FESHM 2100: FERMILAB ENERGY CONTROL PROGRAM (LOCKOUT/TAGOUT)

Revision History

Author	Description of Change	Revision Date
D. Mertz	Revised several sections in response to self-assessment performed on Hazardous Energy Control Program and 10 CFR 851 update to 2018 edition of NFPA 70E. Affected sections are: 1.0, 4.3.3 (new), 4.3.4, 4.4, 5.3, 5.5, 5.7, 5.8 (isolate step), 5.11, 5.11.2, 5.13 (new), 6.0, 7.1, and 8.2.	December 2018
D. Mertz	Added note 2 to definition of Energy Isolating Device in Section 2.0, definitions of equipment and personal lockout devices added. Clarification of second exemption from LOTO in Section 4.2. Identified possible need for more than 1 knowledgeable employee in Section 4.4 In Section 5.7, added 10th item to the list of justifications for written procedures, revised the duties of Knowledgeable Employee(s), and required re-inspection when a written LOTO procedure is revised.	December 2015
M. Utes	General LOTO procedure - clarified the verification step by adding "the proper level of PPE shall be worn until zero voltage verification is assured."	February 2013
M. Utes	Updated LOTO 2 training requirements: Initial LOTO 2 training shall be classroom-based. Periodic retraining shall be done at two-year intervals and may be done using Fermilab's web-based LOTO training.	5 Year Review September 2012
M. Utes	• Section 3 changed "could reasonably be expected" to "could be expected". • Section 12 changed "for service" to "to be returned for service." • Appendix, paragraph 2. Deleted: "LOTO is not at all concerned with the protection of property or equipment". • Changed D/S to D/S/C and LSC to FESHCom	October 2010

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1.0 INTRODUCTION

The servicing and/or maintenance of machines and equipment are frequent activities that can be hazardous. The related hazards may include energized electrical circuits, capacitors or batteries; pneumatic systems; chemicals which may release energy or pose a biological hazard, the mechanical movement of levers, presses, hydraulic systems, pump shafts or fan blades; vacuum vessels, chambers, or pipelines; and pressurized fluids released from vessels, tanks, pipes or valves. Fermilab is required to establish an energy control program and to utilize procedures for applying appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent the unexpected energization, start-up or release of stored energy in order to prevent injury to employees.

This Chapter establishes the Fermilab Energy Control Program. This Program may also be referenced as the Fermilab Lockout/Tagout Program or more simply as the LOTO Program. Important elements of LOTO include energy control procedures, employee training and periodic inspections. Adherence to the requirements and procedural steps outlined in this Chapter are essential to the safety of all employees and the overall success of the Fermilab Safety Program.

By itself, the Energy Control (LOTO) program does not ensure that all workplace hazards are identified and mitigated but is an integral part of Work Planning and Control and Hazard Analysis as described in FESHM Chapter 2060 and of the Integrated Safety Management method.

2.0 DEFINITIONS

Affected Employee - An employee whose job requires him/her to operate or use a machine or equipment on which servicing, or maintenance is being performed under lockout or tagout, or whose job requires work in an area in which such servicing or maintenance is being performed.

Authorized Employee - An employee who:

- Locks out or tags out machines or equipment in order to perform servicing, maintenance or modification on that machine or equipment,
- Is authorized by line management to perform the work,
- Is qualified by training and experience to perform such work,
- Is able to identify the hazards associated with such work,
- Determines whether or not a written procedure exists for the LOTO activity, and
- In the case of a written procedure, is trained in the use of the written procedure.

Capable of Being Locked Out - An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be applied, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

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Employee - The term employee, as related to the Fermilab Energy Control Program, includes Fermilab employees, term and temporary employees, contract technicians, users, experimenters, graduate students, experimental collaborators, visiting or guest scientists and engineers, and United States Department of Energy Fermi Site Office employees.

Energized - Connected to an energy source or containing residual or stored energy.

Energy Isolating Device - A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following:

- Manually operated electrical circuit breaker,
- Disconnect switch,
- Manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors, and, in addition, no pole can be operated independently,
- Line valve,
- Block,
- Any similar device used to block or isolate energy.

Note 1: *Push buttons, selector switches and other control circuit type devices are not energy isolating devices. An interlock system may not be considered as an energy isolating device with respect to LOTO activities.*

Note 2: *Electrical arc-flash hazard mitigation encourages remote operation of larger electrical switches. The specification and construction of remotely-operated switches should include LOTO provisions unless their use as energy isolating devices is not anticipated.*

Energy Source - Any source of electrical, mechanical, hydraulic, vacuum, pneumatic, chemical, thermal, or other energy.

Equipment Lockout Device: A lock and key used to hold an Energy Isolating Device in the safe position in a Type B group lockout. An equipment lock may be a captured-key lock that is integral to the energy isolating device.

Exclusive Control - As applied to the LOTO exemption for working on cord and plug electrical equipment, exclusive control means that the plug is within sight and reach of the employee so as to preclude the possibility of its being plugged into an energy source.

Hot Tap - A procedure used in the repair, maintenance, and service activities that involves welding on a piece of equipment (pipelines, vessels, or tanks) under pressure, in order to install connections or appurtenances. It is commonly used to replace or add sections of pipeline without the interruption of service for air, gas, water, steam, and petrochemical distribution systems.

Job Lockbox - A container or device into which one or more keys from locks used in LOTO activities are captured by all members of a work crew by attaching their own locks and tags.

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Knowledgeable Employee - An employee who assesses the energy source(s) subject to lockout/tagout, and who writes the procedural steps for the lockout and tagout of the machine or equipment being assessed. This employee has sufficient understanding of the operation and configuration of the equipment so as to fully identify and evaluate its associated hazards.

Lead Authorized Employee - A lead authorized employee is one who performs or coordinates one or more LOTO actions for multiple personnel involved in the servicing and/or maintenance of machines and equipment.

Lockout - The placement of a lockout device on an energy isolating device in accord with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout Device - A device that utilizes a positive means, such as a keyed lock, to hold an energy isolating device in a safe position and prevent the energizing of a machine or equipment. Included are blank flanges and bolted slip binds.

Personal Lockout Device: A lockout device with the key under exclusive control of an individual.

Servicing and/or Maintenance - Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, maintaining or servicing machines or equipment. This includes lubrication, cleaning or unjamming of machines or equipment and making adjustments or tool changes, where the employee may be exposed to the unexpected energization or startup of the equipment or release of hazardous energy.

Supervised LOTO - The placement of lockout and tagout devices on an energy isolating device by an employee or non-employee who has not completed the Fermilab course for LOTO Level 2 when under the direct supervision of a Fermilab authorized employee.

Tagout - The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Tagout Device - A prominent warning device, such as a tag and means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

3.0 RESPONSIBILITIES

3.1 All Employees and Subcontract Personnel

All employees at the Laboratory shall comply with the Fermilab Energy Control Program as described in this Chapter. Disciplinary action shall be taken, up to and including termination, for

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any unauthorized removal of or failure to use locks and/or tags for the control of hazardous energy sources.

4.0 PROGRAM DESCRIPTION

This Fermilab Environment, Safety, and Health Manual (FESHM) chapter:

- Establishes a Fermilab Energy Control Program,
- Establishes procedures for applying appropriate lockout devices or tagout devices to energy isolating devices,
- Describes the procedural steps to be followed by the Authorized Employee who must control the release of hazardous energy during servicing and/or maintenance of machines and equipment,
- Describes the evaluation necessary to determine whether or not a written lockout/tagout procedure is required,
- Presents guidelines for the Knowledgeable Employee, who shall prepare written lockout/tagout procedures,
- Outlines the requirements for training/retraining of personnel relative to the Program, and
- Describes necessary periodic inspections.

4.1 This LOTO Program Applies To:

- The control of hazardous energy during the servicing and/or maintenance of machines and equipment where the unexpected energization, start-up or release of stored energy could be expected to cause injury to personnel.
- Work activities on or near electrical conductors, circuits or equipment which are or may be energized and where there is significant potential for electrical shock or other injuries from arcing, flash burns, electrical burns or arc blast.
- The servicing or maintenance that takes place during normal production operations if the employee is required to remove or bypass a guard or other safety device, or if the employee is required to place any part of his or her body into an area on a machine or piece of equipment where work is actually performed upon the material being processed (point of operation), or where an associated danger zone exists during a machine operating cycle.

4.2 This LOTO Program Does Not Apply To:

- Work on cord and plug connected electric equipment when the plug is under the exclusive control of the employee performing the servicing or maintenance, and when unplugged contains no hazardous stored energy and cannot be unexpectedly energized or started up.
- General access to accelerator or beamline enclosures under controlled or supervised access provided that the employee is not working on or in close proximity to exposed electrical conductors.
- Minor tool changes and adjustments, and other minor servicing activities, which take place during normal production operations, provided that they are routine, repetitive, and

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integral to the use of the equipment for production and that the work is performed using alternative measures which provide effective protection.

- Installations under the exclusive control of electric utilities for the purpose of power generation, transmission, and distribution, included related equipment for communication or metering.
- Exposure to electrical hazards from work on, near, or with conductors or equipment that involves inspection or testing activities, or that involve energized work activities as covered by FESHM Chapters 9110, Electrical Utilization Equipment Safety and 9120, .AC Electrical Power Distribution Safety.
- Hot tap operations involving transmission and distribution systems for substances such as gas, steam, water, or petroleum products when they are performed on pressurized pipelines, provided that Fermilab demonstrates that: 1) continuity of service is essential, 2) shutdown of the system is impractical, 3) documented procedures are followed and special equipment is used that will provide proven effective protection for employees.
- When Fermilab can conclusively demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

4.3 TRAINING

Fermilab provides LOTO Level 1 (Electrical Safety Orientation) and LOTO Level 2 training courses to ensure that the purpose and function of the Energy Control Program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of the energy controls are acquired by employees. All employees must be trained. LOTO Level 2 training is required for authorized employees. Additional on-the-job training may be required for the authorized employee for specific machinery or equipment before work is performed. Additional training is always required for the authorized employee to perform a specific Written LOTO Procedure.

4.3.1. LOTO Level 1 Training

All employees shall be trained:

- To know the definition of a lockout/tagout
- To recognize the locks and tags used at the Laboratory
- To recognize LOTO activities in their areas
- To understand the purpose and use of LOTO procedures
- To respect the locks and tags that have been placed by other employees
- To understand the consequences of unauthorized removal of locks and tags

4.3.2. LOTO Level 2 Training

Initial LOTO 2 training shall be classroom-based. Periodic retraining shall be done at two-year intervals and may be done using Fermilab's web-based LOTO training.

Authorized employees shall be trained:

- In the elements of LOTO Level 1 training
- To recognize hazardous energy sources that may be encountered
- To know the type and magnitude of the energy available in the workplace
- To know the methods and means necessary for energy isolation and control

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- To understand the limitations of using only tagout devices

4.3.3. Training for Tagout-Only Procedures

Where a tagout-only LOTO procedure (one in which locks cannot be placed) may be performed, Affected Employees shall be trained in the procedure commensurate with their responsibilities. This is in addition to training for the Authorized Employees.

4.3.4. Retraining

Retraining shall be required for individual authorized and affected employees whenever any of the following conditions exist.

- Significant changes in job assignments
- Significant changes in machines, equipment or processes that present a new hazard
- Significant changes in statutory requirements, or general or written LOTO procedures
- Reasons to believe that there are deviations from or inadequacies in the employee's knowledge or use of general or written LOTO procedures
- Authorized Employees shall receive retraining in LOTO 2 at an interval not to exceed two years.

4.4 PERIODIC INSPECTIONS and AUDITS

Division/Section/Projects (D/S/P) shall perform and document inspections at least annually to assure that each required written LOTO procedure continues to be implemented properly. The periodic inspection shall consist of three parts.

- Each required written LOTO procedure shall be reviewed by a designated knowledgeable employee from each D/S/P that owns, uses, maintains, or services equipment directly affected by or used to execute the written LOTO procedure, including Energy Isolating Devices. Any mistakes, deviations from program requirements, or inadequacies identified in this review of the procedure shall be corrected.
- The written LOTO procedure shall then be reviewed with all employees authorized to perform the procedure. This review shall be performed by a designated authorized employee (the inspector) other than those authorized to perform the procedure being reviewed. The inspector shall ensure that each employee authorized to perform the procedure understands the procedure and their responsibilities under the procedure.
- The inspector shall observe an instance or demonstration of authorized employees performing the written procedure and shall discuss the implementation with all other authorized employees present. Any inadequacies or potential improvements identified relative to the procedure or its performance shall be noted and corrected.
- The interval between inspections of a written LOTO procedure may extend to greater than one year. However, that procedure shall not be performed again until the procedure inspection and the retraining of the personnel authorized to perform that procedure are completed. The first performance of the procedure after the inspection and retraining is completed may be used as the inspector's observation.

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The periodic inspection for a particular written procedure may need to be performed in more than one meeting if all those employees authorized to perform the procedure are not able to attend. The periodic inspection may serve as an occasion for re-certification of authorized employees or for training new employees in the use of the written procedure being inspected. Such inspections also provide an excellent opportunity to emphasize the importance and primary elements of the LOTO Program. The Fermilab Environmental, Safety, Health, and Quality (ESH&Q) Section will conduct periodic audits of the Program as necessary.

4.5 RECORDS AND DOCUMENTATION

D/S/P's must document that periodic inspections have been performed. Documentation must include the machine or equipment on which the energy control procedure was used, the date of the inspection, the employees included in the inspection, and the names of the knowledgeable and authorized employees performing the inspection. The attached written LOTO procedure sample form includes space to document an annual periodic inspection, though other methods of documentation are acceptable.

Documents related to deviations from the requirements of this chapter, periodic inspections, transfers of responsibility between lead authorized employees, or the alternative removal of locks and tags shall be kept on file in a suitable location. Documentation shall be retained for the calendar year plus three additional years.

5.0 PROCEDURES

5.1 GENERAL PROVISIONS

Deviations from the requirements of this chapter shall only be permitted with the written approval of the area Division/Section Head or Project Manager. Such deviations are often formalized in written procedures that are approved by the Division/Section Head or Project Manager.

Machines and equipment shall be physically isolated from sources of energy at an energy isolating device before performing servicing and/or maintenance activities to prevent the unexpected energization, start-up or release of stored energy in order to prevent injury to employees. (Reference Section 3 for exceptions.) Physical isolation requires that the positive control point be locked out and tagged out wherever possible.

When the energy isolating device is not capable of being locked out, the machine or equipment shall be turned OFF and tagged out in accord with the requirements of this chapter. When using only a tagout device to control the energy isolating device, additional steps such as barricades, blocking of a controlling switch, removal of an isolating circuit element, or the posting of personnel shall be taken to increase the overall level of safety equivalent to that of a lockout. If at all reasonable, the machine or equipment should be modified to accept a lockout device at the energy isolating device as soon as possible.

Whenever replacement or major repair, renovation or modification of a machine or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for

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such machine or equipment shall be designed to accept a lockout device. A review of the LOTO provisions for adequacy shall be part of the approval process for new and modified equipment.

Fermilab supervisory personnel, and in particular Department Heads or Group Leaders, shall determine, with the assistance of knowledgeable personnel, whether or not a written LOTO procedure is required for particular servicing and/or maintenance work activities. If required, supervisors shall ensure that the written procedure is drafted, approved, made available, and that selected authorized employees are trained in the use of the written procedure.

An authorized employee may perform a written LOTO procedure only if trained in the use of that procedure. If a group lockout involves execution of a written LOTO procedure, members of the work group not actually performing the procedure need not be trained in the use of the particular written LOTO procedure.

Before performing LOTO, the authorized employee is responsible for determining whether or not a written procedure has been generated that applies to the activity at hand. If there is a written procedure and the authorized employee is trained in and authorized to use the procedure, he or she shall follow the written procedure. If there is no written LOTO procedure for the activity, the authorized employee shall follow the general LOTO procedure described below.

If the authorized employee encounters a work activity for which there is no written LOTO procedure, yet by personal knowledge or experience believes that there should be a written procedure, he or she shall bring the situation to the immediate attention of a supervisor for resolution before continuing the work activity.

During a planned electrical power outage, non-related work activities may be scheduled to occur during and in the area of the outage. When these other work activities involve the isolation of electrical energy, the applicable LOTO procedure shall be performed and completed at least thirty minutes before the planned onset of the outage. This requirement facilitates positive evidence of isolation at the verification step that is not otherwise possible due to the absence of the energy source during the outage.

5.2 LOCKOUT and TAGOUT DEVICES

The lockout and tagout devices used at Fermilab shall be singularly identified as described below. These lockout and tagout devices shall be the only devices used for controlling energy and shall not be used for other purposes for the duration of the LOTO procedure. LOTO devices shall be durable and capable of withstanding the environment to which they are exposed for the maximum period of time that exposure is expected.

The lockout device used for the Fermilab LOTO Program shall be a uniquely keyed lock with a body that is RED in color. Red colored locks shall not be used for any purpose other than LOTO. Each lock shall have only a single key. If a lock is provided with more than one key, additional keys shall be destroyed or otherwise discarded. A non-red lock may be converted to a LOTO lock by application of red tape or red shrink-on tubing to the lock body. The use of combination

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type locks is not allowed. When multiple locks are required for a single LOTO activity, locks with a common key may be used. (The Fermilab Locksmith is capable of re-keying stockroom locks to a common key.)

The tagout device used at Fermilab shall be a plastic tag imprinted with "DANGER - DO NOT OPERATE". The tag shall be colored white, black and red and shall have a space for the authorized employee's name. The tag shall have a reinforced eyelet capable of accepting a lock shackle of 0.25 inch diameter and be able to sustain a continuous 50-lb pull without failing. The "DANGER - DO NOT OPERATE" tags shall not be used for any purpose other than LOTO.

Locks, tags, adapters, and other equipment needed to perform LOTO shall be furnished to workers by their employer. As a convenience, the following items are stocked by Fermilab for use by employees and users in LOTO activities. Equivalent items may be used if approved by Division Safety Officers.

- 1268-500500 Red Padlock, American Lock Company 1107R.
- 2650-400300 DANGER DO NOT OPERATE Tag, Including Nylon Tie Attachment Device, Panduit PVT-41 or Equivalent.
- 2650-400400 DANGER DO NOT OPERATE Tag, Self-Laminating, Electromark 13704 or Equivalent.
- 2650-500000 Multiple Lockout Device Tree, Osborn OG-80 or Equivalent.

5.3 LOCKOUT and/or TAGOUT DEVICE APPLICATION

Lockout and tagout devices or tagout devices alone shall be applied to each energy-isolating device only by authorized employees actually performing the servicing and/or maintenance work activity. Fermilab supervisory personnel, including construction coordinators and task managers, may also apply LOTO devices even though they are not actually performing the servicing, maintenance or construction work activity. Such supervisory applications of locks and/or tags do not relieve or replace the requirement that each authorized employee actually performing the servicing and/or maintenance work activity must apply his or her own lockout and/or tagout devices. These supervisory applications may be desirable for the purpose of overall work activity control, job safety, and of facilitating field inspections of work in progress.

Lockout devices, where used, shall be applied in such a manner as to hold the energy isolating device in a "safe" or "off" position. Tagout devices, where used, shall be applied in such a manner as will clearly indicate that the operation or movement of energy isolating devices from the "safe" or "off" position is prohibited.

When a lockout device is applied, a tagout device must also be applied to the lock shackle. When an authorized employee has applied a lockout device, he or she shall maintain exclusive control of the key to the lockout device.

It is permissible to use only a tagout device when the energy isolating device is not capable accepting a lockout device. In such cases, the machine or equipment shall be turned OFF and then tagged out. The tagout device shall be placed as close as possible to the energy isolating

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device and shall be securely attached so that it cannot be inadvertently detached during use. Refer to the General Provisions section above for additional requirements when using only tagout. When a tagout device is used without a lockout device, the Affected Employees for the specific tagout must also take part in the periodic training on the LOTO procedure.

The tagout device must clearly and legibly display the name of the authorized employee applying the tagout device. The tagout device **may** also display a picture of the authorized employee, the date of application, and other information pertinent to the LOTO activity. The tagout device shall be securely attached when applied. The use of string or tape for attachment is not allowed.

Only the authorized employee may remove his or her applied lockout and/or tagout device. However, situations do occur where alternate removal becomes necessary. (Refer to the Alternative Removal of Locks and Tags section below.)

5.4 SUPERVISED LOTO

Special situations may warrant an employee or non-employee who has not completed the Fermilab course for LOTO Level 2 having to perform LOTO for his or her own personal safety. In accommodation, an authorized employee may supervise the application of lockout and tagout devices to an energy isolating device by such individuals. This activity is subject to the following conditions:

- When the LOTO activity involves a written procedure, the authorized employee must perform the steps of the procedure and apply his or her own lockout and tagout devices. Otherwise the authorized employee performs the General LOTO Procedure steps.
- The subject individual is required to perform the LOTO Device Application and Verification steps of the Written or General procedure~~,~~.
- The machine or equipment must be capable of accepting a lockout device
- The subject individual is briefed by the authorized employee on the major applicable tenets of the LOTO Program - especially with regard to lock key control and lockout and tagout device removal
- If an employee, the subject individual will be scheduled for the earliest available LOTO Level 2 training

A D/S/P head may choose to require that the area Division Safety Officer (DSO) or ESH&Q Section be notified of instances of Supervised LOTO.

5.5 ALTERNATIVE REMOVAL OF LOCKS AND TAGS

Removing lockout and tagout devices places by another person is an extreme measure that is not be done for convenience. While it is not possible to anticipate all situations, three conditions must exist before performing an alternative removal:

- The person who placed the LOTO device(s) is absent from the Fermilab site and it is difficult or impossible for them to promptly return.
- The locked-out or tagged-out equipment must be returned to service before the person who placed the LOTO device(s) can return to the site.
- Alternatives to removing the absent person's lockout or tagout devices have been evaluated and do not meet laboratory mission needs.

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Supervisory personnel, preferably the authorized employee's direct supervisor, must follow the following steps to achieve an alternative removal of the lockout and/or tagout devices

For cases in which communication cannot be established with the absent authorized employee:

- Take all reasonable efforts to contact the absent authorized employee and to confirm that he or she is not available.
- Request the guidance and assistance of the Division Safety Officer to ensure alternative removal protocols are followed.
- Obtain written approval from the appropriate D/S/P head for the alternate removal of the lockout and/or tagout devices.
- Direct a suitably authorized employee to return the machine or equipment to service while following the normal procedural steps. This person should carefully inspect the equipment to ensure that incomplete work is finished, extra parts, tools, and test equipment have been removed, and guards and other protection are restored.
- Take appropriate steps to ensure that the authorized employee is aware that his or her lockout and/or tagout devices have been alternatively removed before the authorized employee resumes work activities at the laboratory.
- Maintain a record of the alternative removal by keeping the written approval on file.

For cases where supervisory personnel are able to communicate with the absent authorized employee via telephone, text message, or e-mail when preparing for the alternative removal, the following substitute steps can be taken to achieve an alternative removal of the lockout and/or tagout devices.

- Request the guidance and assistance of the Division Safety Officer to ensure alternative removal protocols are followed.
- Receive permission via telephone, text message, or e-mail from the absent authorized employee for the alternative removal of their lockout and/or tagout devices.
- Discuss with the absent authorized employee any special steps to be taken or related concerns.
- Once given permission from both the absent authorized employee and the area DSO or ESH&Q Section contact, direct a suitably authorized employee to return the machine or equipment to the availability of service while following the normal procedural steps.
- Document and keep on file a record of the alternative removal.

5.6 SUBCONTRACTOR ENERGY CONTROL PROGRAMS

Subcontractors, including vendors and outside servicing personnel, are required to have their own energy control program if their work activities involve the potential of injury to personnel by the unexpected energization, start-up or release of stored energy. Subcontractors are not required to adhere to the specific requirements of the Fermilab Energy Control Program except as noted below. Subcontractor programs and practices may differ minimally from Fermilab's Program or substantially, as is the case for subcontractors involved in construction activities.

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Employees are advised that the use of the "DANGER - DO NOT OPERATE" tagout device employed by the Fermilab LOTO Program is common to numerous subcontractor energy control programs.

Whenever subcontractors engage in activities at Fermilab that employ their own energy control program or encounter the Fermilab Energy Control Program, Fermilab and the subcontractor shall inform each other of the restrictions and prohibitions of their respective lockout and tagout procedures. Fermilab informs subcontractor personnel of its program by means of the required Subcontractor Safety Orientation training. Subcontractor programs are submitted to the Fermilab Contract Administrator and are subsequently reviewed and accepted by the ESH&Q Section. Fermilab shall ensure that affected employees understand and comply with the restrictions and prohibitions of the subcontractor's energy control program.

While subcontractors are not required to adhere to the specific requirements of the Fermilab Energy Control Program, two exceptions are required. Designated subcontractors and their employees for the Electrical Time and Material Subcontract and the Heating and Ventilation Service Time and Material Subcontract shall adhere to the specific requirements of the Fermilab Energy Control Program. This requirement stems from the frequency with which these subcontractors perform LOTO activities and the large associated group of affected employees. Fermilab shall provide, at no cost to these two T&M subcontractors, LOTO Level 2 training for these subcontractor employees.

As has been stated, Fermilab supervisory personnel, including construction coordinators and task managers, may apply lockout and/or tagout devices even though they are not actually performing the servicing, maintenance or construction work activity. Such applications by Fermilab employees are to be in accord with the Fermilab Program rather than the subcontractor's program, if different. The subcontractor shall be specifically informed of each such application.

5.7 WRITTEN LOTO PROCEDURE

Particular servicing and/or maintenance work activities may be subject to the specific requirements of a written LOTO procedure rather than those of the general LOTO procedure. Written LOTO procedures may be appropriate in accord with machine or equipment complexity, magnitude of encountered hazards, supervisory discretion, or other factors. Additionally, and in particular, a written LOTO procedure is required for a particular machine or equipment when any of the following elements exist.

- The machine or equipment has potential for stored or residual energy or re-accumulation of stored energy after shutdown which could endanger employees.
- The machine or equipment has more than one energy source.
- The machine or equipment has only a single energy source, but it cannot be readily identified or isolated.
- The isolation and locking out of the single energy source will not completely de-energize and deactivate the machine or equipment.
- The machine or equipment is not isolated from that energy source and locked out during servicing or maintenance.

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- A single lockout device will not achieve a locked-out condition.
- The lockout device is not under the exclusive control of the authorized employee performing the servicing or maintenance.
- The servicing or maintenance does create hazards for other employees.
- There have been past incidents involving the unexpected activation or re-energization of the machine or equipment during servicing or maintenance.
- One or more Energy Isolating Devices are remotely operated.

The written LOTO procedure shall be drafted by knowledgeable employees and approved by a line manager at the Department Head level or higher. Such procedures shall include all elements of the general LOTO procedure described hereafter, be operationally particular in related actions to be taken, and specifically address the particular element(s) that cause or demand that the procedure be written. The elements of Return to Service, described below, should be included in the procedure, especially if special actions or precautions are to be taken. It is recommended that the written procedure be in a sequential checklist format to enhance its proper performance.

The written LOTO procedure shall identify the authorized and affected employees who might be exposed to hazardous energy during the execution of the LOTO procedure and the methods employed to protect them.

Development of written LOTO procedures with equipment, including Energy Isolating Devices, that are owned, used, maintained, or serviced by more than one D/S/P shall include representation from all affected D/S/Ps

If the machine or equipment has potential for stored or residual energy or re-accumulation of stored energy after shutdown, the procedure shall address how such energy shall be relieved, disconnected, restrained, or otherwise rendered safe following the application of LOTO devices to energy isolating devices. For some valves, typically vent or drain valves, the safe position may be the “open” position. Valves with actuators must be in the actuator’s de-energized spring-return position, or a mechanical block or “gag” that prevents the actuator from moving must be held in position by the lockout device. If there is a possibility of re-accumulation of stored energy to a hazardous level, verification of isolation shall be required to be continued until the servicing or maintenance is completed, or until the possibility of such accumulation no longer exists. Devices used to release stored energy or prevent of re-accumulation of stored energy shall have lockout and tagout devices, or where lockout devices cannot be applied, tagout devices alone, applied to hold them in a safe position.

A single written LOTO procedure is allowed for multiple machines or pieces of equipment that are similar in design, have the same type and magnitude of energy to be controlled, and have similar types of controls.
If machinery or equipment is altered in a manner that impacts its written LOTO procedure, the procedure shall be revised accordingly and inspected following the procedure in Section 4.4, Periodic Inspections and Audits.

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Written LOTO procedures must be reviewed annually in accord with Section 4.4. Those authorized employees who are trained in and authorized to use a written LOTO procedure must also be re-certified annually.

5.8 GENERAL LOTO PROCEDURE

If there is no written procedure relating to a particular servicing and/or maintenance work activity, the authorized employee shall follow the general LOTO procedure. The authorized employee shall perform the following six steps to lock out and tag out machinery or equipment before initiating the work activity.

NOTIFY: The authorized employee shall, as necessary, notify affected personnel of the impending shutdown of machinery or equipment and of the application of LOTO devices.

PREPARE: The authorized employee shall understand the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

SHUTDOWN: The machine or equipment shall be turned off or shutdown using proper procedures. An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of the equipment stoppage. If the machine or equipment is already shutdown, it may be beneficial to re-energize it in order to positively identify the connection to the energy isolating device. Such re-energization should be performed only if there is no additional or increased hazard(s) to employees or danger of damage to the machine or equipment.

ISOLATE: The energy isolating device that is needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source.

LOCKOUT and/or TAGOUT DEVICE APPLICATION: Lockout and/or tagout devices shall be applied to the energy isolating device by the authorized employee.

VERIFY: The authorized employee shall check by conclusive test that the source of energy has actually been isolated and that the machine or equipment is inoperable. If reasonable, use the normal operating controls to attempt to start the machine or equipment and then return these controls to the “safe” or “off” positions. Verification is the most critical step of the LOTO procedure. The proper level of Personal Protective Equipment shall be worn until zero energy verification is assured. The machine or equipment is now locked out and/or tagged out and the servicing and/or maintenance activity may be performed.

5.9 RETURN TO SERVICE

Before energy is restored to the machinery or equipment after the servicing and/or maintenance work activity, the authorized employee shall perform the following five steps.

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CHECK EQUIPMENT: The work area shall be inspected to ensure that nonessential items have been removed and to ensure that machine or equipment components are operationally intact.

CHECK WORK AREA: The work area shall be checked to ensure that all employees have been safely positioned or removed.

VERIFY: Verify that the machine or equipment controls are in the "safe" or "off" position.

REMOVE LOCKOUT and/or TAGOUT DEVICES: Each lockout or tagout device shall be removed from each energy isolating device by the authorized employee who applied the device.

NOTIFY: Before the machine or equipment is started, notify affected employees that lockout and/or tagout devices have been removed. Servicing, maintenance and LOTO activities are now complete and machine or equipment is now ready to be returned to service. The source of energy may now be connected.

5.10 TEMPORARY REMOVAL OF LOCKS/TAGS FOR TESTING/POSITIONING

If LOTO devices must be temporarily removed from the energy isolating device(s) and the machine or equipment energized to test or position the machine, equipment, or component thereof, the Return to Service procedure shall be followed before energization. After testing or positioning, the steps of the written or general LOTO procedure shall then be followed. Unless warranted, the "Notify" steps of these procedures need not be performed for such temporary removals of LOTO devices.

5.11 GROUP LOTO PROCEDURES

Servicing or maintenance activities frequently involve two or more employees performing the work activity. Group LOTO may be performed with both General and Written LOTO procedures. While each employee is required to apply LOTO devices, it is impractical to demand that each employee always explicitly perform each procedural step. Two types of group LOTO procedures are available to address such situations. Both involve a designated lead authorized employee who performs or coordinates one or more LOTO activities. The lead authorized employee is responsible for coordinating work forces and ensuring continuity of protection when more than one crew, craft, department, etc. is involved. The other participants of a group lockout shall inform the lead authorized employee of any irregularities, restrictions or concerns during or at the conclusion of their specific work activity.

In all cases, it is essential that each authorized employee of the group be satisfied that the personal safety provided by the group lockout is acceptable and equivalent to the safety provided by individual LOTO. Each authorized employee of the group has the right to verify individually that all hazardous energy sources have been isolated.

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5.11.1. TYPE A GROUP LOCKOUT

In a Type A group lockout, the lead authorized employee performs the LOTO activity and each member of the work group shall apply a personal lockout and/or tagout device to the energy isolating device(s). If the energy isolating device(s) cannot accept multiple LOTO devices, a multiple lockout device tree should be used. These other members of the work group shall remove their LOTO devices after their work activity is completed.

5.11.2. TYPE B GROUP LOCKOUT

A Type B group lockout is meant to accommodate complex LOTO activities that may involve multiple pieces of equipment, multiple energy isolating devices, and/or where the energy isolating device(s) cannot accommodate the weight or volume of personal lockout devices needed. The lead authorized employee performs or directs the performance of the LOTO activity. The key(s) from the equipment lockout device(s) are then captured in the job lockbox that is then secured with a personal lockout and tagout device by the lead authorized employee so as to retain control of the captured key(s). Each member of the work group shall then apply their personal lockout and tagout device to the job lockbox. These other members of the work group shall remove their LOTO devices after their work activity is completed. The lead authorized employee shall be the last to remove personal lockout and tagout devices while returning the equipment to service.

5.12 SHIFT OR PERSONNEL CHANGES

Normally, authorized employees may leave their lockout and/or tagout devices in place until the work activity is complete – even if the activity spans more than one day or a weekend. In non-group lockouts, the work activity may need to be completed by another authorized employee. LOTO continuity is simply achieved by the off-going employee removing their LOTO devices immediately followed by the on-coming employee applying their own LOTO devices. There must be direct communication between the two employees as to any special circumstances of the LOTO or work activity. All steps of the LOTO procedure performed before commencement of the work activity need not be repeated, but the on-coming employee shall verify that the machinery or equipment is de-energized before continuing the work activity.

In group lockouts, responsibilities of all members are specified in Section 5.11. Normally the job lockbox and captured keys remain under the singular control of the lead authorized employee for the duration of the work activity – even over shift and personnel changes. If absent, the lead authorized employee may designate another as “designated” lead authorized employee while retaining control of the job lockbox. Here, the lead authorized employee must return to enable the machinery or equipment to be returned to service.

Special circumstances may warrant the complete transfer of responsibility from the initial lead authorized employee to another lead authorized employee. Here, the off-going and on-coming leads would simultaneously remove and apply their respective locks and tags to the job lockbox, thus ensuring control of the captured keys. The on-coming lead would have authority to remove the lockout and tagout devices placed by the initial lead authorized employee.

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Machinery or equipment that is initially shutdown with a LOTO procedure but remains unattended for significant periods of time and not ready for return to service should be considered for transfer to configuration control until the LOTO work activity resumes. Reference the "Configuration Control Policy" Appendix of this chapter. After transfer to configuration control from LOTO control, the machinery or equipment must be controlled to and in a safe state.

5.13 EXEMPTION FROM LOTO

Article 4.2 of this Chapter permits Fermilab to exempt itself from the Hazardous Energy Control Program requirements "When Fermilab can conclusively demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations." Other than potential exposures to hazardous energy while performing the LOTO verification steps (such as zero voltage verification), an exemption from LOTO for these reasons must be approved by a Department Head or higher, or in the Department Head's absence, a person authorized to act in her or his stead. A risk assessment of the alternatives may be performed to facilitate and document the evaluation of additional or increased hazards. Technical Appendix A of QAM Chapter 12030 provides a method for determining the relative risks of the alternatives.

6.0 REFERENCES

The following documents in their most current form or edition are referenced by or related to the Fermilab Energy Control Program.

29CFR1910.147 The Control of Hazardous Energy (Lockout/Tagout)
29CFR1910.301-399 Subpart S – Electrical
29CFR1926 Safety and Health Regulations for Construction
ANSI/ASSE Z244.1-2016, The Control of Hazardous Energy: Lockout, Tagout, and Alternative Methods
National Electrical Code NFPA 70
Standard for Electrical Safety in the Workplace NFPA 70E
DOE-STD-1030-95: Good Practices for Lockout Tagout
Fermilab Environment, Safety and Health Manual
- Chapter 2005 Operational Readiness Clearance
- Chapter 2060 Work Planning and Hazard Analysis
- Chapters in the 5030 Series relating to Pressurized Gas Safety
- Chapter 9110 Electrical Utilization Equipment Safety
- Chapter 9120 AC Electrical Power Distribution Safety
- Chapter 9180 Hazard Mitigation for Electrical Workers
- Chapter 7010 ES&H Program for Construction

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7.0 TECHNICAL APPENDIX A – LOTO PROCEDURE EXAMPLES

Two examples are provided to offer guidance for the general and a specific written LOTO procedure. Both are in check list format. The written LOTO procedure examples include steps to isolate multiple energy sources and accommodation for the documentation of its periodic inspection.

7.1 EXAMPLE: GENERAL LOTO PROCEDURE

FERMILAB GENERAL LOTO PROCEDURE (EXAMPLE)

Perform the following steps before initiating work activity.

❒ **NOTIFY** Notify affected employees, as necessary, of the impending shutdown.
❒ **PREPARE** Understand the type, magnitude, hazards, and means and methods of controlling the energy involved.
❒ **SHUTDOWN** Turn off or shutdown the machine or equipment using normal procedures.
❒ **ISOLATE** Locate and operate the energy operating device to isolate and de-energize the machine or equipment from the energy source.
❒ **LOCKOUT and/or TAGOUT DEVICE APPLICATION** Apply RED lock and DANGER – DO NOT OPERATE tag to energy isolating device.
❒ **VERIFY** Check by conclusive test that the source of energy has been isolated and that the machine or equipment is inoperable.

Perform work activity. When complete, perform the following steps for Return to Service.

❒ **CHECK EQUIPMENT** Remove nonessential items and ensure that machine or equipment components are operationally intact.
❒ **CHECK WORK AREA** Ensure that all employees are safely positioned or removed.
❒ **VERIFY** Verify that machine or equipment controls are in safe or off position.
❒ **REMOVE LOCKOUT and/or TAGOUT DEVICES** Locks and tags removed by employee(s) who placed them.
❒ **NOTIFY** As appropriate and before the machine or equipment is started, notify affected employees that locks and tags have been removed.

The LOTO activity is now complete. Machine or equipment is ready for service.

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7.2 EXAMPLE: WRITTEN LOTO PROCEDURE

FERMILAB WRITTEN LOTO PROCEDURE (EXAMPLE)

V100 C Magnet Power Supply at MI-60 North Equipment Gallery

Knowledgeable Employee _____ *Department Head* _____
Prepared by Date Approved By Date

Reason for Written Procedure: Multiple Energy Sources and Past Failure of Capacitor Discharge Circuit

Perform the following steps before initiating work activity.

❒ **NOTIFY** Notify Main Control Room (x3721) of the impending shutdown.

❒ **PREPARE** 120 and 480 VAC electrical power sources to be isolated by circuit breakers. Prepare to check capacitor discharge circuit.

❒ **SHUTDOWN** ❒ Turn OFF Front Panel Controls
❒ Turn OFF 480 VAC main breaker of PS and interior 120 VAC breaker.

❒ **ISOLATE** Sourcing electrical panelboards are located at front and rear of power supply.
❒ Turn OFF 300A 480 VAC Circuit Breaker #20 at SWBD-MI60-5A
❒ Turn OFF 20A 120 VAC Circuit Breaker #15 at PP-MI60-4A-3A.

❒ **LOCKOUT and/or TAGOUT DEVICE APPLICATION** Apply locks and tags to above breakers.

❒ **VERIFY** Attempt to turn the power supply ON by use of normal front panel controls. Test the adequately rated voltage testing device for proper operation before use. The voltage testing activity of supply conductors has a Hazard/Risk Category of 2 and requires protective clothing with a minimum rating of 8 cal/cm^2. Check line side of the two power supply breakers in the power supply with a voltage meter to verify that ungrounded conductors are de-energized. Test voltage testing device for proper operation after use.

❒ **CHECK C12 CAPACITOR** Interior capacitor C12 normally operates at 100 VDC with a 10K ohm 1W discharge resistor across it. The resistor is prone to failure. Inspect the resistor for damage and measure the voltage across C12. Voltage should be less than 1 VDC.

Perform work activity. When complete, perform the following steps for Return to Service.

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❒ **CHECK EQUIPMENT** Remove all tools from interior of PS. Close and secure doors to PS.
❒ **CHECK WORK AREA** Ensure that all employees are safely positioned or removed.
❒ **VERIFY** Verify that the power supply's controls are in the OFF position.
❒ **REMOVE LOCKOUT and/or TAGOUT DEVICES** Remove locks and tags from sourcing breakers and turn breakers ON.
❒ **NOTIFY** ❒ Notify the MCR (x3721) that the work on E:V100 is complete and that locks and tags have been removed.
❒ Ask the MCR Crew Chief if the power supply should be turned on and enabled locally.

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V100 C Magnet Power Supply at MI-60 North Equipment Gallery (continued)

TRAINED AUTHORIZED EMPLOYEES

The following employees, including those listed under the Periodic Inspection, have been trained in this procedure and are authorized to use it. Include date of training or re-certification.

PERIODIC INSPECTION

Written Procedure Review

_____

Knowledgeable Employee Date

Procedure Performance Review

_____

Performed by Date

Authorized Employees Included:

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8.0 TECHNICAL APPENDIX B – CONFIGURATION CONTROL

This Appendix sets policy about administrative locks and/or tags used as configuration controls. Specifically, it sets policy regarding the selection, use, application and removal of these configuration controls used to prevent unauthorized access or operation of equipment or systems. Configuration control activity is often instrumental in controlling hazards; in avoiding accidental injury to employees, the public, or both; and in protecting property or equipment from damage.

8.1 LOCKOUT/TAGOUT vs CONFIGURATION CONTROL

In the broad sense, the lockout/tagout activities defined in this chapter can, and often do involve configuration control. However, LOTO activities are distinguished by the fact that employees or subcontractors are actively engaged in service or maintenance work where the isolation (i.e. configuration control) of an energy source directly protects them from injury. Briefly, the goal of LOTO is to protect employees and subcontractors performing work.

The activities of configuration control discussed here deal with other applications of locks and/or tags to control the state or operation of equipment or systems where individuals are not actively engaged in servicing or maintenance. Improper removal of these locks and/or tags may lead to accidental injury of personnel or the public, damage to equipment, disruption of normal process, or degradation of system performance.

Examples of configuration control include:

- Locking electrical equipment cabinets or vaults to prevent access by unqualified personnel
- Locking an access door to the top of an elevator shaft
- Locking out an overhead crane electrical disconnect to ensure use by only authorized personnel
- Locking/tagging of equipment while awaiting repair or replacement of a component part
- Locking and/or tagging of a valve to control the flow of fluids
- Locking/tagging of equipment or a system that is shut down for safety concerns or violations
- Locking a high voltage configuration switch in the 13.8 kilovolt electrical distribution system to control the flow of electricity
- Locking a radioactive waste container to prevent unauthorized addition or removal of material

8.2 GENERAL REQUIREMENTS

Locks and tags used for configuration control are not a substitute for LOTO locks and tags. Configuration control locks and tags must be different from those used in the LOTO Program. Specifically, the use of red colored locks or “Danger – Do Not Operate” tags are prohibited for configuration control. The use of combination locks is allowed and keyed locks may have more than one key.

The use of configuration control locks without tags is allowed where their use is obvious or clearly understood by personnel who might need to remove the lock. Examples include the locking of magnet power supply doors and the locking of high voltage switchgear. Identification may be applied to the lock body. The use of tags without locks is also allowed. Locks available through the Fermilab

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Stockroom are a brass padlock (Stock #1208-500700), and a brass combination lock (Stock #1208-501000).

Administrative or configuration control tags may include text indicating “Danger” (but not “Danger – Do Not Operate”), “Caution,” “Warning,” or “Notice.” CFR 1910.145 offers guidance on tag selection. Manila tags are acceptable. Yellow “Caution” tags are available from the Fermilab stockroom (Stock #2650-400600).

When used, tags must indicate the name and telephone number of the person or group placing the tag. When appropriate, tags should also indicate the date of application, reason for application, and conditions for removal.

Locks and/or tags should be applied at a positive control point and readily visible. The use of a multiple lockout device tree may be advised with certain lock applications. Tags should be durable and adequately attached.

Configuration control locks and/or tags are typically removed by the person or group who applied the devices after due consideration to the reason(s) for their application. Removal by other qualified and authorized personnel is permissible if there is assurance that the removal and subsequent change of configuration will not create an unsafe condition for individuals or equipment.

Individual D/S/Ps may impose additional requirements pertinent to removal of configuration control locks and/or tags.

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