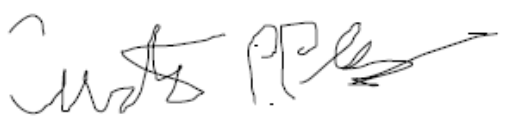

LOCKOUT/TAGOUT PROGRAM

Safety Services – Health & Safety

University of California, Davis

Version 1.0

Revision History

Lockout/Tagout Program		
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LOCKOUT/TAGOUT PROGRAM

I. Introduction

A. Summary

Powered equipment (chemical or thermal), or utility systems use or transfer one or more types of energy. These energy sources must be isolated from equipment to provide a safe working environment for the employees working on the equipment. All employees need written procedures, equipment and training on Lockout/Tagout (LOTO) practices prior to working on equipment that can cause injury due to active power from one or more energy sources, or potential energy from sudden movement.

A written LOTO program is required by UC Davis Policy & Procedure [290-84](#), and Cal/OSHA regulations. The program is almost always required for departments with maintenance responsibilities, such as Facilities, Utilities, Grounds, Housing, construction, installation and renovations in Design and Construction Management (DCM) projects, laboratories, and other groups using research equipment (i.e. Principal Investigators). A written LOTO program is also required for machine shops and off-campus field station locations. Each department must check whether they perform tasks requiring LOTO, and if so, must verify and ensure they meet the following basic LOTO requirements. If tasks requiring LOTO are conducted, they must:

1. Establish a written departmental LOTO plan compliant with this program.
2. Ensure existing and new equipment is capable of being locked out.
3. Provide employees with LOTO equipment (locks, hasps, tags, etc.).
4. Train both affected and authorized employees on the LOTO requirements initially, and complete a refresher training class every three years.
5. Ensure only authorized employees are locking out equipment and isolating energy before working on equipment.
6. Develop written LOTO Standard Operating Procedures (SOP's) for all equipment before commencing work.
7. Review the LOTO SOPs annually for effectiveness.
8. Maintain an inventory of equipment requiring LOTO.

The template found in [Appendix A](#) should be used to develop each department's LOTO plan, and can be modified to fit department needs.

B. Purpose

1. Employee Injury Prevention

The program's prime objective is reducing the risk of serious injury to UC Davis employees from the sudden and unanticipated release of uncontrolled energy. Serious injuries are avoided if the employee tests the equipment before they work on it, verifying there is zero energy. Zero energy means sources of hazardous energy (i.e. electrically or mechanically powered equipment, fluid, pneumatic or hydraulic pressure, steam, compressed gases, or hot water lines) have been identified, shut off, isolated or de-energized, labeled (tagged), and secured. A well-defined LOTO program and plan provides a framework to identify these sources, develop procedures, and train and guide employees on safe installation practices, equipment set-up, and equipment maintenance to isolate the kinetic and static energy prior to beginning work.

C. Applicability and Scope

The LOTO program applies to ALL employees working with all forms of hazardous energy. There are two main categories of energy requiring LOTO:

- **Kinetic energy:** Mechanical, chemical, pneumatic, thermal (i.e. steam, hot water), electrical, hydraulic, or compressed air equipment (i.e. HVAC, machine shop equipment, cranes, wood-working equipment, etc.) where an employee can get struck by, caught in between, crushed, or otherwise injured by moving parts (i.e. rotating gears, fan belts, pulleys, flywheels, rolling or pressing components, etc.). In addition, electrical equipment (i.e. switchgear, transformers, MCC and in general electrical panels) can cause employees to get shocked or exposed to arc flashes or thermal burns. Also, steam, condensate, hot water, or chemical systems expose employees to toxic chemicals or potential burns.
- **Potential energy:** Stored energy released from suspended parts (i.e. equipment suddenly falling, moved by gravity, air flow moving pulleys), energy released from equipment under pressure (i.e., springs), or energy stored in charged capacitors. Equipment that could suddenly fall or move needs blocks for support, or blocks between fan blades or pulleys which could suddenly turn. Capacitors need to be discharged to the ground.

This LOTO program does NOT apply to:

- Minor tool changes, adjustments, or other small service activities taking place during normal operations if they are routine, repetitive, or integral to the use of the equipment (i.e. changing a drill bit on a drill press).
- Unplugged equipment from a utility source. For example, unplugging single-source energy equipment (i.e. a hand-held circular saw when changing a saw blade, or a house vacuum cleaner when changing a vacuum bag) is an energy isolation practice and complies with the LOTO program.

However, work situations where a piece of equipment does not need to have LOTO applied must first meet three conditions:

1. When equipment is isolated and made safe by unplugging an electrical cord, compressed air hose, or some other single-source energy supply*.
2. When the person working on the equipment has exclusive control (within eye sight) over the connection to the energy source.
3. When the single-source energy equipment has no possibility of unsafe movement when the energy source is unplugged.

***Note:** If a piece of equipment is operating on a single utility source, but can store multiple sources of energy, then just unplugging the utility energy is NOT acceptable to Cal/OSHA and LOTO must be applied. For example, if a wood planer plugs into an electrical outlet but has a flywheel on the planer blade, then LOTO must be applied prior to working with the equipment, even if it is unplugged from the electrical source. While the utility energy may be isolated by unplugging the electrical cord, there may be stored energy in the rotating flywheel driving the planer-blades.

Live Work (no LOTO required) is allowed when equipment cannot be shut down or locked /tagged out, provided the following three criteria are met:

1. Department management demonstrates continuity of service is essential.
2. Shutdown of the system is impractical.
3. Personal Protective Equipment (PPE) is provided, and employees follow documented standard operating procedures.

One of the three criteria must exist before Hot Work (work with live power) is permitted. If the three criteria cannot be met, then LOTO must be applied, and Environmental Health & Safety (EH&S) must be consulted prior to initiating any Live Work.

II. Program Roles and Equipment

A. Roles and Responsibilities

1. Faculty, Staff, Affected Persons

An affected person is defined as someone who works on or near equipment, but does not work in a manner that puts themselves at risk of injury requiring LOTO. All faculty, staff, and any other person working with equipment (not maintenance or service) must take the online LOTO awareness training (lms.ucdavis.edu), and must understand they should never work with the equipment, remove a LOTO device, or remove/disturb a mechanical block put in place by someone else which prevents equipment movement.

2. Authorizing Personnel

Managerial personnel (i.e. managers, superintendents, supervisors, etc.) must act as authorizing personnel. They authorize which employees will conduct LOTO, and are authorized as a person who performs duties, which include cleaning, repairing, servicing, setting-up, and adjusting operations on equipment requiring energy isolation. The authorizing personnel will determine an employee's qualification based upon knowledge of the employee's experience, skills and knowledge of the energy sources on the equipment. All authorizing personnel must provide appropriate tools ([Appendix B](#)) for their employees to perform LOTO. It is the responsibility of the authorizing personnel to determine the limitations of authorization for each person working under their direction, and document each employee's LOTO training.

3. Authorized Person

An authorized person is an individual formally recognized and documented by the authorizing person as:

- Responsible for developing and following required written LOTO procedures.
- Having completed required classroom and hands on training on how to perform LOTO.
- Having sufficient understanding of LOTO safe work practices and equipment to recognize and positively control any hazards.
- Possessing the work experience necessary to execute work according to recognized and accepted LOTO safe work practices.
- Having familiarity to a specific equipment's LOTO procedure when working on equipment.

- Being able to conduct annual audits on existing procedures, as necessary.

4. DCM Project Manager

Design and Construction Management (DCM) project managers ensure the requirements of this program by ensuring lockable equipment is purchased and installed through capital projects, including new construction, building retrofits, and specific equipment installation, replacement and upgrades. The project managers are also responsible for verifying LOTO and energy isolation locations are identified in all affected building systems, written LOTO procedures developed and provided to the host department, and LOTO signage and labels (i.e. NFPA70e) are installed on energy disconnects.

5. Owner Departments

An owner department is any department on campus who owns or operates equipment requiring LOTO. Owner departments are responsible for identifying equipment operating with single or multiple sources of energy. Academic departments who own or operate equipment in existing buildings, not under the control of Facilities Management, must develop a LOTO plan ([Appendix A](#)) for their equipment. Every owner department must maintain an inventory of all equipment requiring LOTO, have written LOTO procedures, and train their authorized employees.

These departments must identify which individuals are authorized to conduct LOTO. The departments may arrange with EH&S for their personnel to receive documented LOTO training, or may use another vendor for authorizing personnel as long as the contents of this LOTO program are included in the training curriculum.

6. Maintenance Departments

Departments with maintenance staffs must:

- Develop a LOTO plan for work in their own department/building equipment ([Appendix A](#)).
- Determine the authorized maintenance employees who will work on the equipment.
- Train all authorized employees on the LOTO program and plan.
- Maintain an inventory of equipment requiring LOTO and develop written energy isolation procedures for this equipment for use by authorized employees.
- Properly label, as applicable, all energy disconnects or dissipation locations on specific equipment maintained by the department.

- Conduct an annual audit of equipment-specific energy isolation procedures and verify the accuracy and conformance with required safe work practices.
- Inform all contractors of any known energy sources on the equipment, any energy isolation procedure previously developed for the equipment, and any other known hazards associated with the equipment.
- Conduct pre-work meetings which include a review of the energy isolation procedures for the equipment with all authorized person(s) prior to commencing work.
- Verify, as applicable, the arriving shift workers have put locks and tags on all energy sources before the previous shift's locks and tags are removed (when multiple shifts work on the same equipment).

Note: LOTO procedures can be written in the field prior to initiating the work as long as a written SOP is then developed and kept on file.

7. Department Safety Coordinators, Safety Officers

A Department Safety Coordinator (DSC) is a safety representative who organizes and maintains safety programs within their department. The DSC, Safety Officer, or other responsible safety person has [training](#) log sheet retention and [record-keeping](#) responsibilities as outlined in those sections of this program.

8. Principal Investigators

The Principal Investigator (PI) is a representative of public service projects and research, and is responsible for:

- Informing all faculty, staff, students, work personnel and/or hired-in contractors of the existence of this LOTO program and its applicability and use in their work areas.
- Developing a LOTO plan for their department/area per [Appendix A](#).
- Determining the authorized persons on the team who are able to approve work on the equipment.
- Ensuring subordinates have documented training concerning LOTO at a level appropriate to the anticipated level of exposure to hazardous energy sources in their research and/or workplace.
- Making sure, as applicable, proper labeling is applied to all disconnect locations on specific equipment controlled by the department.

- Making sure safe energy isolation LOTO procedures are written for the equipment being worked on.
- Conducting an annual audit of equipment-specific LOTO energy isolation procedures, and verifying the accuracy and conformance with required safe work practices.
- Informing all authorized person(s) and/or contractors of any known energy sources on the equipment, any energy isolation procedure previously developed for the equipment, and any other known hazards associated with the equipment.
- Conducting staff meetings which include a review of energy isolation LOTO procedures for the equipment with all authorized person(s) prior to commencing work.

PI's may delegate, in writing in the LOTO plan, the above responsibilities to an authorized person.

9. Contractors

Contractors must develop and follow their own LOTO program when working on University property and equipment. Contractors will also provide evidence of their LOTO program to the DCM, or other project managers upon request and provide their own energy isolation equipment including locks, tags, and hasps.

If the owner department or PI previously developed equipment-specific LOTO procedures for equipment the contractor is working on, then the contractor follows the department's or PI's procedures.

10. EH&S

EH&S is responsible for:

- Writing and maintaining this program to meet Cal/OSHA requirements.
- Informing departments of this program's requirements.
- Providing general LOTO program awareness across campus.
- Providing training on program requirements to all affected personnel identified by each department.
- Providing templates for the creation of equipment-specific written SOP's.
- Providing assistance in developing LOTO procedures.
- Recommending energy isolation equipment for general and/or specific use.

- Providing safety engineering assistance to develop alternate safe work procedures when Hot Work (Live Work) must be conducted instead of LOTO.
- Updating this program periodically, or as regulatory changes may dictate.

B. LOTO Energy Isolating Devices: Types and Uses

Mechanical, electric, pneumatic, hydraulic, thermal, machine shop, experimental or research, and other energized equipment or power-driven machines must be equipped with, or readily adaptable to having lockable controls. Machines, equipment, or prime movers not equipped with lockable controls must have another positive means (i.e. de-energizing, disconnecting from power, or other actions), which prevents inadvertent movement or release of stored energy.

The following list contains the basic equipment ([Appendix B](#)) required for LOTO and made available to all employees.

1. Locks

LOTO locks must be clearly identified by a name, number and/or color. Locks are used with tags which are distributed and approved by authorizing personnel. Locks are placed on energy isolation equipment by the authorized employee working on it. The lock ensures other employees do not accidentally turn the equipment back on.

Each LOTO lock has two keys. One key must be in the possession of the authorized employee who applied the lock, at all times. The second key must be destroyed. Only one key is allowed per employee per lock.

Locks Only: UC Davis allows the use of locks on each energy-source isolation point, but without the need to install a written tag at the location when all of the following criterion are met:

1. When the work is completed within a single eight-hour shift.
2. When the work is done by only one person.
3. When all energy isolation points are within eyesight of the person.
4. When the person is present for the entire time the work is done.

If any of the above criterion cannot be met during the work (i.e. the person must leave to eat lunch, or use the restroom), then written tags must be installed at each energy isolation point prior to continuing the work.

The only exception to item four above is when the person can lock up the equipment, and all its energy isolation points in a room to which no one else has access, including janitors or research associates. In such a situation, tags do not need to be installed on lockout points.

2. Tags

LOTO tags are placed on the controls of the equipment during repair work and setting-up operations. The tag is 3" x 5", and must state "DANGER, DO NOT OPERATE" with black lettering against a white background. Tags must be capable of enduring 50 pounds of pull.

Tags must state the:

1. Reason for the lockout.
2. Name of the employee(s) working on the equipment, machinery, or system, and employee contact information.
3. Date and time the tag was put in place.

Tags only: When locking a device is not feasible, a tagout-only system may be utilized. A tagout procedure may only be implemented after the supervisor has reviewed the circumstances and determined using only a tag is safe.

3. Hasps

When more than one worker is servicing a piece of equipment, a lockout adaptor hasp is used. This allows all workers to place their locks on the disconnecting equipment. Each worker puts one of their locks on every isolation device prior to starting work on a machine. After the work is completed, each worker removes their lock(s) and the machine is then returned to service.

4. Group Lock Boxes

Group lockout boxes are used when a group works on a lockout. Workers put their keys inside the lockout box and then each worker places his/her lock on the box. Reactivation cannot proceed until all workers remove their locks.

5. Labels

As applicable, signs or stickers stating "LOCKOUT HERE" with accompanying information of the equipment being controlled at the disconnecting location must be installed directly by personnel to the correct lockout devices. In complicated operations, schematics of the disconnecting means may be developed by the DCM or the relevant department.

6. Blocks, Blinds, and Bleeds

Blocks are used to lockout mechanical energy. Blocks must be placed under raised dies or lifts, and between fan blades, pulleys or any equipment which might inadvertently move by sliding, falling, rotating, or rolling. Blocks, special brackets, or special stands, such as those commonly used under raised vehicles, must be available and used, when applicable. Another form of blocking is the placement of a blind. A blind is a disk of metal or inflatable device inserted into a pipe to ensure no air, water, steam, or other substance will pass through that point if the system is accidentally activated. Before installing blinds or blocks, bleed down the steam, air, or hydraulics lines to get rid of any pressure. Bleed valves must be locked “open”. Coiled springs, spring-loaded devices, or suspended loads must also be released so stored energy will not result in movement.

7. Chemical or Thermal Equipment

Chemical energy includes chemicals stored in tanks and pumped through pipelines under pressure or transferred by force of gravity. Thermal energy can be liquid or vapors (i.e. steam or condensate lines or hot liquids) with various valves which must be closed, locked out, and the liquids drained from vessels before work can safely begin. Valves for these types of energy include gate, butterfly, or ball valve handles which must be locked. Often times, double block and bleed systems are also used to drain down hot fluids or chemicals.

8. Electrical Box or Plugs

Electrical panel boxes with external on/off handles are locked in the closed position with a hasp applied if multiple workers are locking it out. Electric plugs can be locked with the male plug end in the box locked out in the closed position or the electrical switch locked out.

9. Capacitors

Capacitors must be safely discharged to the ground with ground straps installed prior to working around, storing or transporting them. Capacitors can also be discharged using a bleeder resistor, or by discharging the capacitors with other appropriate equipment. If an employee works on circuits with the power off, a resistor of 100 to 500 ohms per V (i.e. 200 V capacitor, use a 20K to 100K ohm resistor) is used for discharge across the capacitor. A loose high voltage capacitor should have a wire connected across the terminals once it has been discharged.

Only experienced and qualified electricians should attempt to discharge a capacitor manually. Proper PPE must be worn, including protective goggles and highly insulated gloves. Equipment must always be tested with a suitable voltmeter and discharged before working on or near them.

C. Methods of Locking Out and Isolating Energy

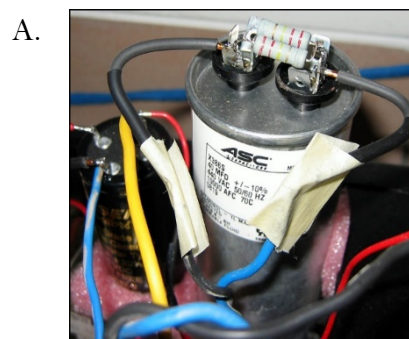
1. Electrical Energy

There are many different ways to lock out electrical equipment. Departments must use the safest method to lock out this electrically energized equipment. In some equipment, an electric control circuit will activate a main power circuit. In such situations, both circuits must be locked and tagged out before safe work can proceed. However, more commonly, the main electrical disconnect switch has only one open position and is locked in the closed position. If more than one employee works on the equipment, the lockout adaptor or multiple-lock hasp, suitable for the installation of several locks must be used, enabling all workers to lock out the machine with their individual locks. If the controls are in a metal-covered box, a hasp can be welded or riveted to the door, along with a lock staple. Then the switch can be opened and the door closed and locked. There are special clips to keep breakers in the open circuit position and locked, and specific clamps used for lockout both for single and multiple breakers. If a breaker was removed in order to de-energize the equipment, the breaker box must be locked in the same way as electrical boxes.

Examples of electrical panels locked out with locks/hasps tied down in the closed position:



Example of capacitor discharged to ground:



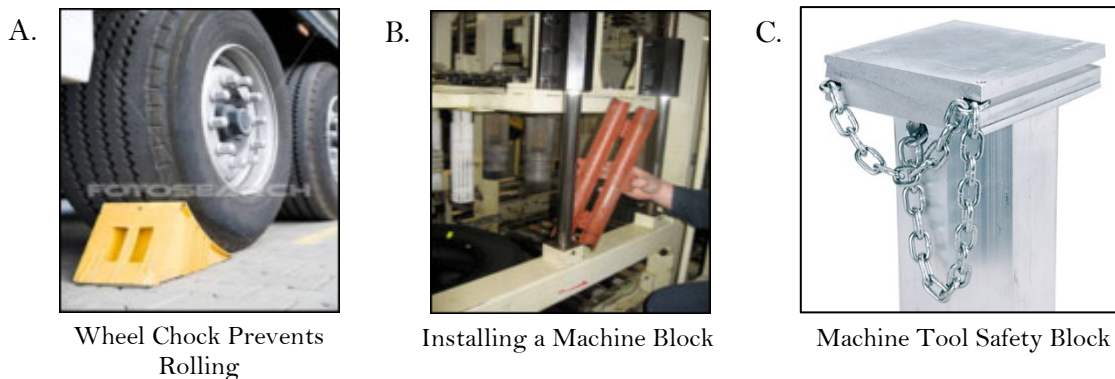
Examples of toggle switch locks plus locks and tags on multiple and single breakers:



2. Mechanical Energy

Each department must establish how mechanical energy will be isolated by locking it out and/or blocking equipment components so they cannot move. Support rods used for counterweights or elevated components, a bar through spokes for a wheel, flywheel or fan blades, a wedge-shape wheel-chalk for rolling components, wrapping and locking chains around a movable equipment component and locking to an immovable object are all methods for isolating mechanical energy.

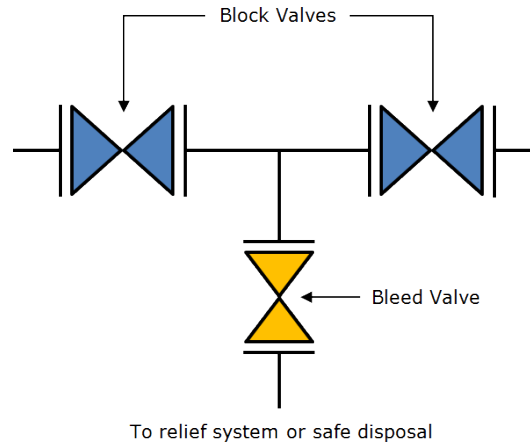
Examples of blocking mechanical energy:



3. Chemical, Thermal or Compressed Gas Energy

Each department must establish how chemical or thermal energy will be isolated by locking it out and/or blocking chemicals pumped through pipelines. An option is physically disconnecting the equipment from the supply plumbing, if possible. If not possible, double valves are used or supply lines blinded off with appropriate flange plates or pipe caps. Flange blinds are also often

installed in order to bleed down the chemical, steam, or hot liquids. Once the system is drained down, the upstream and downstream valves are closed and system relief can be checked with the bleed valve left open.



Compressed gases are closed and locked using either a lockable cylinder cap or a plastic assembly locked over the valve.

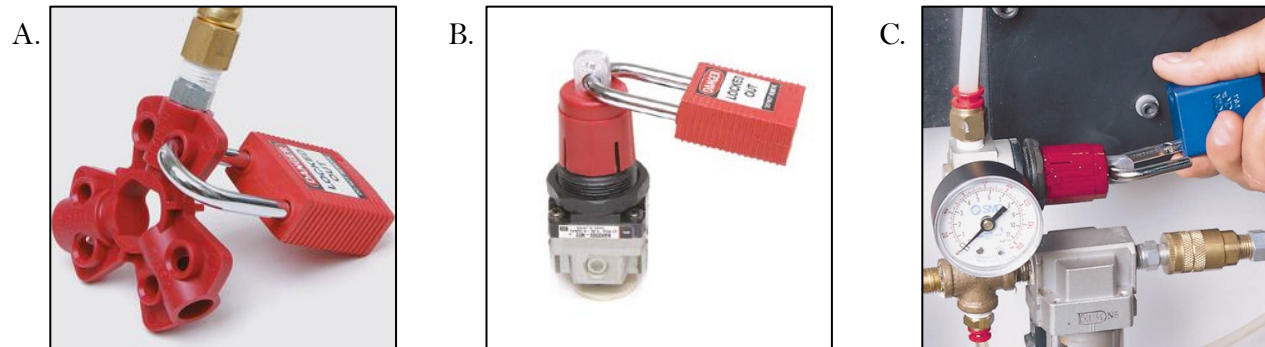


Gas Cylinder Lockout Devices

4. Pneumatic Energy

Pneumatic flow control valves control the flow of pressurized air used as a medium. One of the most common types is the needle valve used to control the rate of flow in a pneumatic system by controlling flow in both directions. In some cases, the valves are operated manually rather than automatically. Machinery with pneumatic or hydraulic power have bleed valves which must be locked open. Lines are bled down to return the system to atmospheric pressure, then blinds/blocks are installed. The department must also lockout machines activated by compressed air valve controlled movement. These valves are locked and bled to release any residual pressure to the atmosphere.

Examples of devices for blocking pneumatic energy

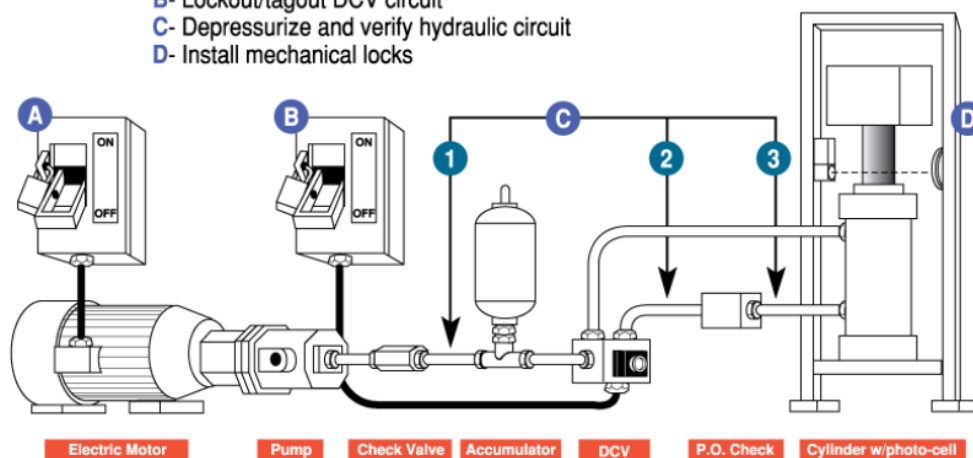


5. Hydraulic Energy

Hydraulic energy is energy stored within a pressurized liquid. When under pressure, the fluid is used to move heavy objects, machinery, or equipment (i.e. power presses, lifts). Hydraulic fluids move machinery parts even when the motor or electricity is off, if a certain valve is opened. The residual energy stored in the system must be removed, which involves shutting down the prime mover driving the pumps, moving the activators to a parked position, removing and supporting any overhanging loads, bleeding off all residual or trapped pressure, and bleeding down accumulators to bleed out the liquid. Until this residual energy is removed from the system, work cannot occur. Methods such as lockable or monitored isolation valves are common ways to isolate hydraulic energy.

Critical steps you must take to safely lockout a hydraulic system:

- A- Lockout/tagout electric motor circuit
- B- Lockout/tagout DCV circuit
- C- Depressurize and verify hydraulic circuit
- D- Install mechanical locks



III. Program Training and Requirements

A. LOTO Training Requirements

This LOTO program requires two levels of LOTO training:

- Affected personnel, having the job of operating or using machines or equipment, must complete LOTO awareness training. These employees need to know they are not authorized to clean, repair, replace parts, lubricate, service, set-up, or adjust equipment or operations if they are putting any part of their body in a hazardous position.
- Authorizing personnel and authorized persons must be trained on the safe installation, set-up, adjustment, and maintenance work on equipment or systems using LOTO procedures. They must also follow written procedures to isolate energy sources prior to commencing work. Updated LOTO training is given every three years or whenever this program changes, its application to specific equipment changes, or if equipment or energy hazards change. All training is documented with, at a minimum, a written attendance roster signed by each trained employee, the date, and reference to the content of the training provided.

B. Owner Department's Training Requirements

Departments must identify the authorized person(s) requiring training, and initiate training either through their enrollment in the UC Davis Learning Center (lms.ucdavis.edu), which must be supplemented by hands on training, or by phoning EH&S (530-752-1493) and arranging for a training session. Initial training must be given within three months of the departments program and LOTO plan development for all current departmental personnel, and within one month upon new hire via the Learning Center website, and/or department or EH&S-provided training program. Training must be completed before any hands-on work on equipment occurs.

Program Administrators are trained on their roles and responsibilities in the management and maintenance of the requirements outlined in the [Roles and Responsibilities](#) section of this program.

C. Written Procedures (SOPs)

Written SOPs ([Appendix C](#)) must outline the scope, purpose, and techniques used to control the release of hazardous energy. Each SOP must list the:

- Task objective and equipment involved.

- Details on all sources of energy for each type of work.
- Required PPE.
- Procedural steps for shutting down, isolating, blocking, and securing machines, or for the placement, removal, and transfer of lockout/tagout devices.
- Procedural steps for testing, verifying deactivation, and for reactivating equipment.
- Employee responsibilities and requirements for testing a machine or equipment to verify that LOTO is effective in isolating the energy.

LOTO SOP templates are available through Safety Services. Contact EH&S at 530-752-1493 for more information, or visit the [Standard Operating Procedures](#) page on the website.

D. LOTO Procedural Requirements

1. Preparation for Lockout

Employees authorized to perform LOTO must be knowledgeable about which switch, valve, or other energy isolating devices to apply to the equipment being locked out. This is accomplished by reviewing or developing a written procedure for all energy sources involved. Any questionable issues regarding the identification of sources must be cleared by the employees with their supervisors and before lockout commences. Job authorization must be obtained from authorizing personnel.

2. General Sequence of Lockout Procedure

1. **Preparation for Shutdown:** Notify all affected employees a lockout is required and the reasons for the lockout.
2. **Equipment Shutdown:** If the equipment is operating, shut it down by the normal stopping procedure, i.e. depress stop button, open toggle switch, etc.
3. **Equipment Isolation:** Operate the switch, valve, or other energy isolating devices so the energy source(s) (i.e. electrical, mechanical, hydraulic, etc.) is disconnected or isolated from the equipment.
4. **Control Stored Energy:** [Capacitors energy](#) must be dissipated by grounding and springs, elevated machine members, rotating fly wheel energy blocking, or repositioning. Hydraulic, air, gas, steam or pressurized systems must be dissipated by opening valves and bleeding down and/or closing valves to isolate the system.

5. **Application of Lockout/Tagout Devices:** Attach the lockout energy isolating devices and assigned individual(s) locks, and apply the appropriate tag on the equipment
6. **Equipment Isolation and Verification:** As a check on having disconnected the energy sources, after ensuring no personnel are exposed, operate the push button, on/off switch, or other normal operating controls to verify the equipment will not operate. **CAUTION:** Return operating controls to neutral position after the test.

3. Procedures Involving More Than One Person

In the preceding steps, if more than one individual is required to lockout equipment, each will place his or her own personal lock on the energy isolating device(s) by using a hasp or each person locking the keys in the group lock box. However, one designated individual of a work crew, with the supervisor's knowledge, may lockout equipment for the whole crew. In such cases, it may be the responsibility of the individual to carry out all steps of the lockout procedure, and inform the crew when it is safe to work on the equipment. Additionally, the designated individual shall not remove a group lock until it has been verified all individuals are clear.

4. Testing and Adjusting Equipment During Lockout

In many maintenance and repair operations, machinery must be tested and energized before additional maintenance work can be performed. For such situations, this procedure must be followed:

- Move all personnel to a safe place.
- Clear away tools and materials from equipment.
- Remove blocks and lockout devices, and re-energize systems following the established safety procedure.
- Proceed with a tryout or a test.
- Shut off all energy sources, reinstalling lockouts on energy sources, reinstall blocks, bleed all pressure systems, and verify all energy sources are de-energized prior to continuing work.

5. Restoring Equipment to Service

After the work is completed and the equipment is ready to be returned to normal operation, this procedure must be followed:

1. Remove all non-essential items.

2. Ensure all equipment components are operationally intact, including reinstalling guards and safety devices.
3. Repair or replace defective guards before removing locks.
4. Remove each lockout device, using the correct removal sequence.
5. Perform a visual check before restoring energy to ensure everyone is physically clear of the equipment.

Each lock is removed by the authorized person applying it, or under his or her direct supervision. If a person is absent from the workplace, then the lock or tag can be removed by an authorized person designated to perform this task provided the immediate supervisor:

1. Verifies the authorized person is not present, and is unable to remove the lock.
2. Informs the authorized person the LOTO device has been removed.
3. Notifies any affected person(s) that equipment has been restored to its operational state.

6. Inventory

An inventory of departmental equipment which requires LOTO must be completed by those responsible for LOTO using existing databases, reviewing “as built” building drawings, equipment manuals, and physical inspections. The equipment inventory list is generated by name, location, equipment details, and energy type and magnitude ([Appendix C](#)).

Example: Air Compressor #1, Roof, HMF Building, Main Electrical – 50 Amps, 240 volts; 3 phase; Control Electrical – 15 Amps 120 volts; 1½” discharge pipe – 300°F; Compressed Air 100 psi; Rotating 50 lbs. spoke flywheel on piston pump; V-belt drive.

E. Periodic Inspection and Annual Audit

Each department with a LOTO plan is required to conduct an annual inspection of energy isolation written LOTO procedures to evaluate their effectiveness, identify necessary changes, or update the written procedures. These inspections must:

- Be performed by an authorized person who does not routinely use the hazardous energy control procedures being audited.
- Identify the equipment on which the hazardous energy control procedure was being used, the date of the audit, the affected persons and authorized persons who are impacted by the procedure being audited, and the person performing the audit.

- Include a random interview(s) between the auditor, affected persons, and authorized persons of their responsibilities under the hazardous energy control procedure being audited.
- Physically inspect signage and energy isolation locks, tags, and other equipment.
- Make recommendations for the department for procedure improvement, or training as the audit may uncover.
- Be documented by the department that the audits have been performed.

F. Record Keeping Requirements

The DSC or Safety Officer must keep training and authorization records of all department personnel trained on LOTO and about the LOTO program requirements. Training records include the name of the person trained, date of training, an outline of training content, and the printed name and signature of the trained individual. A copy of the training record must be sent to Staff Development (sdps@ucdavis.edu) for recording in the Learning Management System (LMS). A copy of their training and authorization must also be kept in the department's permanent file for the duration of the person's employment.

The department's DSC, Safety Officer, or an assigned LOTO program manager will keep the up-to-date LOTO SOP inventory, plus the written LOTO program and procedures. The DSC or program manager provides blank templates of equipment-specific LOTO procedures to authorized person(s) in the department. The DSC or program manager also provides a completed LOTO procedure for a specific piece of equipment to any UC Davis staff, personnel, or contractor conducting work on or around such equipment, upon request.

IV. External Regulations

A. Cal/OSHA Regulations

Cal/OSHA regulation [8 CCR 3203](#), Title 8 of the California Code of Regulations requires employers to establish and maintain an Injury and Illness Prevention Program (IIPP), including but not limited to:

- A hazard assessment program identifying energy isolation needs
- A training program to instruct employees on general safe work practices, and specific instruction with regard to hazards requiring LOTO unique to any job assignment.

- Scheduled periodic inspections (i.e. annual LOTO SOP audits) to identify and correct any unsafe conditions and work practices that may be found.

The applicable Cal/OSHA regulations for LOTO are in the General Industry Safety Orders (GISO; 8 CCR) as follows:

- LOTO general regulatory requirements under [8 CCR 3314](#).
- Potential exceptions to these requirements are noted and inspection, tagging, and training requirements are detailed. An overview of the expectations for LOTO is provided in a [Cal/OSHA publication](#).

Cal/OSHA Low Voltage Electrical Safety Orders

Some regulations of note:

- Work Procedures for energized electrical systems: [8 CCR 2320.2](#).
- Personal Protective Equipment (PPE), and insulated tool requirements: [8 CCR 2320.2](#).
- Procedures and exceptions for de-energizing equipment: [8 CCR 2320.4](#).
- Energizing equipment or disengaging while cleaning, repairing, servicing, setting-up, and adjusting machines and equipment: [8 CCR 2320.5](#).
- Minimum information required for tags: [8 CCR 2320.6](#).

Cal/OSHA High Voltage Electrical Safety Orders

Some other Cal/OSHA regulations of note:

- Work and Operating procedures, qualified workers, and safe access: [8 CCR 2940](#).

The following Title 8 Cal/OSHA codes are regarding electrical equipment installation:

- Motor Automatic Restarting: [8 CCR 2530.43](#).
- Motor Installation: Not in Sight from Controller: [8 CCR 2530.86](#).

V. References

The UCSF [Energy Isolation – Lockout/Tagout Program](#) served as a base reference for the contents of this program, and was adapted for applicability to UC Davis. Supporting and cited materials are referenced electronically via hyperlink throughout the document, whenever possible.

APPENDICES

Appendix A

LOCKOUT/TAGOUT PLAN

University of California, Davis

Revision History

Lockout/Tagout Program		
Version:	Approved by:	
Next Review:	Manager:	Signature:
		Date:
	Author:	Signature:
		Date:

Version	Date Approved	Author	Revision Notes:
1.0			Document created

A. Purpose

The main purpose of this _____ (*dept./group*) Lockout/Tagout (LOTO) plan is for the departments or groups to assign employee responsibilities for implementing the UC Davis Lockout Tagout program. Implementing the EH&S LOTO program prevents employee injuries and ensures compliance with University Policy and Procedure [290-84](#). This LOTO plan ensures energy is isolated when employees work around equipment in which the sudden release of energy in various forms (i.e. electrical, mechanical. etc.) can injure employees. This LOTO plan therefore requires _____ (*dept./group.*) personnel on campus, or in off-campus locations, and contractors retained by the _____ (*dept.*) to be trained and use written energy isolation procedures when working on UC Davis equipment or utility systems with one or more energy sources. The goal is reducing the injury risk to employees from energy sources associated with all equipment/utility systems. The written program is also required by Cal/OSHA [8 CCR 3314](#) safety regulations.

B. Applicability

The _____ (*dept.*) Energy Isolation LOTO program is applied to ALL forms of hazardous energy, and is applied to every individual piece of equipment with hazardous energy. The types of energy needing isolation include both potential energy (mechanical springs in tension or compression, compressed gas cylinder, counter weights, etc.) and kinetic energy (blocking rotating flywheels, fans, moving parts, sheaves, rolling components, etc.), pneumatic, hydraulic, thermal, chemical, compressed gas and utility energy (electricity, compressed air, steam, hot water, etc.) components of a particular equipment, machinery, or utility systems. This equipment may include building mechanical systems, i.e. HVAC and air handlers, some larger experimental equipment hard wired or plumbed to building utility systems such as a Scanning Electron Microscope, air compressors, lasers, compressed gas systems, some machine shop equipment such as a programmable milling machine, powered cranes and other energized equipment.

This program is applied prior to working on all types of equipment powered by one or more energy sources, or whenever an equipment guard is removed or safety interlock is bypassed, or whenever a person must place any part of their body into potentially-operating equipment.

This program does NOT apply to:

- Minor tool changes, adjustments, and other small service activities that take place during normal operations if they are routine, repetitive, and integral to the use of the equipment. (Example: Changing a drill bit on a drill press.)
- Equipment isolated and made safe by simply unplugging an electrical cord, compressed air hose, or some other single-source energy supply when the person working on the equipment has exclusive control over the connection to the energy source.
- Work on equipment which cannot be shut down, provided:
 - (1) Department management demonstrates continuity of service is essential,
 - (2) Shutdown of the system is impractical, and
 - (3) Special equipment is provided or special protective procedures are documented and followed that will provide effective protection for personnel. (Example: Work on certain life-sustaining equipment or utility lines.)

In such situations, contact EH&S to review safe work procedures in order to assist in developing adequate safeguards.

C. Roles and Responsibilities

- A. _____ <Responsible Person> will be responsible for implementing the lockout/tagout program.
- B. _____ <Responsible Person> is responsible for enforcing the program and insuring compliance with the LOTO procedures in this department.
- C. _____ <Responsible Person> is responsible for inventorying building location (Appendix B example) to establish which equipment requires written LOTO procedures (SOP's) for their departments. The inventory is completed using existing databases, reviewing 'as built's of building drawings, equipment manuals and physical inspections. The equipment inventory list then generated by name, location, equipment details plus energy type and magnitude.
- D. _____ <Responsible Person(s)> are responsible for writing and annually reviewing written LOTO procedures (SOP's) for their departments.
- E. _____ <Responsible Person(s)> are responsible for identification, labeling, selection and purchase of locks, tags and blocks for all employees working on the equipment.

- F. _____ <*Responsible Person(s)*> are responsible for training new and existing employees (every 3 years) both affected and authorized employees on this department LOTO program requirements and the required LOTO Safety training from EH&S. Training sign-in log sheets must be used with the topic, name of the instructor, plus printed names and signatures of each of the trainees. A copy of this log sheet is sent to sdps@ucdavis.edu for recording into the Learning Management System (LMS) and the written copy kept on file in the department.
- G. _____ <*Responsible Person*> has the record-keeping responsibilities for all training, LOTO SOP's and the inventory of equipment requiring written LOTO OP energy isolation procedures
- H. _____ <*Authorized Employees*> (those listed in Attachment A) are responsible for following established lockout/tagout procedures. An authorized employee is defined as a person who locks out or tags out machines or equipment by following a specific written LOTO SOP for the equipment in order to safely perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing servicing or maintenance (lockout/tagout).
- I. _____ <*Affected Employees*> (all other employees in the facility) are responsible for ensuring they do not attempt to restart or re-energize locked out or tagged out machines or equipment. An affected employee is defined as a person 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 him/her to work in an area in which such servicing or maintenance is being performed.
- J. _____ <*Faculty, Staff, Supervisors or Principal Investigators*> are responsible for insuring all faculty, staff, students and any affected person are made aware of requirements for lockout/tagout, hazard assessments, purchasing, making available and using LOTO equipment, developing written LOTO SOP energy isolation procedures, plus LOTO training authorized and affected employees.
- K. A periodic inspection (at least annually) will be conducted of each authorized employee insuring compliance with the lockout/tagout procedures. This inspection shall be performed by _____ <*Responsible Person*>. The inspection will include a review between the inspector and each authorized employee of that employee's

responsibilities under the energy control (lockout/tagout) procedure. The inspection will also consist of a physical inspection of the authorized employee while performing work under the procedures.

- L. The _____ <*Responsible Person*> shall certify in writing the inspection has been performed. The written certification shall be retained in the individual's personnel file.
- M. _____ <*Project Supervisor*> is responsible for assuring Contractors have an Energy Isolation Program, follow it, and also must make any previously developed LOTO SOP Energy Isolation Procedure for the equipment available to the Contractor prior to start of work.
- N. _____ <*Contractors*> are responsible for following their own Energy Isolation Program when working on University property/equipment. The Contractor will provide evidence of their Energy Isolation (LOTO) program to the University upon request, as well as their own energy isolation equipment including locks, tags and hasps.
- O. _____ <*Capital Projects/DCM or departmental Construction Project Manager*> for new construction, building retrofits and equipment installed by Capital Projects. The Project Manager assures the requirements of this program are integrated into project documentation, energy isolation inventories of all affected building systems are completed and provided to the host department, and signage and labels are installed on energy disconnects in compliance with this program.
- P. EH&S is responsible for:
 - Monitoring and advising on how to maintain this program to meet or exceed Cal/OSHA requirements,
 - Informing departments of the Safety Services main LOTO program requirements,
 - Providing assistance and training for departments and personnel as requested for implementation their LOTO program,
 - Providing training on LOTO
 - Providing easy methods for creation of equipment-specific LOTO SOP's,
 - Providing and maintaining a library of completed LOTO SOP's from other departments,
 - Recommending energy isolation equipment/processes for general and/or specific use,
 - Providing assistance in development of LOTO SOP's, and
 - Updating this program periodically or as regulatory change may dictate.

Appendix B

A. Energy Isolating Equipment



Locks



Hasps



Tags



Valve Cable Locks



Gate Valve Handle Cover



Breaker Locks



Lock box to store keys



Butterfly Fly lock device



Ball valve locking device



Locked Comp. Air Line



Locked Gas Cylinder



Air Line Lockout



Air Line Regulator Lockout



Steering Wheel Lock Cover



Wheel Chock



Circuit Breaker Clamp



Electrical Plug Box



Panel and breaker locks



Equipment Press Block



Pipe Blinding Flange



Support Stands for Blocks

Appendix C

A. Standard Operating Procedures

There are three SOP options available to use for developing LOTO procedures:

1. Use LOTO designed software.
2. Use the [Cal/OSHA procedural format](#).
3. Department created SOP format.

The following sections are required in each SOP no matter the format:

- A. Purpose
- B. Equipment Description
- C. Hazardous Energy Schematic Showing Isolation Points
- D. Hazardous Energy Assessment
- E. Preparation and Notification
- F. Steps for Controlling Hazardous Energy Identified in Section D
- G. Steps to Return to Service
- H. Designated Authorized Workers

Contact EH&S (rawachter@ucdavis.edu) for any questions about SOP formatting and requirements.

B. LOTO Inventory Form

INVENTORY EXAMPLE

Instructions: This form may be used by Departments/DSCs to inventory all their equipment requiring an energy isolation LOTO procedure. Prior to conducting energy isolation activities on equipment, Cal/OSHA requires that an initial survey of all energy sources to the equipment be conducted. This must be done by physical inspection, possibly in combination with a study of drawings and equipment manuals. This survey may be conducted by an authorized person in a department, Utilities, Facilities Maintenance BMS, EH&S, or a contractor who will be working on the equipment.

Equipment Name	Location	Energy Sources	Magnitude	Procedure Date Initials	Audit Date Initials
Example: Piston Air Compressor #3	Level 1, Machine Room Haring Hall	Electricity Compressed air Heat Rotating Equipment	3 Phase, 50 Amps, 480 volts 120 psi tank / piping Manifold 220 degrees F 50 lbs. flywheel and belts	4/15/15 JNG	4/05/11 GWB