UITF Operations Directives

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Jefferson Lab

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Preface

This document, the Upgraded Injector Test Facility (UITF) Operations Directives (UOD), provides directives for operation and maintenance of Thomas Jefferson National Accelerator Facility's (Jefferson Lab's) UITF.

The UITF is a **TEST** facility for R&D in accelerators, detectors for experimental nuclear and particle physics and experiments which can use the facility's electron beam.

The UITF Facility Manager has the authority and responsibility to authorize who can operate UITF. Operation in this context means any powering of UITF components which can or have the potential to generate radiation (HV, Lasers, RF and electron beam). *No one shall be authorized to operate the accelerator at the UITF unless they have read and concur with the UOD and have received such hands-on training as required by the UITF Facility Manager for their activity.*

As a Test Facility, UITF does not require Continuous Electron Beam Accelerator Facility (CEBAF)/ Low Energy Recirculator Facility (LERF) type Operators and SSOs.

This document consists of the following sections. Each chapter describes the personnel and their responsibilities for UITF operations and the applicable directives.

Chapter 1: Program Control
Describes how safety is integrated into execution of the UITF program and establishes how the program is defined and executed.

Chapter 2: Configuration Management
Outlines how configuration management standards and work practices are applied as part of UITF operations.

Chapter 3: UITF Operations
Specifies directives for how the UITF program is carried out, including the safety responsibilities of the control room staff and the role of safety organizations.

Chapter 4: Maintenance & Tracking
Describes the planning, scheduling, and coordinating of maintenance activities to maintain and improve UITF availability.

Appendix A: UOD Release Memo
The memo used to release the UOD, including the associated change summary and review cycle.

This document has been approved by:

Bernard Matthew Poelker
UITF Facility Manager

Date: March 13, 2019

Acronyms & Abbreviations

ARM	Assigned Radiation Monitor
BCM	Beam Current Monitor
BLM	Beam Loss Monitor
BPM	Beam Position Monitor
CARM	Controlled Area Radiation Monitor
CEBAF	Continuous Electron Beam Accelerator Facility
CTF	Cryogenic Test Facility
CIS	Center for Injectors and Sources
COO	Conduct of Operations document
DOE	Department of Energy
DSO	Division Safety Officer
EPICS	Experimental Physics and Industrial Control System
ERR	Experimental Readiness Review
ESAD	Experiment Safety Assessment Document
ESH&Q	Environment, Safety, Health and Quality
FSD	Fast Shutdown
IOC	Input/Output Controller
ISM	Integrated Safety Management
JLab	Thomas Jefferson National Accelerator Facility (Jefferson Lab)
PI	Principal Investigator
LERF	Low Energy Recirculator Facility
LOSP	Laser Operational Safety Procedure
LPSS	Laser Personnel Safety System
MPS	Machine Protection System
ODH	Oxygen Deficiency Hazard
OSP	Operational Safety Procedure
OPS-PR	Operations Problem Report
PSS	Personnel Safety System
QCM	Quarter cryomodule
RCD	Radiation Control Department
RF	Radio Frequency

RSAD	Radiation Safety Assessment Document
RWP	Radiation Work Permit
SRF	Superconducting Radio Frequency
TOSP	Temporary Operational Safety Procedure
UED	UITF Element Database
UITF	Upgraded Injector Test Facility
UOD	UITF Operations Directives
USI	Unreviewed Safety Issue

1 Program Control

The Accelerator Division develops, controls and manages the UITF program. This chapter describes how safety and work planning are integrated into UITF program development and execution, how the program is authorized, and the roles and responsibilities of personnel involved in defining, conducting, and scheduling the program.

1.1 Program Safety

All facets of UITF program planning and execution integrate safety as defined in the *JLab Integrated Safety Management System Program Description*.

The JLab safety program establishes Integrated Safety Management (ISM) practices that guide worker actions, from the development of safety directives to work performance. Below are seven ISM guiding principles. Refer to *JLab Integrated Safety Management System Program Description* for additional information.

1. Line management responsibility for safety
2. Clear roles and responsibilities
3. Competence commensurate with responsibilities
4. Balanced priorities
5. Identification of safety standards and requirements
6. Hazard controls tailored to work being performed
7. Operations authorization

It is JLab's policy not to compromise safety and health of personnel and environment regardless of the urgency or importance of any activity. All JLab employees, subcontractors, and users have the power to stop any work that endangers people, the environment, property, or quality without any fear of reprisal. *ES&H Manual, Section 3330, Stop-Work and Re-Start for Safety Program* documents this 'stop work policy'.

In addition to the seven guiding principles, there are five core safety management functions to ensure the safety of workers, the public and the environment. These are:

1. Define the scope of work
2. Analyze the hazards
3. Develop and implement controls
4. Perform work within controls
5. Provide feedback for continuous improvement

A structured framework of administrative tools, policies, and procedures guide the safety and consistency of UITF's program planning and execution. ISM principles and the policies established in the *ES&H Manual* and guide scheduled and unscheduled maintenance activities at UITF as described in Chapter 4 of this document.

1.1.1 Program Scope

There are two broadly definable programs at UITF. These are:

i) Accelerator related programs, e.g. improvements to the Lab's injectors for stringent beam control for parity experiments, testing accelerator components such as the quarter cryomodule (QCM), beam diagnostic equipment and testing concepts for future accelerators such as JLEIC and

ii) Nuclear Physics related programs, e.g. testing and preparing equipment for nuclear physics experiments such as the HDIce target, executing experiments that can be done with a 10 MeV electron beam, such as the bubble chamber experiment and testing detectors for nuclear physics experiments.

UITF is primarily a ***test facility*** used to evaluate critical components intended for use at the CEBAF accelerator and experiment halls. But there is also the possibility that UITF will be operated as a ***user facility***, to conduct physics experiments or to evaluate techniques or equipment not intended for use at CEBAF. Regardless of the task, the UITF program follows a structured evaluation process commensurate with the complexity of the activity.

Nuclear Physics experiments and major test installations such as HDIce follow the traditional path of a typical physics experiment. Figure 1 illustrates the process. The path for other activities depends on the scale, with small scale (< 2 FTE weeks) tests requiring only the approval of UITF facility manager and the Accelerator Division Department Head.

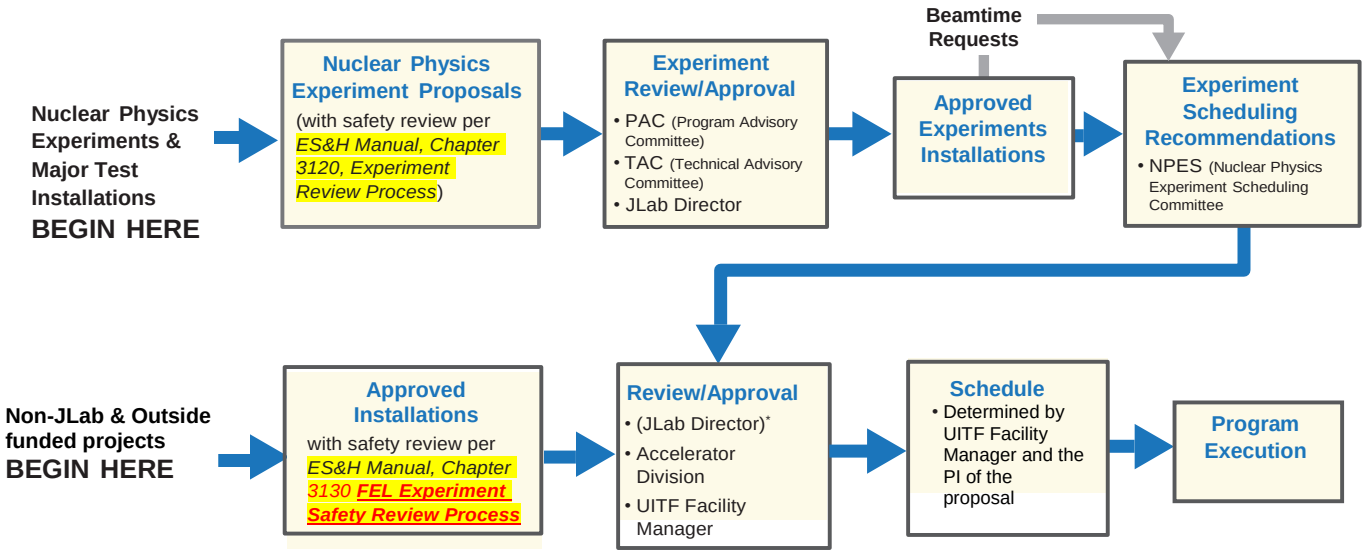

Figure 1: Approval/Scheduling Process for Nuclear Physics experiments and test installations at UITF

(*) Projects whose requirements impact lab resources, as determined by the Associate Director of the Accelerator Division and the UITF Facility Manager, will require JLab Director's approval

1.1.1.1 Nuclear Physics Experiment Proposals

Groups of collaborating experimenters submit experiment proposals to the Program Advisory Committee (PAC) (see Figure 1). The PAC, which consists of distinguished members of the worldwide physics community who are not JLab employees, reviews all experiment proposals, judging the scientific merit, technical feasibility, and the manpower requirements before making a recommendation to the Jefferson Lab Director. Each experiment proposal is also reviewed for its effect on the environment, safety, and health using the review process defined in the *ES&H Manual, 3120 Experiment Review Process*. A second committee, the Technical Advisory Committee (TAC), also evaluates each experiment proposal and makes a recommendation to the Jefferson Lab Director based on the technical aspects of the proposal. The Jefferson Lab Director makes the decision to grant beam time.

Approved experiments can make formal beamtime requests using the standard *Beam Request* form and the *Radiation Budget* form. These forms are submitted to the Nuclear Physics Experiment Scheduling Committee (NPES) for consideration, along with a one-page summary of the scientific goals of the experiment. NPES, which consists of key JLab employees appointed by the Jefferson Lab Director, meets at least twice per year to consider beamtime requests. NPES takes into account a wide range of factors such as budget and manpower constraints, UITF performance capabilities, experiment staging space requirements and radiation budgets required to meet program goals.

1.1.1.2 Major Test Installations for approved Experiment Proposals

Major test installations, e.g. HDIce follow the Physics Division's process for conducting the tests. These may include an ESAD, RSAD, COO and ERR. This process is defined in the ES&H Manual, 3120 Experiment Review Process.

1.1.1.3 Outside-Funded Experiment Proposals

Experiments with outside funding, normally tests of equipment with electron beam, will be considered for approval by Jefferson Lab Director, the Associate Director for Accelerators and the UITF Facility Manager. Each proposal is reviewed for its effect on the environment, safety, and health using the review process consistent with ES&H Manual, 3130 FEL Experiment Safety Review Process. The UITF Facility Manager will schedule approved experiments in consultation with the Lead Scientist of the project and the Lab leadership.

1.1.1.4 JLab activities at UITF

The present UITF Facility Manager is also the Department Head for the Center for Injectors and Sources. The UITF Facility Manager, aka the CIS director, has the authority and responsibility for the scheduling and executing JLab-focused activities.

1.1.1.5 Program Development for non-JLab activities at UITF

The UITF Facility Manager appoints a coordinator for each approved non-JLab specific project. The UITF Facility Manager will liaise with project PIs to develop overall and shift-by-shift run plans.

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1.1.2 Program Hazard Analysis

The potential hazards associated with executing the UITF program are analyzed as two distinct segments:

1.) The hazards associated with operating the UITF, and

2.) The hazards associated with each non-JLab activity that will use the UITF beam.

Physics installations and installations of non-JLab staff that use the UITF beam will follow the Physics Division processes for hazard analyses and experimental readiness reviews outlined in *ES&H Manual, 3120 Experiment Review Process*. For all other activities, UITF Facility Manager has the authority and responsibility to require hazard analyses and mitigations measures and safety reviews.

1.1.2.1 UITF Hazard Analysis

As required by *DOE Order 420.2C, Safety of Accelerator Facilities*, two documents address the hazards associated with UITF operations: the *JLab Final Safety Assessment Document* (FSAD) and the *JLab Accelerator Safety Envelope* (ASE). Laser safety is addressed by the *ES&H Manual, Section 6410, Laser Safety Program.*

JLab Final Safety Assessment Document (FSAD) – The FSAD analyzes and identifies hazards and associated on-site and off-site impact to workers, the public, and the environment from normal accelerator operations and credible accidents. The FSAD provides descriptions of engineered controls (e.g., interlocks and physical barriers) and administrative measures (e.g., training and documentation) used to eliminate, control, or mitigate the hazards from accelerator operation.

The Department of Energy (DOE) has designated JLab as a “Low-hazard, Non-Nuclear Accelerator Facility.” This designation means that the hazards at Jefferson Lab have the potential for no more than minor on-site and negligible off-site impacts to people or the environment.

UITF **Accelerator Safety Envelope (ASE)** – The ASE defines the physical and administrative bounding conditions for safe operations based on the safety analysis documented in the FSAD. When operations are performed within the boundaries of the ASE, the facility staff, facility users, general public, and environment are protected. Variations beyond the boundaries of the ASE are treated as reportable occurrences and are reported using the process defined in the *ES&H Manual, Section 5300, Occurrence Reporting to Department of Energy (DOE)*.

Laser Safety – The *ES&H Manual, Section 6410, Laser Safety Program* addresses mitigation of the hazards associated with operating the UITF.

1.1.2.2 UITF operation is support of Physics Division activities

Each Nuclear Physics experiment and major installation must follow the experiment review process defined by the Physics Division. This process, outlined in *ES&H Manual, 3120 Experiment Review Process*, specifies that an Experiment Safety Assessment Document (ESAD) and a Conduct of Operations document (COO) must be approved and in place before beam delivery. The ESAD addresses safety issues and activities for the experiment, while the COO describes the operational parameters for the experiment (e.g., duration, beam energy, beam current) and any required configuration changes to hardware or software. These two documents work together to address and communicate safety and operational information unique to each specific experiment

1.1.3 Unreviewed Safety Issues

An Unreviewed Safety Issue (USI) is a safety issue that presents a significant safety risk and was not previously identified, analyzed, and already mitigated as documented in the FSAD. The word "unreviewed" in the term USI does *not necessarily* mean that hazards and controls were not properly reviewed; rather, it refers to hazards associated with a particular configuration or activity that may be new or different than those previously identified, analyzed, and mitigated as documented in the FSAD. A USI can result from either of the following:

- Discovery of a potential hazard that may not have been fully addressed in the development of the FSAD and ASE, including the discovery of errors or omissions in the hazard analysis.
- A proposed accelerator configuration or operational change that is beyond the scope of the hazard analysis in the FSAD.

It is important to note that the USI process does NOT apply to standard industrial hazards, unless the hazard could directly impact accelerator safety.

If a USI is suspected, either as the result of a proposed modification or due to unexpected circumstances, then the JLab *Unreviewed Safety Issue (USI) Procedure* (https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-16644/USI%20Procedure.doc) is followed. The form used to report a safety concern as a potential USI, the Safety Concern Form, can be found at https://jlabdoc.jlab.org/docushare/dsweb/Services/Document-17393. If an activity is *potentially* outside of either the analysis or the set of controls documented in the FSAD, then the review process is performed. All personnel must immediately report any potential USI to their supervisor, the owner of the affected system, and the Accelerator Division Safety Officer. If a significant safety hazard is suspected, the supervisor ensures the immediate termination of the suspect activity and follows the notification sequence described in the *Unreviewed Safety Issue (USI) Procedure*.

1.1.4 Program Hazard Controls

1.1.4.1 Credited Controls

The UITF program is conducted using credited controls to eliminate, control, or mitigate the identified hazards. The Credited Controls identified in the ASE must be in-place and functional before beam is delivered in the UITF and must remain functional during beam delivery. Credited controls are described in brief in the following paragraphs. A credited control is determined through hazard evaluation to be essential for safe operation directly related to the protection of personnel or the environment. Credited controls are assigned a higher degree of operational assurance than other controls. If a credited control is altered in any way, the

Unreviewed Safety Issue (USI) Procedure must be followed.

Credited controls used during UITF operations fall into two categories: engineered controls and administrative controls. Engineered controls are identified as either active or passive controls while administrative controls are usually passive. FSAD Revision 8, Table 20 – Basis for UITF ASE, lists the credited controls for UITF operations are as follows:

- **1. Credited Passive Engineered Controls**
  1.1 Permanent Shielding
  1.2 Movable Shielding
  1.3 Nitrogen Gas Supply Orifices
  1.4 ODH Vents, Lintels and Facility Configuration

- **2. Credited Active Engineered Controls**
  2.1 PSS Access Controls
  2.2 PSS Beam Containment Controls
  2.3 ODH Systems Controls

  3. Credited Administrative Controls
  3.1 Doors, Gates, Fences, and other Barriers
  3.2 Lab Experimental Review Process
  3.3 UITF Staffing – Sweep
  3.4 UITF Staffing - Operations

1.1.4.2 Additional Safety Controls

While the credited controls specified by the FSAD address worker safety, public safety, and environmental safety, UITF Operations uses other additional safety controls to provide an added safety margin and to help protect against property damage (i.e., damage to accelerator components) arising from accelerator operations.
These controls provide additional layers of protection to mitigate potential problems before the credited controls even come into play. Examples of these additional safety controls are as follows:

- **Machine Protection System (MPS)** – An active engineered system designed to turn off the beam whenever an off-normal condition is detected and before significant damage to accelerator components can occur or a credited control threshold is reached. There are a variety of inputs to this fast shutdown system such as vacuum valves, RF systems, beam loss monitors, water flow monitors, beamline apertures, window comparators for critical devices like photogun high voltage and dipole magnets, beam current monitors, beam dumps, and target motion devices.
- **Rapid Access System** – There are two gamma radiation probes inside the UITF enclosure used to monitor the presence of ionizing radiation, with the control chassis located inside the UITF control room. The control chassis emits an audible warning when ionizing radiation is detected. These probes provide assurance that is safe to enter the UITF enclosure after operating the UITF as an accelerator. These probes are not part of the UITF PSS.

- **UITF-Specific Operational Safety Procedures (OSPs) and Temporary Operational Safety Procedures (TOSPs)** – OSPs and TOSPs are developed when a task involves unusual safety hazards that are not fully addressed in the *ES&H Manual* or where the hazard has unique operational features such as tasks involving multiple work groups (see *ES&H Manual, Section 3310, Standard Operating Procedures and Operational Safety Procedures*). Copies of specific OSPs and TOSPs that pertain to UITF accelerator operations are maintained in a binder in the UITF Control Room and on the CIS-wiki page "UITF Safety Documents:: https://wiki.jlab.org/ciswiki/index.php/UITF_Safety_Documents. These documents are reviewed by all UITF Operators.
- **Laser Operational Safety Procedures (LOSPs)** – As specified by the *ES&H Manual, Section 6410, Laser Safety Program*, each Class 3B or Class 4 laser must have an associated LOSP that covers the piece of equipment and the area where it is located.
- **Channel Access Security** – An active engineered system that establishes a security protocol limiting the ability of individuals to access electronic process variables used to control the accelerator.

1.1.5 Program Execution Within Controls

As a Test Facility, UITF does not routinely operate 24/7. Most of the operations take place during work hours and occasionally may extend a few hours past the normal work hours. All UITF operations are conducted by CIS and Operations staff under the authority of the UITF Facility Manager. Subject Matter Experts may perform specific tasks at UITF with permission from the UITF Facility Manager, for example, application of RF to the QCM, buncher cavities and chopper cavities.

Activities performed by staff outside CIS and the Operations Department, such as testing equipment either for Physics experiments or for accelerator systems, adhere to the following regulations.

- **Training and Qualification** – The staff operating UITF are authorized by UITF Facility Manager to operate the facility. UITF Facility Manager will appoint a UITF Work Coordinator.
- **Pre-shift Preparedness** – The coordinator and the crew will have an Operational Plan for the Day,
- **UITF Logbook**: All pertinent operations will be recorded in the UITF logbook.
- **Test procedures**: The UITF Principle Investigator, the UITF Work Coordinator, and/or UITF Facility Manager will work together to ensure that all documents such as OSPs and TOSPs are in place and are readily available.

1.1.6 Program Feedback and Continuous Improvement

Feedback and continuous improvement are integrated throughout the process of developing and then executing the UITF program. A variety of communication tools provide opportunities for specific lessons learned and general feedback to flow back into the system, resulting in improvements based on experience. Some feedback channels provide information that can be used immediately, while others gather data that can be used later for trend analysis and future planning.

Examples of feedback and continuous improvement tools used during program development and execution are as follows:

- **UITFLog** – As a time-based repository for information associated with program execution, the *UITFLog* provides a way to document events and can also be searched and sorted for useful information by system experts and other JLab employees with password privileges. Log entries can also be sorted by type, which includes downtime, tune, and OPS-PR entries.
- **UITFList –** similar to the Accelerator Task List (*ATLis*) used at CEBAF, *UITFList* is a web-based work planning tool where maintenance and project tasks are electronically submitted, approved, and then scheduled. Task descriptions submitted via *UITFList* provide the required supporting information, including task details, the potential impact to accelerator operations, task hazard identification and a hazard mitigation plan, a backout plan, and supporting documentation as attachments. Once submitted, a task is automatically routed via email to the appropriate parties for comment and approval. After approval, the task waits in the pending queue until the work is scheduled by the UITF Facility Manager. Although work is scheduled by the UITF Facility Manager, individual work tasks are authorized by the line manager for the staff conducting the

work. Following completion, the task and any appended comments remain in the database to provide work history and lessons learned information.

- **Operations Problem Reports (OPS-PR)** – The OPS-PR system provides system owners with specific information about system failures and a mechanism for communicating when the problems are fixed and how they were repaired. The resulting data can be used for trend analysis.
- **Off-Normal Operation and Events** – Off-normal operation and off-normal events should be logged to *UITFLog* and reported to the UITF Facility Manager. The UITF Facility Manager will consult with the Jefferson Lab Reporting Officer so that Off-Normal Events can be screened for reporting requirements to the DOE and for internal review using the Notable Event Investigation process identified in *ES&H Manual Section 5200, Event Investigation and Causal Analysis Process.*
- **Corrective Action Tracking System (CATS)** – The lab-wide CATS system tracks action items that arise from the various inspections, assessments, and audits.
- **DOE/JLab Hotlines/Web Sites** – Telephone hotline numbers for addressing issues such as waste, fraud, abuse, management, and safety concerns are posted on the DOE information bulletin board in the MCC. Such issues shall always be addressed first through the normal supervisory chain, but if results are unsatisfactory or there is fear of retribution, the hotlines provide other avenues of recourse.

1.2 Personnel and Responsibilities

The key personnel involved in defining, scheduling, authorizing the UITF program and planning for safe operations are described in the following section. Responsibilities of the other personnel are described in the appropriate committee charters and elsewhere. Responsibilities may be delegated to other responsible parties as appropriate.

1.2.1 UITF Facility Manager

The UITF Facility Manager provides UITF operations oversight, including participating in program development and scheduling, and authorizing beam operations. UITF Facility Manager responsibilities include the following:

- Authorizing who can operate UITF i.e. UITF Operator
- For non-JLab activities appoint a UITF Work Coordinator to liaise with the PI or the PI's Designee.
- Develop the UITF schedule for tests that span multiple days or multiple tests than can occur over the same time period
- Approve deviations from the UITF schedule.
- Authorize resumption of beam operations as appropriate following critical events such as Safety Envelope violations, Operations Envelope and Operational Restrictions violations, Personnel Safety System malfunctions, Machine Protection System malfunctions, and beam-strike events.
- Ensure the operating guidelines are current and communicated to authorized workers.
- Verify that all outside-funded experiments have completed the UITF Safety Review Process before scheduling beam time.
- Approves proposed tasks submitted via *UITFList*

1.2.2 UITF Work Coordinator

For non-JLab activities, the UITF Work Coordinator works with the PI or PI's designee and with a variety of internal stakeholders and outside entities to ensure that the UITF facility best accommodates potential users and the operating program is well defined and supported with appropriate resources. Serve as the designated spokesman for the facility.

- Meet with representatives of potential outside-funded experiments to determine if their requirements are in line with the capabilities of the facility and help move appropriate experiments through the approval and scheduling process.
- Refer to the Radiation Control Department for special review any potential outside-funded experiment with requirements that fall outside the normal facility operating envelope.
- Present the appropriate safety documents for potential experiments to the Division Safety Officer (DSO) prior to the Experiment Review Process.

1.2.3 Experiment Principal Investigator

Each proposed Nuclear Physics Experiment and non-JLab activity at UITF is required to have an associated Principal Investigator (PI), who supplies all of activity-specific information necessary for any design and safety review process. The PI could be a lab employee or a non-JLab person. The PI's responsibilities

are as follows:

- Work with the UITF Work Coordinator to conduct a design and safety analysis of all experiment equipment and proposed operating conditions.
- Work with the UITF Work Coordinator to guide the experiment through all phases of the readiness and safety review process, including primary responsibility for completion of the steps defined in *ES&H Manual, 3120 Experiment Review Process* (for nuclear physics experiments) and *ES&H Manual, Section 3130, FEL Experiment Safety Review Process* (for non-JLab activities). This includes preparing and submitting the final ESAD and COO for the experiment.
- Work with the UITF Work Coordinator to safely install any new experiment equipment.
- At the conclusion of the experiment organize the decommissioning of any equipment that is to be removed and arrange for removal.

UED Administrator

UED Administrator reviews the proposed changes to verify that they are valid and also runs audit software that determines if the information meets UED requirements. If problems are identified, the UED Administrator notifies the person who submitted the proposed changes and discusses how to correct the issues. After all criteria are met, the UED Administrator releases the changes to the UED production database and stakeholders are notified.

1.3 Program Schedules

1.3.1 UITF Activities Schedule

These activities are scheduled by the UITF Facility Manager or his designee.

1.3.2 Non-JLab Activities Schedule

These activities are scheduled by the UITF Facility Manager and the PI of the experiment or major installation.

1.3.3 Shift-by-Shift Schedule

For JLab activities, these are determined by the UITF Facilities Director in consultation with the CIS and Operations staff. For non-JLab activities, the UITF Facilities Manager, the UITF Work Coordinator and the experiment PI will meet and determine the shift-by-shift schedule. The shift plan must be entered in the UITF Logbook.

2 Configuration Management

According to DOE-STD-1073, *DOE Standard, Configuration Management*, the basic objectives of a configuration management system are to

- establish consistency among design requirements, physical configuration, and documentation, and
- maintain this consistency for the life of the facility, especially when changes are made.

Configuration management standards and work practices are already in place for the systems and equipment that make up the UITF facility. These standards, which are maintained by the specific organizations, also apply to new systems that are designed, fabricated, and then installed in the accelerator. Successful operation of UITF, however, requires a single, definitive, up-to-date source of operating information for beamline elements. This central repository for the accelerator is the UITF Element Database (UED), which serves as the information source for such tools as model-driven accelerator setup, on-demand control screens, and element-by-element hot checkout.

Consistency between the installed equipment configuration and the information contained in the UED is critical, making appropriate application of configuration management principles of paramount importance for accelerator operations.

2.1 The UITF Element Database (UED)

The UED is the central element-specific information repository used to operate UITF. All beamline elements that affect beam operations are included in the database, with the information for each type of element tailored to match the specific function. Operations-critical tools pull element information from the database, relying on the UED as the single, authoritative source for operating information. With the UED as the central information repository, changes ripple immediately through all tools whenever an element in the UED is updated or a new element is added. From a configuration management perspective, the UED is key for establishing and maintaining consistency between the physical accelerator configuration and the tools used to operate it

2.1.1 The UED Revision Process

A well-defined revision control process is critical for maintaining the integrity of the UED. This includes defining roles and responsibilities and providing appropriate communication tools. Figure 2, below, provides an overview of the process.

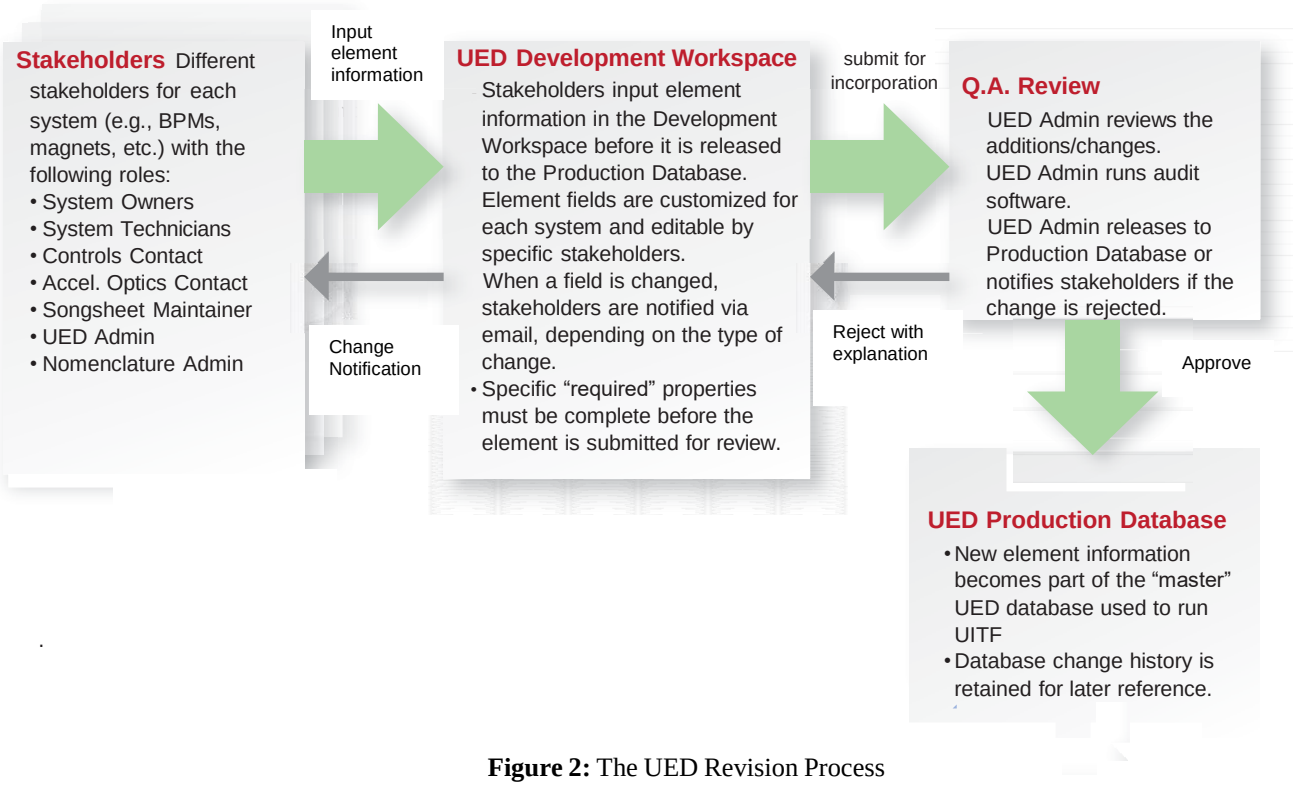


Figure 2: The UED Revision Process

2.1.2 Project Stakeholders

Elements in the UED are organized by system (e.g., BPMs, magnets, RF, vacuum), and each system has a different group of stakeholders. The various stakeholders are listed in Figure 2. Each UED element has a set of associated fields, and each field has assigned write privileges, so that stakeholders can contribute their portion of the information. Specific "required" fields are assigned only to the Project Lead. The Nomenclature Administrator has the final say with regard to element names. Others contribute various information, depending on the type of system and element. An UED Administrator helps facilitate the process and maintain UED standards.

An important by-product of the UED revision process is improved communication between stakeholders. As element changes are made, the various stakeholders are notified, providing them with information that can be used in their planning process.

2.1.3 The UED Development Workspace

System Stakeholders prepare updates or new elements in a development workspace; they do not directly edit the production UED production database. Within that workspace, each element can have a variety of fields that are editable by specific stakeholders. Each element has "required" fields that must be completed before the element is submitted for incorporation in the production database. However, during the development phase, the workspace can be quite freeform, allowing stakeholders to add and remove fields and even proceed without a final element designator. As element field changes are made, automatic notifications are sent, depending on the type of change. After the information in the development workspace is complete, a request to merge the information with the production database is made, and the request is considered by a UED Administrator.

2.1.4 UED Quality Assurance Review

Before changes are merged from the development workspace into the production database, an UED Administrator reviews the proposed changes to verify that they are valid and also runs audit software that determines if the information meets UED requirements. If problems are identified, the UED Administrator notifies the person who submitted the proposed changes and discusses how to correct the issues. After all criteria are met, the UED Administrator releases the changes to the UED production database and stakeholders are notified. This review process ensures the integrity of the element data contained in the UED production database.

3 UITF Operations

UITF operations refers to the activities associated with operating the UITF. This chapter describes the roles and responsibilities of the operating staff and others involved with UITF program execution, provides protocol for critical event response, and lists directives that govern specific aspects of the conduct of operations.

3.1 UITF Operations Overview

UITF operations are conducted from the UITF Control Room by authorized staff. The UITF Operator controls and monitors the UITF beam acceleration systems. Other qualified individuals can be granted access to the control system (i.e., "channel access") but must be in the presence of a UITF Operator when making control system changes that will affect the electron beam delivery.

Critical event response for the UITF, is directed by the UITF Facility Manager.

3.2 Personnel and Responsibilities

The personnel involved in UITF operations include the UITF Operator and support staff.

3.2.1 Control Room Personnel and Responsibilities

3.2.1.1 UITF Operator

The UITF operator is responsible for UITF program execution. The UITF Operator controls and monitors the UITF to deliver the beam required for the scheduled UITF programs.

- Be aware at all times of the PSS status of the UITF.
- Ensure that the UITF is operated in accordance with the requirements outlined in the ASE.
- Verify that, before leaving the UITF in the Beam OFF state, the PSS state for the UITF is changed to OPEN state and the Rapid Access System indicates no radiation.
- Read and understand all approved UITF-specific OSPs and TOSPs.
- Know the intended delivery points for all UITF beams and the approximate average beam currents and beam energies.
- Request that the Radiation Control Department conduct a radiation survey of the UITF beamline after operating the UITF accelerator under new conditions, e.g., at higher beam energy and/or beam current
- Ensure that FSD masking is properly configured to protect UITF accelerator and experiment-specific components.
- Control or directly supervise the operation of devices that interface to the UITF PSS such as gun high-voltage controls and high power RF systems.
- Ensure that the appropriate Machine Protection Systems (MPS) are used during beam operations.
- Understand and respond appropriately to all PSS, LPSS, and MPS faults.
- Using the procedures specified in the UITF Sweep Procedure, search and secure the UITF beam enclosure before electron beam operation.
- Close any UITF-related Operations Problem Reports (OPS-PRs)

Program coordination:

- Coordinate the activities of the PI or PI's designee.
- Understand all responsibilities specified in this document, the *UITF Operations Directives*.
- Understand the UITF-specific information in the shift plan.
- Read and understand the experiment-specific information.

Program execution:

- Open channel access as needed for qualified individuals.
- Read all UITF beam plans listed in the Shift Plan
- Monitor beam quality to ensure that the beam specifications meet the program goals.
- Monitor the performance of operating accelerator systems.
- Measure and adjust accelerator and electron beam parameters according to approved procedures to optimize performance.
- In case of critical system failure, bring UITF to OPEN State.

3.2.1.2 UITF Rapid Access System

The UITF includes a "rapid access" radiation monitoring system, composed of two gamma probes and a neutron probe. These devices produce an audible alarm inside the UITF control room. The absence of an alarm indicates it is safe to enter the UITF enclosure when the PSS state is set to OPEN. These devices are not part of the PSS. The UITF Operator will contact the Radiation Control Department when alarms are present.

Because the beam energy at UITF is low (10 MeV or less), equipment is not expected to become activated, but the Radiation Control Department will survey the beamline after operating the UITF accelerator under new conditions, e.g., higher energy and/or beam current.

3.3 Critical Event Response

The nature of critical events can vary widely. The basic responses to the most common critical events are described or referenced in the following sections.

3.3.1 Safety Envelope Violations

If the Safety Envelope is violated during UITF operations, beam must be terminated and the investigation process followed as specified in the *ES&H Manual, Section 5200, Event Investigation and Causal Analysis Process.* The AD of Accelerators, the UITF Facility Manager, the Safety System Group Leader, and the Accelerator Division Safety Officer (DSO) must be notified as soon as possible.

Beam operations shall not resume until the AD of Accelerators gives direct approval.

3.3.2 Operational Restriction Violations

The Operational Restrictions establish the thresholds for UITF operation, including beam current maximums, beam dump power limitations, and experiment target limits. Variations outside of the Operational Restrictions require specific administrative action as described below.

If an Operational Restriction violation occurs, beam must be terminated and the AD of Accelerators, the UITF Facility Manager, and the Safety System Group Leader (for PSS-related violations) must be notified immediately. Beam operations shall not resume until the AD of Accelerators gives direct approval.

3.3.3 Personnel Safety System (PSS) Malfunctions

The PSS is designed to protect personnel during UITF operations. If, during operations, a malfunction of the PSS is perceived, beam delivery shall be terminated immediately. The UITF Operator shall report the perceived malfunction to the Safety System Group Leader for resolution.

If, on investigation, the Safety System Group Leader determines that the PSS operated as designed and such operation does not pose a previously undetected personnel hazard, then beam operations may resume after direct approval is given by the UITF Facility Manager.

If the Safety System Group Leader determines that a previously unidentified hazard exists, the USI process must be followed.

If the Safety System Group Leader determines that the PSS did not function correctly, the occurrence reporting process described in the Safety Envelope Violations section 3.3.1 of UOD shall be followed.

3.3.4 Machine Protection System (MPS) Malfunctions

The Machine Protection System (MPS) is a hardware-based system used to shut off the electron beam in cases where sustained beam, or energy directly related to the electron beam, could damage components. MPS inputs include variables such as beam loss and superconducting cavity arcs or quenches. The backbone of the MPS system is the Fast Shutdown system (FSD), which has the ability to shut off the beam from anywhere in the UITF in less than 40 µs. MPS subsystems include beam loss monitors (BLMs), pressure monitoring along the beamline via ion pump power supplies, and cooling waterflow meters.

If, during accelerator operations, a malfunction of the MPS is observed or perceived, beam delivery in the affected segment shall cease immediately, and the UITF Operator must report the observed or perceived malfunction for resolution to the appropriate UITF or JLab staff member. Beam operations shall not resume until the system is repaired and verified and direct approval is given the UITF Facility Manager.

3.3.5 Electron-Beam-Strike Events

Although the MPS is designed to minimize the potential for beam-related and laser-related equipment damage, such events can still occur.

- An acute loss of beamline vacuum can be caused by an electron beam strike. Vacuum loss is considered to be acute whenever supplemental vacuum pumping equipment is required to restore beamline vacuum.
- Physical damage to beamline components has been caused by a beam strike. This includes physical damage to components such as beam pipe, beam dumps, magnets, BPMs, targets, and insertable devices like harps and viewers. Radiation damage to components such as viewer cameras is not considered to be caused by beam strike.

If a beam strike event occurs, the beam shall immediately be turned off (if not already off) and the appropriate staff notified. Beam operations shall not resume until direct approval is given by the UITF Facility Manager.

3.3.6 Emergency Response

The UITF Operator assumes the role of Internal Incident Commander (IIC) until relieved. Emergency response guidance can be found at the JLab Emergency Management web page: https://www.jlab.org/eshq/emergmgt with a detailed list

of Emergency Response Procedures for specific topics listed below found at: http://opsntsrv.acc.jlab.org/ops_docs/MCC_web_interface/interface_pages/operating_procedures.asp:

- 911 call
- Bomb threat
- Fire
- Injury
- ODH alarm
- Power outage
- Radiation event
- Spill
- Weather emergency

Emergency response guidance is given in the UITF Safety Familiarization Training which outlines the principal hazards and mitigations in the UITF including the locations of alarm panels, emergency shutoff switches (including those for water flow and electrical power), Run Safe Boxes, fire extinguishers, Muster Points, etc. This training outlines appropriate actions during emergent situations that may occur in the UITF.

3.4 Directives

This section specifies directives that shall be followed by all UITF personnel and others engaged in the operation or oversight of components that are part of the UITF.

3.4.1 Control System Interaction

The UITF is operated using EPICS (Experimental Physics and Industrial Control System), an open-source computer interface that reads and writes to process variables, which remotely control accelerator system components. All UITF beam operations is conducted from computer terminal inside the UITF control room. A computer terminal above the control room, near the electronics racks, can be used for system commissioning and troubleshooting, via temporary channel access granted to system experts.

3.4.1.1 UITF Control System Access

The UITF Facility Manager provides authorization to manipulate UITF accelerator system process variables via EPICS to approved individuals (i.e., UITF Operators) through the use of the channel access security protocol. Approved UITF Operators can open UITF channel access to anyone with a valid operations computer system account for limited time periods.

During beam operations, channel access is generally closed to everybody except control room staff. The UITF Operator can use discretion to temporarily grant channel access to others so long as the activity will not affect ongoing electron beam transport.

During maintenance periods, channel access is generally opened to anyone with a valid operations computer system account.

3.4.1.2 UITF Operator Control System Interaction

Only qualified UITF Operators have unlimited channel access to all UITF process

variables at all times; however, these personnel must observe the following restrictions.

- Be approved by the UITF Facility Manager and added to the list of qualified UITF Operators.
- Be physically present in the UITF Control Room and working from a UITF computer console when making control system changes during beam operations.

3.4.1.3 Control System Interaction Affecting Beam Transport by Others

Personnel other than UITF Operators who, when beam is present in the UITF accelerator, need to make control system changes that will affect beam transport, must meet the following requirements.

NOTE: On occasion, those who are solving specific problems at the request of the UITF Operator may need access to the control system but may not meet the following criteria. They can be granted access for a limited time period under the direct supervision of the UITF Operator because they are solving a specific problem and not executing the UITF program.

- Be approved by the UITF Operator and added to the list of those qualified to have UITF channel access for areas where beam is being transported.
- Have explained to the UITF Operator, in advance, the anticipated changes and been given UITF Operator approval. The UITF Operator will open channel access as appropriate for the task.
- Be physically present in the same control room as the UITF Operator and working from a UITF computer console when making control system changes. A computer terminal above the control room, near the electronics racks, can be used for system commissioning and troubleshooting, via temporary channel access granted to system experts.

3.4.2 Shift Protocol

Shift protocol includes staffing requirements, shift schedules, and control room staff conduct.

3.4.2.1 Staffing Requirements for Operations

Table 3: Minimum Staffing Requirements for UITF Operations

NOTE: The paragraphs following this table provide information required to understand these staffing requirements.

UITF Operating Condition	UITF PSS State	Minimum Required Staffing
Beam OFF	*OPEN State*	None
Beam OFF	*SWEEP State*	Authorized UITF operator

Beam OFF • **Laser Shutters CLOSED & Locked out** • **MeV RF Controls OFF and Locked out.** • **Insertable Faraday Cup IN and Locked out** • **Beam Valve before CM CLOSED and Locked out**	*RUN State*	None
Beam ON	*RUN State*	Authorized UITF Operator

UITF has three PSS states: OPEN, SWEEP and RUN.

The staffing requirements shown in Table 3 address the possible UITF operating conditions; other constraints and conventions are as follows:

- Beam ON is defined as the UITF being in PSS *RUN State* and capable of sending MeV beam of any type.
- Beam OFF is defined whenever the UITF is in a safe condition that is incapable of delivering MeV beam of any type, as outlined in Table 3.
- Whenever UITF Operator changes occur for any reason, the oncoming staff member must receive a summary of the shift activities, receive task assignments from the off-going UITF Operator.

3.4.2.2 Shift-Turnover Meeting

Because it is a test facility, the need for a shift turnover meeting will be rare. The shift-turnover meetings are held at the end of each shift so that the off-going staff can transfer information to the oncoming staff.

The shift-turnover meetings are held in the UITF Control Room and usually last less than fifteen minutes.

3.4.3 Control Room Equipment

The UITF Control Room equipment consists of console equipment, fire alarm equipment, radiation-monitoring equipment, communications equipment, computer workstations, printers, video monitors.

3.4.4 Record Keeping

Accurate record keeping is an essential part of UITF operations and is required for both administrative and technical reasons. UITF operations record-keeping documents include the *UITFLog*. Requests for additional record keeping by the control room staff should be directed to the UITF Facility Manager.

The UITF Operator is responsible for on-shift record keeping. The UITF Operator must enter and review these records frequently to ensure that entries clearly and accurately describe shift activities.

3.4.4.1 UITFLog

The *UITFLog* is the sequential record of the events occurring during the operation of the UITF. All information must be entered promptly, since delays often lead to incomplete or inaccurate entries. All entries require the date, time and name of the person making the entry. The *UITFLog* is a computer based electronic log book which can be accessed from the ELOG home page.

3.4.4.2 Radiation Survey Log

Although activation of equipment is not expected at UITF because the maximum beam energy will be ~ 10 MeV, radiation surveys will be performed by the Radiation Control Department each time the UITF accelerator is operated at a higher beam energy or current, to identify areas where activation of beamline hardware may have occurred. The radiation survey sheet must be filled out in pen, signed, and dated by the Radiation Control Department staff member. The original survey sheet must be scanned, with the resulting image posted in the electronic *UITFLog* and *Radiation Survey Log* and the original survey sheet placed in the Radiation Survey binder inside the UITF Control Room, which contains a record of previous surveys. Any activation of equipment will require radiological work controls or access controls, with instructions from the Radiation Control Department conveyed to the UITF Facility Manager who is responsible for transmitting work restrictions to all effected personnel.

4 Maintenance & Tracking

Maintenance refers to work performed on the hardware or software of the UITF. Examples of UITF maintenance activities include:

- Making repairs after a failure
- Periodic replacement of high-wear parts
- Fixing inspection deficiencies
- Post-repair testing
- Calibration
- Alignment
- Equipment and software upgrades

As a test facility, the UITF maintenance tasks are expected to be carried out within the priorities for resources set by the laboratory management.

Any major installations may be performed either by JLab staff and/or subcontractors and require either cross-divisional coordination or extensive engineering effort in the planning and execution phases and during checkout.

4.1 Personnel and Responsibilities

For JLab-related tasks, maintenance of the UITF is the responsibility of UITF Facility Manager. Maintenance and project oversight for non-JLab tasks is a shared responsibility between the UITF Facility Manager and the project's PI. For these tasks, the UITF Work Coordinator handles day-to-day task scheduling and oversight. Maintenance and project activities for UITF are supported by the Jefferson Lab system support groups and subcontractors, who perform maintenance tasks for the UITF, LERF and CEBAF accelerators. Approved repairs are performed by authorized personnel.

4.1.1 UITF Work Coordinator

The UITF Work Coordinator responsibilities encompass the UITF facility and include coordination and scheduling of all maintenance and non-JLab installation activities.

UITF Work Coordinator responsibilities are as follows:

- Serve as the primary contact for work to be performed in the UITF.
- Coordinate and schedule the safe and efficient installation of equipment in the UITF, including new experiment equipment and UITF system modifications or upgrades to accommodate the non-JLab projects.
- Maintain equipment documentation and work control documents in a

central electronic repository.

- Participate in the demonstration and testing of new equipment and systems as they move from development to operational running.
- Lead focus meetings to address any potential or existing issues.

4.1.2 System Owners

System Owners oversee all aspects of a UITF system (e.g., SRF, RF, magnets, BPMs) to assure system performance in support of the scheduled program. System Owners should ensure that the element data contained in the UITF Element Database (UED) matches the existing system configuration, and incorporate any UED changes in a timely manner.

4.2 Directives

4.2.1 Safety Guidelines for Maintenance Activities

Maintenance and project tasks are performed within the guidelines established by the Jefferson Lab *ES&H Manual, Section 3000, Planning for Safe Operations.*

Work control documents associated with these tasks include, but are not limited to, Standard Operating Procedures (SOPs), Fire Hazard Work Permits, Confined Space Work Permits, Electrical Service Work Permits, and Radiological Work Permits. Prior to performing work, the *ES&H Manual, Section 3210, Work Planning, Control, and Authorization Process* must be followed in order to properly plan the work, identify and analyze risks, and gain the required authorization.

The *UITFList* Work Planning Tool, in Section 4.2.7 below, contains a Hazard Identification Worksheet that can provide a preliminary Task Hazard Analysis information an aid in identifying the associated risks while planning work.

If a hazard associated with a task is not addressed by the *ES&H Manual*, then the hazard is considered unusual, and specific written approval in the form of Operating Safety Procedures (OSPs) or Temporary Operating Safety Procedures (TOSPs) is required prior to beginning the work.

When planning or performing maintenance work, Unreviewed Safety Issues (USIs) that might arise from the work must be identified and reported. In general, the standard industrial hazards encountered during maintenance are addressed by the *ES&H Manual.* However, certain work may affect systems that act as credited controls used to mitigate the known hazards of UITF operations. Such work includes, but is not limited to the following:

- UITF modifications that are not replacement-in-kind activities.
- Change-out/replacement of safety equipment that is identified in the FSAD or ASE and not identical in form, fit, and function.
- Changes to the safety systems and equipment.

The *Unreviewed Safety Issue (USI) Procedure* provides additional guidance helpful in identifying USIs and specifies the steps required to address any USI.

4.2.5 Bypassing System Interlocks

Interlocks are present in many UITF systems and serve to protect personnel, equipment, or both. Interlocks constrain the operation of equipment in some fashion, either electronically or mechanically. Interlocks found in the UITF

typically rely on some type of electronic transducer, sensor, switch or physical mechanism to keep equipment from being placed in an unsafe state. It can be difficult to determine whether or not a specific item should, in fact, be considered an interlock. For example, a water valve is not an interlock, but an associated sensor that detects water flow, temperature, pressure, or valve position and constrains the operation of equipment *is* part of an interlock for that equipment.

From time to time it may be necessary to bypass a system interlock. Bypassing can be accomplished in a variety of ways, including installing a physical wire or jumper, modifying software, or making a change in one or more process variables or set points. Specific steps must be taken whenever an interlock is bypassed; however, these steps differ depending on whether the equipment remains in service or is physically disconnected from the accelerator (i.e., out-of-service). These two possibilities and the required steps are defined in the following sections. It should be noted that this directive does not apply to equipment associated with the Personnel Safety System, which is governed by a separate document, the *Jefferson Lab Personnel Safety System Configuration Control Policy.*

4.2.5.1 In-Service Equipment

Equipment is considered to be "in-service" when the physical, critical connections to the accelerator remain in place. In other words, the equipment remains in-service even if a switch (or switches) is thrown or a fuse is removed. Only actions like physically removing the equipment or disconnecting critical cabling change the status to "out-of-service".

When an interlock is bypassed on an in-service system, the person performing the bypass must ensure that an appropriate entry is made in the *UITF Logbook* and also apply a standard Interlock Bypassed tag when the interlock is bypassed. This tag must include the name of the person installing the bypass, the date, the purpose, the location of the jumper. Each bypass requires a separate tag, and the tag must be placed in a location that is obvious to anybody who would be removing the bypass.

There are two exceptions to this requirement.

- **Exception #1** – Bypasses made by changing a software process variable *do not* require an Interlock Bypassed tag. Examples are masking a fast shutdown (FSD) node or bypassing an ODH head through software.
- **Exception #2** – Bypasses made during repairs to correct conditions that impede the scheduled program.

4.2.5.2 Out-of-Service Equipment

Equipment is considered to be "out-of-service" when critical physical connections to the UITF have been removed. This is accomplished by, at a minimum, physically removing critical cabling that connects the system to the UITF. Equipment such as a box power supply may remain in place but be considered out-of-service after critical physical disconnects have been made. Equipment that has never been installed in the accelerator is also considered to be out-of-service.

Bypassed interlocks in out-of-service equipment must be identified by a tag. The person installing the bypass must fill out and apply a standard Interlock Bypassed tag when the interlock is bypassed. This tag must include the name of the person installing the bypass, the date, the purpose, and the location of the jumper (a serial number is not required for out-of-service equipment). The tag must remain attached to the equipment until the bypass is removed. Each bypass requires a

separate tag, and the tag must be placed in a location that is obvious to anybody installing the equipment.

4.2.6 OPS-PR Problem Reporting System

OPS-PR (Operations Problem Report) is an electronic tracking and reporting system for corrective action requests. OPS-PR entries are made using either the control screen interface or the web-based interface.

The OPS-PR initiator describes the problem and also selects from the lists of systems, groups, and regions to categorize the problem. For some common problems, guidance for a solution may be presented as the entry is made. Files can be attached, and the entry can also be associated with other similar entries. The electronic logbook(s) where the entry will appear can also be specified. When the entry is submitted, the system owner and other subscribed personnel automatically receive the entry via email; other recipients can also be entered. Once generated, an OPS-PR can be reassigned by the system owner and comments can be added as progress is made toward resolution.

4.2.7 UITFList Work Planning Tool

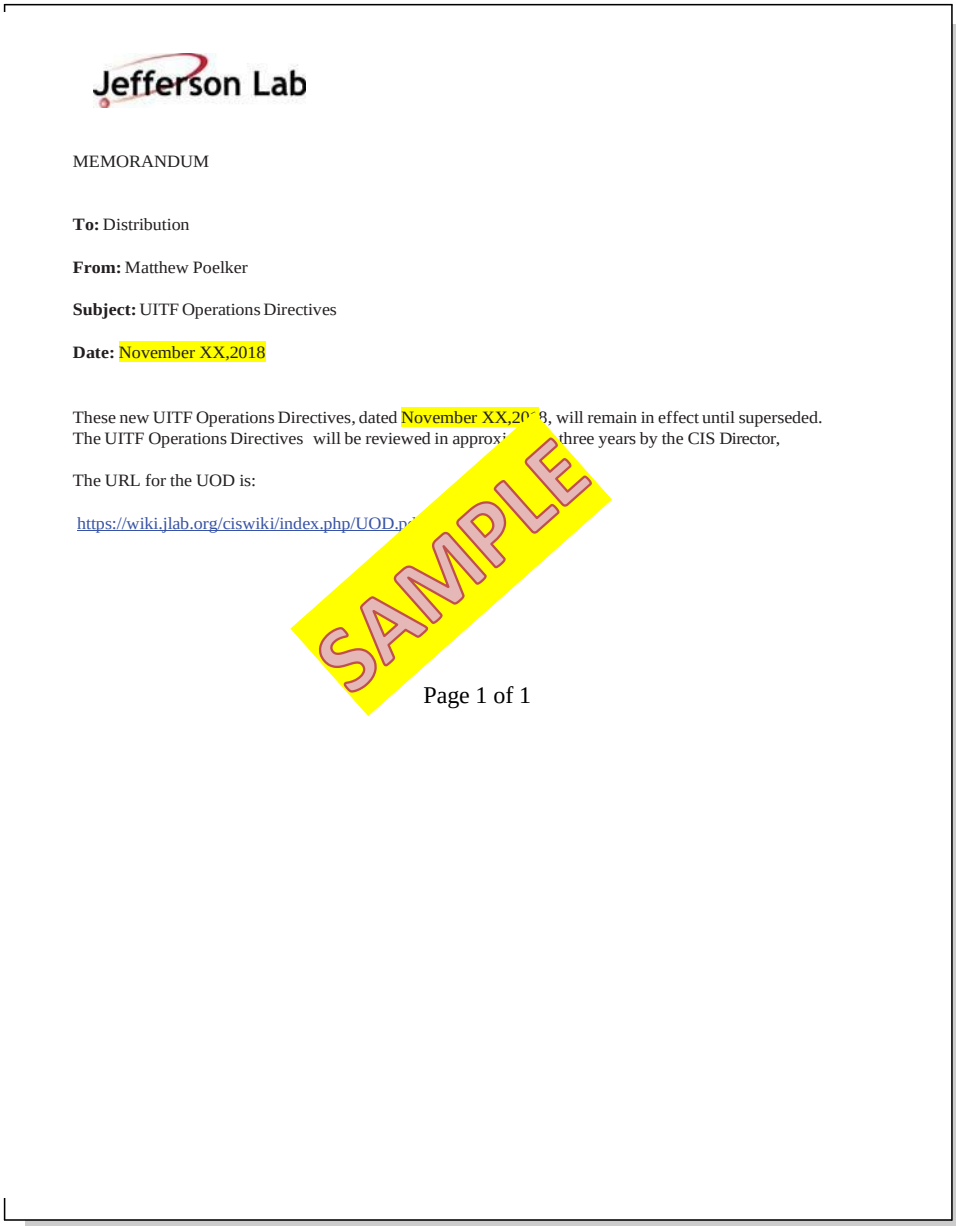
Through *UITFList*, accelerator personnel can electronically submit tasks for approval and scheduling, as a means to efficiently perform work that could interfere with accelerator operations, or UITF-related work performed by other groups, or activities happening outside of UITF but within the Test Lab High Bay. Each *UITFList* submission includes task details, the potential impact to accelerator operations, task hazard identification and a hazard mitigation plan, a backout plan, and supporting documentation as attachments. Once submitted, a task is automatically routed via email to the appropriate parties for comment and approval. After approval, the task waits in the pending queue until the work is scheduled by the UITF Facility Manager.

Appendix A

UOD Release Memo

After each revision, the UOD is re-released under cover of the UOD Release Memo, which includes a brief change summary and a list of those receiving hard copies of the document.

Figure A-1: UOD Release Memo, p. 1



Jefferson Lab

MEMORANDUM

To: Distribution

From: Matthew Poelker

Subject: UITF Operations Directives

Date: November XX,2018

These new UITF Operations Directives, dated November XX,20[illegible]8, will remain in effect until superseded. The UITF Operations Directives will be reviewed in approx[illegible] three years by the CIS Director,

The URL for the UOD is:

https://wiki.jlab.org/ciswiki/index.php/UOD.p[illegible]

SAMPLE

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