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C-A OPERATIONS PROCEDURES MANUAL

2.36 Lock and Tag Program for Control of Hazardous Energy

Text Pages 2 through 23

Hand Processed Changes

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Approved: \_\_\_\_\_ *Signature on File* \_\_\_\_\_  
Collider-Accelerator Department Chairman      Date

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## 2.36 Lock and Tag Program for Control of Hazardous Energy

### 1. Purpose

- 1.1 This document covers LOTO procedures and requirements, for servicing and maintaining machines and equipment, in which the unexpected restoration of power or start-up, of the machines or equipment, or the release of stored energy, could cause injury to employees. The requirements apply to fixed, permanently installed equipment; to temporarily installed equipment; and to portable equipment.
- 1.2 The program applies to all types of energy sources, such as electrical, mechanical, hydraulic, pneumatic, chemical, thermal resulting from high or low temperatures, or other energy sources. Appropriate procedures should be implemented for specific machines and equipment.

**Note:**

This procedure complies with the SBMS Subject Area [Lockout/Tagout \(LOTO\)](#) which is based on OSHA, NFPA 70E and DOE 5480.19 and uses the more restrictive requirements of each

- 1.3 As per the BNL SBMS there are three types of lockout/tagout procedures. At C-AD we treat all LOTO the same with regard to the need for a LOTO plan/procedure. The annual LOTO Plan/Procedure in [C-A OPM-ATT 2.36.a](#) satisfies the minimum plan/procedure requirements for all LOTO. Individual jobs may need more specific LOTO procedures as determined by the Supervisor or Work Planner. The SBMS definitions are listed below:

- 1.3.1 **Simple Lockout/Tagout Procedure**- involves Authorized Employee locking/tagging equipment with one source of energy. When more than one Authorized Employee is involved each attaches their lock and confirms\* de-energization of energy source.
- 1.3.2 **Complex, Group and Operations Lockout/Tagout Procedure** – involves a Responsible Employee locking/tagging the equipment. The Responsible Employee is the first to LOTO and the last to remove their lock at the completion of work.

**Note:**

Complex, Group and Operations LOTO are equivalent.

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\* This could be as simple as visually checking that the first employees lock is in place, attempting to start the equipment using the pushbutton, or as complicated as the normal verification procedure for placing LOTO, at the discretion of the other employees hanging their lock.

- 1.4 An approved Accountable Key System (Captive or Kirk Key), described in Section 5.1.12, may be used as equivalent to LOTO as long as it protects employees as safely as LOTO.

## 2. Authority and Responsibilities

All employees, users and contractors must comply with lock and tag procedures to protect life and prevent injury. No individual shall attempt to start, energize, or use machinery or equipment that is locked or tagged out of service (except as required during verification of LOTO). Nor shall any employee attempt to defeat a lock or remove a tag without proper authorization as per Reference 7.2.

### 2.1 Authorized Employee

C-AD requires that only an Authorized Employee shall apply the lock and tag. To become authorized, an employee must receive training and be listed in the Brookhaven Training Management System (BTMS) database by the department, group, or shop responsible for the group equipment (see Section 2.3.3). If you are authorized for this particular equipment, proceed with the lock and tag according to the appropriate procedure.

C-AD defines **two** classes of "Authorized Employees."

- 2.1.1 **"Knowledgeable Employee"** - Knowledgeable employees' names are carried on an Organizational list as having received formal coursework in LOTO, and formal training, or documented "hands-on experience", in safety-related technical aspects of the equipment. The authorization of these employees to perform LOTO is limited in that they cannot install "Complex, Group or Operations LOTO." However, they are authorized to attach additional locks and tags in "group LOTO", "complex LOTO" or "operations LOTO" situations, provided that their lock and tag is not the first applied or the last one to be removed.
- 2.1.2 **"Responsible Employee"** (equivalent to NFPA 70E Person-in-Charge) - Responsible employees' names are carried on an Organizational list as having received formal coursework in LOTO, and formal training, or documented "hands-on experience", in safety-related technical aspects of the equipment. They also have the experience to exercise group and system-level judgments. These employees are authorized to LOTO any equipment for which they have organizational approval. They are authorized to perform Complex, Group or Operations LOTO. If coordinated multiple locks and tags are applied by more than one employee, those of the "Responsible Employee" is the first to be applied and the last to be removed.

## 2.2 Affected Employee

An employee whose job requires operating or using a machine or equipment on which maintenance, servicing, or construction is being performed under LOTO, or whose job requires work in an area in which LOTO is performed. An "Affected Employee" need only be able to recognize when the energy control procedure is being implemented, to identify the locks or tags being used, to understand the purpose of LOTO and the importance of not attempting to start up or use the equipment that has been LOTO'd. The "Affected Employees" are personnel who will not actually perform maintenance or service. To become an "Affected Employee", an employee must receive training.

## 2.3 Supervisor (or Work Planner)

- 2.3.1 Responsible to develop, document and utilize specific LOTO plans/procedures for maintenance and servicing when the minimum LOTO plan/procedure in [C-A OPM-ATT 2.36.a](#) is insufficient to protect personnel.
- 2.3.2 The Supervisor of each group within the Department, who utilizes LOTO, shall utilize a LOTO log. This log shall be used to record LOTO tags and locks applied to equipment. It shall be reviewed annually by the Supervisor to verify the status of locks and tags utilized during the required review period. The C-AD QA Manager prompts this review by ESSHQ Division Tickler Card # 303.
- 2.3.3 Supervisors are responsible to annually document, in the form of a memo to the C-A Training Manager, the competency of their workers in performing the duties of an Authorized LOTO employee within their group.
- 2.3.4 All Supervisors of workers who perform LOTO shall be trained at least as an "Authorized Employee" and it is desirable to be trained to the level of "Responsible Employee" for equipment under their purview.

## 3. Prerequisites

All employees must comply with required training.

### 3.1 Purpose of Training

The purpose of training and retraining is to ensure that the employees understand the purpose and function of the LOTO Program. It shall also provide the knowledge and skills required for the safe application, usage, and removal of the lock and tag.

## 3.2 Types of Training

### 3.2.1 Authorized Employees

Each authorized employee shall be trained to recognize applicable hazardous energy sources, the type and magnitude of the energy (electrical and non-electrical), that the machine or equipment utilizes, and in the methods and means necessary for energy isolation and control. BNL's [Lock Out/Tag Out Authorized Employee Training](#) (HP-OSH-151B-W). As designated by the Chief Electrical Engineer, certain electrical workers who are Authorized Employees must also be trained in CPR, which includes First Aid training (TQ-ADULTCPR), in accordance with NFPA70E, Standard for Electrical Safety in the Workplace.

### 3.2.2 Affected Employees

Each affected employee shall be instructed in the purpose and use of the LOTO program. The instruction needs to be sufficient to enable the employees to determine if a control measure is in use and make them aware that disregarding or violating the prohibitions imposed by the LOTO Program could endanger their own lives, or the lives of their coworkers. BNL's [Lock Out/Tag Out Affected Employee Training](#) (HP-OSH-151A-W).

### 3.2.3 On-The-Job Training

As per Section 2.3.3, the appropriate C-A Group Supervisor shall document in a memo to the C-A Training Manager, that an individual in their group, has demonstrated the knowledge and skills required for the safe application and usage of energy controlling devices as an Authorized Employee within their group. The approval memo is required in addition to the individual being current in the Laboratory's LOTO Authorized Employee Training.

3.2.4 Other training may be required depending upon the type of work being performed (e.g. Electrical Safety, Electrical Safe Work Practices, etc.).

## 4. Precautions

- 4.1 The safety of personnel is of primary importance. Be careful not to give instructions to personnel which might place them in the way of physical harm.
- 4.2 Individuals are responsible to take actions to protect themselves from danger and may use STOP Work Authority as required.
- 4.3 The department, group, or shop having control over the equipment shall be responsible to develop and document the use of the LOTO for that equipment.
- 4.4 Restrictions placed on use of push button, unlockable selector switches, and interlocks may not be used as a substitute for LOTO.

- 4.5 Interlocks by themselves shall not be used as a substitute for LOTO. In particular, door switch interlocks (on panels, cabinets, or equipment) are not acceptable as a substitute for LOTO. Using LOTO on an interlocking device instead of on the power source device will be allowed only when *all* of the following conditions are met:
1. The interlocking device(s) is completely reliable and lockable.
  2. The interlock bypass switch(es), if any, is also lockable, and is LOTO along with the interlock device.
  3. Approval has been given by the Chief Electrical Engineer.

## 5. Procedures

### Notes:

These procedures do not apply to the following conditions/situations:

- 1) If a cord and plug-connected electrical equipment is unplugged and the plug is within sight and under the exclusive control of the employee performing the service, a LOTO is not necessary. This provision applies **ONLY** to cord and plug-connected equipment and does not extend to any other disconnecting or isolating equipment. If absent from the area, the employee shall re-ensure safe conditions and control of the plug before resuming work.
- 2) Installations over 600 volts that are electric utility transmission and distribution systems are not covered by this procedure (these installations are covered in 29 CFR 1910.269).
- 3) Minor tool changes and adjustments, other minor servicing, and normal production operations if they are routine, repetitive, and integral to the use of the equipment for production. The work must be performed using alternative measures, such as machine guarding, which provide effective protection.

### 5.1 Implementing LOTO – General Requirements

- 5.1.1 Supervisors and Work Planners shall ensure that all personnel are informed as to the hazard level they will be exposed.
- 5.1.2 Authorized Employees must develop plans and controls for the servicing and maintenance, including LOTO, of machines and equipment using accepted work planning practices. This may be as simple as a brief discussion for routine work or as complex as a specific written LOTO procedure/plan.

### Note:

The minimum plan/procedure for all LOTO is in [C-A OPM 2.36.a](#) which is issued annually for sign-off of all C-AD Authorized Employees.

- 5.1.3 The equipment operator or the Authorized Employee shuts down the equipment using the approved procedures established for the machine or equipment.
- 5.1.4 Authorized Employees, while performing the LOTO process, shall verify that all sources of hazardous energy are controlled to minimize exposure to all persons, whether those persons are involved in the servicing and/or maintenance or not.
- 5.1.5 As determined by the Supervisor or Work Planner, ensure that a specific written LOTO plan is developed, documented, and utilized when the minimum LOTO plan/procedure in [C-A OPM-ATT 2.36.a](#) is insufficient to protect personnel.
- 5.1.6 C-AD shall ensure that all newly purchased equipment that may require servicing or maintenance and is capable of causing injury is capable of being locked out.

**Note:**

Equipment installed prior to January 2, 1990, was not required to have means for locking out. Ensure that this older equipment is designed to accept a lockout device whenever major replacement, repair, renovation, or modification of the equipment is performed.

- 5.1.6.1 If an energy isolating device is not capable of being locked, tagout devices shall be affixed to clearly indicate that the operation of the energy isolating device is prohibited and additional means shall be used for full employee protection including the implementation of additional safety measures such as the removal of an isolating circuit element, blocking of a controlling switch or valve operator, opening of an extra disconnecting device, or the removal of a valve handle to reduce the likelihood of inadvertent energization.
- 5.1.7 If a job is expected to last beyond the end of the working shift, the worker shall notify the responsible supervisor and discuss the circumstances involved. For example, the supervisor may then decide, 1) to install a supervisor's lock and tag, then the worker may remove their lock and tag to provide continuity of the LOTO, or 2) have the worker keep the lock and tag on until the job is completed and the equipment is restored to service. To ensure the continuity of LOTO protection at the time of shift or personnel change, transfer of lock and/or tag shall take place between going and coming workers. If the supervisor's lock and tag is installed in addition to the worker's it may be used as a bridge for exchanging locks and tags between going and coming workers. Other methods may be used that provide equivalent LOTO continuity.

- 5.1.8 The equipment required for LOTO for servicing or maintenance include a distinct Master Lock with a red band (BNL Stock #I-65064) to be identifiable to the Authorized Employee and only used for personal LOTO, and as required by Section 5.1.9, a distinctive red tag (BNL Stock #S-81045)
  - 5.1.8.1 C-AD must provide locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware to employees.
  - 5.1.8.2 Secure LOTO tags using a non-reusable nylon cable tie, suitable for the environment, with strength of not less than 50 pounds.
  - 5.1.8.3 LOTO tags may be secured using tape, or black-and-yellow striped safety tape, only if it is not possible to use the non-reusable nylon cable tie.
  - 5.1.8.4 BNL tags must clearly indicate the name of the employee and organization applying it.
- 5.1.9 Tags are required in addition to locks with the following exceptions:
  - 5.1.9.1 When a Responsible Employee attaches his lock and tag, subsequent Authorized Employees may attach locks only;
  - 5.1.9.2 When a single Authorized Employee is within clear sight of a single disconnecting means (Simple LOTO) and completes the task within one shift and the lock has employee identifying information. (e.g. a drill press disconnect switch which is right next to the drill press).
- 5.1.10 Authorized Employees ensure that LOTO tags are logged in the appropriate LOTO log book.

**Note:**

Logs may be maintained in bound logbooks or on a computer system which may provide access to a single database by persons widely separated in geography and function.

5.1.11 Contractors

- 5.1.11.1 Whenever contractor service personnel are required to perform LOTO, as per the requirements of this procedure, C-AD must ensure that they comply with the minimum LOTO requirements of [C-A OPM-ATT 2.36.a](#) or that they have an approved equivalent procedure.

5.1.11.2 Personnel not supervised by BNL Employees, such as outside service or contractor personnel, who are involved in operations relating to equipment or machinery lockout that affects BNL employees, must submit their energy control (lock and tag) procedures to the BNL Construction Safety Engineer. The contractor shall ensure that his or her employees working on the site are instructed about the program and the prohibition relating to attempts to restart or re-energize machines or equipment, which are locked or tagged out. BNL shall notify the cognizant manager(s) of the affected area(s) about the outside employer's energy control program.

5.1.11.3 The cognizant manager(s) shall ensure that the affected employees understand and comply with the restrictions and prohibitions of the outside employer's energy control program. The manager(s) shall also ensure that the affected employees are informed of the type of lock, tag, and other pertinent contractor's procedures by implementing Enhanced Work Planning.

5.1.11.4 Contractors may use a Danger Tag that meets ANSI Z535.5, Safety Tags and Barricade Tapes, and must use red banded locks with similar look to the BNL required lock. Tags must be capable of withstanding the environment to which they are exposed (laminating, sleeves, etc.).

5.1.11.5 Contractor tags must clearly indicate the company and employee applying the lock, if this information is not contained on the lock.

#### 5.1.12 Accountable Key Systems

5.1.12.1 If an isolating device has a built-in locking mechanism, such as an Accountable Key System (e.g., Kirk-key lock), then it can be used as a locking device and it is not necessary to affix an additional padlock.

5.1.12.1.1 For a Simple LOTO, a personal LOTO tag properly dated and signed must be attached to the built-in lock to indicate that work is being done on the circuit or equipment if the work extends beyond a single shift.

5.1.12.1.2 If there is more than one person involved, the Kirk-key (or a similar device) shall be placed in a lockbox with a tag by the Responsible Employee as for a Group LOTO and then each crew or person shall affix their own lock to the lockbox.

- 5.1.12.1.3 Each Accountable Key System shall be certified by the C-AD Chief Electrical Engineer before it may be used as equivalent to LOTO.
- a. A qualified employee (who is familiar with the operations of the system) must design an Accountable Key System that will be used for servicing or maintenance.
  - b. System design must be kept under configuration control;
  - c. Each key must be uniquely identified;
  - d. Prior to initial start-up of the system, the qualified employee must test the integrity of the accountable key system by verifying that the locked equipment protects employees from the hazardous energy.
  - e. In the event an accountable key is lost or damaged and a duplicate key (if available) is used, follow the procedure in [C-A OPM 2.14, Removal of Locks and Tags by Others](#)

5.1.12.1.4

**Caution:**

If an Accountable Key inspection fails, the accountable key shall not be used as equivalent LOTO and the Authorized Employee must use regular LOTO to place the equipment in a safe condition.

As each Accountable key system that is used for LOTO is operated, the Responsible/Authorized Employee performs a visual inspection to ensure that the mechanical portion of the system is working and that the device is physically prevented from being repositioned to restore hazardous energy to the device. This inspection during each use satisfies the requirement to perform periodic inspections of Accountable Key systems used for LOTO.

## 5.2 Simple LOTO – Specific Requirements

**Caution:**

All LOTO procedures require pre-planning, caution and attention to detail. Always verify your lockout/tagout and retest absence of energy if conditions change, or when there is any doubt as to the safety of the work being performed.

- 5.2.1 The Authorized Employee must have a specific, written and utilized LOTO plan/procedure when the minimum LOTO plan/procedure in [C-A OPM-ATT 2.36.a](#) is insufficient to protect personnel.
- 5.2.2 Ensure that all persons working on the equipment, either directly or indirectly are involved in the LOTO process by attaching their own lock. They must be informed of the type, magnitude and the hazards of the energy, and methods of control.
- 5.2.3 Ensure that all Affected Employees are notified prior to the application and after the removal of LOTO.
- 5.2.4 The equipment operator or the Authorized Employee shuts down the equipment using the approved procedures established for the machine or equipment.
- 5.2.5 Each Authorized Employee working on the task must attach their individual lock and verify de-energization of the hazardous energy.
- 5.2.6 IF there WILL NOT BE exposure to potentially energized electrical conductors or circuits while performing the work, THEN go to Section 5.4, LOTO Requirements When There is NO Potential Exposure to Energized Conductors or Parts.
- 5.2.7 IF there WILL BE exposure to potentially energized electrical conductors or circuits while performing the work, THEN go to Section 5.5, LOTO Requirements When There IS Actual or Potential Exposure to Energized Conductors or Parts.

### 5.3 Complex LOTO (also known as Group or Operations LOTO)– Specific Requirements

**Caution:**

All LOTO procedures require pre-planning, caution and attention to detail. Always verify your lockout/tagout and retest absence of energy if conditions change, or when there is any doubt as to the safety of the work being performed.

- 5.3.1 The Responsible Employee (equivalent to NFPA 70E “Person-in-Charge”) has the primary responsibility for directly implementing a complex LOTO when maintaining or servicing equipment, or during construction activities, and must:
- Apply the LOTO and perform the verification testing prior to work being performed by a crew, craft, department, or other group working under the Responsible Employee’s LOTO;
  - Always apply LOTO tags in addition to locks for a Complex, Group or Operations LOTO;
  - Understand and explain the potential hazards to members of the crew, craft, department, or group. This may be done through the work planner;
  - Accept primary responsibility for persons working under their LOTO;
  - Control and coordinate work forces and ensure continuity of LOTO protection when more than one crew, craft, department, or other group is involved in the overall job associated with the LOTO. This may be done through the Work Planner.
- 5.3.2 If determined by the Supervisor or Work Planner, each Group or Complex LOTO must have a specific written plan when the minimum LOTO plan/procedure in [C-A OPM-ATT 2.36.a](#) is insufficient to protect personnel.
- 5.3.3 A Responsible Employee for each crew, craft, department, or other group must ensure that all persons working under their lock are knowledgeable of the LOTO process. The workers under the group lock must be informed of the type, magnitude and the hazards of the energy and methods of control and they must be notified when the Responsible Employee removes their lock.
- 5.3.4 Ensure that all Affected Employees are notified prior to the application and after the removal of LOTO.

- 5.3.5 The equipment operator or the Authorized/Responsible Employee, must shutdown the equipment using the approved procedures established for the machine or equipment.
- 5.3.6 Responsible Employees, while performing the LOTO process, must verify that all sources of hazardous energy are controlled to minimize exposure to all persons.
- 5.3.7 Each Authorized Employee working on the task must attach their own individual lock.
- 5.3.8 IF there WILL NOT BE exposure to potentially energized electrical conductors or circuits while performing the work, THEN go to Section 5.4, LOTO Requirements When There is NO Potential Exposure to Energized Conductors or Parts.
- 5.3.9 IF there WILL BE exposure to potentially energized electrical conductors or circuits while performing the work, THEN go to Section 5.5, LOTO Requirements When There IS Actual or Potential Exposure to Energized Conductors or Parts.

**5.4 LOTO Requirements When There is NO Potential Exposure to Energized Conductors or Parts**

**Note:**

This section must be followed when there is no potential of exposure to non-electrical hazardous energy during servicing or maintenance. If there is also the potential for exposure to electrical conductors or circuit parts operating at 50 volts or more that may potentially be energized, you must also follow the requirements in Section 5.5, LOTO Requirements When There IS Actual or Potential Exposure to Energized Conductors or Parts.

- 5.4.1 Ensure that the following equipment is available prior to performing lockout/tagout (LOTO):
  - An approved lock and tag identifiable to an Authorized Employee;
  - The required verification test equipment; and
  - Personal protective equipment (PPE), as required.
- 5.4.2 Primary responsibility is vested in the Authorized/Responsible Employee who applies the lock and performs the testing for verification of energy control. Any other Authorized Employees working on the equipment must also attach their own locks to the disconnecting and/or isolating devices or the lock box.

- 5.4.3 Physically locate all energy-isolating devices using available, up-to-date schematics or drawings, and identification tags, as necessary, and notify all Affected Employees and any other personnel in the area of the planned shutdown, prior to the application of LOTO.
- 5.4.4 The equipment operator or the Authorized/Responsible Employee, must shutdown the equipment using the approved procedures established for the machine or equipment.

**Caution:**

1. Operating electrical breakers, disconnects, MCC starters and plugs requires proper PPE to protect against injury from arc flash. See [OPM 1.5.3, Procedure to Open or Close Circuit Breakers, Disconnect Switches, MCC Starters, Meter Switches and Connecting/Disconnecting Plugs](#)
2. For other PPE requirements see C-AD ESSHQ Division web page on [PPE](#).

- 5.4.5 Authorized/Responsible Employees must isolate the equipment from all sources of energy (there may be more than one) using the proper PPE. Only circuit disconnecting means can be used for isolation (control devices, such as pushbuttons or unlockable selector switches cannot be used). Examples of isolation include disconnecting mechanical drives or linkages; closing valves; opening the equipment's disconnecting device (not the operating control).
- 5.4.6 For mechanical equipment, where there is no possibility of working on or near exposed energized conductors or circuit parts, the Authorized/Responsible Employee disconnects, de-energizes, and releases stored energy, and then applies LOTO. If an electrical disconnect was used for the LOTO, electrical testing is not required and may introduce additional hazards.
- 5.4.7 Verify equipment is electrically de-energized by using on-off switches, push buttons, or normal operating controls. Verification must only be performed when all personnel are clear of the equipment. Return all rotary or toggle switches to the OFF or neutral position after testing to ensure the equipment does not automatically start when power is restored.

**Caution:**

For all situations where an individual Authorized Employee applies a lock, the worker keeps the key in their immediate possession under the principle of "lock it and pocket the key." Multiple-lock adapters such as lock trees or lock boxes may be used to allow several locks to be applied to a single energy-isolating device

- 5.4.8 For Simple LOTO, the Authorized Employees apply their padlock to prevent operation of the disconnect or isolating device (verify device locked off by trying to move the operating handle). For Complex, Group or Operations, LOTO, a Responsible Employee designated by the organization must be the first to apply their lock and the last to remove their lock.

**Note:**

If the lock cannot be placed directly on the energy control device, use a special lockout device such as covers for valve hand-wheels; locking devices for ¼ turn valves; or position-restricting devices for toggle switches and circuit breakers.

- 5.4.9 If it is not possible to attach a lock for equipment installed before January 2, 1990, it must be tagged out together with additional measures, such as disabling and labeling a supplemental device to render the system safe. Examples of supplemental devices include removing an isolating circuit element, blocking a controlling switch, removing a valve handle, inserting a blank flange, or operating the next upstream disconnecting device. The intention is to bring the tagout to the same level of safety as lockout.
- 5.4.10 Relieve, or otherwise render safe, all potentially stored or residual energies before working on the equipment or system.
- 5.4.10.1 Dissipate or restrain stored or residual energy (i.e., springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure) by repositioning, blocking, and/or bleeding down. Acceptable methods of dissipation include leaving vent or drain valves open on pressurized hydraulic or pneumatic systems as appropriate.
- 5.4.11 Prior to working on the LOTO equipment, Authorized persons must:
- Define the boundary of their work area (may require ropes, postings, barriers, etc.)
  - Verify the isolation of hazardous, residual energy continually, until the servicing or maintenance is completed, or until the possibility of re-accumulation of stored energy to a hazardous level no longer exists.
  - Repeat verification, or confirm isolation of residual energy as described above when conditions change, boundary changes, or when the job location is left unattended.
- 5.4.12 Upon completion of the required service or maintenance, refer to Section 5.6, Removing LOTO.

**5.5 LOTO Requirements When There IS Actual or Potential Exposure to Energized Conductors or Parts**

**Note:**

1. This section must be followed when there is actual or potential of exposure to energized conductors or parts during servicing or maintenance. If there is also the potential for exposure to mechanical or other non-electrical hazardous energy, you must also follow the requirements in Section 5.4, LOTO Requirements When There is NO Potential Exposure to Energized Conductors or Parts.
2. The required method of electrically de-energizing equipment for service or maintenance is LOTO; however for situations such as long term removal of utilization equipment, disconnecting the conductors may be required. In these situations the electrical LOTO may be removed from the disconnecting device if: the electrical conductors are removed at the utilization equipment, the wiring is left in compliance with the National Electrical Code, and a LOTO tag explaining the condition is attached.
3. If electrical equipment is disabled for the long term, a LOTO is the preferred method of control.
4. For demolition or permanent abandonment of electrical equipment, removal of wiring is required for uncontrolled access. If removal of wiring is impossible or not desired because they may be used again, the removal of the section of wiring at both ends to the wireway is required with a Disconnected Cable Tag hung at both ends in accordance with [C-A OPM 1.5.1, Disconnected Cable Policy](#).

**Caution:**

1. All electrical circuit conductors and circuit parts shall be considered energized until the source of energy is removed, the disconnecting means is under LOTO, the absence of voltage is verified, and, if required, appropriate grounding is in place.
2. Electrical conductors and circuit parts that have been disconnected, but are not under LOTO, tested and grounded (where appropriate) shall not be considered to be in an electrically safe condition.
3. All Authorized Employees must attach their lock to the energy disconnecting devices when there is the possibility of direct or indirect contact with hazardous electrical circuits or parts that may be potentially energized.

5.5.1 Ensure that the following equipment is available prior to performing lockout/tagout (LOTO):

- An approved lock and tag identifiable to an Authorized Employee;
- The required verification test equipment (e.g., meter rated for the proper category based on the available short circuit current), see [C-A-OPM 1.5](#), Section 5.2.1.6, and Attachment 8.8.

**Caution:**

- 1 Personal protective equipment (PPE) required by [C-A OPM 1.5.3, Procedure to Open or Close Circuit Breakers, Disconnect Switches, MCC Starters, Meter Switches and Connecting/Disconnecting Plugs](#) or in the BNL SBMS Subject Area on [Electrical Safety](#) for verification that the circuits are safely de-energized.
2. For all other PPE see the ESSHQ Division web page [PPE](#).

5.5.2 Authorized Employees ensure that they follow the procedure for the type of lockout/tagout required:

5.5.2.1 A Simple Lockout procedure requires that every Authorized Employee attaches their own lock to the lockout device and verifies absence of energy;

5.5.2.2 A Complex, Group or Operations LOTO requires a specific written plan/procedure if the minimum LOTO plan/procedure in [C-A-OPM-ATT 2.36.a](#) is insufficient to protect personnel. Primary responsibility is vested in the Responsible Employee who applies the lock and tag and performs the testing for verification of energy control. All Authorized Employees working on the equipment may observe the verification as it occurs at their discretion, and must attach their own locks to the disconnecting and/or isolating devices or lock box.

**Caution:**

If there is any doubt as to the accuracy of schematics, drawings, or identification tags used in the next step, contact your supervisor, the Power Distribution Group, or the CEE.

- 5.5.3 Physically locate all energy-isolating devices using available up-to-date schematics, drawings and identification tags, as necessary, and notify all Affected Employees and any other personnel in the area of the planned shutdown, prior to the application of LOTO. If required, review up-to-date drawings to ensure no interlocks or relays can result in reenergizing the circuits.
- 5.5.4 The equipment must be isolated from all sources of power (there may be more than one for example, emergency power or control power) using the proper PPE. Only circuit disconnecting means can be used for isolation (control devices, such as pushbuttons or selector switches can not be used). Examples of isolation devices include: opening the safety switch, fusible disconnect, or circuit breaker to the OFF position; racking out a MCC circuit bucket or motor starter in the cubicle; mechanically disconnecting circuit parts, if required.
- 5.5.5 Verify isolation by measuring for voltage on the load side of the disconnect switch. Stop work if voltage is found at this circuit location; provide physical barriers before leaving the work location; and report the condition to the supervisor. Electrical disconnects are considered energized until verified de-energized, therefore a valid Testing, Troubleshooting, & Voltage Monitoring (TTVM) Electrical Work Permit is required. These work permits may be obtained from your Supervisor or the C-AD ESSHQ Division. See your Supervisor, the Chief EE, or the ESSHQ Division if you need a copy of this permit. Since disconnect switches will not permit the door to be opened when a locking device is applied to the switch lever, it is necessary to verify absence of voltage before LOTO devices are applied. Authorized Employees using the proper test equipment (see [C-A-OPM 1.5](#), Section 5.2.1.6, and Attachment 8.8), and wearing the required PPE as required in the Work Permit, must conduct the verification by performing the following procedure:
- 5.5.5.1 Visually check that all contacts have opened. Also, check to make sure that the disconnect switch is not wired backwards, a condition occasionally found in older buildings at BNL (load side terminals installed at line side lugs).
- 5.5.5.2 Using a properly-rated and listed voltmeter, first test an energized source within the range of the circuit being verified, then, while not changing the switch setting, measure between ground and each of the load terminals, then measure phase-to-phase. All measurements should register approximately zero volts. If there is any doubt, contact your supervisor or the CEE before proceeding. Finally test the meter again on an energized source to verify the meter was not malfunctioning. Close the door of the disconnect switch and apply LOTO.

**Note:**

The test shall also determine if any energized condition exists as a result of inadvertently induced voltage or unrelated voltage back feed even though specific parts of the circuit have been de-energized and confirmed to be safe.

5.5.5.3 A similar procedure is applied for equipment isolated by opening a panel-mounted circuit breaker or by "racking out" a large cubicle circuit breaker. For these cases, perform the zero volts check, with a TTVM Electrical Work Permit, at the line terminals of the equipment supplied by the circuit breaker.

5.5.5.4 Where possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching.

**Note:**

Properly engineered and installed voltage monitoring can simplify operations by providing a method of implementing lockout/tagout without requiring the use of personal protective equipment, see [Engineered Voltage Monitoring Solutions for Lockout/Tagout](#)

5.5.6 To apply LOTO the Authorized Employees apply their padlock to the disconnect device to prevent operation and then attempt to operate the device to verify effective lockout. If the lock cannot be placed directly on the energy control device, use a special lockout or position-restricting devices for toggle switches and circuit breakers (control devices, such as pushbuttons or selector switches, must not be used as the primary isolating device). If Complex, Group or Operations LOTO is used, a Responsible Employee designated by the organization must be the first to apply their lock and tag.

**Note:**

For all situations when an individual employee applies a lock, the worker keeps the key in their immediate possession under the principle of "lock it and pocket the key." Multiple-lock adapters, such as lock tree or lock box, can be used to allow several locks to be applied to a single energy-isolating device. For complex jobs in large facilities using multiple locks on multiple energy sources, organizations may implement procedures using a "lockout box" to maintain control over the keys to these multiple locks.

5.5.7 Relieve, or otherwise render safe, all potentially stored or residual energies before working on the equipment or system:

- Short or ground appropriate electrical components to prevent any re-accumulation of energy.
- Install grounding equipment/conductor device on phase conductors or circuit parts to eliminate induced voltage or stored energy. If contact with other exposed energized conductors or circuit parts is possible apply ground connecting devices rated for available short circuit duty.
- Verify the isolation of hazardous energy continually until the servicing or maintenance is completed, or until the possibility of re-accumulation of stored energy to a hazardous level no longer exists.
- Dissipate or restrain stored or residual energy (i.e., capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure) to the extent that the circuit parts can not be accidentally energized by grounding, repositioning, blocking, and/or bleeding down. Acceptable methods of dissipation include grounding, repositioning, blocking, and leaving vent or drain valves open on pressurized hydraulic or pneumatic systems as appropriate.

5.5.8 Verify the equipment is LOTO by operating the normal starting mechanisms for the equipment.

**Note:**

Verification should only be performed when there is no danger to personnel. Return all rotary or toggle switches to the OFF or neutral position after testing to ensure the equipment does not automatically start when power is restored.

5.5.9 Prior to working on the LOTO equipment, Authorized Persons must:

- Define the boundary of their work area (may require ropes, postings, barriers).
- Verify absence of voltage on all exposed conductor or circuit parts within defined boundary using a properly rated and listed voltmeter. Since the equipment has already been verified LOTO, re-verifying absence of voltage does not require any PPE (see [LESC Interpretation at PPE for Zero Energy Rechecks](#)).
- Repeat verification or confirm for absence of voltage as described above when circuit conditions change, boundary changes, or when the job location is left unattended.

- If required, install grounds.

**Note:**

If there is no accessible exposed point to take voltage measurements, other methods of verification must be used (e.g., permanently installed meters on the equipment, or other method approved by the CEE).

5.5.10 Upon completion of the required service or maintenance, refer to Section 5.6 Removing LOTO.

## 5.6 **Removal of LOTO**

**Caution:**

1. Lockout/tagout (LOTO) must not be removed by anyone except the Authorized Employee who applied it. The only exception to this is when the Authorized Employee is not available following the requirements of [C-A OPM 2.14, Removal of Locks and Tags by Others](#).
2. Complex systems under Complex, Group or Operations LOTO require that the last device to be removed must be that of the Responsible Employee who first applied their device.

**Note:**

For temporary release of LOTO for testing or as required, follow the steps below as much as possible. Reinstall LOTO immediately after completion of the testing or positioning.

- 5.6.1 Inspect the work area to ensure that nonessential items have been removed and the machine or equipment is operationally intact. This includes removing all tools and reinstalling all guards. Guards may remain removed if required for testing and the area is safely barriered. Return guards before job is completed.
- 5.6.2 Check the work area and any other area into which the operation of this equipment may project, to ensure that all employees have been safely positioned or removed from the area. Notify Affected Employees and others in the area that the LOTO devices will be removed and the equipment may start.
- 5.6.3 Verify that the operating controls for the system and equipment are in the OFF or neutral position.
- 5.6.4 Remove the LOTO devices and return the equipment or system to operational status by restoring the energy source(s) before turning on the controls to the equipment. Notify operators when equipment is back in

service. Qualified operators follow the checklist, if required, for steps to restore the system. Safe working procedures suggest an operational check of an entire system, even if the equipment under LOTO was only a part of it.

- 5.6.5 If appropriate, return the removed LOTO tag(s) so that it may be recorded in the LOTO log and, if applicable, forward the completed procedure to your Lockout/Tagout Coordinator, Work Planner or Supervisor.

## 5.7 **Periodic Audits**

- 5.7.1 The QA Manager or designee shall perform an annual assessment of this LOTO procedure and the LOTO plan/procedure in [C-A OPM-ATT 2.36.a](#) to ensure that LOTO requirements are being followed.
- 5.7.3 In accordance with ESSHQ Division Tickler Card #303, the Supervisor of each group within the Department who utilize a LOTO log shall annually review the log. This review is used to:
  - 5.7.3.1 Verify that tags and locks have been removed from equipment on closed out LOTOs.
  - 5.7.3.2 Verify that tags and locks are in place on equipment if the LOTO is open for greater than one year. The Supervisor performing the review of open LOTOs shall document the review in the log by entering initials and date of the review.
- 5.7.4 The C-AD QA Group shall work with the Supervisors to this same type of review with the WinSTETS LOTO program.
- 5.7.5 Any deviations or inadequacies identified during the annual assessment shall be corrected.

## 6. **Documentation**

- 6.1 LOTO Logs
- 6.2 LOTO Plan/Procedure (must be kept on file for at least one year)

**7. References**

- 7.1 [BNL SBMS Subject Area, Lockout/Tagout \(LOTO\)](#)
- 7.2 [C-A-OPM 2.14, "Removal of Locks and Tags by Others"](#).
- 7.2 [C-A-OPM 2.37, "WinSTETS"](#).
- 7.3 BNL Red Tag (BNL Stock #S-81045).
- 7.4 BNL Master Lock (BNL Stock #I-65064).

**8. Attachments**

- 8.1 [C-A-OPM-ATT 2.36.a "Sample LOTO Procedure/Plan"](#).