Jefferson Lab

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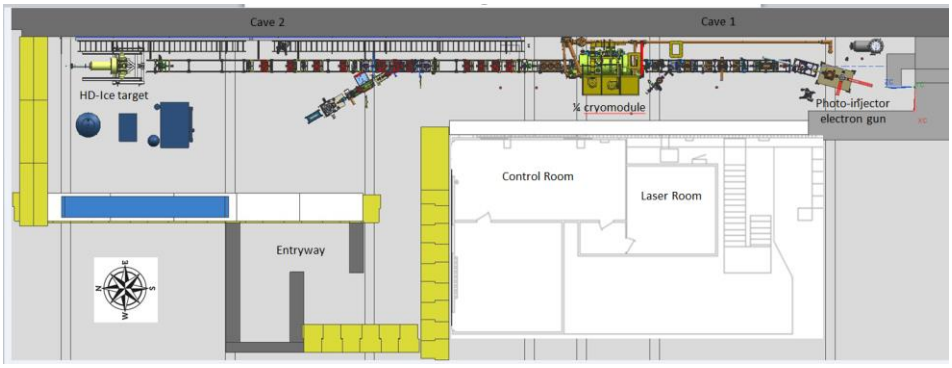
THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY
UPGRADED INJECTOR TEST FACILITY
ACCELERATOR SAFETY ENVELOPE
Revision 0



March 2019

Approval Page
for the
Thomas Jefferson National Accelerator Facility
Upgraded Injector Test Facility
Accelerator Safety Envelope
Revision 0

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Document Revisions

All revisions to this document require approval from the Thomas Jefferson Site Office.

Major revisions require approvals on a new signature page that includes the Laboratory Director, and Associate Directors of Physics, Accelerator, and Environment, Safety, Health, and Quality (ESH&Q). Major revisions are uniquely identified as Revision 7, 8, etc. (the next positive integer). Changes are summarized in the revision history table below.

Interim revisions incorporating minor changes such as clarifications, minor corrections that do not change the intent of the document, and typographical corrections require Jefferson Lab approval by the Associate Director(s) of the affected division(s) and Associate Director, ESH&Q Division. Minor changes are summarized and approval indicated in the revision history table below. Interim revisions are identified by adding a letter suffix, e.g. Revision 7a, 7b, 7c, etc.

Revision History

Rev.	Reason for Revision	Approval	Date
0	Initial issue.	See signature page	3/2019

Table of Contents

1. Introduction

The *Department of Energy (DOE) Order 420.2C Safety of Accelerator Facilities* (ASO) establishes accelerator-specific safety requirements and approval authorities. The ASO requires Thomas Jefferson National Accelerator Facility (Jefferson Lab) to conduct a hazard analysis for accelerator-specific safety risks and identify the controls necessary to mitigate those risks. The accelerator-specific hazard analysis and necessary controls associated with operation of the Upgraded Injector Test Stand (UITF) are provided in the *Jefferson Lab Final Safety Assessment Document* (FSAD) Revision 8. The set of accelerator-specific controls identified in the safety analysis that are essential for safe accelerator operations are referred to as Credited Controls. These Credited Controls collectively form the bounding conditions for the Accelerator Safety Envelope (ASE).

The ASE is approved by the Thomas Jefferson Site Office (TJSO) and is contractually binding for operation of the Jefferson Lab accelerators referenced herein.

2. Accelerator Safety Envelope (ASE) Violation

Operation of the UITF without the specified credited controls in place and functional is a violation of the ASE. If a Credited Control is inoperable or ineffective, compensatory measures may be used. Acceptable compensatory measures are listed with each Credited Control. Other compensatory measures may be used if those measures are evaluated by the Safety Configuration Management Board (SCMB) and approved by the TJSO. When an ASE violation occurs, beam delivery in the affected segment shall stop and not resume until:

- The situation is investigated and documented in accordance with the Critical Event Response section of the UITF *Operations Directives*, the cause(s) identified, corrective actions or approved compensatory measures implemented, and,
- Formal notification is made to TJSO documenting the cause of the occurrence, corrective actions and the intention to restart accelerator operations in the affected segment(s).

If a Credited Control proves to be inoperative or ineffective, and that Credited Control serves more than one segment of the accelerator, beam delivery in all affected segments – up to and including the entire accelerator – shall stop until the actions specified above are taken.

If an ASE violation is identified by TJSO and UITF beam delivery is stopped at TJSO's request, beam delivery shall not resume in the affected segment(s) until approved by TJSO.

A violation of the ASE is typically very clear. However, there may be minor failures of controls that are less obvious but still constitute a violation of the ASE. Determining whether a condition is a violation or a (less severe) safety concern can be subjective. The following examples of ASE violations are intended to serve as guidance to facilitate such determinations. (Judgment may be necessary to evaluate specific situations and a list below is not comprehensive.):

- Surveillance of Credited Controls in an actively used accelerator segment is not conducted in the time-frame specified in the ASE.
- Moveable shielding identified as a Credited Control is not in place when beam is delivered in that segment of the accelerator.
- Both independent Personnel Safety System (PSS) channels for the same Credited Control are inoperable during beam delivery in the accelerator.
- A locked access (door or gate) serving as a Credited Control remains unlocked when beam is delivered in the accelerator.
- Beam is delivered to an experiment in the accelerator without the required experiment review process completed.
- Beam is delivered in the accelerator with less than the minimum specified qualified staffing in the UITF Control Room.

The SCMB is chartered by the Jefferson Lab Director to evaluate safety concerns and determine if they represent an ASE violation and/or an Unreviewed Safety Issue (USI). A USI is a condition that may require an update to an existing hazards analysis in the FSAD or may require the addition of a new FSAD hazard along with new Credited Controls. The SCMB operates in collaboration with TJSO.

3. Credited Controls

Credited Controls mitigate hazards that pose unacceptable risk and reduce that risk to acceptable levels. The Credited Controls identified in the FSAD are listed below. These Credited Controls must be in place and functional when required by the state of accelerator operations

The ASE also specifies the management and surveillance practices that must be performed to assure the continued effectiveness of the Credited Controls. Management and surveillance practices are part of an approved configuration management process that helps to ensure that the physical configuration and functionality of Credited Controls remain accurate and in accordance with the analysis and requirements in the FSAD. The management and surveillance practices may have a specified frequency. Occasionally, a management and surveillance interval for a Credited Control will expire during a period when an accelerator is operational. Prior to this, the SCMB shall evaluate the condition as a safety concern that represents a USI or a potential ASE violation. The surveillance interval may be extended with approval of DOE depending on the outcome of the evaluation. If a required management and surveillance interval exceeds one year, the due date for the next required management and surveillance verification will be listed on the current beam authorization.

The same configuration management process is applied to temporary changes during maintenance to ensure that the integrity and performance of Credited Controls is restored before beam delivery. Configuration control is accomplished by the Safety Systems Group Procedures, Radiation Control Department (RCD) Procedures, the SCMB, and in accordance with the relevant Quality Assurance Program Procedures/Processes. For example, Accelerator Safety is assessed as part of the triennial Assessment cycle incorporated into the Annual Assessment Plan. The management and effectiveness of Credited Controls is evaluated during the triennial cycle.

Certain management and surveillance records, such as verification of the functionality of a Credited Control before beam operations, may rely on electronic records and logs. Software that supports electronic records and logs is developed and maintained in accordance with the Site-Wide Cyber Security Program Plan and controlled in accordance with the Accelerator Division Controls Software Group User Account/Usage Policy.

Certain Credited Passive Engineered Controls are listed in the FSAD as initial assumptions, that is, they are assumed to be in-place and functional prior to the start of accelerator operations - the concrete accelerator enclosure, for example. Administrative controls are either programmatic in nature or are embodied in specific operational procedures. Sections 3.1 – 3.3 below list the Credited Controls applied to the UITF accelerator and follow "hierarchy of controls" principles – the controls that are most effective and least prone to failure are applied first. These are typically passive engineered controls that are physical safety features that are built into the accelerator design. Active engineered controls are used when the control requirements are more complex, interactive, or interdependent. Administrative controls, which are typically programmatic in nature or are embodied in specific process and procedures, are used last and often in conjunction with engineered controls.

3.1. Credited Passive Engineered Controls

Credited Passive Engineered Controls include physical design features including shielding, physical barriers, flow limiting devices, and vents.

3.1.1. Permanent Shielding

Applicability:

When beam delivery[1] is possible.

Specific Controls:

- Structural shielding, typically reinforced concrete that defines the accelerator enclosure,
- Built in shielding design features such as labyrinths and penetration routing.

Management and Surveillance:

- The status of structural shielding shall be recorded in the Credited Control Certification Log in the UITF OSP by Facilities Management and Logistics along with the expiration date for the status determination.
- Structural shielding shall be inspected as specified by Facilities Management and Logistics Procedures and recorded in the Maximo work order system at least every five years. Design changes shall be reviewed in accordance with the *ASE Violation/USI Review Process*.

[1] Gun high voltage processing and/or cathode re-cesiation and gun operation (producing electrons at energy up to the applied bias voltage on the gun) is not beam delivery in this ASE.

Acceptable Compensatory Measures:

If, during RCD inspection, shielding for the accelerator enclosure is found to be less than the values specified in the FSAD, the shielding shall be evaluated by the RCD and approved by the Manager and compensatory measures, (such as additional access control, installation of temporary shielding, etc.) if necessary, shall be used to maintain performance specified in the Jefferson Lab Shielding Policy for Ionizing Radiation until the shielding is restored to the values specified in the FSAD or the FSAD is amended. The SCMB shall review and evaluate RCD recommendations using the *ASE Violation/USI Review Process*. The design, approval, and use of compensatory measures for permanent shielding shall be subject to the *Jefferson Lab Shielding Policy for Ionizing Radiation*.

3.1.2. Movable Shielding

Applicability:

When beam delivery is possible.

Specific Controls:

Movable shielding[2].

Management and Surveillance:

The status of moveable shielding shall be recorded in the Credited Control Certification Log in the *UITF OSP* by the RCD along with the expiration date for the status determination. The design, approval, and use of Movable Shielding shall be subject to the *Jefferson Lab Shielding Policy for Ionizing Radiation*. For non-PSS interlocked Movable Shielding locking devices and/or tags installed according to ES&H Manual Chapter 6111, Administrative Control Using Locks and Tags, shall be used to maintain correct placement of moveable shielding. Correct placement of moveable shielding shall be verified in accordance with the Jefferson Lab *Radiation Control Department Procedures* specified in *HPP-OPS-002*, *Performance of Periodic Routines.* Credited movable shielding shall be robustly labeled as such.

Acceptable Compensatory Measures:

Fences or barriers with informational signs or postings consistent with the hazard that prevent inadvertent access to the affected area and that mitigate the radiation hazard consistent with the requirements of the *Jefferson Lab Shielding Policy for Ionizing Radiation*.

[2]Discrete shielding materials or an assembly of material that can be moved and/or disassembled, and is determined to be a Credited Control in the FSAD hazard analysis.

3.1.3. Nitrogen Gas Supply Orifices

Applicability:

When affected system is charged with gas and personnel are in the affected area within the accelerator enclosures.

Specific Controls:

Orifices in the supply lines restrict the flow rate to levels that would be dispersed through normal area ventilation without significantly reducing the oxygen concentration.

Management and Surveillance

Orifice is in place and labeled in accordance with ES&H Manual Chapter 6111 Administrative Control Using Locks and Tags.

Acceptable Compensatory Measures:

Work control procedures for work in affected area shall specify Oxygen Deficiency Hazard (ODH) mitigation as required by the ES&H Manual Chapter 6540 Oxygen Deficiency Hazard (ODH) Control Program.

3.1.4. ODH Vents, Lintels and Facility Configuration

Applicability:

Quarter Cryomodule is supplied with cryogens or Target is supplied with cryogens.

Specific Controls:

UITF passive vents in accelerator enclosure and passive vents incorporated into moveable shielding

Management and Surveillance:

No surveillance is required for features that are part of UITF poured concrete structures. Passive vents incorporated into moveable shielding identified as Credited Controls are labeled in accordance with ES&H Manual Chapter 6111 Administrative Control Using Locks and Tags and verified after movement according to the UITF OSP.

Acceptable Compensatory Measures:

Work control procedures for work in affected area shall specify ODH mitigation as required by the ES&H Manual Chapter 6540 Oxygen Deficiency Hazard (ODH) Control Program.

3.2. Credited Active Engineered Controls

Active Engineered Controls include the PSS and the ODH Monitoring systems. The PSS provides monitoring of the perimeter and segment access points of the accelerator and

halls in order to keep people away from beam related radiation hazards and provides monitoring of critical devices that prevent beam transport to any segment of the accelerator and halls that is open for any type of personnel access. The ODH System provides monitoring of oxygen levels in the accelerator and halls in order to protect people from ODH caused by the release of oxygen displacing gases.

3.2.1. PSS Access Controls

Applicability:

When beam delivery is possible.

Specific Controls:

The UITF PSS shall have no loss of safety function during beam delivery.

Management and Surveillance:

Interim changes to the PSS are reviewed and approved in accordance with the *PSS Configuration Control Policy* and the *ASE Violation/USI Review Process.* PSS functional requirements are established in the *Beam Containment and Access Control Policy*. The UITF PSS shall be certified annually.

3.2.2. UITF PSS Beam Containment Controls

Applicability:

When beam delivery beyond the quarter cryomodule is possible.

Specific Controls:

The UITF PSS shall have no loss of safety function during beam delivery.

Management and Surveillance:

Interim changes to the PSS are reviewed and approved in accordance with the *PSS Configuration Control Policy* and the *ASE Violation/USI Review Process*. PSS functional requirements are established in the *Beam Containment and Access Control Policy.* The UITF PSS shall be certified annually.

3.2.3. ODH System Controls

Applicability:

A fixed ODH monitoring system shall be installed in UITF areas when required by the ES&H Manual Chapter 6540 Oxygen Deficiency Hazard (ODH) Control Program and an ODH analysis document.

Specific Controls:

An ODH system shall provide adequate monitoring coverage of the affected areas.

Management and Surveillance:

- The system shall be maintained such that it is operational when required by the ODH assessment for the location.
- Maintenance will be done in accordance with Safety Systems Group procedures.
- ODH sensing devices shall be tested every two years.

Acceptable Compensatory Measures:

- Entry only by authorized personnel in accordance with ES&H Manual Chapter 6540 Oxygen Deficiency Hazard (ODH) Control Program.
- Procedures for entry into a reduced oxygen atmosphere.
- Exclusion of personnel from the areas in which the ODH system performance is inadequate.

3.3. Credited Administrative Controls

Credited Administrative controls include processes, limits, and conditions necessary for safe accelerator operation as described.

3.3.1. Doors, Gates, Fences, and other Barriers

Applicability:

When beam delivery is possible.

Specific Controls:

Entrances to accelerator enclosures shall be blocked and interlocked via the PSS Interlocks or locked, barred, or bolted into place to prevent unauthorized access.

Management and Surveillance:

Access shall only be permitted in accordance with approved procedures. Keys shall be controlled and issued to authorized personnel.

Locked, barred, or bolted entrances shall be verified in accordance with the *Radiation Protection Department Procedures* specified in *HPP-OPS-002, Performance of Periodic Routines*.

3.3.2. Lab Experimental Review Processes

Applicability:

When beam delivery is possible into the affected segment containing a nuclear physics experiment.

Specific Controls:

Any experiment that has completed the Proposal Phase described In the ES&H Manual Chapter 3120 The CEBAF Experiment Review Process, that is, the experiment has a decision by the Director of Jefferson Lab to grant beam-time formally communicated by a letter from the Director accompanying the PAC report, will undergo the remaining steps in the experimental review process before the experiment is run using the UITF accelerator.

A proposal that has not completed the Proposal Phase described in the ES&H Manual Chapter 3120, i.e. has not been granted beam time but has been evaluated by laboratory leadership and found to have sufficient merit to pursue that proposal using laboratory resources, shall follow the requirements in the ES&H Manual Chapter 3130, FEL Experiment Safety Review Process, (check this out to make sure it aligns) before the experiment is run using the UITF accelerator.

Management and Surveillance:

ES&H Manual Chapters are maintained in accordance with ES&H Manual Chapter 1300 Content Review Process.

3.3.3. Operations

Applicability:

Applies when UITF PSS is being made ready for PSS state above Ready.

Specific Controls:

Before beam operations commence, there must be:

- A trained UITF Operator must be present in the UITF Control Room, and
- A documented beam authorization by the Facility Manager

Management and Surveillance:

UITF operations follow the steps defined in the *UITF* Operations Directives (UOD). These steps are carried out by a trained UITF Operator in the UITF Control Room.

4. Document List (In Alphabetical Order)

Accelerator Safety Envelope (ASE) Violation/Unreviewed Safety Issue (USI) Review Process
UITF Operations Directives
DOE Order 420.2C Safety of Accelerator Facilities
ES&H Manual Chapter 1300 Content Review Process
ES&H Manual Chapter 3120 The CEBAF Experiment Review Process
ES&H Manual Chapter 3130 Low Energy Recirculator Facility (LERF) Experiment Safety Review Process (Check this to make sure this has changed)
ES&H Manual Chapter 3320 Temporary Work Permits
ES&H Manual Chapter 6111 Administrative Control using Locks and Tags
ES&H Manual Chapter 6540 Oxygen Deficiency Hazard Control Program
Facilities Management and Logistics Procedures
Final Safety Assessment Document (FSAD)
HPP-OPS-002, Performance of Periodic Routines
Jefferson Lab Beam Containment and Access Control Policy
Jefferson Lab Shielding Policy for Ionizing Radiation
Low Energy Recirculator Facility Operations Directives (LOD)
Personal Safety System (PSS) Configuration Control Policy
Quality Assurance Program Procedures/Processes
Site-Wide Cyber Security Program Plan (CSPP)
User Account/Usage Policy
UITF OSP…

Appendix – Acronyms

Acronym	Definition	Page
ASE	Accelerator Safety Envelope	1
ASO	Accelerator Safety Order	1
CEBAF	Continuous Electron Beam Accelerator Facility	6
DOE	Department of Energy	1
ES&H	Environment, Safety & Health	4
ESH&Q	Environment, Safety, Health, and Quality	ii
FSAD	Final Safety Assessment Document	1
Jefferson Lab	Thomas Jefferson National Accelerator Facility	1
ODH	Oxygen Deficiency Hazard	5
PSS	Personal Safety System	2
RCD	Radiation Control Department	2
SCMB	Safety Configuration Management Board	1
TJSO	Thomas Jefferson Site Office	1
UITF	Upgraded Injector Test Stand	1

Acronym	Definition	Page
USI	Un-reviewed Safety Issue	2