three types of high voltage power supplies: a 580 kV, 5 mA DC gas-insulated power supply, a 225 kV, 32 mA DC solid state power supply, and a 150 kV, 67 mA DC solid state power supply. Only one power supply can be connected at a time to the gun. Changing between HV power supplies require coordination with PSS Group and PSS re-certification.

A cathode solenoid coil for studying magnetized beam has been installed between the gun and the beam line, providing a magnetic field of about 1400 Gauss at the photocathode with a maximum operational current of 400 A and operational voltage of 80 V. The magnet power supply is interlocked to the sliding concrete shield door to prevent access to the magnet when it is energized. When personnel is required to work on the magnet while energized, that work will be conducted under a separate OSP (ACC-16-64488-OSP), in which all personnel accessing the 600 Gauss area around the magnet will also be trained to remove ferromagnetic objects from themselves including wallet. The magnet is shown in yellow in Figure 2.

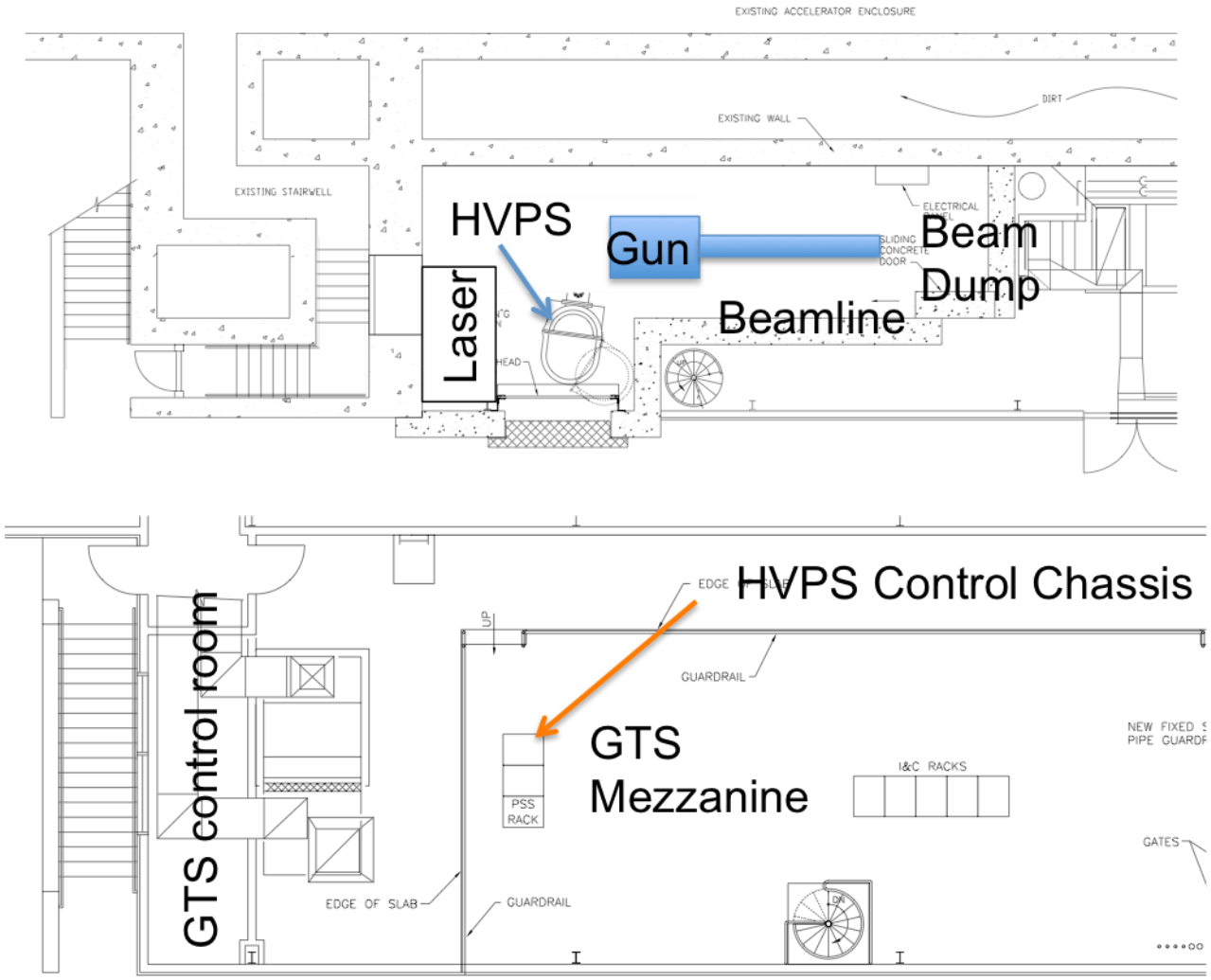


Figure 1: GTS enclosure civil drawing showing the location of the DC gun, the high voltage power supply (HVPS) and laser hutch.

In normal operating conditions, the only access to the GTS enclosure is via the sliding concrete shield door (shown near the beam dump location in Figure 1). Behind the concrete shield door, a sliding steel door is part of the LPSS to block any laser non-ionizing radiation. During installation periods, a metal overhead roll-up door is used for access to move equipment in and out such as the electron gun or the High Voltage Power Supply. The roll-up door is located at the opposite end of the room and is locked from the inside with a chain. This roll-up door is not an exit during normal GTS operating conditions. Concrete shield blocks are placed outside the roll-up door, therefore no access is possible through this door. Since the GTS is the plenum for the LERF vault HVAC, there is a vent between the LERF emergency exit staircase and the GTS, see Figure 1.

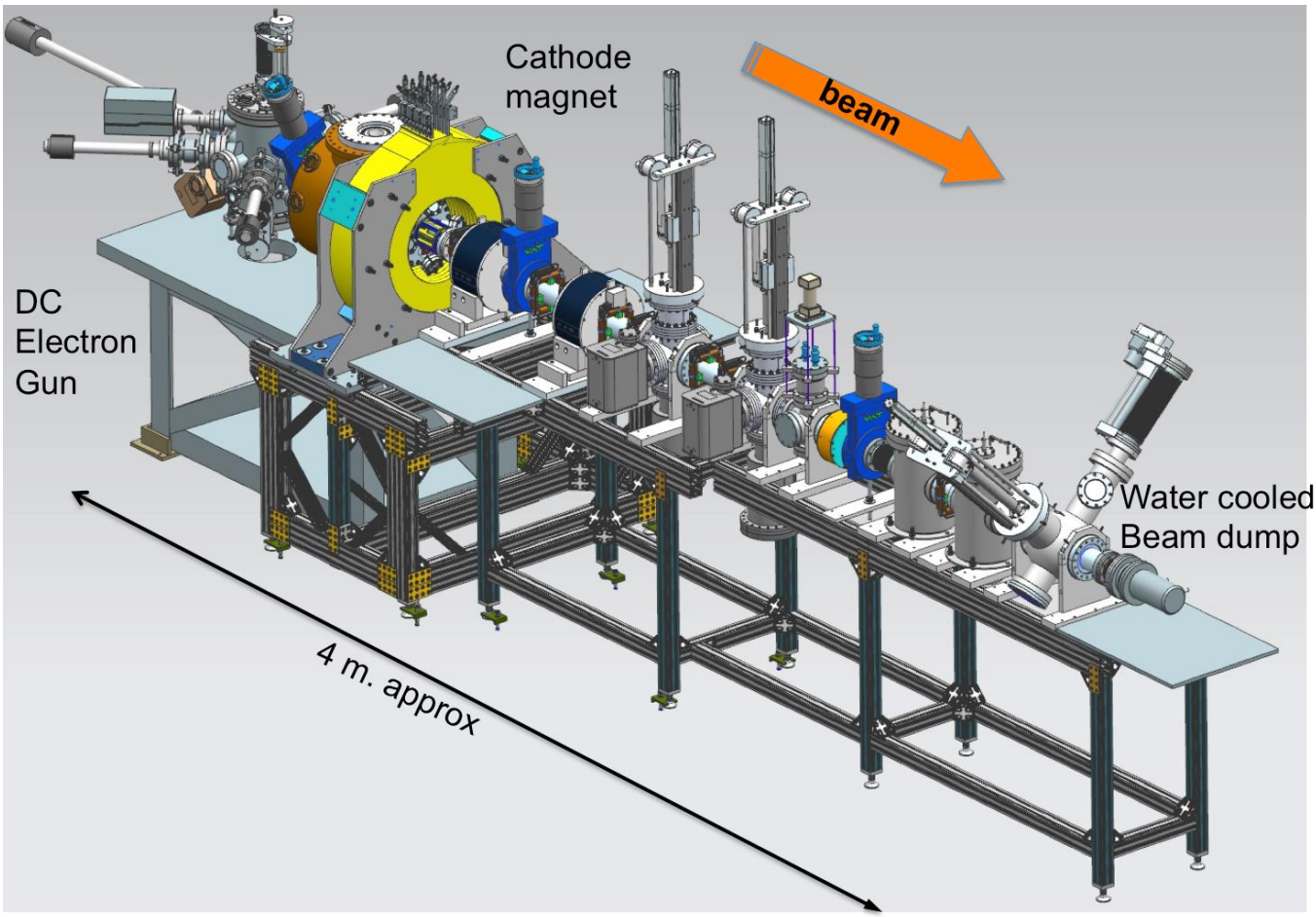


Figure 2: Isometric view sketch of the GTS beam line.

4. Authority and Responsibility:

4.1 Who has authority to implement/terminate

Gun operations: Matt Poelker and/or Riad Suleiman
Laser operations: Laser System Supervisor (LSS) – Shukui Zhang
Thermionic gun operations: Matt Poelker and/or Fay Hannon

4.2 Who is responsible for key tasks

Riad Suleiman is responsible for training GTS operators, for ensuring safe operation of the Gun Test Stand (GTS) and for leading the R&D program. Shukui Zhang (LSS) is responsible for laser alignment and operation. Fay Hannon is responsible to thermionic gun operations.

4.3 Who analyzes the special or unusual hazards (See ES&H Manual Chapter 3210 Appendix T1 Work Planning, Control, and Authorization Procedure)

Ionizing Radiation – K. Welch
Oxygen Deficiency Hazards – J. Williams
Safety Officer – Joe Gubeli (room 217) Kevin Banks (room 109A)

4.4 What are the Training Requirements (See http://www.jlab.org/div_dept/train/poc.pdf)

Please note the following:

- The concrete shield door operation is part of this OSP.
- The PSS/LPSS user manual is part of this OSP. PSS Group in coordination with the CIS personnel keeps its certification up-to-date.
- The cathode solenoid magnet is covered under a separate OSP (ACC-16-64488-OSP).
- The Laser system is covered under a separate LOSP (ACC-18-78924-LOSP).
- Training on operational procedures for the DC gun and for Drive Laser will be given by Riad Suleiman (gun) and Shukui Zhang (laser) to personnel participating in GTS studies and experiment on as-needed basis. The training on the thermionic gun OSP is given by Fay Hannon or Mark Stefani.

For safe operations, GTS operators must receive the following training:

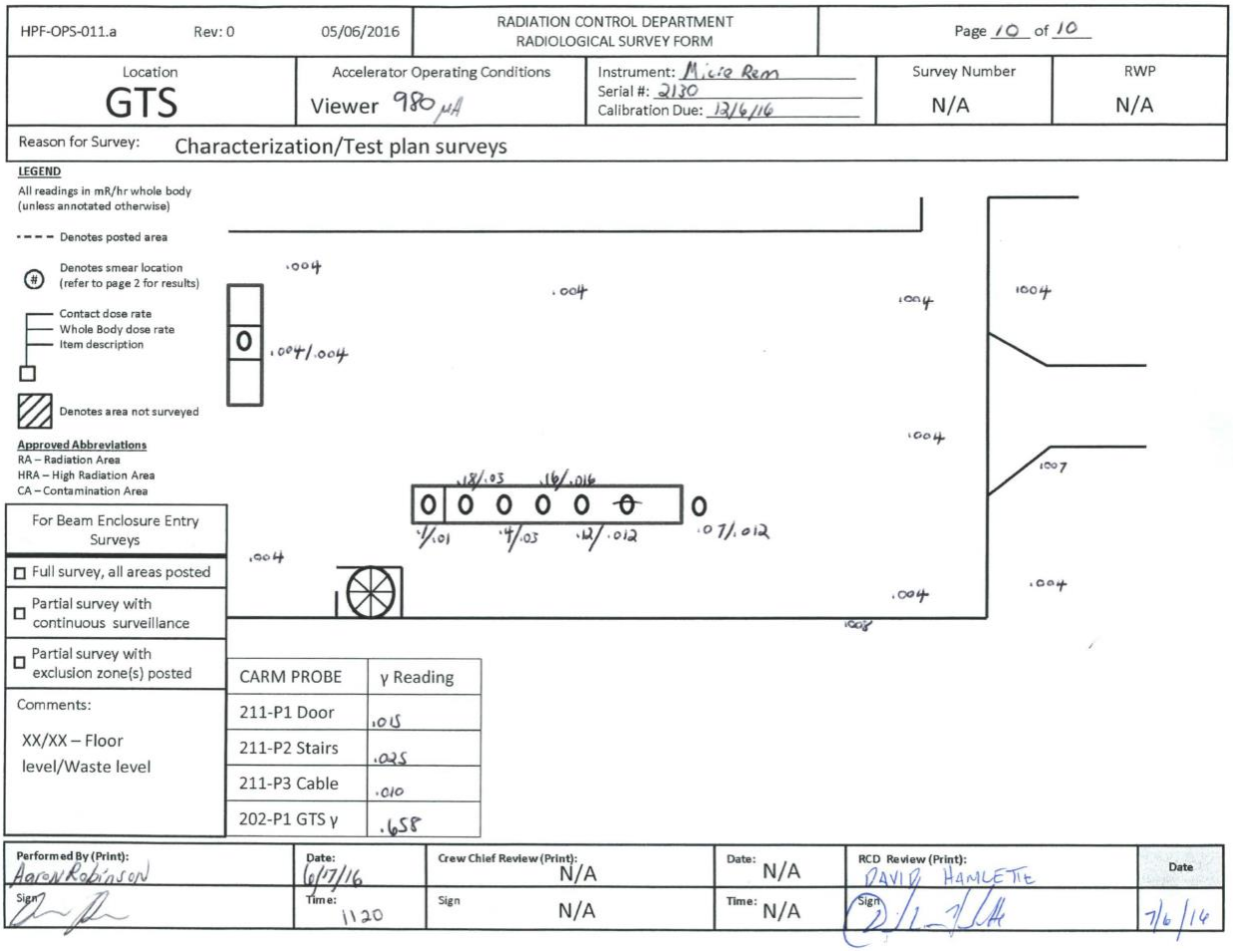
- SAF100 ES&H Orientation
- SAF103 Oxygen Deficiency Hazard
- SAF104 Lock, Tag and Try
- SAF801 Radiation Worker I
- Cathode solenoid magnet OSP (ACC-16-64488-OSP)
- This OSP
- Thermionic gun OSP if it is the gun being used

5. Personal and Environmental Hazard Controls Including:

5.1 Shielding

The prompt ionizing radiation hazard is due to x-ray emission caused by electrons impinging on a material, typically vacuum chambers and beam lines. The GTS enclosure shares the north wall with the LERF vault. The east wall is shared with the LERF vault exit staircase. Access to the staircase is interlocked to the LERF and GTS PSS. The south and east walls, as well as the ceiling that make the enclosure are considered permanent, that is, there is currently no shielding in place that can be easily disturbed. A roll-up overhead door (see Figure 1) located in the south wall has concrete blocks stacked on the outside and is PSS-interlocked. The only "movable" shielding is the concrete sliding door but that is also interlocked to the PSS.

A series of surveys were conducted in June 2016 around the GTS area while current was generated in the gun and terminated in the beam dump. With the gun at 300 kV, surveys were performed with current varying in steps of 100 µA from 100 µA to 980 µA. At each step radiation measurements were performed around the facility, concentrating especially on the penetrations through the roof of the GTS enclosure. Detailed results can be found in the survey report at https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-123883/2016_06_17-GTS%20surveys-75072.pdf. The survey at 980 µA is included in Figure 3.



HPF-OPS-011.a Rev: 0 05/06/2016 | RADIATION CONTROL DEPARTMENT RADIOLOGICAL SURVEY FORM | Page 10 of 10

Location	Accelerator Operating Conditions	Instrument: Micro Rem Serial #: 2130 Calibration Due: 12/6/16	Survey Number	RWP
GTS	Viewer 980 μA		N/A	N/A

Reason for Survey: Characterization/Test plan surveys

LEGEND
All readings in mR/hr whole body (unless annotated otherwise)
---- Denotes posted area
(#) Denotes smear location (refer to page 2 for results)
Contact dose rate
Whole Body dose rate
Item description
Denotes area not surveyed

Approved Abbreviations
RA – Radiation Area
HRA – High Radiation Area
CA – Contamination Area

For Beam Enclosure Entry Surveys
☐ Full survey, all areas posted
☐ Partial survey with continuous surveillance
☐ Partial survey with exclusion zone(s) posted

Comments:
XX/XX – Floor level/Waste level

CARM PROBE	γ Reading
211-P1 Door	.015
211-P2 Stairs	.025
211-P3 Cable	.010
202-P1 GTS γ	.658

Performed By (Print):	Date:	Crew Chief Review (Print):	Date:	RCD Review (Print):	Date
Aaron Robinson	6/17/16	N/A	N/A	DAVID HAMLETT	
Sign	Time: 1120	Sign N/A	Time: N/A	Sign	7/6/16

Figure 3: Radiation survey results at 980 μA and 300 kV.

It should be noted that the only radiation levels above background were detected a) with CARM probes located inside the GTS enclosure, and b) immediately above the roof penetrations, where levels at waist level did not exceed the RCA limit of 50 μR/h. A close look at signal from CARM probes outside the enclosure, in particular the one near the stairs leading to the exit door on the west side of the building, indicates that no radiation above background was detected. The area above the mezzanine penetrations has been marked as RCA. A personnel radiation dosimeter (OSL) is required to access this area marked as RCA. However, **no dosimeter is required to enter the GTS enclosure or the control room**. Recently, a wire scanner (harp) was installed in the GTS beamline. The harp was previously used at CEBAF accelerator and has residual activation. This required the posting of the sign "CAUTION RADIOACTIVE MATERIAL" at the entrance of the GTS enclosure but did not affect the dosimetry requirement (*i.e.*, still no dosimeter is needed to enter the enclosure).

More recent push to deliver higher beam currents at the GTS was completed in 2018 in coordination with the Radiation Control Group. A radiation survey was performed after every 1 mA step. The results of these surveys are summarized in this ATLis: http://opsweb.acc.jlab.org/CSUEApps/atlis/task/18399. We were able to deliver 1 mA at 300 kV, 14 mA at 200 kV, and 28 mA at 100 kV without the need for any new restrictions on beam operation. However, since we are continuously changing the GTS beamline we are approved to

deliver up to 1 mA. To deliver higher currents, we are required to submit an ATLis and coordinate with the Radiation Control Group.

Maximum Credible Accident: The high voltage power supply physical limits are 580 kV at 5 mA. Accidental beam losses at these values will result in loss of vacuum in the beam line, and subsequently in the electron gun where the photocathode emission is severely affected by vacuum conditions, therefore electron emission should cease within one minute. Due to the uncertainty of the source term, we estimate that the total dose accumulated over 2 minutes could be below about 500 mrem per occurrence, which complies with the new accident limit scenario, defined as mis-steering or loss of control of the electron beam under conditions corresponding to the upper limit of the beam power possible in a specific area. Under such conditions the integrated equivalent dose per occurrence shall not exceed 150 mSv (15 rem), see Radiation Control manual: https://www.jlab.org/ehs/ehsmanual/RadCon/2017/RCManual_Chapter%202_rev5-2017.pdf#page=17.

Summary: Current shielding of the GTS has been deemed satisfactory and compliant with applicable Jefferson Lab policies by the Radiation Control Group via surveys performed for currents up to 28 mA. However, after long downs or after modifications to the gun or beamline, to run higher than 1mA, CIS staff will coordinate with the Radiation Control Group to perform more radiation surveys every time the current is increased beyond that for which radiation surveys are performed. Additional measures (posting and shielding) may be necessary depending on radiation survey results at higher current.

Note: All the shielding is the same as when first installed in Dec 2007 and verified in August 2016.

5.2 Interlocks

The GTS personnel safety system (PSS) is an engineered interlock system to help protect personnel from exposure to prompt ionizing radiation (PIR) that results from operation of the electron gun. The GTS is composed of a concrete enclosure (vault) Room 109A, and a control room above the enclosure in the mezzanine Room 217 as shown in Figure 1. There are two personnel doors, a sliding concrete door and a sliding steel door. A rollup over-head door is only used for loading large pieces of equipment. This door is interlocked and is blocked by concrete shield blocks during operations. See Figure 1.

Figure 4 shows the concrete sliding door and the steel sliding door. The concrete sliding door can only be closed from the outside, but it can always be opened from the inside by pushing the crash button. In case of power loss, the door can be opened from the inside with provided manual red winch. The system is designed to prevent anyone being inside with the concrete sliding door closed.

The PSS is interlocked to the gun High Voltage Power Supply (HVPS) and to the Drive Laser Power Unit. It is the job of the PSS logic to determine the status of the GTS enclosure and, if a fault is detected, both the gun HVPS and the laser power unit are de-energized.

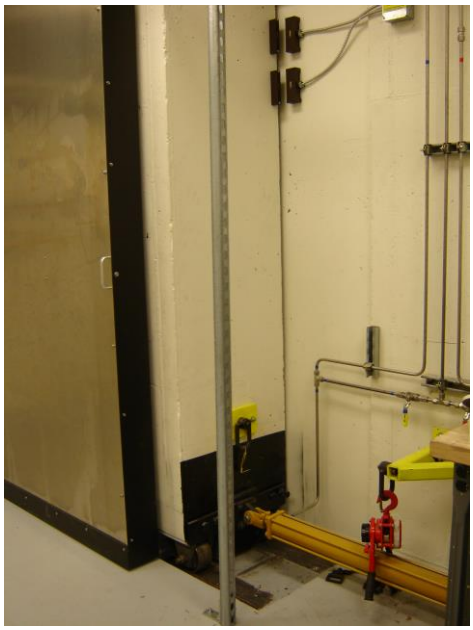


Figure 4: Picture showing the sliding concrete door and the sliding steel door from within the GTS enclosure.

The cathode solenoid magnet is interlocked to the sliding concrete door interlock preventing access to the GTS enclosure when the magnet is energized. However, there will be a sliding concrete door interlock bypass key to be able to enter GTS with the magnet ON for specific measurements and studies. When the sliding concrete door interlock is bypassed, to prevent personnel with surgical implants and bioelectric devices from entering the 5 Gauss boundary, strobe light indicators are installed on the top of power supply and at the access sliding concrete door to show that the solenoid is energized. In addition, flashing red beacons and personnel barricades are installed at the actual 5 Gauss contour. A 5 Gauss boundary sign is posted at the GTS by the sliding concrete door entrance and a 600 Gauss boundary is posted near the solenoid. For more details see the cathode solenoid OSP.

An interlock between the nitrogen source and the air-handling unit has been installed and is operational as an engineered control. The interlock is a fail-closed solenoid valve up-stream of the nitrogen manifold and mounted outside of the GTS enclosure that closes when the air handling unit is off due to power loss.

5.3 Monitoring systems

The GTS enclosure has one Radiation Alarming Monitor (CARM) connected to the LERF radiation monitoring system to alert personnel working in the GTS enclosure in the event of LERF electron beam loss (one gamma probe, RM 202-p1, is located behind the laser table attached to the air vent, one neutron probe, RM 202-p2, is located also inside the GTS to one side of the laser table in the upper-left corner).

The GTS enclosure has its own CARM radiation monitoring system consisting of one gamma probe (RM 211-p1) located next to the concrete shield door controls outside the enclosure, a second gamma probe (RM 211-p2) is located in the LERF exit staircase, and a third gamma probe (RM 211-p3) is located above the penetrations in the GTS mezzanine.

ODH sensors are inside the GTS enclosure, in the rear staircase, and at collection points in the LERF vault.

The PSS Group electronics continuously monitor the ODH sensors.

5.4 Ventilation

The GTS enclosure is part of the air conditioning system of the LERF vault. When the air conditioning system is operational, any SF_6 spill or leak off the high voltage power supply would be quickly dispersed due to the high flow rate of the air conditioning system. When the air conditioning system is off, any SF_6 would drain out of the GTS vault through the air conditioning recovery port and into the rear staircase of the LERF vault and then into the LERF vault.

The GTS enclosure is designed as an ODH 0 area.

The ODH assessment is addressed under a separate document, JLAB-TN-07-082. The floor area of room 109A was measured as 606.5 square feet with a 10-foot ceiling (6065 cubic feet). At one end of the room is an intake duct to the air-handling unit that supplies heated or cooled air mixed with fresh air to the LERF accelerator room. At the other end of the room is a hole in the wall that is open to the accelerator room and is covered with steel screen. Therefore, the GTS enclosure room 109A is considered a plenum. There is one roll up door, normally closed, and a concrete door, normally open. The concrete doorway has plastic panels to eliminate airflow through the doorway. In accordance with Appendix 6500-T3, reliable ventilation may be considered a relevant factor in this ODH assessment if the volume of air in the room is replaced with fresh air at a minimum of once an hour. The ventilation for this room comes from an air-handling unit. This unit operates 24 hours a day and 7 days a week. Because this room is a plenum, the air changes are larger than 50 air changes per hour.

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

The following hazards are detailed in attached Task Hazard Analysis.

- ODH
- Magnetic DC fields
- Exposure to ionizing radiation
- Exposure to non-ionizing (laser) radiation
- Fire hazard from Class 4 lasers
- Potential of crushing of limbs by operation of the concrete shield door
- Potential of tripping off while stepping over the concrete shield door trench

6. List of Safety Equipment:

6.1 List of Safety Equipment:

Laser safety goggles are located next to the PSS/LPSS console in the GTS control room 217.
Inside the GTS enclosure, the PPE cabinet contains leather gloves and safety glasses.

6.2 Special Tools:

A grounding stick is attached to the high voltage power supply tank in the GTS enclosure. Ground sticks are required when disconnecting the high voltage cable from the gun or form the HVPS. Lock-Tag & Try personal lock(s), labels and a hasp to be used in the HVPS disconnect are located inside a toolbox just below the HVPS disconnect in the GTS mezzanine room 217.

DEVELOP THE PROCEDURE

1. Associated Administrative Controls

The configuration of the gun and laser systems is highly dependent on administrative procedures and configuration control. There are several assumptions concerning HVPS system configuration that form part of this logic.

- Safety Systems Group staff is responsible for:
  - LPSS engineered controls
  - PSS administrative and engineered controls

- Center for Injectors and Sources (CIS) staff is responsible for:
  - LPSS administrative controls
  - SF_6 Gas insulated HVPS administrative and engineered controls
  - Cathode solenoid magnet administrative and engineered controls

*Administrative controls includes: Authority/responsibility, Procedures, Postings, and PPE

- CIS GTS personnel are responsible for safe operation of the GTS facility. This includes limiting beam power to fall within the identified operations and safety parameters.
- LERF vault PSS logic manages the LERF exit labyrinth door switches and Run/Safe Box 204 to provide an "Area Secure" signal to the GTS PSS logic
- The GTS enclosure is currently rated ODH 0
  - Since SF_6 is heavier than air, one active ODH sensor is installed under the HVPS tank and will set the off the alarm in the event of SF_6 leakage
- The HVPS control unit is interlocked to the PSS, it cannot be energized unless the PSS is in "Run" mode, attained after the GTS enclosure has been swept.
- The cathode magnet is interlocked to the sliding concrete door interlock preventing access to the GTS enclosure when the magnet is energized but is not part of the PSS.
- The laser power unit in interlocked to the GTS PSS/LPSS.
- The CARMs/radiation probes are interlocked to the PSS.
- Fixed and removable shielding - i.e. concrete and steel walls, doors, vents and blocks - are adequate to meet all safety requirements that are not protected by functions of the PSS or LPSS.
- The door/gate in the LERF vault leading to the west side labyrinth exit is interlocked to the PSS. This is the area where the Run/Safe Box 204 is located, and shared by the LERF PSS and the GTS PSS.

2. Operating Guidelines

The GTS is operated under this Operational Safety Procedure, which addresses hazards associated with maintenance and operation and their mitigations through engineered and administrative controls. Fault conditions in the GTS can produce only local work area impacts.

Staffing

The GTS can be operated by either a single trained and authorized user (typically the personnel conducting gun and/or beam studies), or in multiple unattended shifts. See:
Final Safety Assessment Document Rev 8a: https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-4440

GTS Operation

Prior to beam operation, the GTS must be placed in a personnel safe mode using the Personnel Safety System (PSS) and/or the Laser Personnel Safety System (LPSS). These involve using the proper door configuration, sweep and mode procedures, and securing of the GTS test cave and LERF exit staircase area described later in this document. Once the GTS PSS is in "Run" mode, the operator uses computer terminals in the GTS control room to generate and monitor electron beam.

Laser alignment requires GTS LPSS in ALIGNMENT mode. This OSP does not cover laser alignment, this will be covered in a separate LSOP document. The laser alignment is completed by the laser system owner and/or designee qualified personnel prior to electron beam operations. The GTS operator may operate the drive laser remotely from a computer terminal in the control room to generate electron beam, but this OSP does not qualify personnel in drive laser alignment tasks.

GTS Operator Requirements

Additionally to the training listed in section 4.4, the GTS operator must:

1. Read and understand this OSP that includes PSS sweep procedures,
2. Receive the practical training on this OSP and on Gun operational procedures from system owner (Riad Suleiman) or designee and,
3. Perform walkthrough of the following areas: GTS control room, mezzanine, spiral staircase, and enclosure.

3. Notification of Affected Personnel (who, how, and when)

Safety: GTS Safety Warden: Joe Gubeli (room 217) Kevin Banks (room 109A)
GTS system owner: Riad Suleiman
ODH, Fire: CEBAF Crew Chief: 269-7045, cell: 757-630-7050.
Emergency: Guard Gate 269-5822

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

The GTS enclosure can operate in two modes: a) Laser Alignment and b) Run mode. Laser Alignment mode is utilized for laser work only and no high voltage operations are permitted by LPSS/PSS.

This OSP addresses Run mode only and DOES NOT qualify personnel in Laser Alignment mode tasks. This will be covered in a separate LSOP document.

The enclosure is shielded from non-ionizing laser radiation to the outside by a sliding steel door interlocked to the LPSS/PSS. In case of emergency, this door can be manually slide open form the inside or outside. If the door is opened while in Laser Alignment mode permit, it will crash the LPSS and therefore close laser shutters and cut power to the laser.

In Run mode, the PSS gives "Gun Permit" which allows high voltage operations and Laser operations. A sliding concrete door in front of the steel sliding door shields the outside of the enclosure from prompt ionizing radiation during high voltage and beam operations. Procedures to operate the sliding concrete shield door are described at the end of this section.

The PSS/LPSS console is located in the GTS control room. Figure 5 shows a picture of the console (left), and a picture of the PSS/LPSS rack in the GTS Mezzanine (right).

Figure 5: (Left) PSS console is located in the GTS control room. (Right) PSS rack is located in the GTS mezzanine alongside racks housing IOCs, controls and monitoring equipment.

SSI Status

The Safety System Interface (SSI) status lamps display the active permits to the Gun, Drive Laser, and future RF systems.
"Gun Permit" will light when the gun HVPS has a PSS permit.
"Laser Permit" will light when the Drive Laser shutters receive a permit from the LPSS.

Door Status

The Door Status lamps in the PSS console indicate the important positions of the doors.
The sliding concrete door is the standard personnel door.
Note: this door will automatically open when any PSS/LPSS crash switch is pushed.
The sliding steel door is used to minimize laser light emanating from the enclosure during Laser Alignment mode. This door must also be closed during and after a PSS sweep, as it is interlocked to this system.
The roll-up door is only used to install large pieces of equipment.

The LERF exit staircase door in the west side of the LERF vault is interlocked to the GTS PSS. It is normally closed but can be pushed open in case of emergency. When pushed open, it will crash the GTS PSS. Figure 6 shows a picture of the LERF exit staircase door. The green beacon flashes once the Run/Safe Box 204 in the staircase has been armed.

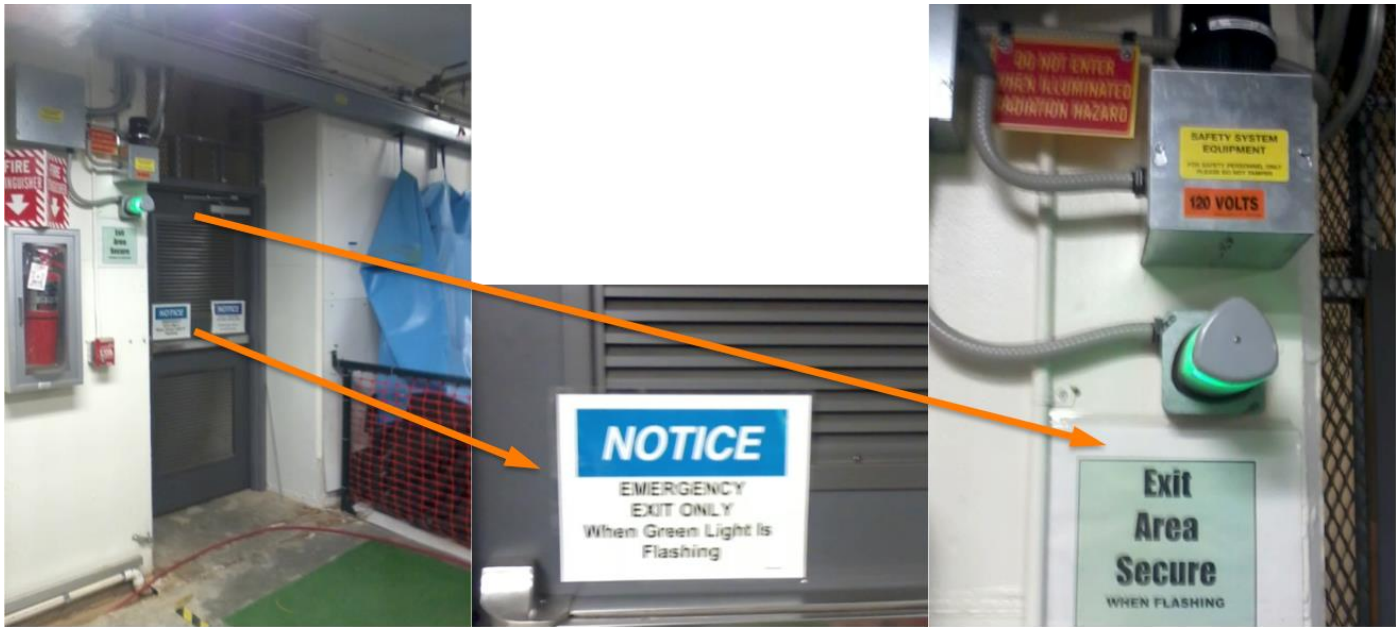


Figure 6: Picture of the LERF exit staircase door located in the west side of the LERF vault (next to the SF_6 blue bladder).

Key Switch Controls

The key switch controls are used to change the state of the PSS and LPSS operating modes and reset non-access control faults. See Figure 5 (left).

The colored LEDs indicate the status of the PSS operating mode. For the PSS there are two key switches and one key used in the operation of the GTS. The left hand key switch is used to switch between OPEN mode and SWEEP

mode. The key can only be removed when in the "Sweep" position. The same key is used for the sweep so that the GTS cannot be accidentally switched to RUN while the sweeper is in the test cave. When a sweep is completed the key is returned to the right hand key switch and used to set the operating mode to RUN.
If a non-access control fault occurs, such as a radiation monitor trip, the key must be cycled from RUN to SWEEP then back to RUN in order to reset the PSS system.

Note: Switching the key switch from Sweep to RUN starts a timer. The gun HVPS and Laser shutters may not be operated until the timer has reached 30 seconds.

The PSS console is configured to allow either Run mode (gun energized and capable of generating electron beam) or Laser Alignment mode with the gun de-energized, not capable of generating electron beam, but the enclosure PSS interlocked to allow laser alignment tasks.

NOTE: this OSP does not cover Laser Alignment mode. This will be covered in a separate LSOP document. The following related to LPSS mode is to inform the personnel to be qualified on this OSP of the functionality of the GTS PSS/LPSS console.

For LPSS Laser Alignment there are two key switches with a shared key. The key switch on the panel is used to switch between RUN mode and ALIGNMENT mode. The key can only be removed when in the "Alignment" position. The same key is used in the Laser permit status box in the cave so that the GTS cannot be accidentally switched to RUN while laser qualified staff are performing tests. The key switch in the cave is used to switch the shutter permits to ALIGNMENT mode. When testing is complete, the key is returned to the control room panel key switch and used to set the operating mode to RUN.

Safety Crash Button

The Safety Crash button is used to shutdown all GTS systems in an emergency.

This crash button will remove permits to the high voltage power supply and the laser shutters. It will also crash the sweep and force the concrete door to open.

Door Configurations

Gun Operations

In this mode, the sliding concrete door, the sliding steel door, the roll-up door and the LERF exit staircase door must be closed completely.

Laser Alignment Operations

Not covered in this OSP. Please check with laser system owner (Shukui Zhang) for training and LSOP.

PSS Operational Modes

Pre-operational Checks:
In order to avoid having to re-sweep, the following preoperational checks should be made:

- Confirm that the LERF exit staircase located in the west side of the LERF vault is secure.
- Door operation
  - Check that the roll-up door is closed

- Check that there are no obstacles blocking the moving concrete and sliding steel doors

- **Open Mode**

Open mode is the default state for the PSS. In this mode all Run/Safe boxes are not armed and the gun HVPS and laser shutter permits are OFF. This mode can be reached by turning the sweep key switch to OPEN or by pushing any PSS/LPSS crash switch.

Conditions:
- No Gun HVPS permitted
- Laser Power Supply permitted when Class 1 enclosure is secure
- Roll-up door may be open
- LERF exit staircase area can be in any state

Note: The sliding concrete door must be fully open.

- **Sweep Mode**

Prior to beginning operations, the GTS enclosure and the LERF exit staircase must be searched to ensure all personnel leaves those areas.

*Note: See **Section 8.0** of this user's guide for instructions that describe the proper sweep procedures and patterns.*

Conditions:

- No Gun HVPS permitted
- Laser Power Supply permitted when Class 1 enclosure is secure
- Roll-up door must be closed
- LERF exit staircase door must be closed and Run/Safe Box 204 must be armed. This area must be swept and the Run/Safe box armed BEFORE sweeping the GTS enclosure
- Sliding steel door must be fully closed before, during, and after sweep
- Sliding concrete door must be fully open before and during sweep, and fully closed when sweep is complete

- **Ready Mode**

"Ready Mode" is an internal PSS mode. It serves as a mode that the PSS will drop to when there is a non-access control fault, such as a radiation monitor.

- **Run Mode**

In order to enter and remain in RUN mode, all PSS interlocks must be OK.

Conditions:
- LERF exit staircase area swept and Run/Safe Box 204 armed
- GTS enclosure must be swept and secured
- Sliding concrete door closed
- Sliding steel door closed
- Roll-up door closed
- Crash buttons active
- Audible warnings (for 30 seconds)
- Visible warnings (continuous)

- PSS shutters open (30 second delay)
- CARMs active
- Sweep Key in RUN position
- Laser Alignment Key in RUN position (Run Mode excludes Laser Alignment mode)
- Gun HVPS permitted (30 second delay)
- Laser Power Unit permitted

The concrete sliding door cannot physically be closed from the inside, ensuring that no personnel is inside the GTS enclosure when the PSS interlocks acknowledge concrete sliding door as closed.

- In the LERF exit staircase and in the GTS enclosure the Run/Safe box lamps switch to "Unsafe"
- An alarm klaxon sounds for 30 seconds before the HVPS is enabled.

If someone is present in the enclosure after a sweep is complete, he/she should immediately exit the enclosure by hitting the nearest crash button to open the sliding concrete door. This will be a DOE reportable incident. All operations must cease at once and assistance given to any injured personnel, if required. The Principle Investigator must write down the names of all personnel on shift and that of the person(s) that were in the enclosure. The Principle Investigator must then contact the accelerator division safety officer and the radiation control group leader for further instructions.

- **Returning to Open Mode**
  - Turn off the gun HVPS
  - Switch the PSS key to "Sweep" mode
  - Remove key and insert in left hand key switch
  - Switch the PSS to "OPEN" mode

Sweep Procedures:

- **General Duties of the Sweeper**

Prior to sweeping, the sweeper must go to the GTS enclosure and ask personnel to leave the enclosure. In addition, the presence of the cathode solenoid magnet now requires an additional pre-sweep check: The strong magnetic field will attract loose ferromagnetic objects, possibly injuring personnel or striking fragile components. Prior to energizing the magnet, a sweep of cordoned area around the magnet will be performed for any loose magnetic objects such as tools, bolts, etc. All personnel accessing the 600 Gauss area around the magnet will also be trained to remove ferromagnetic objects from themselves including wallets.

Afterwards, the sweeper should ensure that all of the appropriate doors are closed. Confirm that the PSS panel or screens indicates that the doors are closed and the PSS panel LEDs read "Sweep Mode" for both system A and B.

It is the duty of the sweeper to thoroughly search the GTS enclosure for personnel. During the sweep, the team members must assume that there may be personnel who did not hear announcements or are incapacitated.

The sweeper should not perform any other tasks when doing an area sweep. Once the sweep starts, a 2-minute timer also starts. If the sweep is not completed within 2 minutes, the sweep will drop and will have to be re-swept.

The sweeper must be qualified and have signed this OSP. This is someone who is familiar with the sweep procedures for the GTS and for the LERF, and has swept the area at least once.

If anyone is found in the enclosure during a sweep, the person(s) must accompany the sweeper back to the GTS control room, and the sweep process must be re-initiated.

- **GTS Sweep Procedure for Gun Operations**

Identify a qualified personnel as the sweeper. Walk through the GTS enclosure:

- Ask any personnel in the cave to leave immediately
- Confirm that the roll-up door is closed
- Confirm that no magnetic objects are laying in the cordoned area around the cathode magnet
- Confirm that the sliding concrete door is fully open
- Return to the control room ensuring that the slide steel door is fully closed
- Look at the PSS console
    - Verify that the doors indicates their proper positions
    - Verify that the all system permits are OFF
    - Verify that the LERF exit staircase lamp is ON. If not, proceed to sweeping this area (see LERF exit staircase area sweep procedure below).

- Switch the PSS left hand key switch to Sweep mode and remove the sweep key
    - Verify that the PSS changes to Sweep mode
    - Take a copy of the sweep map if desired

The sweepers exit the control room area and enters through the concrete door.

- Open the sliding steel door, enter the GTS enclosure and close the sliding steel door behind you ensuring it closes completely
- Do a search for any personnel
- Arm the first Run/Safe box on the west wall to the right of the plenum vent
    - Verify that the Yellow “Operational” indicator is lit
- Arm the second Run/Safe box on the east wall near the exit
    - Verify that the Yellow “Operational” indicator is lit
- Turn the lights off, the switch is near the exit
- Exit the GTS enclosure ensuring the sliding steel door is fully closed upon exiting
- Close the sliding concrete door using the push buttons located next to the door on the right hand side. It must close within 60 seconds in order to maintain the sweep
- Return to the control room
- Place the sweep key in the right hand key switch and switch it to “Run” mode to begin operations

Note: Once the sweep is complete, the sweeper has exited the test cave and closed the concrete door, the PSS will automatically go to “Ready” mode.

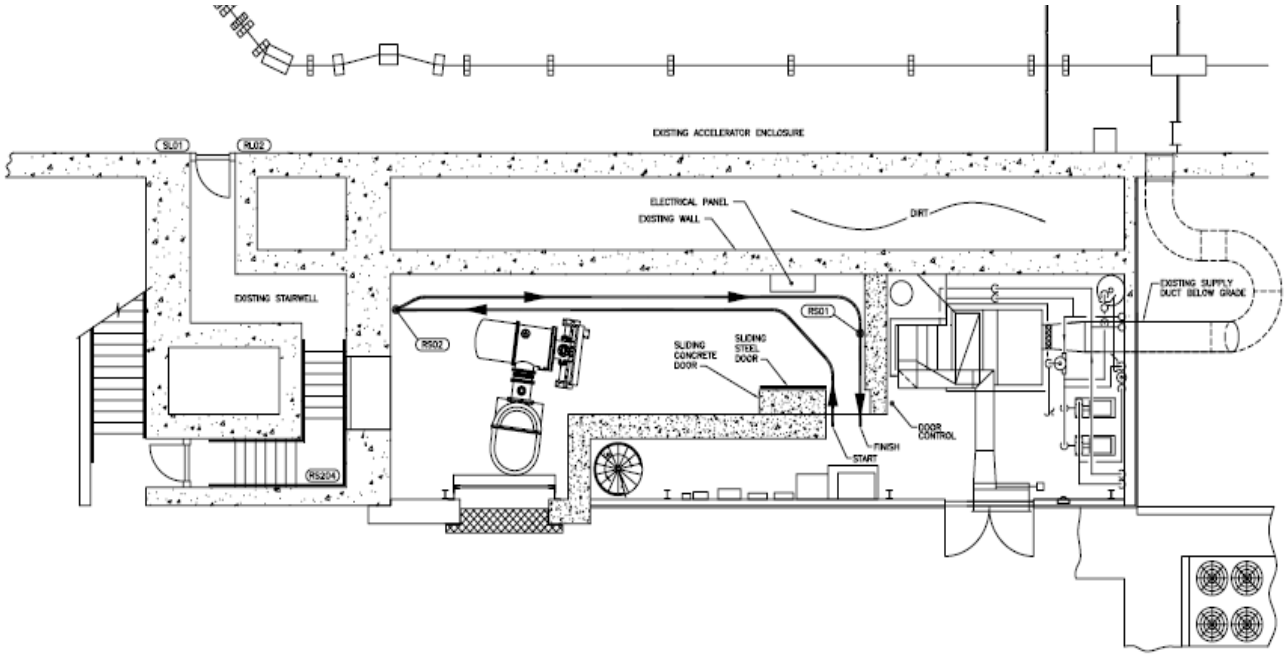


Figure 7: GTS sweep diagram.

- **LERF Exit Staircase Area Sweep Procedure**

LERF exit staircase area must be secured prior to sweeping the GTS enclosure.

Identify a qualified personnel as the sweeper.

- Go to the MCC and request the special sweep key (Key #10) from the Key Watcher panel
- Look at the LERF screen on the PSS computer.
    - Verify that the exit area doors are closed

Sweeper enters the LERF vault and passes through the wire door, see Figure 8.

- Close the wire door behind you
- Go to the fire door and confirm that it is completely closed and locked
- Arm the Run/Safe Box 204 on the south wall
    - Verify that the Yellow “Operational” indicator is lit
- Exit the area closing the wire door completely upon exiting
- Check that the "Area Secure" light on the wall outside of the door is lit
- Return to the key to the MCC Key Watcher panel

Note: Once the sweep is complete, the PSS will send an "area secure" signal to both the LERF and GTS.

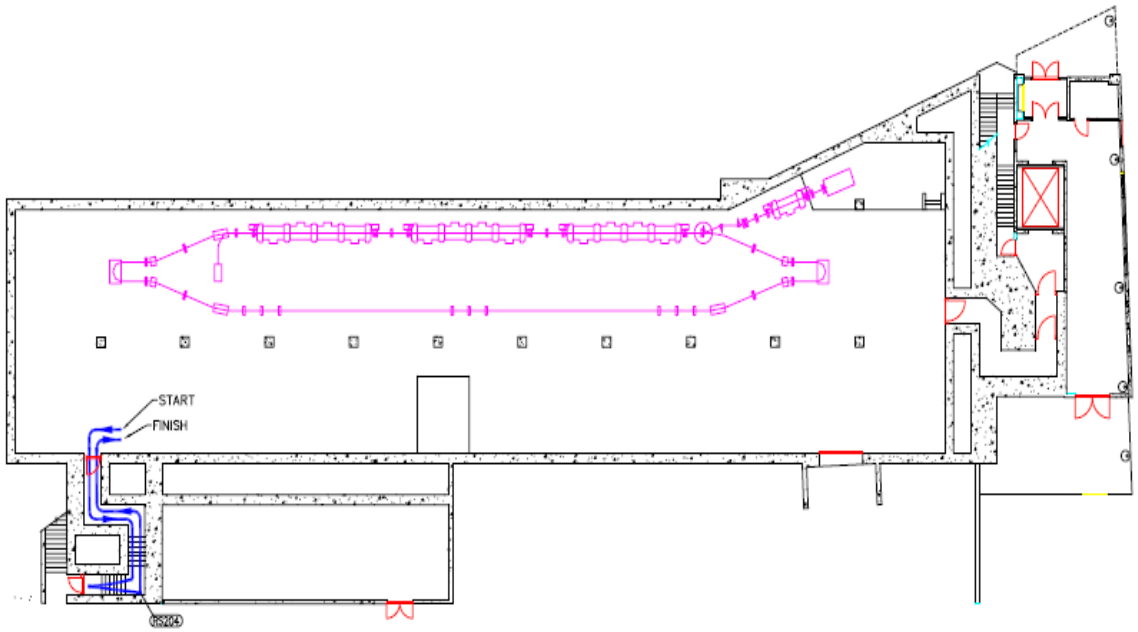


Figure 8: LERF fire exit staircase sweep diagram.

- **Concrete Sliding Door Normal Operating Procedures:**

  – To close sliding concrete door:
    a. Remove the trench plate using plate-pulling tool. The plate-pulling plate is on a hook affixed to the wall inside the GTS enclosure next to the sliding door.
    b. Press door close button and keep it held in for the door to move. There will be a few seconds delay before the door starts to move due to the pre-set time delay switch to allow pump to come up to speed. The door will stop moving when it reaches the limit switch, at this point the close button can be released. **A red flashing light with a high volume buzzer will go off each time the door is actuated.**
    c. Monitor the space between the door and the jam to ensure that no one enters while the door is in motion. The door will move slowly, it will take approximately 45 seconds for the door to travel from the fully open to closed.

  – To open sliding concrete door:
    a. Press open button and keep it hold in for the door to move, there will be a few seconds delay before the door starts to move due to the pre-set time delay switch to allow pump to come up to speed. The door will stop moving when it reaches the limit switch, at this point the open button can be released. **A red flashing light with a high volume buzzer will go off each time the door is actuated.**
    b. Once to door is fully open, set the trench cover plate in the trench to prevent tripping.

Note: The control buttons must be kept depressed to move the door. When the door reaches the open or close limit switches, it will stop moving and the button can be released. It is necessary for the door to reach the limit switch in open or close position to activate the PSS interlocks.

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

At any time during GTS operations, the PSS can be brought to OPEN or safe mode, in case there is a need for accessing the enclosure or to conclude high voltage or beam operations.

- **Returning PSS to Open Mode in Normal Operating Conditions:**
  - Turn off the gun HVPS from the EPICS control screen
  - Proceed to the PSS console and switch the key to "Sweep" mode
  - Remove key and insert in left hand key switch
  - Switch the key to "OPEN" mode
  - Proceed to the GTS enclosure entrance and open the sliding concrete door following procedure described above.

6. Special environmental control requirements:

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

SF_6 is a powerful greenhouse gas, 23,900 times worse than CO_2. SF_6 is used as an electrical insulating gas inside the pressurized (10 psi) Glassman 580 kV high voltage power supply. SF_6 is a greenhouse gas that must be re-used to avoid releasing it into the atmosphere when there is a need to open the tanks, i.e. high voltage power supply maintenance. Activities related to SF_6 are not part of normal GTS operations and not covered under this OSP. See C. Hernandez-Garcia for details on gas transferring operations.

6.2 Abatement steps (secondary containment or special packaging requirements)

To prevent the escape of this gas we have installed a SF_6 recovery system. This system passes the gas back and forth between a flexible storage bag, located outside, and the high voltage power supply. The system is also equipped with a vacuum pump to ensure near complete SF_6 gas recovery.

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

The gamma radiation monitors have their Warn Set Point at 0.25 mR/h and High Set Point at 2 mR/h. These set points are managed by the Radiation Control Group. There will be an audible alarm if the radiation levels exceed the Warn Set Point. If the radiation levels exceed the High Set Point, PSS will drop.

1. Check CARM readings from the EPICS radiation screen. If levels reached >2 mR/h, contact Radiation Control Group and inform about the situation and if high voltage conditioning or electron beam running is taking place.
2. Turn the key from RUN back to Sweep, then back to RUN in order to reset the fault.
3. If CARM trips PSS a second time, stop and contact Radiation Control Group to investigate.

Returning the PSS to Open Mode in case of emergency or any other abnormal conditions:

At any moment the PSS Safety Crash buttons can be depressed. This action will cut off the gun high voltage power supply and will close the laser shutter if those systems are operational. It will also crash the sweep and will force open the sliding concrete shield door.

Since ionizing radiation is present in the enclosure only when the gun is at high voltage, depressing any of the PSS Safety Crash buttons will restore the area to a safe level.

The following is a list of currently installed alarms:

1. ODH (blue strobe + buzzer)
2. Fire (white strobe + high pitch)

The expected response to any of the alarms is to evacuate the GTS enclosure immediately, proceed to LERF muster point located at the LERF front door, and notify the crew chief.

Return to normal operations occurs when alarms are cleared by the following personnel:

1. ODH cleared by MCC Crew Chief
2. Fire cleared by Facilities Management

Other emergency procedures not covered by alarms are:

a) Ventilation failure: Expected Response is to evacuate area immediately and convene at muster point.

b) Personnel inside GTS enclosure and sliding concrete door closed. **NOTE: This event should never occur if proper sweep procedures are followed.** Expected response is to proceed to the sliding concrete door exit and press the crash button. This will open the door.

c) Electrical Power failure and sliding concrete door closed. **NOTE: This event should never occur if proper sweep procedures are followed.** In case of power failure and personnel trapped inside GTS with the concrete shield door closed:

    1. Proceed to the sliding door and open the two manual hydraulic by-pass valves located on the wall behind the ram and shown in Figure 9.
    2. Attach the big red winch hook to the pull point on the door edge.
    3. Set chain winch to lift and operate lever to tighten the chain. This will pull the door open. **NOTE:** It should not take a great deal of force to open the door.
    4. If excessive force is required on the chain hoist lever: a) Set the hoist to lower, b) Release the chain tension, c) Check to ensure the manual by-pass valves are open, d) Re-try opening door. If still excessive force is needed call the Guard Gate at 269-5822 for help.

Figure 9: Sliding door and the two manual hydraulic by-pass valves located on the wall behind the ram.

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

ODH heads are maintained and continuously monitored by the Safety Systems Group.
CARMS are maintained by the Radiation Control group.
Both groups are responsible for calibrations and maintenance of their systems.

9. Inspection Schedules

PSS certifications are performed every six months by the Safety Systems Group in coordination with CIS personnel.

10. References/Associated Documentation

- Laser Alignment: ACC-18-78924-LOSP
- Cathode Solenoid Magnet: ACC-16-64488-OSP

- Thermionic Gun OSP
- GTS 580 Glassman HVPS SF_6 related activities: C. Hernandez-Garcia
- PSS/LPSS User guide Revision 1.0 January 10, 2008
- ODH Assessment JLAB-TN-07-082

11. List of Records Generated (Include Location / Review and Approved procedure)

Click
To Submit OSP
for Electronic Signatures

Distribution: Copies to: affected area, authors, Division Safety Officer
Expiration: Forward to ESH&Q Document Control

Form Revision Summary

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 – 10/05/09 – Updated to reflect current laboratory operations

ISSUING AUTHORITY	FORM TECHNICAL POINT-OF-CONTACT	APPROVAL DATE	REVIEW REQUIRED DATE	REV.
ESH&Q Division	Harry Fanning	12/01/11	12/01/14	1.3

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Task Hazard Analysis (THA) Worksheet

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

Click For Word

Author:	Riad Suleiman	Date:	November 1, 2019	Task #: If applicable	

Complete all information. Use as many sheets as necessary

Task Title:	Gun Test Stand (GTS) operations	Task Location:	Bldg 18 (LERF), room 217 and room 109A
Division:	Accelerator	Department: Center for Injectors and Sources	Frequency of use:
Lead Worker:	Riad Suleiman		

Mitigation already in place:
Standard Protecting Measures
Work Control Documents

Ionizing Radiation Engineered Controls

- Concrete shielding at least 24" thick surrounds the GTS except in the vent to the LERF exit staircase
- Concrete shield blocks are permanently installed outside roll-up door.
- Concrete shield sliding door (only access to GTS enclosure) is interlocked to the PSS so that opening it will drop the HVPS permit.
- Two baffle steel plates are permanently installed in the vent to the LERF exit staircase and are sufficient to mitigate radiation hazards (See Appendix B).
- The high voltage power supply contactor is made up only when the PSS allows it.

Exposure to Laser non-ionizing Radiation
Drive Laser hazards are mitigated through use of Class 1 laser enclosures (hutch and laser beam line transport) and via redundant laser shutters interlocked to the Laser Personnel Safety System (LPSS). For laser alignment mode when a person needs to be in the enclosure with the laser turned on, administrative procedures require use of laser goggles, training and sliding steel entrance door interlocked to the LPSS. Laser hazards and procedures are fully covered under a separate document ACC-18-78924-LOSP.

Oxygen Deficiency Hazard
The GTS enclosure is designed as an ODH 0 area. The ODH assessment for Nitrogen is addressed under a separate document JLAB-TN-07-082. The ODH assessment for SF_6 is covered in the High Voltage Power Supply FEL-07-002-SOP.

An interlock between the nitrogen source and the air-handling unit has been installed and is operational as an engineered control. The interlock is a fail-closed solenoid valve up-stream of the nitrogen manifold and mounted outside of the GTS enclosure that closes when the air handing unit is not working.

Oxygen Deficiency Hazard (continued)

	There is one active ODH sensor installed under the HVPS tank. This ODH alarm will go off in the event of SF6 leakage. Two ODH sensor mounts have been installed in the north wall of the GTS enclosure, one close to the floor and one close to the ceiling for future use in case Liquid Helium is ever used. **Crushing during Sliding Concrete Shield Door operation, Engineered controls** 1. Location of controls has been set to provide clear line of sight of the doorway. 2. Activation button must be kept depressed to move the door. 3.System pressure shall be set at minimum required to move the door

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Task Hazard Analysis (THA) Worksheet

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

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	Gun operation / Exposure to Ionizing Radiation	M	M	3	See Mitigations already in place	A Personnel Safety System (PSS) has been designed and implemented to protect individuals from ionizing radiation during high voltage and electron beam operations. The system has 3 Alarming Radiation Monitors (CARM) plus one more CARM linked to the LERF PSS system. A red flashing light will automatically be turned on in the GTS enclosure when the HVPS permit is allowed by the PSS. A sign just below the red flashing light is displayed indicating to exit immediately by pressing the concrete shield door crash button. The concrete shield door cannot be physically closed from the inside. A sweep will be done prior to closing the GTS concrete shield door following procedures referenced in the GTS OSP. Magenta beacons are activated when high voltage interlocks are armed, indicating potential for ionizing radiation inside the GTS enclosure.	1
2	Laser operation / Exposure to non-ionizing laser radiation / Fire hazard from Class 4 lasers	M	M	3	See Mitigations already in place	Use of Class 1 laser enclosures (hutch) interlocked to the LPSS, use of laser goggles, training and LPSS laser shutters interlocked secured access during alignment	1

Jefferson Lab
Thomas Jefferson National Accelerator Facility

Task Hazard Analysis (THA) Worksheet

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

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
3	Magnet coil operation / Magnetic Field Hazard	M	M	3	A sliding concrete shield door Interlocked to the magnet power supply will prevent access to the magnet when it is energized.	A 5 Gauss boundary sign is posted at the GTS enclosure door and a 600 Gauss boundary is posted near the solenoid. Strong magnetic field will attract loose ferromagnetic objects, possibly injuring body parts or striking fragile components. Prior to energizing the magnet, a sweep of cordoned area will be performed for any loose magnetic objects. When personnel is required to work on the magnet while energized, that work will be conducted under a separate OSP, in which all personnel entering the 600 Gauss area will also be trained to remove ferromagnetic objects from themselves including wallet.	1
4	Enclosure occupancy / Oxygen Deficiency Hazard/SF_6 exposure	L	EL	1	See Mitigations already in place	In case of ventilation loss due to HVAC failure (noticed by the sudden absence of ambient noise and air flow in the enclosure) personnel must leave area immediately and proceed to muster point located in the LERF building main entrance.	1
5	Sliding Concrete Shield door operation/ Crushing	M	M	3	See Mitigations already in place	GTS OSP requiring operators be trained in the operation of the door and associated risks	1

Task Hazard Analysis (THA) Worksheet

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

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
6	Sliding Concrete Shield door operation/ Trip	L	M	2	A steel trench cover plate is already used	GTS OSP requires installing trench cover plate prior to entering and removal prior to closing.	1

Highest Risk Code before Mitigation:	3	**Highest Risk Code after Mitigation:**	1

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.)

Task Hazard Analysis (THA) Worksheet

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

Form Revision Summary

Periodic Review – 08/13/15 – 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	08/13/15	08/13/18	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: ACC-19-94662-OSP

Title: Gun Studies and Electron Beam Operation at Gun Test Stand (GTS)

Name	Signature	Date