Jefferson Lab

Revision 1

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

UPGRADED INJECTOR TEST FACILITY ACCELERATOR SAFETY ENVELOPE

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JSA

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Approval Page
for the
Thomas Jefferson National Accelerator Facility
Upgraded Injector Test Facility (UITF) Accelerator Safety Envelope
Revision 1

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DOCUMENT REVISIONS

Approvals

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

Major revisions require approval, on a new signature page. These include the Laboratory Director, and Associate Directors of Physics, Accelerator, and Environment, Safety, and Health (ES&H). Major revisions require a full number change incremented appropriately (i.e. Rev 2.1 becomes Rev 3; Rev 3 becomes Rev 4; etc.) and a notation within the Revision Summary.

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, ES&H Division. Minor revisions are denoted by a mantissa (fractional number) incremented as appropriate (i.e. Rev 0 becomes Rev 0.1; Rev 1.2 becomes Rev 1.3, etc.), and a notation is made within the Revision Summary.

Revision History

Rev.	Reason for Revision	Approval	Date
1	Revision for implementation of 420.2D: removal of references to 420.2C and replacement with 420.2D, updated FSAD to SAD Rev9, removed all footnotes regarding “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” and specifying a non-beam mode.	See signature page	4/2025
Periodic Review	There are no changes to the UITF ASE. This can stay as a two-year review. Robert May, Deputy Director ES&H	N/A	09/2023
Periodic Review	There are no changes to the UITF ASE. This can go to a two-year review. Nothing has come up through the USI process. Robert May, Deputy Director ES&H	N/A	09/2021
Periodic Review	There are no changes to the UITF ASE. Nothing has come up through the USI process. Robert May, Deputy Director ES&H	N/A	10/2020
0	Initial issue.	See signature page	10/2019

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1.0 INTRODUCTION

The *Department of Energy (DOE) Order 420.2D Safety of Accelerators* establishes accelerator-specific safety requirements and approval authorities. The DOE O 420.2D 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 the operation of the Upgraded Injector Test Stand (UITF) are provided in the *Jefferson Lab Safety Assessment Document* (SAD) Revision 9a. 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 the operation of the Jefferson Lab accelerators referenced herein.

2.0 FACILITY DESCRIPTION

The UITF is an upgrade to the former Injector Test Stand (ITS) located in the Test Lab High Bay (High Bay). The UITF occupies the former ITS cave (Cave 1) and includes a second contiguous enclosure (Cave 2) that extends the facility further into the High Bay area.

The UITF has two principle purposes: conduct small-scale physics research experiments at low energy and serve as a research accelerator to test accelerator capability and accelerator components. For these purposes, beam can be delivered to in-line dumps and experimental apparatus in Cave 1 or 2. Experimental equipment is subject to *Environment, Safety, and Health (ES&&H) Manual Chapter 3130 Accelerator Experiment Safety Review Process*.

The requirements in this ASE apply to either mode of operation. UITF operations for the purposes of testing accelerator components may be done by applying RF to accelerator components without beam delivery. This is referred to as non-beam operation. The UITF also serves as an electron gun test stand.

3.0 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, facility operation 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 (UOD)*, the cause(s) identified, corrective actions or approved compensatory measures implemented, and,
- If conditions are discovered that introduce accelerator specific hazards that are not adequately addressed by the current SAD and this approved ASE, impacted/affected operations must be suspended immediately and put in a safe and stable configuration. Discovered conditions must be addressed using DOE approved measures, as appropriate. DOE must provide written approval for resumption of impacted/affected operations.

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. There may also be situations where a Credited Control is potentially ineffective but the identified compensatory measures are in place. Determining whether a condition is a violation or a (less severe) safety concern can be subjective. The following are examples of potential ASE violations that are intended to serve as guidance to facilitate such determinations. Judgment may be necessary to evaluate specific situations and the list below is not comprehensive:

- Surveillance of Credited Controls in an accelerator during beam delivery is not conducted in the time frame specified in the Management and Surveillance description for that Credited Control.
- Movable shielding identified as a Credited Control is not in place during beam delivery in 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 during beam delivery in the accelerator.
- Beam is delivered to an experiment in the accelerator without completing the required experiment review process.
- Beam is delivered in the accelerator with less than the minimum specified qualified staff in the UITF Control Room.

The SCMB, chartered by the Jefferson Lab Director, evaluates safety concerns and determines if they represent an ASE violation and/or an Un-reviewed Safety Issue (USI). A USI is a condition that may require an update to an existing hazards analysis in the SAD or may require the addition of a new SAD hazard along with new Credited Controls. The SCMB membership incorporates a TJSO Observer.

4.0 CREDITED CONTROLS

Credited Controls mitigate hazards that pose unacceptable risk and reduce that risk to acceptable levels. The Credited Controls, identified in the SAD, 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 ensure that the physical configuration and functionality of Credited Controls remain accurate and in accordance with the analysis and requirements in the SAD. Management and surveillance practices may have a specified frequency. Occasionally, it becomes apparent that a management and surveillance interval for a Credited Control may expire during a period when an accelerator is either scheduled for operation or is operational. Prior to the expiration of the management and surveillance interval, the interval may be extended based on the results of evaluation by the SCMB and approval by TJSO. A management and surveillance interval that expires during beam delivery should be evaluated by the SCMB as a safety concern that represents a USI or a potential ASE violation.

The same configuration management process is applied to temporary changes during maintenance to ensure the integrity and performance of Credited Controls are 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 a triennial assessment cycle. This cycle is incorporated into the Annual Assessment Schedule. The management and effectiveness of Credited Controls is evaluated during these triennial assessments.

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* and controlled in accordance with the *Accelerator Division Controls Software Group User Account/Usage Policy*.

The application of Credited Controls follows "hierarchy of controls" principles – the controls that are most effective and least prone to failure are applied first. Certain Credited Passive Engineered Controls are listed in the SAD as initial assumptions (i.e. they are assumed to be in-place and functional prior to the start of accelerator operations). For example, the concrete accelerator enclosure. Active engineered controls are used when the control requirements are more complex, interactive, or interdependent. Administrative controls are either programmatic in nature or are embodied in specific operational procedures. Administrative controls are used last and often in conjunction with engineered controls. Sections 4.1 – 4.3 below lists the Credited Controls applied to the UITF accelerator. These are typically passive engineered controls that are physical safety features built into the accelerator design.

4.1. Credited Passive Engineered Controls

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

4.1.1. Permanent Shielding

Applicability:

- When beam delivery is possible.
- When SRF operations are possible.

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:

- Permanent shielding shall be subject to the *Shielding Policy for Ionizing Radiation (RCD-POL-14-001).*
- Shielding design and changes shall be reviewed in accordance with the *ASE Violation/USI Review Process* and approved by the Radiation Control Manager (RCM) or designee.
- The Dig/Blind Penetration Permit specified in ES&H *Manual Chapter 3320 Temporary Work Permits* shall be used to manage penetrating or otherwise disturbing the structure in a way that can impact shielding effectiveness.

- Structural shielding shall be inspected as specified by Facilities Management and Logistics (FM&L) and recorded in the Condition Assessment Information System (CAIS) at least every five years. The inspection results shall be communicated to the RCM or designee.
- The RCM or designee shall evaluate all permanent shielding at least every five years against applicable design specifications and SAD requirements, and its general condition with respect to shielding effectiveness. The evaluation shall be recorded in the Jefferson Lab Authorization Manager (JAM) before facility operation.

Acceptable Compensatory Measures:

If RCM evaluation determines the condition of permanent shielding associated with an accelerator enclosure does not meet the requirements specified in the SAD or is otherwise unacceptable, the RCM or designee will recommend compensatory measures (such as additional access control, installation of temporary shielding, etc.), if necessary, to maintain the performance specified in the *Shielding Policy for Ionizing Radiation (RCD-POL-14-001)* until the shielding is restored to the values specified in the SAD or the SAD is amended. The SCMB shall review and evaluate RCM recommendations using the *ASE Violation/USI Review Process*. The design, approval, and use of compensatory measures for permanent shielding shall be subject to the *Shielding Policy for Ionizing Radiation (RCD-POL-14-001)*.

4.1.2. Movable Shielding

Applicability:

- When beam delivery is possible.
- When SRF operations are possible.

Controls: Movable Shielding[1].

Management and Surveillance:

- Movable shielding shall be subject to the *Shielding Policy for Ionizing Radiation (RCD-POL-14-001)*.
- Movable shielding design and changes shall be reviewed in accordance with the *ASE Violation/USI Review Process* and approved by the RCM or designee.
- Movable shielding shall be visibly labeled or tagged consistent with *ENG-AD-01-001 Conduct of Engineering Manual Section 5.2.6.1 Implementing Item Identification.*
- Correct placement of movable shielding shall be verified in accordance with the Jefferson Lab Radiation Control Department Procedures specified in *HPP-OPS-002, Performance of Periodic Routines* and *HPP-OPS-015, Shielding Package Determination and Tracking.*

[1] Movable shielding is considered to be discrete shielding materials or an assembly of material that can be moved and/or disassembled and may be a Credited Control in the SAD hazard analysis.

- The RCM or designee shall record the movable shielding status, along with the expiration date for the status determination, in the JAM before facility operation.

Acceptable Compensatory Measures:

Fences or barriers with informational signs or postings consistent with the hazard that prevent inadvertent access to the affected area and mitigate the radiation hazard consistent with the requirements of the *Shielding Policy for Ionizing Radiation (RCD-POL-14-001)*.

4.1.3. ODH Vents, Lintels and Facility Configuration

Applicability:

When cryomodule is supplied with cryogens or target is supplied with cryogens.

Controls:

UITF passive vents in accelerator enclosure and passive vents incorporated into movable shielding.

Management and Surveillance:

- No surveillance is required for these controls if they are part of a concrete structure that defines the UITF accelerator enclosure and, once placed, they are not intended to move to facilitate UITF operation.
- Passive vents, incorporated into movable shielding and identified as Credited Controls, are visibly labeled or tagged consistent with *ENG-AD-01-001 Conduct of Engineering Manual Section 5.2.6.1 Implementing Item Identification* and verified after movement.
- FM&L shall record the status of passive vents incorporated into movable shielding and identified as Credited Controls, along with the expiration date for the status determination, in the JAM before facility operation.

Acceptable Compensatory Measures:

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

4.2. Credited Active Engineered Controls

Active Engineered Controls include the PSS and the ODH Monitoring systems. The PSS provides monitoring of the access points of the accelerator. In combination with Passive Engineered Controls such as shielding and Administrative Controls such as doors, gates, fences, etc., the PSS is designed to keep people away from accelerator hazards. Such hazards include, but are not limited to, prompt exposure from the beam or RF components. The ODH System provides monitoring of oxygen levels in the accelerator in order to protect people from ODH caused by the release of oxygen displacing gases.

4.2.1. PSS Access Controls

Applicability:

- When beam delivery is possible.
- When SRF operations are possible.

Controls:

The UITF PSS shall have no loss of safety function during facility operation[2].

Management and Surveillance:

- UITF PSS components shall be visibly labeled or tagged consistent with *ENG-AD-01-001 Conduct of Engineering Manual Section 5.2.6.1 Implementing Item Identification*.
- Interim changes to the PSS (hardware or software) are reviewed and approved in accordance with the *PSS Configuration Management Procedure* 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.
- The Safety Systems Group shall verify the status of the UITF PSS, along with the expiration date for the status determination, in the JAM before facility operation.

4.2.2. ODH System Controls

Applicability:

When required by the *ES&H Manual Chapter 6540 Oxygen Deficiency Hazard (ODH) Control Program* and an ODH Analysis document, a fixed ODH monitoring system shall be installed and maintained functional in UITF areas.

Controls:

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

Management and Surveillance:

- UITF ODH system components shall be visibly labeled or tagged consistent with *ENG-AD-01-001 Conduct of Engineering Manual Section 5.2.6.1 Implementing Item Identification*.
- The system shall be maintained such that it is operational when required by the ODH assessment for the location.
- ODH system shall be identified in accordance with *Labeling Procedure for PSS and ODH Equipment* and the status shall be reflected in the JAM.
- ODH sensing devices shall be tested every two years and the status shall be reflected in the JAM.

[2] Loss of safety function is considered to be failure of both independent interlock chains.

- The Safety Systems Group shall verify the status of ODH System Controls, along with the expiration date for the status determination, in the JAM before facility operation.

Acceptable Compensatory Measures:

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

4.3. Credited Administrative Controls

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

4.3.1. Doors, Gates, Fences, and other Barriers

Applicability:

- When beam delivery is possible.
- When SRF operations are possible.

Controls:

Entrances to the accelerator enclosure and other designated spaces shall be interlocked via the PSS Interlocks or shall be locked in accordance with *ES&H Manual Chapter 6111, Administrative Control Using Locks and Tags*, barred, or bolted into place to prevent unauthorized access.

Management and Surveillance:

- Doors, gates, fences, and other barriers serving as Credited Controls shall be clearly identified by visible labels or tags consistent with *ENG-AD-01-001 Conduct of Engineering Manual Section 5.2.6.1 Implementing Item Identification*.
- The RCM or designee shall verify the locked, barred, or bolted entrances in accordance with the *Radiation Protection Department Procedures* specified in *HPP-OPS-002, Performance of Periodic Routines* and *HPP-OPS-015, Shielding Package Determination and Tracking*. The status, along with the expiration date for the status determination, shall be recorded in the JAM before facility operation.

4.3.2. Lab Experimental Review Processes

Applicability:

When beam delivery to an approved nuclear physics experiment is possible in the UITF.

Controls:

- Any experiment that has completed the Proposal Phase (i.e. the experiment has a decision, formally communicated by the Physics Advisory Committee report and a letter from the Laboratory Director granting beam-time) will

undergo the remaining experimental review process steps as described in the *ES&H Manual Chapter 3120 The CEBAF Experiment Review Process* before the experiment is run using the UITF accelerator.

- A proposed experiment that will not undergo the experimental review process steps as described in the ES&H Manual Chapter 3120 described above shall follow the requirements in the *ES&H Manual Chapter 3130 Accelerator Experiment Safety Review Process*.
- If the experiment is not addressed by either Chapters 3120 or 3130, it shall undergo a USI review.

4.3.3. Staffing – Sweep and Operations

Applicability:

When UITF PSS is being made ready for PSS state above Open Access.

Controls:

One Qualified UITF Operator within UITF.

Management and Surveillance:

- UITF Operators must have current UITF Operator Training, SAF162.
- Trained UITF staff carry out UITF Sweeps follow the steps defined in the specific sweep procedure maintained by the Safety System Group.

4.3.4 UITF Staffing – Beam On or RF Only Operations

Applicability:

When UITF PSS is being made ready for PSS state above Open Access.

Controls:

One Qualified UITF Operator within UITF.

Management and Surveillance:

UITF Operators must have current UITF Operator Training, SAF162.

DOCUMENT LIST (Alphabetical Order)

Accelerator Division Controls Software Group User Account/Usage Policy
Accelerator Safety Envelope (ASE)
Accelerator Safety Envelope Violation/Unreviewed Safety Issue Review Process
Beam Containment and Access Control Policy
Conduct of Engineering Manual ENG-AD-01-001 Section 5.2.6.1 Implementing Item Identification
Department of Energy (DOE) Order 420.2 Safety of Accelerators
ES&H Manual Chapter 3120, The CEBAF Experiment Review Process
ES&H Manual Chapter 3130, Accelerator Experiment Safety Review Process
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 (ODH) Control Program
Jefferson Lab Safety Assessment Document
Labeling Procedure for PSS and ODH Equipment
PSS Configuration Management Procedure
Radiation Control Department Procedures - HPP-OPS-002, Performance of Periodic Routines
Radiation Control Department Procedures - HPP-OPS-015, Shielding Package Determination and Tracking
Shielding Policy for Ionizing Radiation (RCD-POL-14-001)
Site-Wide Cyber Security Program
UITF Operations Directives (UOD)

ACRONYMS

Acronym	Definition	Page
ES&H	Environment, Safety, and Health	II
ASE	Accelerator Safety Envelope	1
CAIS	Condition Assessment Information System	4
DOE	Department of Energy	1
ITS	Injector Test Stand	1
Jefferson Lab	Thomas Jefferson National Accelerator Facility	1
SAD	Safety Assessment Document	1
SCMB	Safety Configuration Management Board	1
TJSO	Thomas Jefferson Site Office	1
UITF	Upgraded Injector Test Facility	1
UOD	UITF Operations Directives	1
PSS	Personnel Safety System	2
USI	Un-reviewed Safety Issue	2
RCD	Radiation Control Department	3
RCM	Radiation Control Manager	3
FM&L	Facilities Management and Logistics	4
JAM	Jefferson Lab Authorization Manager	4