CMTF Testing Operations Directives

CMTF-AD-01-000
Revision 1
April 21, 2025

Jefferson Lab

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Preface

This document, the Testing Operations Directives (TOD), provides directives for operation and maintenance of the Cryomodule Test Facility (hereafter referred to as the CMTF) at Thomas Jefferson National Accelerator Facility (also known as Jefferson Lab or JLab).

The CMTF is primarily an acceptance testing facility for horizontally-oriented SRF cavities packaged and assembled in cryostats which serve as beam accelerating devices for CEBAF and other accelerators and facilities throughout the world. Periodically the shielded and enclosed space may also be used for the testing of other RF devices and technologies associated with them, as a conveniently located and available test bed.

The CMTF Manager, in conjunction with the Head of SRF Operations, authorizes who may operate the facility for testing purposes. Operation in this context means any powering of CMTF components which can or have the potential to generate radiation (through the application of high voltage, SRF fields, or the generation of field emission). No one shall be authorized to operate the Cryomodule Test Facility unless they have read and concur with the TOD and have received such hands-on training as required by the CMTF Manager (or their designee) for the test activity.

As a Test Facility, CMTF does not require (and is not supported by) Continuous Electron Beam Accelerator Facility (CEBAF) / Low Energy Recirculator Facility (LERF) Operators, Crew Chiefs, or Safety System Operators (SSOs).

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

Chapter 1: Program Control
Describes how safety is integrated into the execution of the CMTF 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 CMTF operations.

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

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

Appendix A: List of External Links
A list of links to external resources referred to in this document.

Appendix B: TOD Release Memo
The memo used to release the TOD.

This document has been approved by:

April 21, 2025

Anthony Reilly, Head of the SRF Operations Department — Date

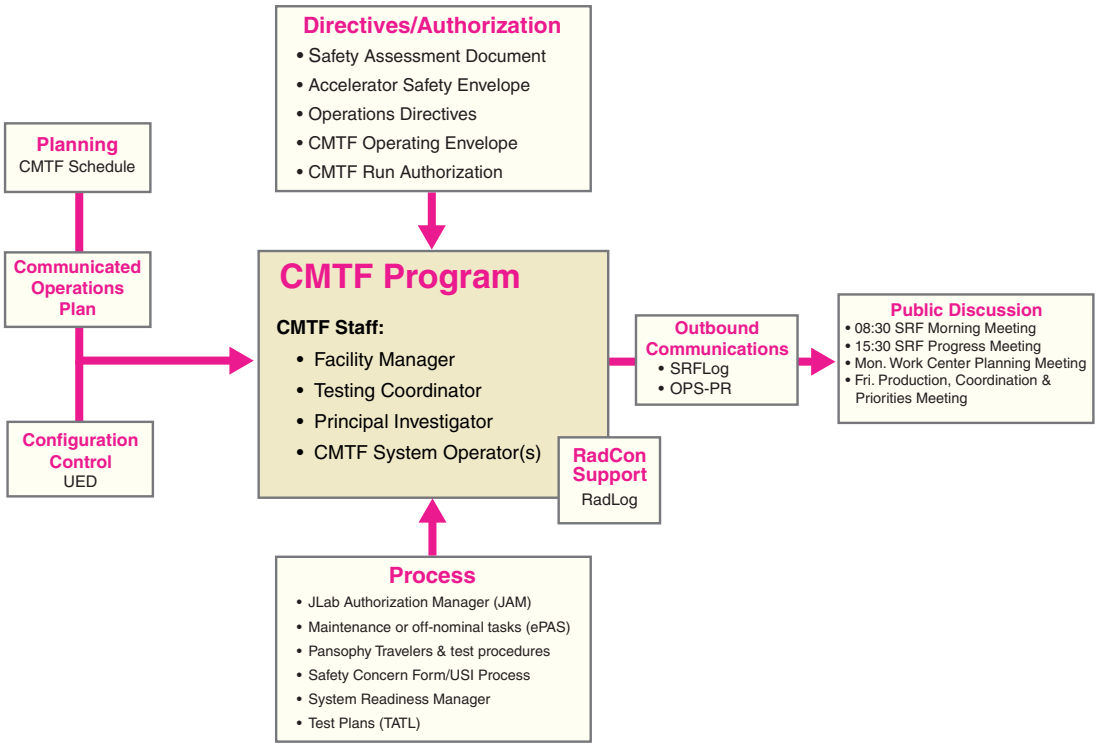
Acronyms & Abbreviations

ARR	Accelerator Readiness Review
CANS	Central Alarm Notification System
CARM	Controlled Area Radiation Monitor
CATS	Corrective Action Tracking System
CEBAF	Continuous Electron Beam Accelerator Facility
CMTF	Cryomodule Test Facility
CTF	Cryogenic Test Facility
DOE	Department of Energy
DSO	Division Safety Officer
ePAS	Electronic Permit Authorization System
EPICS	Experimental Physics and Industrial Control System
ES&H	Environment, Safety & Health
IOC	Input/Output Controller
ISM	Integrated Safety Management
JAM	JLab Authorization Manager
JLab	Thomas Jefferson National Accelerator Facility (Jefferson Lab)
PI	Principal Investigator
MPS	Machine Protection System
ODH	Oxygen Deficiency Hazard
OPS-PR	Operations Problem Report
PSS	Personnel Safety System
RCD	Radiation Control Department
RF	Radio Frequency
RWP	Radiation Work Permit
SOP	Standard Operating Procedure
SRF	Superconducting Radio Frequency
UED	UITF Element Database
UITF	Upgraded Injector Test Facility
TOD	Testing Operations Directives
USI	Unreviewed Safety Issue
VTA	Vertical Test Area

1 Program Control

The SRF Operations Department within the Accelerator Division develops, controls, and manages the CMTF program. This chapter describes how safety and work planning are integrated into CMTF program development and execution, how the program is authorized, and the roles and responsibilities of personnel involved in defining, conducting, and scheduling the program. See Figure 1-1 for an overview of the program.

Figure 1-1: CMTF Conduct of Operations



1.1 Program Safety

All facets of CMTF 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 the JLab Integrated Safety Management System Program Description for more 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 Jefferson Lab's policy not to compromise safety and health of personnel and environment regardless of the urgency or importance of any activity. All lab employees, subcontractors, and users have the power to stop any work that endangers people, the environment, property, or quality without 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 that are integrated into planning and performing all work activity that could adversely affect workers, the public, or the environment. These core functions are as follows:

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

A structured framework of administrative tools, policies, and procedures guide the safety and consistency of CMTF's program planning and execution. ISM principles and the policies established in the *ES&H Manual* guide scheduled and unscheduled maintenance activities at CMTF as described in Section 4.2 on page 4-3 of this document.

1.1.1 Program Scope

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

- **Cryomodule Acceptance Testing**, e.g. the qualification of cryomodules produced by JLAB's SRF Operations department for both internal and external customers. These cryomodules must meet testing requirements defined for each customer's project or

face a potential remediation process defined by the nature of the problem and requirement encountered AND

- **Research and Development**, e.g. testing and preparing equipment to advance the capabilities of (S)RF technology in general. These may include tests of new cryomodule or cavity designs, diagnostics, etc.

These break out across three defined ‘projects’ and two ‘services’ as enumerated in SRF Operations work control documents (SRF Project Execution Program Description, SRF-11-PD-001 & SRF Project Execution SRF-11-PR-001):

Projects:

- **CEBAF Support**: Refurbishment of CEBAF cryomodules through projects or service agreements controlled by the JLab Accelerator Division.
- **Multi-Lab Partnership:** Fabrication and delivery of SRF components to external customers through projects controlled by the JLab MLP office.
- **Work for Others/R&D**: Fabrication and delivery of SRF components and/or data to external customers through projects managed through SRF Ops., Lab Directed Research & Development projects, or projects from SRF Science & Technology.

Services:

- **CEBAF Support Services**: SRF Ops maintains CEBAF cryomodules and components through project / service agreements administered by the Accelerator Division.
- **Lab Service Requests**: SRF Ops provides labor, equipment, products, or data for Work for Other projects controlled by S&T and other JLab organizations.

The CMTF is solely a *test facility* used to evaluate critical components intended for use at CEBAF and other accelerators, as well as for research and development activities. The CMTF will **not** be operated as a *user facility*. Activities in partnership with members of other laboratories may occur, but will always be conducted with an internal liaising member of staff and will be prioritized via SRF Operations internal review process.

The testing schedule and prioritization is developed based on an optimization of project deliverables as well as availability of testing resources (staff, cryogens, etc.) in conjunction with the Vertical Test Area (VTA), Upgraded Injector Test Facility (UITF), and Physics Division resources using cryogens accessible from a bayonet box located in front of the CMTF control room adjacent to the access doors.

1.1.1.1 Internal Needs

The Test Lab and what is now the SRF Institute has been on-site at JLAB since its inception and stands ready to meet the operational needs of

CEBAF and the other Jefferson Lab site accelerators as necessary. As SRF technology advances and the energy requirements of accelerators change, periodically there is a need to either construct new or refurbish existing cryomodules to enhance the availability of accelerating gradient. As these opportunities arise – either funded internally, or through the DOE – project scope and requirements are defined with stakeholders and construction and testing of cryomodules may commence against the schedule and requirements agreed upon by the stakeholders.

1.1.1.2 Externally-Funded Project Proposals

Externally funded projects (aka Work for Others) may be considered for approval by Jefferson Lab Director, the Associate Director for Accelerator Operations, the SRF Operations Department Head, and the CMTF Manager. The CMTF Manager will schedule approved project cryomodule tests in consultation with the Project coordinators (internal and external) for the project, as well as the Lab leadership.

1.1.2 Program Hazard Analysis

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

- Hazards associated with operating the CMTF with its base equipment, and
- Hazards associated with the use of non-standard equipment added to the CMTF test bed for WFO activities. For example, the 1 MW pulsed klystron used for SNS testing.

For all activities, CMTF Manager has the responsibility and authority to require hazard analyses & mitigations measures and safety reviews.

1.1.2.1 CMTF Hazard Analysis

As required by DOE Order 420.2D, Safety of Accelerators, two documents address the hazards associated with CMTF operations: the JLab Safety Assessment Document (SAD) & CMTF Accelerator Safety Envelope (ASE).

JLab Safety Assessment Document (SAD) – The SAD 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 SAD 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.

CMTF Accelerator Safety Envelope (ASE) – The CMTF ASE defines the physical and administrative bounding conditions for safe operations based on the safety analysis documented in the SAD. 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 Environmental Safety & Health Manual, Section 5300, Occurrence Reporting to Department of Energy (DOE). See Section 3.5.1 on page 3-5 for details on responding to violations of the ASE.

CMTF Operations Envelope – A second set of more stringent controls known as the Operations Envelope is used to provide assurance that the Safety Envelope is not exceeded. Variations of operating parameters outside the Operations Envelope, but within the Safety Envelope, are not treated as a DOE reportable occurrence but may result in administrative actions taken by JLab management. See Section 3.5.2 on page 3-6 for details on responding to violations of the Operations Envelope.

Operations Envelope limits include Defense-in-depth measures listed in the SAD, and any additional restrictions which the CMTF Manager may wish to impose on and communicate to the staff.

1.1.3 Unreviewed Safety Issues

An Unreviewed Safety Issue (USI) is an accelerator safety issue that presents a significant safety risk and was not previously identified, analyzed, and already mitigated as documented in the SAD (see Section 1.1.2 on page 1-4). 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 SAD. 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 SAD 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 SAD.

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 is followed. The Safety Concern Form, is used to report a safety concern as a potential USI. If an activity is *potentially* outside of either the analysis or the set of controls documented in the SAD, 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 CMTF program is conducted using credited controls to eliminate, control, or mitigate the accelerator-specific identified hazards. The credited controls identified in the ASE (see Section 1.1.2 on page 1-4) must be in place and functional before operation of the CMTF. 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 (see Section 1.1.3 on page 1-5).

Credited controls used during CMTF operation 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. The Hazard Assessment and Mitigation section of the SAD - the basis for CMTF ASE, lists the credited controls for CMTF operations are as follows (provided for reference only):

- **Credited Passive Engineered Controls**
  - Permanent shielding
  - Movable shielding
  - ODH vents and facility configuration
- **Credited Active Engineered Controls**
  - Personnel Safety System (PSS) access controls
  - ODH systems controls
- **Credited Administrative Controls**
  - Doors, gates, fences, and other barriers
  - CMTF staffing – Sweep
  - CMTF staffing – Run

The Safety Envelopes – The CMTF ASE specifies the credited controls, which ensure that the accelerator safety risks are within acceptable limits. These controls are collectively referred to as the Safety Envelope. Variations of operating parameters outside the Safety Envelope are DOE reportable occurrences.

1.1.4.2 Additional Safety Controls

While the credited controls specified by the SAD address worker safety, public safety, and environmental safety, CMTF 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:

- **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 (see Section 3.6.1.1 on page 3-7).

- **CMTF-Specific Operational Safety Documents** – CMTF-specific Work Control Documents (WCDs) 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 3210, Work Planning, Control & Authorization*). Copies of specific WCDs that pertain to CMTF accelerator operations are maintained online - for best version control. Paper reference copies are printed as needed and available in the CMTF control room. These documents are reviewed by all CMTF Operators.

- **RF Operations Authorization** - The SRF Operations Department Head, with the recommendation and concurrence of the CMTF Manager, will use the JLab Authorization Manager (JAM) to authorize CMTF Operations. This authorization verifies that the credited controls and unmasked items in the System Readiness Manager meet all safety standards for the planned program.

- **CMTF Test Plans** – Procedures written by system experts to perform specific tests of CMTF systems or execute non-standard RF tests. Test plans are written and submitted using an on-line form that is a part of the web-based Test Lab Area Task List (TATL) work planning system. Each test plan incorporates a review of potential safety issues, and when submitted, is electronically routed for review/approval by key personnel. Scheduled CMTF test plans are listed in the Test Lab Accelerator Task List (TATL).

1.1.5 Program Execution Within Controls

As a Test Facility, the CMTF does not routinely operate 24/7. Most of the operations take place during work hours, and may include Swing (16:00-24:00) shifts as well when cryomodule testing is in progress. All CMTF operations are conducted by trained staff under the authority of the CMTF Manager. Subject Matter Experts, such as staff from other accelerators whose cryomodules are under test, members of CASA, MCC Operations, etc., may be engaged to participate in testing with permission from the CMTF Manager. Activities performed by staff will adhere to the following regulations.

- **Training and Qualification** – CMTF Operators are trained to a level of proficiency established by the CMTF Manager. Their names appear a list of CMTF Operators authorized by CMTF Manager to operate the facility. This list is displayed in the control room (Section 3.3 on page 3-4).

- **Pre-shift Preparedness** – The coordinator and the crew will have an Operational Plan for the day communicated by the CMTF Manager (or their designee).

- **Preshift Reading:**
  - **SRF Logbook** – All pertinent testing activities will be recorded in both the paper and electronic logbooks for later reference. This information will be reviewed by the CMTF Operator before they come on shift.
  - **System Readiness Manager (SRM)** – As part of shift turnover, the CMTF-applicable parts of the SRM will be reviewed to ensure that all required systems are operational.
  - **JLab Authorization Manager (JAM)** – The authorization manager is used as a method of clearly communicating both the status and readiness of an accelerator's credited controls as well as the authorization to operate the accelerator by the responsible party. In the case of both CMTF and VTA, the responsible party is the Head of the SRF Operations Department (or their designee), as advised by each of the respective facility managers. All of a facility's credited controls must be in place and verified by the responsible group's managers in order to proceed with facility operation. Credited control approval may not be masked or bypassed in any way. If for any reason the duration of credited control approval has expired while in operation, or a control is found to not be in place as expected operations must immediately cease and notifications must be made per Section 3.5.1 on page 3-5. If the facility is not in operation, notification to the CMTF Manager is sufficient.
  - **Test procedures** – The CMTF Manager will ensure (with their staff) that all documents and procedures required for testing are in place and are readily available to staff testing.
  - **CMTF-specific Work Control Documents** - Read and understand applicable work control documents (Pansophy, TATL, & ePAS).)

- **Shift-Turnover Meetings** – Between consecutive shifts of CMTF running, the oncoming & outgoing RF and Cryogenic Operators hold a shift-turnover meeting to discuss the ongoing program and any off-normal conditions that exist. When shifts do not overlap, pre-shift reading and the communicated Operation Plan take the place of the shift-turnover meeting.

- **Pansophy** – As testing progresses, data will be analyzed by the CMTF Manager (or their designee) and be added to the traveler in Pansophy– the formal document outlining tests and results which travels with the piece of hardware under test.

1.1.6 Program Feedback and Continuous Improvement

Feedback and continuous improvement are integrated throughout the process of developing and then executing the CMTF 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 & future planning. Examples of feedback and continuous improvement tools used during program development and execution are as follows:

- **SRFLog** – As a time-based repository for information associated with program execution, the SRFLog 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.

- **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.

- **TATL** – similar to the Accelerator Task List (ATLis) used at CEBAF, the Test Lab Area Task List (or TATL) is a web-based work planning tool where maintenance and project tasks are electronically submitted, approved, and then scheduled. Task descriptions submitted via TATL 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 CMTF Manager. Although work is scheduled by the CMTF 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.

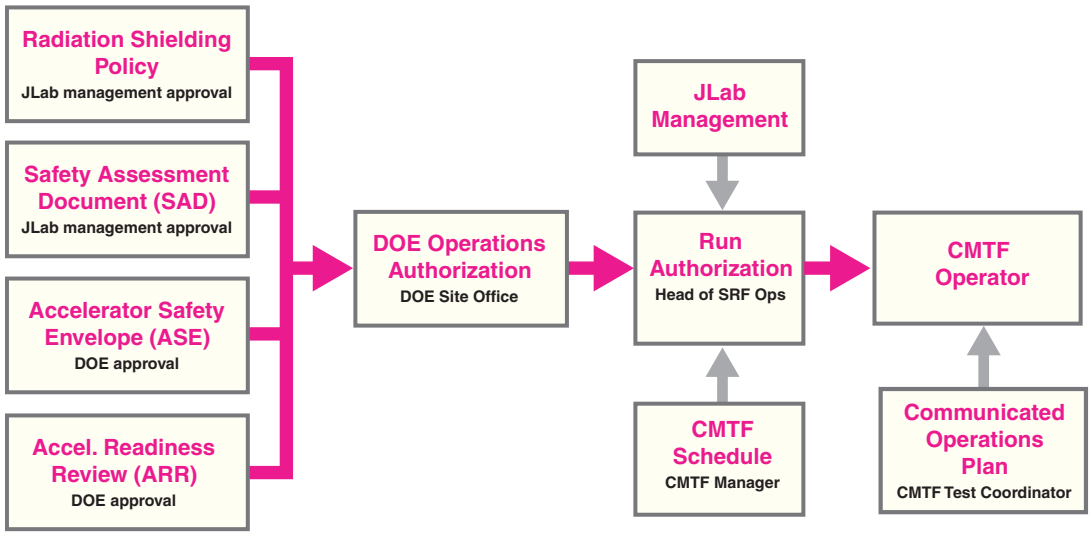
- **ePAS** – An electronic permit administration system that attempts to improve, simplify, and centralize lab processes for hazard identification and mitigation. The goal for ePAS is to provide a single lab-wide process for task hazard assessment and hazard mitigation, accessible through existing work planning platforms, for activities associated with the maintenance and operation of Jefferson Lab. ePAS is designed to centralize work planning, scheduling, and hazard identification and mitigation through its interface with other pre-existing JLAB work controls.

- **Pansophy** – An electronic database developed in-house that replaced the need for several commercially available software products. The system is designed to lay out testing processes and procedures within the SRF institute, while also serving as a location to gather and analyze the data associated with them for both internal and external needs – but to also provide quality control and feedback in addition to program control.
- **Off-Normal Operation and Events** – Off-normal operation and off-normal events should be logged to SRFLog and reported to the CMTF Manager. The CMTF 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 Program Authorization

The DOE Site Office has authorized JLab to perform routine operations of the CMTF within the safety envelopes listed in the *CMTF Accelerator Safety Envelope* (ASE) (see Section 1.1.2 on page 1-4). Before granting operations authorization, the DOE carried out a rigorous review process (see Figure 1-2, below) as specified in *DOE Order 420.2D, Safety of Accelerator Facilities*.

Figure 1-2: CMTF Program Authorization



To meet the review requirements, JLab maintains a *Radiation Shielding Policy* and a *Safety Assessment Document* that conformed to DOE standards; these documents were approved by JLab management. JLab also prepares an *Accelerator Safety Envelope* document, which is reviewed and approved by the DOE. With these required documents in place, an Accelerator Readiness Review (ARR) verifies that all conditions for safe operations are met, and the DOE may then subsequently authorize CMTF operations. A copy of the DOE letter authorizing CMTF operations will be posted in the CMTF Control Room.

The CMTF program is developed by the CMTF Manager in consultation with JLab SRF & senior management. The Head of the SRF Operations Department authorizes the CMTF Operator to carry out the CMTF program as specified in the Communicated Operations Plan provided by the CMTF Test Coordinator (see Section 1.4.3 on page 1-15). Before high-power RF is run in the CMTF, the Head of the SRF Operations Department must authorize operations via the System Readiness Manager, ensuring all sub-systems and credited controls are ready for testing and operation.

1.3 Personnel and Responsibilities

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

1.3.1 Head of SRF Operations Department

The Head of the SRF Operations Department owns and authorizes all cryomodule fabrication and performance verification processes at Jefferson lab, both for internal work and Work-for-Others. Implicit in this is the acceptance testing processes for cavities at the Vertical Test Area (VTA) and cryomodules at the Cryomodule Test Facility (CMTF), as well as the testing of any other equipment which may occur at those facilities. The

Head of the SRF Operations responsibility for those facilities includes the following:

- Uses the JAM to authorize the CMTF or VTA Operators to operate those facilities under the parameters laid out in the Facility ASEs, SAD, and the Operational Directives. This confirms that all credited controls are in place and verified as functional.
- Authorize resumption of operations as appropriate following critical events such as Safety Envelope violations, Operations Envelope, Personnel Safety System malfunctions, and Machine Protection System malfunctions as detailed in Section 3.4 of this document.
- Meet with the CMTF Manager and VTA Facility Manager as necessary to stay updated on the status and schedule of the program at those facilities.

1.3.2 CMTF Manager

The CMTF Manager is selected by the SRF Operations Department Head and is the designated owner of the CMTF, with overall responsibility for the facility's safe configuration and operation. The CMTF Manager provides operations oversight, including participating in program development and scheduling, and advises the Head of the SRF Operations Department on authorizing operations. CMTF Manager responsibilities include the following:

- Serve as the designated spokesperson for the facility.
- When performing 'Work for Others,' personally serve as or appoint a liaison with the Principal Investigator (PI) or the PI's designee.
- With input from management and Principal Investigators, develop the CMTF schedule to accommodate tests that span multiple days or multiple tests occurring concurrently.
- Approve deviations from the CMTF schedule.
- Ensure the operating guidelines are current and communicated to authorized workers. If there are any applicable restrictions to facility operation those are to be clearly communicated as well.
- Maintain a listing of all safety documentation applicable to the facility and make such documentation accessible to CMTF staff.
- Verify that all projects/activities have completed the required safety reviews before authorizing operations
- With the Test Coordinator, assess the qualifications of CMTF Operators and post a list of qualified CMTF Operators in the CMTF Control Room.

The CMTF Manager also has responsibilities for ensuring system readiness. Those responsibilities are detailed in Section 4.2.6.2 on page 4-9.

1.3.3 Work Coordinator

The CMTF Manager also fulfills the role served by the Work Coordinator, though they may delegate these responsibilities if desired:

- Review, schedule, and approves proposed tasks submitted via the Test Lab Areas Task List (or TATL), ePAS, or Pansophy.
- Coordinate any applicable maintenance, installation, or upgrade activities.
- Meet with representatives of potential projects to determine if their requirements are in line with the capabilities of the facility and help facilitate the approval and scheduling process.
- Refer to the Radiation Control Department for review any potential externally-funded test with requirements falling outside the facility operating envelope.
- With the PI (or their designee) and with a variety of internal and external stakeholders, ensure that the facility best accommodates potential users and the program is well defined and supported with appropriate resources.

1.3.4 CMTF Test Coordinator

The CMTF Manager typically fulfills the role of the Test Coordinator – though they may delegate this responsibility. If a separate Test Coordinator is appointed, that individual will work closely with the CMTF Manager.

The Test Coordinator has overall responsibility for a given CMTF test plan (such as a Cryomodule Acceptance Test). The Test Coordinator is responsible for planning and executing the test plan, ensuring that operations are carried out in a safe manner, directing the activities of system Operators while they are on shift, and ensuring that the facility is properly staffed. The Test Coordinator must be cognizant of the status of the facility and any device under test in the facility for the duration of the Test Plan. They must also have a thorough understanding of the configuration and operation of the relevant systems required to support the execution of the planned test.

Responsibilities include:

- Coordinate the activities of the Principal Investigator or PI’s designee.
- Provide an Operation Plan for the day based on schedule and testing requirements and communicate it to the CMTF Operators on duty prior to the start of their shift.

- Schedule staffing for all shifts of CMTF operations consistent with staffing requirements.
- Assumes responsibility for activities during unattended periods of operation - such as weekends or overnight.
- Train all CMTF Operators to a level that supports safe facility operation.
- Perform online analysis of testing data to determine the need for re-tests and coordination of punch list activities.
- Ensure that acceptance testing travelers are populated promptly with test results.
- If it becomes apparent through testing or data analysis that repairs to the facility or testing apparatus are required, contact the Work Coordinator and help schedule and facilitate necessary repairs.

1.3.5 CMTF Principal Investigator

Non-JLab activities are 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:

- Demonstrate to the Test Coordinator that the test is appropriate.
- Ensure that any visiting CMTF Operators have the training and ability to perform the test.
- Work with the CMTF Manager to conduct a design and safety analysis of all test equipment and proposed operating conditions.
- Work with the CMTF Manager to safely install any new equipment for testing.
- At the conclusion of the test, organize the decommissioning of any equipment that is to be removed and arrange for removal.
- The PI (or their designee) must be available on-call while a test is on-going.

1.4 Program Schedules

1.4.1 CMTF Activities Schedule

Testing activities are scheduled and administered by the CMTF Manager or their designee with input from both management and schedule as enumerated in Section 1.2 on page 1-10.

1.4.2 Non-JLab Activities Schedule

These activities are scheduled by the CMTF Manager, SRF Operations Department Head, and the Principal Investigator of the test or major installation as enumerated in Section 1.2 on page 1-10

1.4.3 Shift-by-Shift Schedule

The testing schedule is determined by the CMTF Manager in consultation with available testing staff. For non-JLab activities, the CMTF Manager may also consult the PI to determine details of the testing schedule. The shift plan (also known as the Communicated Operations Plan) may be communicated verbally or in writing to each oncoming shift for execution, and may be modified based on the progress (or lack thereof) on the previous testing shift. These tasks may be delegated to the Test Coordinator if one is appointed.

1.5 SRF Meetings

Meetings are necessary to plan, schedule, and coordinate activities and to disseminate important information. When appropriate, these meetings are hybrid: they are conducted in person, but use video conferencing tools to allow remote attendance. Meetings that address CMTF operations, maintenance, and support include:

- **Shift-Turnover Meeting** – Takes place in the facility control room between oncoming and off-going shifts and is primarily an exchange of information. (See section 3.5.3 on page 3 – 9)
- **SRF Morning Meeting** (08:30) to summarize the previous day's progress and coordinate activities for that day.
- **SRF Progress Meeting** (15:30) to update progress over that morning's plan, and to begin to coordinate work for presentation at the following day's 8:30 meeting.
- **Production, Coordination, & Priorities Meeting** (Friday; 13:30) is a manager's meeting to review the existing weeks progress and to set milestones for coming fer weeks of work.
- **Work Center Planning Meeting** (Monday; 9:30) is a manager's meeting to review the Friday 1:30's milestones and to set the plan for the upcoming week's work at a high level.

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 Cryomodule Test 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 the CMTF, 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.

The UED was the first such database set up in the test lab, and has sufficient capacity to be used by the UITF, CMTF, and VTA – so it makes sense to use it for all of the accelerators vice setting up multiple parallel databases, which requires significantly more administrative overhead.

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)

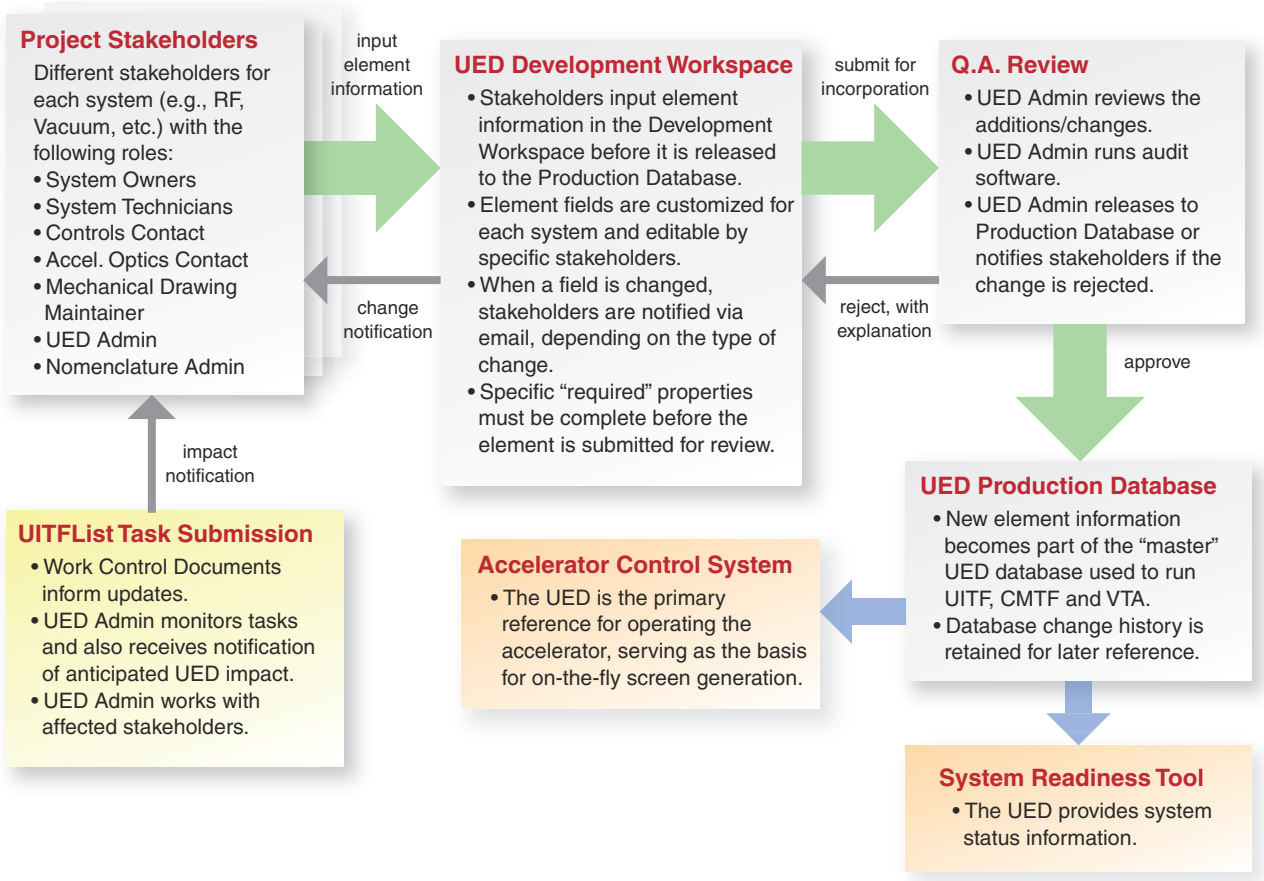
The UED is the central element-specific information repository used to operate UITF, CMTF, and VTA. All accelerator elements which beam would eventually transition are included in the database, with the information for each type of element tailored to match the specific function. Operations-critical 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 2.1.2, below, provides an overview of the process.

Figure 2-1: The UED Revision Process



2.1.2 Project Stakeholders

Elements in the UED are organized by system (e.g., RF, vacuum, etc.), and each system has a different group of stakeholders. The various stakeholders are listed in Figure 2.1.2 on page 2-2.

Each UED element has a set of associated fields, and each field has assigned write privileges, so that The UED is the central element-specific information repository used to operate UITF, CMTF, and VTA.

All accelerator elements which beam would eventually transition 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.

Stakeholders can contribute their portion of the information. Specific “required” fields are assigned only to the Principal Investigator. 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 Timely UED Updates

To accommodate the system readiness management and accelerator operating requirements, UED updates must be incorporated in the production database in order to support the scheduled program. This means that the changes must have already passed the quality review and been incorporated in the production database by UED Administration before the system readiness management begins. Populating a UED Development Workspace during the early stages of any project is a good practice that facilitates consistent nomenclature assignment and makes timely final approval/incorporation much easier.

2.1.4 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 (see Section 2.1.6 on page 2-4). 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 can be 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 (see Section 2.1.5 on page 2-4).

2.1.5 UED Quality Assurance Review

Before changes are merged from the development workspace into the production database, the UED Administrator reviews the proposed changes to verify that they are valid. They also run 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.

2.1.6 The UED Production Database

The production version of the UED database is the official repository for CMTF element information, storing the present accelerator configuration and serving as the primary reference for the software tools that operate the CMTF. This includes element nomenclature designations, where the UED is considered the authoritative reference, with the final designations being approved by the Nomenclature Administrator.

The configuration management process described in Figure 2.1.2 on page 2-2 maintains consistency between the installed equipment and the information contained in the UED. It is critical that all System Stakeholders contribute their portion of the element information when a new element is added and continue to update the information as they make changes in the field. Additionally, the UED automatically creates a series of read-only historical snapshots as element changes are made. This feature provides a means for understanding past configurations should the need arise.

2.1.7 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.

3 CMTF Operations

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

3.1 CMTF Operations Overview

CMTF operations are conducted from the CMTF Control Room by trained and approved staff who are authorized by the SRF Operations Department Head. The CMTF Operators control and monitor SRF or supporting systems. Other qualified individuals with sufficient technical knowledge may be granted access to the control system (i.e., “channel access”) but must be in the presence of a CMTF Operator when making control system changes that will affect the test in progress. Staffing requirements for sweeping and operation are described in Section 3.6.2.1 on page 3-10.

Critical event response for the CMTF is described in Section 3.5 on page 3-5.

3.2 Control Room Personnel and Responsibilities

The personnel involved in CMTF operations include the SRF System Operator, Cryogenic System Operator, and support staff.

3.2.1 RF System Operator

The SRF Operator ensures that the Operations Plan is executed and communicate any deviations to the CMTF Manager.

The SRF Operator must have a thorough understanding of the configuration and operation of the PSS and MPS systems, as well as the configuration of the MPS and SRF systems required for the execution of the planned tests. They should also have a general understanding of the interactions of the cryogenic and vacuum systems with the specific SRF tests. SRF Operators are certified and authorized by the CMTF Manager following a period of On-the-Job training (OJT).

The SRF Operator is responsible for safe operation of the facility and has the authority to stop any test if they feel that there is unnecessary potential

to damage equipment or if there is an elevated level of risk of injury. Their responsibilities include:

- Read and understand the pre-shift reading outlined in Section 1.1.5 on page 1-7 of this document (SRFLog, System Readiness Manager (SRM), JLab authorization manager (JAM), and all applicable Test Procedures & Work control documents)
- Understand the Communicated Operations Plan outlined by the CMTF Test Coordinator.
- Monitor operational conditions to ensure that test conditions meet the program goals and safety conditions as outlined in the work control documents.
- Monitor the performance of the SRF and supporting sub-systems.
- Measure and adjust accelerator parameters according to approved procedures to optimize performance.
- In case of critical system failure, bring CMTF to safe state.
- Be aware at all times of the PSS status of the CMTF.
- Ensure that the CMTF is operated in accordance with the requirements outlined in the ASE.
- Know the energy of the cavity or cavities under test, and remain within the maximum acceleration gradient outlined in the safety documentation for the module under test.
- Before leaving the CMTF unoccupied, verify that:
    - RF high voltage is off, and the Cathode Power Supply operations key is in the key station.
    - Verify that there has been no CARM alarm. If there has been one, contact the Radiation Control Department for survey of the CMTF cave.
    - The PSS state is in a READY or OPEN state. If in an OPEN state, ensure that the concrete roll-up doors are down.
    - The PSS key is located on the person of the SRF Operator (if not leaving the test lab) OR in the key station (if leaving the test lab).
    - Applicable log entries with regard to state changes, the end of shift, and leaving the facility unoccupied are made in all appropriate locations. (Paper and electronics logbooks.)
- Control or directly supervise the operation of devices that interface to the CMTF PSS such as high-power SRF systems.
- Ensure that the Machine Protection Systems (MPS) functions appropriately for cryomodule testing in CMTF operations through the Interlock check recommended in the traveler for each module.

- Understand and respond appropriately to all PSS and MPS faults.
- Using the process specified in the CMTF Sweep Procedure, search and secure the CMTF enclosure before SRF operation.
- Open, pursue, and close any CMTF-related Operations Problem Reports (OPS-PRs) as issues present themselves.
- Open channel access as needed for qualified individuals.
- The Duty SRF Operator is expected to only interact with the control system from the CMTF control room, and must be present there in a manner consistent with section 3.6.2: Shift Protocol.

3.2.2 Cryogenic System Operators

Cryogenic Operators are authorized by the CMTF Manager. They assist the principal investigators in the execution of tests and the changing of system configurations. They must have a thorough understanding of the configuration and operation of the cryogenic systems required for the execution of the planned tests. They should also understand the interactions of the specific SRF tests with operations of the cryogenic systems. They are responsible for safe operation of the facility and have the authority to stop any test if they feel that there is unnecessary potential to damage equipment or if there is an elevated level of risk of injury.

Cryogenic operations may be executed by the Cryogenics System Operator on or off-site and via remote system access if desired, and at the discretion of the CMTF Manager. The Cryogenic Systems Operator may be responsible for monitoring operations at various different locations on the Jefferson Lab campus simultaneously – as well as on various shifts – and as such, this flexibility is necessary.

3.2.3 Duty Operators

The Duty Operators are the individual SRF or Cryogenic System Operators whom have been assigned to be responsible for operations of that system on a specific shift. The Test Coordinator assigns Duty Operator shifts.

3.2.4 Visiting Operators

Visiting Operators are approved by the Test Coordinator to assist Principal Investigators in the execution of tests and the changing of system configurations. When using high power SRF systems, their activities are to be directed and closely monitored by the Duty Operator.

3.2.5 Radiation Control Department

The Radiation Control Department will provide radiation survey support as well as maintenance support of any radiation monitoring equipment that is associated with Personnel Safety.

3.2.6 Industrial Hygiene

Industrial Hygiene shall be available to provide SRF field leakage survey assistance upon request.

3.2.7 Safety Systems Group

The Group Leader of the Safety Systems Group (SSG) or his designee is the designated owner of the Personnel Safety System (PSS).

3.3 Training

CMTF Operators are trained to a level of competence that allows for safe operations and maximized operating efficiency. This includes understanding basic accelerator operating concepts, key operational aspects of all systems, and attaining/maintaining a level of competence that contributes to efficient operations.

Each new CMTF Operator must successfully complete a training program that consists of

- Reading and understanding the following documents:
    - Jefferson Lab Safety Assessment Document (SAD)
    - Accelerator Safety Envelope for CMTF.
    - CMTF Operational Directives Document (TOD; this document).
    - CMTF-specific Radiological Work Permit (RWP)
- Participation in the following required training:
    - Facility-specific Radiological briefing, which includes a brief on the year's RWP
    - Facility-specific familiarization training, which includes a briefing on the elements of the Operational Directives document as well as specific configurations, postings, hazards, and credited controls.
    - On-the-Job-Training as designated by the CMTF Manager.

The CMTF Manager determines who is a qualified CMTF Operator and can suspend or terminate such qualifications at their discretion. If some portion of a CMTF Operator's training expires, the CMTF Manager may limit their assignments until their qualifications are reviewed. A list of qualified CMTF Operators is maintained by the CMTF Manager and displayed in the control room.

3.4 The CMTF Personnel Safety System

The CMTF Personnel Safety System (PSS) is interfaced to the radiation monitoring system, composed of several Controlled Area Radiation Monitors (CARMS) with both gamma and neutron probes distributed throughout the facility.

When radiation above a pre-determined threshold determined by the Radiation Control Department (RadCon) is detected, these devices produce an audible alarm inside the CMTF control room.

The absence of an alarm with SRF and high voltage off indicates it is safe to enter the CMTF enclosure when the PSS state is set to OPEN, as the radiation source term is prompt when in operation. Several of these CARM probes are integrated into the CMTF PSS System, and when they reach their 'High' threshold the permit to the SRF High Voltage source is removed.

The CMTF Duty Operator will contact RadCon when alarms audibly enunciate and RadCon will determine if and when a survey of the Cave area is required per their guidelines.

While individual cavity tests may exceed 10 MV accelerating potential, the duration of tests is short – with 1 hour of continuous operation sufficient to demonstrate cavity capabilities. In addition, radiation sources are typically prompt – due to cavity field emission. As such, in the course of normal testing equipment is not expected to become activated - but RadCon will survey each module prior to moving it out of the test cave or after any CARM alarm.

In addition to single cavity testing, some Work-for-Others projects require a 'Unit Test' where all (or most) of the cavities are powered simultaneously. This is done to ensure any possible field emitted particles do not exceed a critical dark current or radiation threshold specified by the project is not exceeded as measured in a Faraday cup or via the CARM or Decarad gamma radiation monitoring systems respectively. The same conditions apply in this case, where any enunciation of the CARM motivates a survey by RadCon.

3.5 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. A 'Critical Event Response' section is available in Web On-Call to aid with the following notifications.

3.5.1 Safety Envelope Violations

If the Safety Envelope is violated during CMTF operations, operations must be terminated and the JLab Unreviewed Safety Issue (USI) Procedure be followed. The incident will be investigated using the investigation process specified in the *ES&H Manual, Section 5200, Event Investigation and Causal Analysis Process*. The ES&H Reporting Officer, Associate Director for Accelerator Operations, the CMTF Manager, Head of SRF Operations, the Safety Systems Group Leader (for PSS-related violations), and the Accelerator Division Safety Officer must be notified as soon as possible.

CMTF Operations shall not resume until the Associate Director for Accelerator Operations gives direct approval to the CMTF Manager.

Safety Envelope Violations occur when credited controls are not in place in alignment with those laid out in the CMTF Accelerator Safety Envelope. These could include, but are not limited to, the following:

- **Permanent Shielding:** Shielding out of place, damaged, or inspection period has lapsed.
- **Movable Shielding**: Shielding out of place, damaged, or inspection period has lapsed. (Movable shielding package data is available here: https://misportal.jlab.org/radcon/shielding/ packages)
- **PSS or ODH system damage or malfunctions**: Stop operations and contact the Safety Systems group to respond to the issue as outlined in Section 3.5.3 on page 3-7.
- **PSS or ODH System lapse of certification**: Operation of the facility with a lapsed PSS or ODH system certification is considered an ASE violation. The certification schedule for the PSS and ODH systems are located online.
- **Inadequate Staffing**: Staffing shall be maintained as outlined in Section 3.6.2.1 on page 3-10 of this document for PSS sweeps and Operation of the CMTF. If staffing is not maintained this is an ASE violation.
- **Damage** to credited doors, gates, fences, and other barriers.

In addition to the credited controls, the facility's shielding has been evaluated under RCD-DEP-24-003, On Adequacy of the CMTF Shielding for Upcoming Tests for LCLS II He Cryomodules. Operation of a cryomodule at energies above the limits evaluated by RCD are also considered a safety envelope violation.

Violation of any element of the safety envelope will result in an immediate cessation of facility operations and provoke the critical event response outlined above.

3.5.2 Operating Envelope Violations

The Operations Envelope provides administrative assurance that the Safety Envelope for these controls is not exceeded. The Operational Envelope establishes thresholds for facility operation, including energy maximums. Variations outside the Operations Envelope, but within the Safety Envelope, are not treated as a DOE-reportable occurrence but require specific administrative action as described below.

If an Operations Envelope violation occurs, SRF and High Voltage operations must be terminated and the CMTF Manager, Head of SRF Operations, the Safety Systems Group Leader (for PSS-related violations), and the Accelerator Division Safety Officer must be notified as soon as possible.

CMTF Operations must not resume until the Head of SRF Operations gives direct approval to the CMTF Manager.

The present CMTF Operating Envelope is as follows:

- Cryomodule projects specify a maximum administrative gradient limit based on their design and project requirements. For example,

the CMTF is presently focused on testing of CEBAF-style cryomodules. The Operating Envelope facility energy limit being set for these tests is E <= 145.6 MeV (26 MV/m admin limit for C100 cavities x 0.7 m length x 8 cavities).

- Administrative limits for the cavities under test will be communicated by the CMTF Manager to the Duty Operators.
- Any activation of a cryomodule pressure relief.
- Sustained vacuum pressure excursions (t > 30s) of beam line or waveguide vacuum above 5e-7 torr.
- Transient vacuum pressure excursions resulting in a sudden step change in pressure of two or more decades.
- Sustained insulating vacuum pressure excursions above 1E-4 torr.
- Transient insulating vacuum pressure excursions resulting in a sudden step change of two or more decades.
- Inability to maintain liquid level with the JT valve fully open.

3.5.3 Personnel Safety System (PSS) Malfunctions

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

If, on investigation, the Safety Systems 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 CMTF Manager.

If the Safety Systems Group Leader determines that a previously unidentified hazard exists, the USI process must be followed (see Section 1.1.3 on page 1-5).

If the Safety Systems Group Leader determines that the PSS did not function correctly, the occurrence reporting process described in Section 3.5.1 on page 3-5 shall be followed.

3.5.4 Machine Protection System (MPS) Malfunctions

The Machine Protection System (MPS) is a hardware-based system used to remove the ‘RF Permit’ signal to high voltage components in cases where sustained SRF operation could potentially damage components. The CMTF MPS subsystems include systems like Vacuum Ion or Non-evaporative Getter Pumps pressures, Arc detectors, and coupler / window temperatures.

If, during accelerator operations, a malfunction of the MPS is observed or perceived, operations shall cease immediately, and the Duty Operator must report the observed or perceived malfunction for resolution to the appropriate CMTF or JLab staff member. Operations shall not resume until

the system is repaired and verified by the CMTF Manager, or their authorization to bypass and mask the interlock has been given.

3.5.5 Emergency Response

In the event of most emergencies, the role of the CMTF Duty Operator is to take the facility to a safe state with SRF and High Voltage off – and to set the PSS to an open state. Afterwards, they should follow the emergency response guidance which can be found at the Emergency Management web page.

CMTF-specific Emergency response guidance is given in the CMTF Operational Safety Procedure which outlines the principal hazards and mitigations in the CMTF including the requires actions and escalation calls for specific classes of emergencies. The locations of alarm panels, emergency shutoff switches / breakers, Run Safe Boxes, fire extinguishers, Muster Points, etc. in covered via on-the-job training.

3.6 Directives

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

3.6.1 Control System Interaction

The CMTF is operated using a blend of 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 and LabVIEW – a proprietary visual programming tool for rapid prototyping and data acquisition created by National Instruments.

All CMTF SRF operations will be conducted from a computer terminal inside the CMTF control room. A computer terminal on the CMTF mezzanine - near the electronics racks - may be used for system commissioning and troubleshooting, via temporary channel access granted to system experts – as well as for operation of the Window Test stand.

Cryogenic operations may be executed by the Cryogenics System Operator on or off-site and via remote system access if desired and at the discretion of the CMTF Manager. The Cryogenic Systems Operator may be responsible for monitoring operations at various different locations on the Jefferson Lab campus simultaneously – as well as on various shifts – and as such, this flexibility is necessary.

3.6.1.1 CMTF Control System Access

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

During operations, channel access is generally closed to everybody except trained SRF or Cryogenic System Operators and system subject matter experts. The CMTF Operators can use discretion to temporarily grant channel access to others via opening IOC channel access so long as the activity is not expected to negatively affect the ongoing test in progress.

Channel access control generally remains in place even during scheduled accelerator downs and maintenance periods.

The CMTF LabVIEW environment is maintained on a few computers in the CMTF control room specifically designated for data acquisition and pushing selected information into the EPICS environment. Access to these computers is regulated through a group login which rotates passwords frequently and requires face-to-face communication with the software administrator in order to get the new password in order to prevent hacking or social engineering scenarios to gain unauthorized access. Addition of personnel which are qualified for access is specifically communicated from the CMTF Manager to the software administrator.

3.6.1.2 CMTF Operator Control System Interaction

Only qualified CMTF Operators have unlimited channel access to all CMTF process variables at all times; however, these personnel must observe the following restrictions.

- Be approved by the CMTF Manager and added to the list of qualified CMTF SRF or Cryogenic Operators.
- RF System Operators must be physically present in the CMTF Control Room and working from a computer console therein when making control system changes during operations.
- Cryogenic Operators may operate remotely while connected to CMTF systems as long as they remain available for constant communication to available to Cryogenics On-call personnel, the CMTF Manager, and the SRF Operator on-duty. The Cryogenic Operator may communicate their contact information and hours of responsibility via email to the above in order to communicate both clearly and unobtrusively if working during off-nominal hours.

3.6.1.3 Control System Interaction Affecting Testing by Others

Personnel other than CMTF Operators who, while CMTF testing is on-going, need to make control system changes that may affect testing must meet the following requirements.

- Be approved by the Duty Operator or the CMTF Manager and be cognizant of any tests presently in progress.
- Have explained to the Duty Operator, in advance, the anticipated changes and been given their approval. The Duty Operator will then open channel access as necessary and appropriate for the task.

- Remain available for constant contact to the Duty Operator or the CMTF Manager (as appropriate) and make periodic progress reports on ongoing work.

NOTE: On occasion, those who are solving specific problems at the request of the CMTF Operator may need access to the control system but may not meet the above criteria. They may be granted access to individual IOCs for a limited time period under the direct supervision of the Duty Operator because they are solving a specific problem disrupting the execution of the program.

3.6.2 Shift Protocol

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

3.6.2.1 Staffing Requirements for Operations

Table 3-1, below, and the paragraphs that follow describe minimum staffing requirements for the CMTF.

Table 3-1: Minimum Staffing Requirements for UITF Operations

CMTF Operating Condition	CMTF PSS State	Minimum Required Staffing
• SRF **OFF**	• *OPEN*	• None
• SRF **OFF**	• *SWEEP*	• Trained Sweeper & Guard per the PSS Sweep Procedure. (Control Room can be unstaffed)
• SRF **OFF**	• *READY* *(Sweep Complete)*	Key control of PSS & SRF source keys. (No staffing required)
• SRF **ON or OFF**	• *RUN*	Authorized SRF Operator in Control Room.

CMTF has four PSS states: OPEN, SWEEP, READY (an exclusion state, when the state when the PSS Sweep has been completed), and RUN.

The staffing requirements shown in Table 3-1 address the possible CMTF operating conditions; other constraints and conventions are as follows:

- RF ON is defined as the CMTF being in PSS *RUN* State and capable of producing SRF fields of any type. (i.e. High Voltage is ON and available to any SRF power sources such as klystron or solid-state amplifiers [SSAs].)
- RF OFF is defined as whenever the CMTF is in a safe condition, being unable to deliver SRF due to High Voltage to the SRF source being off.
- The *OPEN* state: CMTF enclosure open; no SRF or High Voltage permit.
- The *SWEEP* state is where the CMTF is executing the timed PSS Sweep Procedure with a trained Operator and guard to ensure there

are no personnel in the enclosure prior to potential operation. The length of time one may remain in this state is timed by the PSS system; if the sweep is not completed & the key turned to RUN mode in that time frame the PSS-state will revert to OPEN access.

- *READY* is the state the PSS enters when the SWEEP has been completed, and one is capable of entering the *RUN* state with the turn of the PSS key in the chassis. Any attempt to access the enclosure would result in a disruption of one of the PSS access controls, which would in turn drop the enclosure to an *OPEN* state. In effect, *READY* is a personnel exclusion state. CMTF PSS-Interlocked CARM trips will also drop the PSS to this state.
- RF ON or OFF and PSS State: *RUN* – Trained SRF Operator in the control room.
- RF OFF and PSS state: *READY* – Once SRF and high voltage have been turned off, the PSS system may be taken to ready mode – an exclusion state which prevents personnel access to the accelerator enclosure but does not permit the operation of an SRF source. If key control is maintained by removing the PSS key from the chassis and storing it in the CMTF key station – preventing possible operation of the PSS chassis to a run state – the CMTF Operator may leave the JLab site. By procedure the key(s) which energizes the SRF sources associated with testing are also removed and stored in the key station when the CMTF Operator leaves the JLab site. This status allows for a swing shift SRF Operator to leave at the end of their shift, and for the on-coming day shift SRF Operator to continue testing the next morning promptly without requiring the time and staff required for a sweep – which is particularly helpful for operations across weekend days where the majority of staff are off-site. If remaining on the JLab site, the Duty Operator may also hold the key on their person in this state to maintain key control and allow for short breaks for meals, meetings, restroom use, etc.
- Whenever CMTF Operator changes occur for any reason, the oncoming staff members must receive a summary of the shift activities and receive task assignments from the off-going CMTF Operator.
- The key box (used for key control) is located in the CMTF Control Room behind rack TL06B14, adjacent to the RM301 CARM unit. The combination is managed by the CMTF manager and rotates as-needed.

3.6.3 Shift-Turnover Meeting

The shift-turnover meetings are held between consecutive shifts so that the off-going staff can transfer information to the oncoming staff. As CMTF typically only operates 2 shifts per day while testing, this occurs when day shift hands operations off to swing shift. The next on-coming day shift would then review log entries and the shift summary log from the previous shift as well as receive the Communicated Operations Plan from the CMTF

Test Coordinator or their designee. The shift-turnover meetings are held in the CMTF Control Room and usually last less than fifteen minutes.

3.6.4 CARM Response

3.6.4.1 CARM Alarm Response

CARM alarms will terminate CMTF radiation-producing activities by dropping the high voltage supplying the SRF source. In event of a CARM alarm, the Principal Investigator (PI) or Duty Operator shall notify RadCon through the duty phone 757-876-1743 and discuss the operational activities that preceded the alarm. The Test Coordinator and CMTF Manager should also be notified – though this may be done in writing by email, text, etc. RadCon staff may require a supplementary radiation survey as radiation producing activities recommence.

RadCon staff will address the results of the radiation survey with the Test Coordinator, CMTF Manager, PI and/or Duty Operator and discuss the mitigating measures, if necessary, for continued operation. The Test Coordinator will then determine when operations may resume.

3.6.4.2 Neutron CARM Alert Response

One neutron radiation detector in the cave is configured to produce an “alert level” alarm in the control room. This alarm will occur if the neutron levels in the vicinity of the cryomodule exceed 0.5 mrem/hr. This alarm will NOT terminate the test. The Operator may acknowledge the alarm to silence the audible annunciator. When this condition occurs, the Duty Operator shall proceed with the CARM Alarm Response above.

In the event that the alarm occurs outside of a day shift and a survey is not immediately available, the Duty Operator shall place signage prominently at the PSS console stating “Contact RadCon at 876-1743 Survey required” and make an appropriate ELog/SRFLog entry copied to the Radiation Control Manager, CMTF Manager, and to the Test Coordinator. The PSS may then be secured in the ‘Sweep Complete’ state for the evening with RF/HV off and the PSS and CPS keys secured in the Key station as described in Section 3.6.2.1 on page 3-10.

3.6.5 Radiation Surveys

Radiation surveys will be performed by the Radiation Control Department each time the CMTF accelerator is operated, a CARM response is triggered, and the Radiation Control Department deems a survey necessary. Radiation surveys are recorded as discussed in Section 3.6.8.3 on page 3-14

After RadCon has performed an access survey and established any necessary controls, signage should be placed on the cryomodule itself that a radiological release survey is required prior to the removal of the cryomodule from the CMTF enclosure. The Test Coordinator must contact RadCon prior to removal of the cryomodule from the cave so that a survey for activation can be performed. The move must be scheduled far enough in advance to facilitate coordination of the survey.

Any activation of equipment will require radiological work controls or access controls, with instructions from the RadCon conveyed to the CMTF Manager who is responsible for transmitting work restrictions to all affected personnel.

3.6.6 Test Plans

Test plans are procedures written by system experts to perform specific tests of CMTF systems, execute non-standard SRF tests, or as work control documents to coordinate repairs beyond the scope of program outlined in the Pansophy Traveler.

Test plans are written and submitted using an on-line form that is a part of the web-based Testlab Areas Task List (TATL) work planning system (which interfaces with the electronic Permit Authorization System). The form is used to provide the specific test steps, along with a variety of other critical information such as a backout plan, any safety considerations, test conditions required, and contact persons. Once submitted by the author, each test plan is electronically routed for review by key personnel. The test plan can either be approved for execution or rejected for revision. The CMTF Manager evaluates all test plans and schedules them for execution by control room staff.

3.6.7 Control Room Equipment

The CMTF Control Room equipment consists of various computer consoles, ODH response equipment, radiation-monitoring equipment, communications equipment, computer workstations, printers, video monitors and various system specific chassis associated with the monitoring and operation of the PSS and SRF systems and their supporting infrastructure. Various cabling types, connectors, tooling, and office supplies are also available.

3.6.8 Record Keeping

Accurate record keeping is an essential part of CMTF operations and is required for both administrative and technical reasons. CMTF operations record-keeping documents include the ELog (specifically the SRFLog), Pansophy, and a hard-copy paper logbook for every project. Requests for additional record keeping by the control room staff should be directed to the CMTF Manager.

In addition to the above – there is also a paper logbook available in which to capture state changes, certifications, and maintenance of the PSS system.

The CMTF Duty Operators are responsible for on-shift record keeping. Each Operator must enter and review these records frequently to ensure that entries clearly and accurately describe shift activities.

3.6.8.1 Paper Logbooks

Hard-copy paper logbooks are the oldest continuous form of record keeping in use by CMTF. Laboratory style gridded paper composition notebooks are labelled with the date, project, and cryomodule(s) under

test. Each preparatory step, test, and result is logged sequentially in the logbook along with the date and person(s) performing the test. Any errors in the logbook are struck with a single line and initialed as the logbook is a legal document which must be retained per government standards.

Project logbooks are retained in the office of the CMTF Manager and may be checked-out as needed if they need to be referred to later. Paper logbooks for past projects are in the process of being digitized for easier reference by multiple parties. The hard-copy paper logbooks will be retained for at least the required length of time specified for US government record keeping.

3.6.8.2 SRFLog

The SRFLog is the sequential record of the events occurring during the operation of the CMTF, as well as other SRF activities around the laboratory. All information must be entered promptly, since delays often lead to incomplete or inaccurate entries. All entries are automatically annotated with the required date, time and name of the person making the entry. The SRFLog is a computer based electronic log book which can be accessed from the ELog home page.

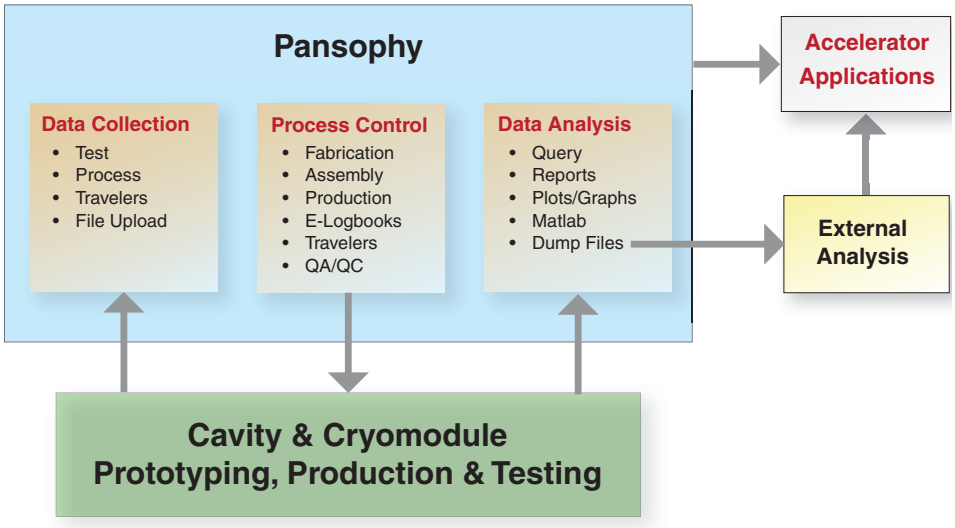
3.6.8.3 Radiation Survey Sheets

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 SRFLog and Radiation Survey Log and the original paper survey sheet archived by the RadCon.

3.6.9 Pansophy

Constructing and managing SRF accelerator systems is complex logistically – with the need to keep track of assembly and subcomponent test data and an ever-evolving set of processes and testing procedures presenting a very real challenge. In addition, accelerator development and construction projects often intentionally push the envelope of well-established technical performance and manageable complexity. The desire to efficiently retain and exploit accumulated experience across the multi-decade life cycles of major SRF installations led to the development of a robust user-friendly online knowledge management system. Users range from process managers, shop-floor technicians, test engineers, to after-the-fact data miners and operations staff.

Figure 3-1: The Pansophy System



To create the possibility for maximum learning from expensive prototyping and low-volume production work Pansophy integrates elements of procedural control, quality assurance, automated data accumulation into a secured central database, prompt and reliable data enquiry and retrieval coupled with a variety of automated online analysis tools – replacing the need for a host of commercially available software packages simultaneously. The system was put into place in 2001, and successfully used for support of the construction of the initial complement of cryomodules for the ORNL Spallation Neutron Source. It has been in continuous operation ever since.

3.6.9.1 The Pansophy System

Pansophy is used throughout the JLAB SRF institute. For the purposes of the CMTF, the portion which applies is largely used from program control and definition: the acceptance testing traveler. Serialized components and assemblies have bodies of testing information which move with them from work center to work center within SRF as they are constructed. These are known as travelers. Once construction of a full cryomodule has been completed, the involved stakeholders create a traveler for that will document its acceptance testing.

The outlined process includes such items as pressure testing, vacuum verification, verifying all connections to the module and operation of interlocks as they come online, cool-down and warm-up of the module to operational and room temperatures, as well as the actual testing of the properties and capabilities of the assembled module itself. This traveler works through the program is small sequential related portions of the test process. The process includes multiple hold points for appropriate managers to stop and review information prior to moving on with the next stage of testing. This properly regulates the flow of work.

Testing in the CMTF establishes the capabilities of the cryomodule. When issues are discovered they may be corrected though the various work control processes (Pansophy, TATL, & ePAS) prior to installation in another accelerator – saving program time further down the line. If there is some significant defect discovered in the cryomodule or component under test, this is also the last opportunity to catch and correct it prior to its production installation at the facility at which it will be used.

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4 Maintenance

Maintenance refers to work performed on the hardware or software of the CMTF. Examples of CMTF 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 CMTF 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, supervising maintenance of the CMTF is the responsibility of CMTF Work Coordinator. Maintenance and project oversight for non-JLab tasks is a shared responsibility between the Work Coordinator and the project's Principal Investigator. For these tasks, the CMTF Work Coordinator handles day-to-day task scheduling and oversight.

Maintenance and project activities for CMTF are supported by the Jefferson Lab system support groups and subcontractors, who perform maintenance tasks for all of the other site accelerators as well as the CMTF and VTA. Approved repairs are performed by authorized personnel. The Work Coordinator role is typically filled by the CMTF Manager, though they may delegate those responsibilities at their discretion.

4.1.1 CMTF Work Coordinator

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

CMTF Work Coordinator responsibilities are as follows:

- Serve as the primary contact for work to be performed in the CMTF.
- Review, schedule, and approve proposed work submitted via the appropriate Work Control Documents (Testlab Areas Task List (TATL), ePAS, or Pansophy).
- Lead focus meetings to address any potential or existing issues, and coordinate any applicable maintenance, installation, or upgrade activities.
- Refer to the Radiation Control Department for special review any potential externally-funded test with requirements that fall outside the normal facility operating envelope.
- With the PI (or their designee) and with a variety of internal and external stakeholders ensure that the facility best accommodates potential users and the program is well defined and supported with appropriate resources.
- Meet with representatives of potential projects to determine if their requirements are in line with the capabilities of the facility and help facilitate the approval and scheduling process.
- Coordinate and schedule the safe and efficient installation of equipment in the facility, including new test equipment and system modifications or upgrades to accommodate the non-JLab projects.
- Participate in the demonstration and testing of new equipment and systems as they move from development to operational running.

4.1.2 System Owners

System Owners oversee all aspects of a specific CMTF system (e.g., SRF, RF, Vacuum, etc.) 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 Testlab Area Task list (TATL) Work Planning Tool and electronic Permit Authorization System (ePAS), contain a hazard identification worksheet that helps facilitate preliminary task hazard analysis and identify any risks associated with the planned 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 is required prior to beginning the work. This approval is obtained through the ePAS system of task submission, review, and approval. EPAS employs required peer review, hazard identification and mitigation, ES&H required review, isolation certificates, and permit / work authorization to include required lock-out/tag-out work controls and pre-job briefings as part of tasks.

When planning or performing maintenance work, Unreviewed Safety Issues (USIs) that might arise from the work must be identified and reported (see Section 1.1.3 on page 1-5). In general, the standard industrial hazards encountered during maintenance are addressed by the *ES&H Manual*. Certain work, however, may affect systems that act as credited controls used to mitigate the known hazards of CMTF operations. Such work includes, but is not limited to the following:

- CMTF modifications that are not replacement-in-kind activities.
- Change-out/replacement of safety equipment that is identified in the SAD or *CMTF 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.

4.2.2 Bypassing System Interlocks

Interlocks are present in many CMTF 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 CMTF 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.

4.2.2.1 In-Service Equipment

Equipment is “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 SRF 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 include bypassing an ODH head through software.
- Exception #2 – Bypasses made during repairs to correct conditions that impede the scheduled program.

Whether a paper tag is required or not, bypasses of in-service equipment shall be logged in the SRF paper and electronic logbooks.

4.2.2.2 Out-of-Service Equipment

Equipment is considered to be “out-of-service” when critical physical connections to the CMTF have been removed. This is accomplished by, at a minimum, physically removing critical cabling that connects the system to the CMTF. Equipment such as a 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.

4.2.3 OPS-PR Problem Reporting System and Repair Protocol

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. When a repair has been completed, an OPS-PR may be marked 'No attention required.'

4.2.3.1 CMTF Repair Protocol

Accelerator repairs are made whenever hardware or software problems interrupt the primary program. The following guidelines describe the repair process:

- The Duty Operator determines whether the problem can be corrected quickly by SRF or control room staff or if external on-call help is required. If on-call help is required, the Duty Operator uses the protocol established by the Web On-Call tool (see Section Section 4.2.3.2 on page 4-6).
- The Duty Operator shall update the Ops Problem Report with the details of the repair (if known), and record any notifications there associated with program interruptions.

- The Duty Operator notifies the CMTF Testing Coordinator if the program interruption is anticipated to be longer than two hours.
- The Duty Operator notifies the CMTF Manager if the program interruption is anticipated to be longer than four hours.
- At the 8-hour mark, the Duty Operator shall update the CMTF Testing Coordinator, CMTF Manager, and apprise the Head of SRF Operations of the issue.
- If the repair takes longer than eight hours or spans two or more shifts worked by repair personnel, then the component must be downgraded in the System Readiness Tool, either by the technician or the Duty Operator (see Section 4.2.6 on page 4-7).

4.2.3.2 On-Call Lists

On-Call lists are used to summon support staff to carry out immediate repairs or to perform repairs that require specific expertise. Support Group Leaders are ultimately responsible for organizing their on-call response program and providing contact information for continuous 24/7 coverage. The on-call information, including escalation contacts, must be supplied using the Web On-Call tool.

4.2.4 Testlab Areas Task List (TATL) Work Planning Tool

Through TATL, personnel can electronically submit tasks for approval and scheduling, as a means to efficiently perform work that could interfere with CMTF operations, facility related work performed by other groups, or activities happening outside of CMTF but within the Test Lab High Bay. Each TATL 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 CMTF Work Coordinator. TATL is interfaced to ePAS.

4.2.5 The electronic Permit Authorization System Work Planning Tool

The goal for electronic Permit Authorization System (ePAS) is to provide a single lab-wide process for task hazard assessment and hazard mitigation, accessible through existing work planning platforms, for activities associated with the maintenance and operation of Jefferson Lab. ePAS is a commercially available industrial-scale software product which is intended to supplement ATLis (and its local clone the TATL), which were locally generated at Jefferson Lab. More information about generating permit requests / permits to work, isolation certificates, and other work planning may be found in the ePAS manual.

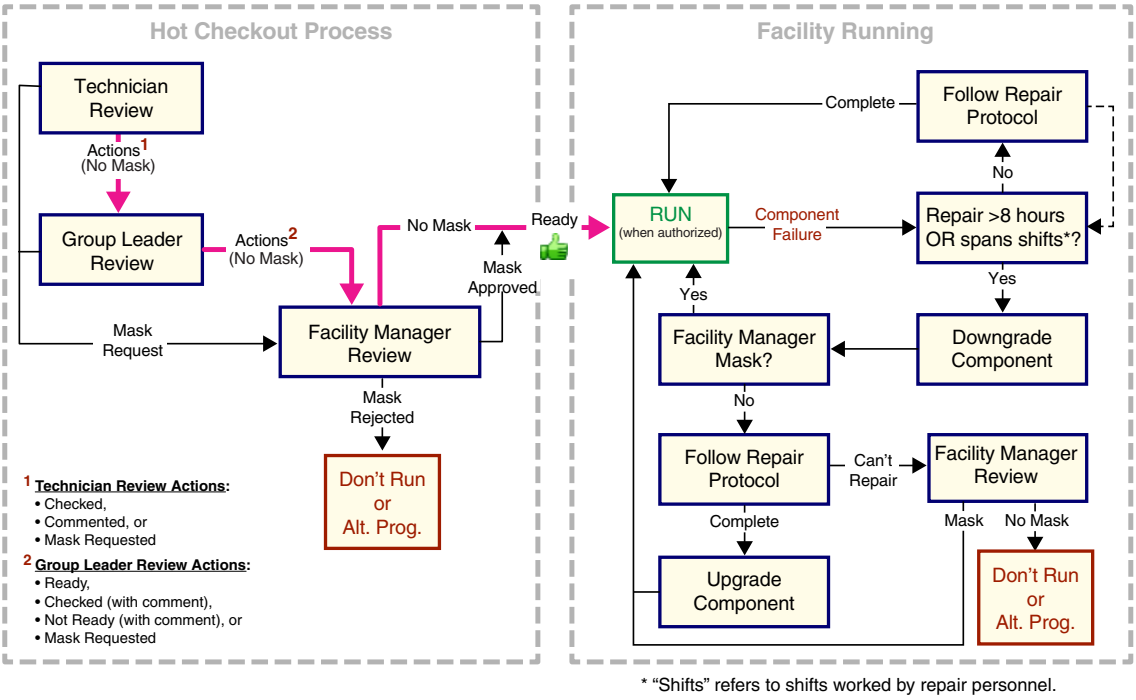
4.2.6 System Readiness

Whether or not a system is ready to support the accelerator program is referred to as system readiness. Because an accelerator has many complex, interdependent systems, it is important to transition to a higher state of readiness in an organized, prescribed fashion, and then continue to know the readiness state of every system during accelerator running. Each system has three possible states of readiness as follows:

- Off – No planned operations.
- Hot Checkout – The transition from Off to Running using a pre-defined process. When the hot checkout process is complete, system experts have confirmed that their systems are ready to support 24/7 operations.
- Running – The turnover to Operations is complete and components are in a state that supports scheduled operations. Component failures during running are addressed using the CMTF repair protocol.

Figure 4-1 shows how system readiness flows through the hot checkout process and integrates with the accelerator repair protocol during running. Additional hot checkout and running details are provided in the following sections.

Figure 4-1: CMTF System Readiness for Hot Checkout and Running



The readiness status of any individual component can be "downgraded" at any time, by anybody, if a component is reconfigured, modified, or potentially compromised. It is ultimately the responsibility of System Support Groups to maintain their components and systems statuses in the System Readiness Manager. Group Leaders and the CTMF Manager routinely downgrade components before any scheduled run period, and System Support

Groups are responsible for downgrading components worked on during a shutdown. The responsible group(s) receives email notification any time a component is downgraded.

4.2.6.1 System Hot Checkout

System hot checkout is a period of scheduled, dedicated time, during which all accelerator systems are recovered, exercised, and made ready for facility operations. Hot checkout ensures that systems and tools are verified as operational. The technicians responsible for facility system installation and maintenance and their managers must participate in hot checkout activities to ensure that their systems are ready for accelerator operations.

The System Readiness Manager is a database-driven web tool that supports a consistent, prescribed hot checkout process. The tool is used to track and communicate progress toward system readiness, and when complete – communicate that readiness to the Head of SRF Operation to issue the Authorization to run for the facility and for the Duty Operators to inspect continued system readiness.

The System Readiness Manager is populated with readiness checklists and checkout procedures that are detailed and repeatable. As shown in Figure 4-1, technicians execute the documented process for each system by changing the status to Checked, adding a comment to explain why the system is not ready, or making a mask request. Group Leaders perform a second level of readiness verification, changing the status to Ready, Checked (with a comment added), Not Ready (with a comment added), or making a mask request.

As the period of planned operations approaches, the CMTF Manager (or their designated work coordinator) evaluates the status of all systems. They review downgraded components and work with System Support Groups to verify that downgrades align with maintenance tasks. As the hot checkout process progresses, the CMTF Manager coordinates with relevant stakeholders to shepherd the process to completion and reviews component mask requests.

Component mask requests can be made at any point during the hot checkout process. Mask requests are submitted with an expiration date. A masked component is hidden in the System Readiness Manager readiness reports. Masks can be removed prior to their expiration or will automatically be removed upon expiration. Mask requests are approved by the CMTF Manager.

After all systems reach a sufficient state of readiness, the CMTF Manager completes the checkout process by issuing final approval of system readiness via a checkoff in the System Readiness Manager along with a logbook entry verifying that all required systems are ready to support facility operations. The Head of the SRF Operations Department may then inspect the state of accelerator readiness - as well as the credited controls - and choose to Authorize facility operations, or not.

While the goal is every relevant component be marked Ready in the System Readiness Manager, this is not a requirement for Operations – though all credited controls must be in place and verified as specified by the CMTF Accelerator Safety Envelope for the facility to operate. The System Readiness Manager is used by the CMTF Manager to assess the technical status of accelerator systems. There may be some individual components not ready and not masked, and the SRF Operations Department Head may choose to authorize RF operations.

4.2.6.2 Work Coordinator Responsibilities in the Systems Readiness Process

The role of the Work Coordinator in the Systems Readiness Process is as follows:

- Oversee the System Readiness Manager and coordinate functional changes as necessary.
- Ensure that all systems required for upcoming operations are included in the System Readiness Tool.

- Define which components will be automatically downgraded at the beginning of every shutdown.
- Work with System Support Groups to downgrade specific components at the beginning of each shutdown, considering planned work and the upcoming program schedule.
- Monitor TATL, ePAS, & Pansophy tasks and work with System Support Groups to downgrade components as necessary.
- Report on readiness progress at the accelerator as necessary during preparations to run.
- Track system readiness and keep the Head of SRF Operations (and the CMTF Manager, if these responsibilities have been delegated) apprised of potential readiness problems.

When the Systems Readiness process has completed and the CMTF Manager has been notified the hot checkout process has concluded – the CMTF Manager may audit the tool and decide whether or not to recommend to the Head of the SRF Operations Department that 'Authorization to Run' the facility be issued.

See Section 1.3 on page 1-11 for detailed descriptions of personnel responsibilities.

4.2.6.3 System Readiness During Running

During scheduled running, it is important to be able to determine the readiness state of all systems required to support the run program. When a component fails, the CMTF repair protocol (see Section 4.2.3 on page 4-5) is followed and the system readiness state is tracked as shown in Figure 4-1 on page 4-8. If the repair progresses quickly, there is no need to downgrade the component; however, if the repair takes longer than eight hours or spans two shifts worked by repair personnel, then the component must be downgraded in the System Readiness Manager by the RF Operator.

Each mask must have an accompanying comment in the System Readiness Manager to explain the rationale for the exception and any associated limitations that the non-operational component may cause. If the failed component will be non-operational for an extended period of time, the CMTF Manager can review and extend the expiration of the mask for the component.

Appendix A List of External Links

General Description:

These external documents were linked to in the document.

- Accelerator Bypassed-Interlock Log (ABIL): http://opsweb.acc.jlab.org/abil/pro/
- Corrective Action Tracking System (CATS): https://mis.jlab.org/ehs/
- CMTF Accelerator Safety Envelope (ASE)
- DOE O 420.2D, Safety of Accelerators: https://www.directives.doe.gov/directives-documents/400-series/0420.2-BOrder-d
- DOE-STD-1073, *DOE Standard, Configuration Management:* https://www.standards.doe.gov/standards-documents/1000/1073-astd-2016
- Emergency Management: https://www.jlab.org/eshq/emergmgt
- Enviornmental Safety & Health Manual: https://www.jlab.org/eshq/ehsmanual
- ePAS: https://www.jlab.org/esh-man/epas
- JLab Integrated Safety Management System Program: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-149177
- JLab Safety Assessment Document: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-21395
- Logbooks: https://logbooks.jlab.org/logbooks
  - SRFLog: https://logbooks.jlab.org/book/srflog
  - RadLog: https://logbooks.jlab.org/book/radlog
- Operations Problem Reports (OPS-PRs): https://logbooks.jlab.org/content/web-based-pr-form
- Pansophy: https://pansophy.jlab.org/pansophy/
- PSS Configuration Management Procedure: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-110171/PSS%20Config%20Mgmt%20Proc%201.pdf

- PSS and ODH System Certification Schedule: https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-10790
- RCD-DEP-24#002, On Adequacy of the CMTF Shielding for Upcoming Tests for LCLS II He Cryomodules https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-59445
- Safety Concern Form: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-17393/Unreviewed%20Safety%20Issue%20-%20Safety%20Concern%20Form.doc
- SRF Production Process: -https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-286312/SRF-10-PR-001%20Production-R2_signed.pdf
- SRF Project Execution Program Description: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-261051
- SRF Project Execution: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-260685
- Testlab Areas Task List (TATL): https://tasklists.jlab.org/tatl/tasks?statusCode=approved
- UITF Element Database (UED): https://ued.acc.jlab.org/
- Unreviewed Safety Issue (USI) Procedure: https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-16644/USI%20Procedure.doc
- Web On-Call: http://opsweb.acc.jlab.org/CSUEApps/weboncall/WebOnCallMain.htm

Appendix B TOD Release Memo

General Description:

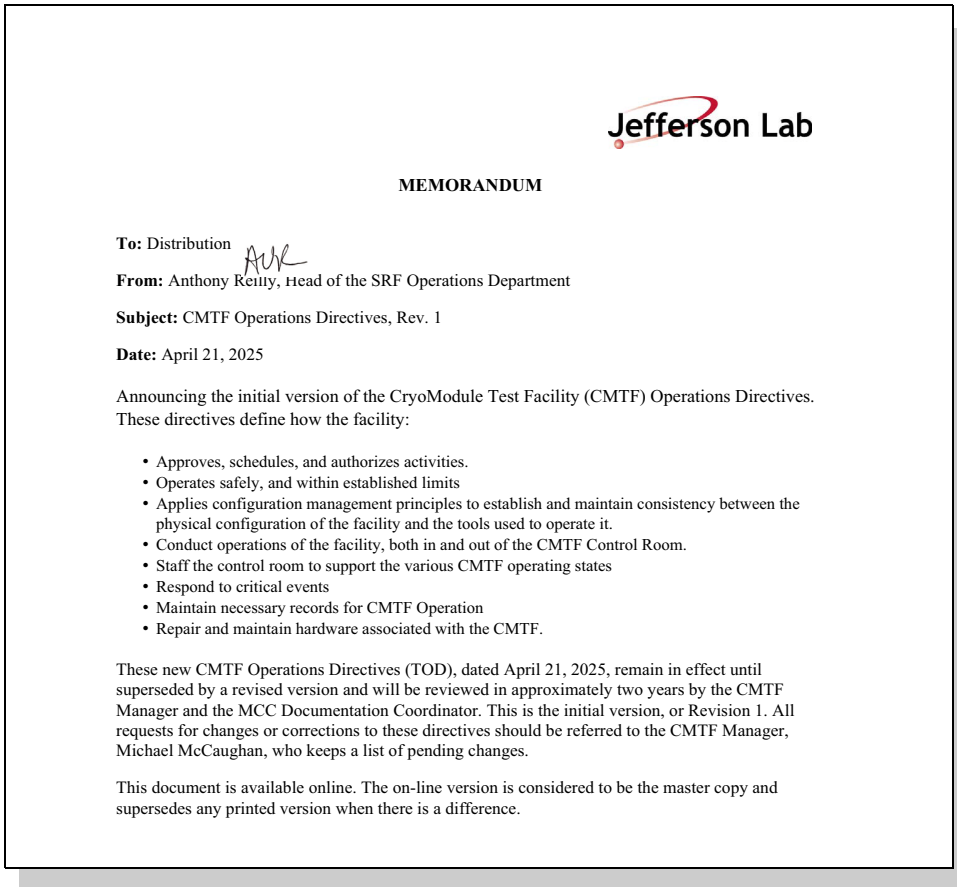
After each revision, the TOD is re-released under cover of the TOD Release Memo, which includes a brief change summary and a list of those receiving notification of the document.

These directives will remain in effect until superseded. Major reviews and updates occur approximately every two years by the CMTF Manager, MCC Documentation Coordinator, and the Director of Accelerator Operations.

Major revisions are noted by a whole number increase in the document's version number. Minor updates that occur before the next major review will be noted by a 0.1 increase in version number and will be announced on the OpsDocs website and via email with this memo attached. Updates for the purposes of correcting spelling or grammatical errors will not be announced, nor will they require a change in version number.

Following is the Release Memo for this version of the TOD.

Figure 4-2: TOD Release Memo, p. 1



Jefferson Lab

MEMORANDUM

To: Distribution

From: Anthony Reilly, Head of the SRF Operations Department

Subject: CMTF Operations Directives, Rev. 1

Date: April 21, 2025

Announcing the initial version of the CryoModule Test Facility (CMTF) Operations Directives. These directives define how the facility:

- Approves, schedules, and authorizes activities.
- Operates safely, and within established limits
- Applies configuration management principles to establish and maintain consistency between the physical configuration of the facility and the tools used to operate it.
- Conduct operations of the facility, both in and out of the CMTF Control Room.
- Staff the control room to support the various CMTF operating states
- Respond to critical events
- Maintain necessary records for CMTF Operation
- Repair and maintain hardware associated with the CMTF.

These new CMTF Operations Directives (TOD), dated April 21, 2025, remain in effect until superseded by a revised version and will be reviewed in approximately two years by the CMTF Manager and the MCC Documentation Coordinator. This is the initial version, or Revision 1. All requests for changes or corrections to these directives should be referred to the CMTF Manager, Michael McCaughan, who keeps a list of pending changes.

This document is available online. The on-line version is considered to be the master copy and supersedes any printed version when there is a difference.

Figure 4-3: TOD Release Memo, p. 2

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