Session No. 509

Energy Isolation: Building Your Own Equipment Specific Procedures

James N. "Jim" Gilson, PE
Safety Engineer, Assistant Manager Safety
UC Berkeley, Berkeley, CA

Introduction

The University of California at Berkeley (UCB) is one of the largest publicly funded higher education research universities in the world. With more than 20 Nobel laureates on faculty, more than $3 billion in ongoing research grants, more than 140 academic departments, an additional 100 staff and support-services departments, a campus community of 58,000+, multiple campuses in the bay area, and field research locations world-wide, the safety concerns for implementing an energy isolation program to both operational and research work go beyond compliance need. UCB's safety engineer was charged with developing an Energy Isolation Program that promoted equipment-specific procedure development by research faculty, staff, maintenance personnel, visiting scholars and students alike. The result is a web-based Energy Isolation – Lock out Tag out (LOTO) Program that is user driven, easily navigated, digestible for persons of various levels of education and experience, and provides a framework for users, including vendor contractors, to develop their own equipment-specific energy isolation procedures for UCB equipment.

The Problem

Energy Isolation has become a complex and equipment-specific process for many pieces of equipment in the built environment. OSHA is no longer accepting a generic energy isolation LOTO procedure for complex pieces of equipment and installations with multiple sources of energy. Complex equipment must have specific written procedures and documented training that informs personnel of the energy sources, their associated hazards and the hazard control methods to be applied, to isolate all energy sources for individual pieces of equipment in the built environment.

At UCB, there are literally thousands of air handlers and other space-conditioning equipment, world class performing arts and athletic facilities, its own co-gen power plant, central steam and other utility systems, besides 50+ research buildings, 26 libraries including rare book vaults and animal research facilities that are extremely utility dependent. And, the business of the University is research that in many cases cannot be stopped, and where hazards may not yet be known.

The Solution

A user-driven process was developed by UCB Safety Engineering that documents the creation of equipment-specific energy isolation / LOTO procedures. These procedures fit onto one sheet of paper, meet OSHA requirements for an "Equipment Specific" energy isolation LOTO procedure, can be stored in electronic format and then automatically attached to a maintenance work-order or vendor contract, can be equipment-mounted as one sheet of paper located on or inside a control panel, and can

be quickly applied to and completed by local maintenance workers and researchers for most equipment installed in the built environment.

Success of this program's acceptance on campus has been the user interface and web-driven content. All UCB safe-work programs are in the process of being put into a standard program format with a standard Q&A entry page into the program content. Links to various information locations within the program are buried in the program's front web-page. In this way, all personnel on campus can be trained on the program format and web-page structure, and then will know how to navigate any program to quickly find needed information at any time from any computer workstation.

The link to the UC Berkeley Energy Isolation/LOTO Program is:
http://ehs.berkeley.edu/healthsafety/loto.html

What follows is the content of the program document, and the associated attachments to apply the program in the UCB environment. To appreciate the user friendliness of the program, however, it is recommended the reader use the online web-based program to better understand its use and applicability.

The Program

Please go to the next page to see the content document for the UCB Energy Isolation – Lock out Tag out Program.

UNIVERSITY OF BERKELEY
ENERGY ISOLATION
LOCK-OUT TAG-OUT PROGRAM

"No person ever touches or tries to actuate an energy source that has been 'locked' and/or 'tagged' in the 'off' position, or in any way disturbs a mechanical block that has been placed to prevent equipment movement, by someone else." **– Anonymous but Wise "CalOSHA" Sage**

Prepared by: Jim Gilson, PE., Assistant Manager, Safety

Brandon DeFrancisci, Associate Director, Health and Safety

1. Purpose / Introduction

The UC Berkeley Energy Isolation - Lock Out / Tag Out (LOTO) Program requires campus, field station personnel and contractors to implement safe procedures when working on UCB equipment or utility systems with one or more energy sources. Because of the potential for injury from energy sources that operate equipment / utility systems, this program guides safe installation, set-up, adjustment and maintenance work on equipment by isolating energy sources prior to commencing work. The program is required by CalOSHA safety regulations.

2. Applicability

This Energy Isolation LOTO Program is applied to ALL forms of potentially hazardous energy and is applied to every individual piece of equipment that has potentially hazardous energy. The types of energy needing to be isolated include the potential energy (mechanical springs in tension or compression, compressed gas cylinder, counter weights, etc.), kinetic energy (rotating flywheel, moving parts, rolling components, etc.) and utility energy (electricity, compressed air, steam, domestic water, etc.) that may be part of a particular machine or utility system. Such equipment may include building mechanical systems such as HVAC and air handlers, some larger experimental equipment that is hard wired or plumbed to building utility systems such as a Scanning Electron Microscope, an air compressor, a printing press, some shop equipment such as a programmable milling machine, powered cranes and other lift equipment, etc.

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 that is 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 that cannot be shut down, provided that (1) department management demonstrates that 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 Safety Engineering to review safe work procedures in order to assist in developing adequate safeguards.

3. Roles / Responsibilities

Faculty, Staff and any "Affected Person"

All Faculty, Staff and any "Affected Person" are made aware through the EH&S website that "No person ever touches or tries to actuate an energy source that has been 'locked' and/or 'tagged' in the 'off' position, or in any way disturbs a mechanical block that has been placed to prevent equipment movement, by someone else."

"Authorized Person"

Faculty and staff who work on equipment affected by this program must be "authorized" to do so by their Supervisor and follow the energy isolation procedures outlined by this program. They must be trained on, and remain current to, its requirements and application through documented training. An "Authorized Person" may develop written equipment-specific energy isolation procedures by completing 'Attachment 2' of this program.

Capital Projects / Construction Project Manager

For new construction, building retrofits and equipment installed by Capital Projects, the Project Manager assures requirements of this program are integrated into project documentation, that energy isolation surveys of all affected building systems are completed and provided to the host department, and that signage and labels are installed on energy disconnects in compliance with this program. Requirements are detailed under "Procedures – Administrative Requirements – Equipment Survey – New Facilities and Equipment".

Departments

For existing buildings and equipment not under control of PP-CS, departments are responsible for identifying equipment that has single or multiple sources of energy for operation that fall under the energy isolation requirements of this program. Departments must survey and may list all equipment owned by the Department that requires an Energy Isolation LOTO Procedure. Attachment 1 is a template a Department may use to survey and inventory equipment requiring an Energy Isolation LOTO Procedure, and track CalOSHA-required annual audits of those procedures.

Departments must create and provide for employee / contractor use written energy isolation procedures for individual "location specific" pieces of equipment. Attachment 2 of this program is a template used to develop individual Energy Isolation LOTO procedures for specific pieces of equipment.

Departments must identify individuals who are 'authorized' to conduct energy isolation and who are trained on this Energy Isolation – LOTO Program. Departments must arrange with EH&S for these employees to receive documented training.

Department Safety Coordinator (DSC) or Other Responsible Person

The DSC or Other Responsible Person has "Training" and "Record-keeping" responsibilities as outlined in those sections of this program.

Principal Investigator / Project Supervisor / "Supervisor"

The Principle Investigator / Project Supervisor / "Supervisor" must, or may delegate in writing an "Authorized Person" to:

1. Inform, all faculty, staff, students, work personnel and / or hired-in Contractors working in the area, collectively known as “Affected Persons”, of the existence of this program and it’s impact on their work area,
2. Assure that their subordinates have had documented training concerning Energy Isolation - LOTO at a level appropriate to the anticipated level of exposure to hazardous energy sources in their research / workplace.
3. Assure that proper labeling is applied to all disconnect locations on specific equipment controlled by the department. Labeling activities may be conducted by the PI, Supervisor or Authorized Person, another department member under the leadership of this person, or by an outside contractor.
4. Determine safe energy isolation procedures specific to equipment to be worked on.
5. Conduct an annual audit of equipment-specific energy isolation procedures to assure they are still accurate and appropriate to needed safe work practices.
6. Determine who is an “Authorized Person” and may work on the equipment.
7. Inform all “Authorized Person(s)” and / or the Contractor 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.
8. Conduct a meeting that includes review of energy isolation procedures for the equipment with all “Authorized Person(s)” prior to commencing work, and at the beginning of each work shift.
9. Assure the current shift’s supervisor ensures that the arriving shift has put locks and tags on the energy sources before the earlier shift’s locks and tags are removed when multiple shifts work on the same equipment.
10. Assure the arriving shift supervisor is oriented as to the job status along with the arriving shift work crew prior to commencement of work with the guidance of the departing shift supervisor.
11. Contact EH&S for assistance in developing energy isolation procedures and providing training to subordinates and “Authorized Personnel” as needed.

For departments hiring Contractors to conduct work at UCB, the Project Supervisor representing the department who owns the equipment is responsible for assuring the Contractor has an Energy Isolation Program and follows it. However, the Supervisor is not responsible for evaluating the Contractor’s Energy Isolation Program. The Supervisor must make any previously developed Energy Isolation Procedure for the equipment available to the Contractor prior to start of work. The Supervisor may also make this Energy Isolation Program available to the Contractor for their information and use.

<u>Contractors and Joint Projects</u>

The Contractor follows their own Energy Isolation Program when working on University property / equipment. The Contractor provides evidence of their Energy Isolation Program to the University upon request. The Contractor provides their own energy isolation equipment including locks, tags and hasps. The Contractor follows “Joint Project” requirements as outlined below.

If the Department has previously developed equipment-specific Energy Isolation / LOTO procedures for equipment the Contractor is working on, the Contractor follows the Department’s procedure. For equipment that has not previously had an Energy Isolation procedure developed, the Contractor surveys the equipment and develops a written Energy Isolation Procedure for it. A copy of the Contractor’s equipment-specific Energy Isolation Procedure for the equipment is provided to the Project Supervisor and EH&S Safety Engineering. As Contractor work progresses, the Contractor informs the Project Supervisor immediately of any newly discovered energy sources or hazards associated with the equipment.

For Joint Projects where employees of the University and Contractor(s) are working on the same equipment at the same time, the Project Supervisor, whether employed by the Contractor or University, must hold joint meetings with all personnel in attendance who will be working on the equipment to promote understanding of safe work practices, and open lines of communication between work crews.

EH&S

EH&S is responsible for:

- Writing and maintaining this program to meet or exceed CalOSHA requirements,
- Informing departments of this program's requirements,
- Providing general program awareness information across campus,
- Providing assistance for departments and personnel in implementation of this program,
- Providing training on program implementation and requirements to all affected personnel identified by each department,
- Providing an easy method for creation of equipment-specific Energy Isolation Procedures,
- Providing and maintaining on its website a library of completed Energy Isolation Procedures developed by other departments,
- Recommending energy isolation equipment and processes for general and / or specific use,
- Providing assistance in development of Energy Isolation Procedures, and
- Updating this program periodically or as regulatory change may dictate.

4. Definitions

Affected Person. A person who works near or on equipment on which cleaning, repairing, servicing, setting-up or adjusting operations are or may be performed under this Energy Isolation Program.

Authorized Person. A person who locks out and/or tags out specific machines or equipment in order to perform cleaning, repairing, servicing, setting-up, and adjusting operations on that machine or equipment. An "Authorized Person" must be approved as such by their Supervisor, trained on identifying and controlling hazardous energy as well as application of this program, provided Energy Isolation locks and tags, and be familiar with all equipment components prior to conducting work on equipment. An "Authorized Person" may develop written equipment-specific energy isolation procedures by completing 'Attachment 2' of this program. Authorization is documented using the Attachment 3 form, and kept in an "Authorized Person's" permanent file.

Blind. Another form of blocking is the placement of a blind. A blind is a disk of metal placed in a pipe to ensure that no air, steam, or other substance will pass through that point if the piping system is accidentally activated / pressurized.

Blocked. Equipment is "BLOCKED" by inserting a mechanical device to prevent inadvertent movement. Potential energy that may need to be blocked can come from suspended or rolling parts subject to movement or gravity, may be energy stored in springs, can cause movement due to air flow, etc. The "block" must be strong enough to support the entire load of the equipment components if the equipment moves. Blocks should have chain or some other means that can lock the block in place.

De-energize / Disengage. There is a difference between turning off a machine and actually disengaging or de-energizing a piece of equipment. When a control switch is turned off, the control circuit is off. However, there is still electrical energy at the switch, and a short in the switch or someone inadvertently turning on the machine may start the machine running again. In addition, control circuits may only control power relays on main power panels. Prior to maintaining, adjusting or repairing equipment, main power

and control circuit power must be de-energized / disengaged. To de-energize / disengage equipment, the fuses / breakers must be removed or turned 'off' and the electrical box containing the fuse / breaker locked shut. A knife switch disconnect locked in the 'off' position is also considered de-energized.

Lockout / blockout, This means that any energy source—whether electrical, hydraulic, mechanical, compressed air, or any other source that might cause unexpected movement—must be disengaged or blocked, and electrical sources or pressurized fluids / gases must be de-energized, bled to atmosphere, and locked or blinded in the "off" position.

Testing Equipment. Once the equipment is locked, blocked and / or blinded, it must be TESTED to make sure the machinery is, in fact, de-energized. CAUTION: Return disconnects and operating controls to the off position after each test.

5. Methods of Locking Out Energy

Electricity

There are many different ways to lock out a piece of equipment. Commonly, the main electrical disconnect switch has one opening where a single lock can be placed. If more than one employee works on the equipment, a 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 switches are in a metal box, the box itself must be locked out in the closed position. If a fuse was removed in order to de-energize the equipment, the fuse box must be locked. If the controls are in a metal-covered box, a common 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 padlocked. Fuse boxes can also be locked in this way. In some equipment, an electric "control circuit" will actuate a main "power circuit". In such situations, both circuits must be 'locked and tagged' out before safe-work can proceed. Capacitors must be safely discharged to ground with ground straps installed prior to working around, storing or transporting them. Refer to the UCB Electrical Safety Program appendix on the EH&S website for safe procedures to discharge and ground capacitors.

Figure 1. Locks and Tags on Single and Multiple Electrical Breakers: Electrical Plug Lock Box

Compressed Air / Gasses / Hydraulic Fluids / Steam / Pressurized Water

Machines activated by compressed air or steam will have valves that control movement. These valves will need not only to be locked out, but also bled to release any residual pressure. Physically disconnect the equipment from the supply plumbing if possible. If not possible, use double valves or blind off supply lines with appropriate flange plates or pipe caps.

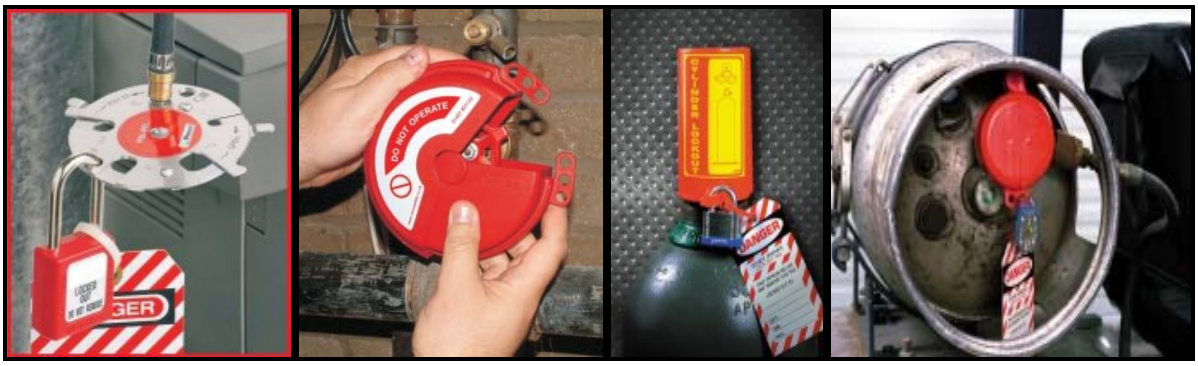

Figure 2. (From left): Locked Comp. Air Line (photo 1); Locked Globe Valve (photo 2); Locked Gas Cylinder (photo 3); Locked Gas Cylinder (photo 4).

Mechanical Energy

Blocking equipment components so they cannot move, using support rods for counterweights or elevated components, a bar through spokes of a wheel, flywheel or fan blades, a wedge-shape wheel-chalk for rolling components, etc. are all examples of blocking mechanical energy.

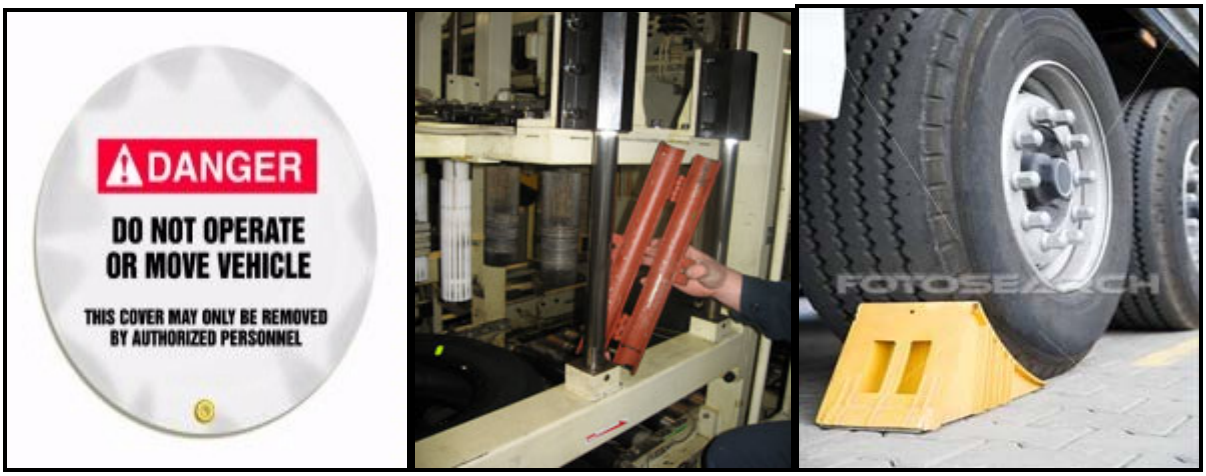

Figure 3. (From left: Steering Wheel Locking Cover (photo 1); Installing a Machine Block (photo 2); Wheel Chock Prevents Rolling (photo 3)

6. Program Requirements and Procedures

This Energy Isolation – LOTO Program includes the following CalOSHA required elements:

- A survey of equipment conducted by "Authorized Persons" in each department who are thoroughly familiar with equipment operation and associated hazards, in order to identify which components and energy sources are to be locked and blocked out.
- Identification and labeling of lockout devices for the equipment.
- Selection and purchase of locks, tags and blocks for all employees who will be working on the equipment.
- A standard energy isolation procedure that is followed by all personnel working on equipment.
- Adaption of the standard procedure into a written "location-specific" energy isolation procedure for individual pieces of equipment.

Administrative Requirements

Surveying Equipment's Energy Disconnecting Means

An initial survey of equipment specific to a department and/or work-project site is completed to identify all energy sources requiring isolation. This is done by physical inspection, possibly in combination with a study of building drawings and equipment manuals. Categorize the identification and labeling details as to the type of equipment supplied, its physical location, and energy type and magnitude.

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.

New Facilities and Equipment. For new facilities or equipment being built or brought on line by a Project Manager, the requirements of this program are integrated into project documentation by use of project specifications. The Project Manager assures that Energy isolation surveys are documented by completing Steps 1, 2 and 3 of Attachment 2 for each individual piece of equipment, and provides this completed documentation to EH&S and the host Department. EH&S provides recommendations for Step 4 of the energy isolation procedure directly to the host Department. Completed energy isolation surveys are provided to the host department. The Project Manager assures signage and labels are installed on energy disconnects in compliance with this program specification by the General Contractor.

Existing Facilities and Equipment. For previously constructed facilities / equipment, this initial survey is conducted as location-need and equipment work arises. The survey is completed by the host department / owner of the equipment, by PP-CS, or a Contractor, whoever will be maintaining, repairing or adjusting the equipment needing energy isolation. This survey is documented by completing Steps 1 and 2 of Attachment 2. Further completion of Steps 3 and 4 documents the complete procedure as detailed below.

Once each survey is complete, a list of all equipment requiring an Energy Isolation – LOTO procedure and annual procedure audit is kept by the host department and made available to anyone requiring this information to conduct safe equipment-specific energy isolation work as needed for future reference / use. Attachment #1 is a template that may be used for developing this Equipment List, and tracking annual audits.

Identifying & Labeling the Energy Disconnecting Means

For each piece of equipment identified, all energy sources must be determined and the corresponding disconnecting means must be appropriately marked indicating its function. Signs or stickers stating — **"LOCKOUT HERE"**— with accompanying information of the equipment being controlled at the disconnecting location must be installed to direct personnel to correct lockout devices. In complicated operations, schematics of just the disconnecting means may be developed by the EH&S or PP-CS engineering department.

Figure 4. Disconnect Panels with "Lockout Here" Label and Energy Isolation Information

Providing Locks, Blocks, & Accident Prevention Tags

Locks

Each worker has their own lock set and the only key to that lock set. These are provided to the worker by their Supervisor / Department. To maintain harmony with LBNL facility requirements, it's suggested all locks be 'RED' in color to quickly identify locked / tagged energy sources. The locks are substantial and durable, and have the name of the employee or some other uniquely identifiable marking on them. In addition, locks may have a color-coded stripe to indicate different shifts, types of crafts or lock owners. When more than one worker is servicing a piece of equipment that must be locked out, a lockout adaptor hasp is used which allows all the workers to place their locks on the disconnecting means. 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.

Figure 5. Typical Locks and Hasps for use in Locking Out Equipment

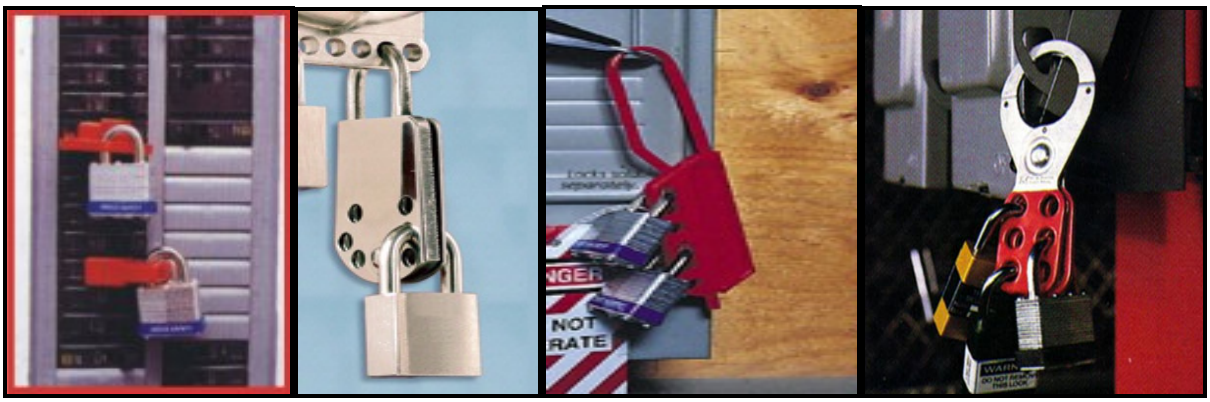

Figure 6. Electrical Panels Shown "Locked Out"

Figure 7. Piping shown "Locked Out"

Blocks, Blinds and Bleeds

Blocks are placed under raised dies, lifts, or any equipment that might inadvertently move by sliding, falling or rolling. Blocks, special brackets, or special stands such as those commonly used under raised vehicles, must be used. Before installing blinds or blocks, steam, air, or hydraulic lines are bled down to return the system to atmospheric pressure, then blinds / blocks are installed. Coiled springs, spring-loaded devices, or suspended loads are released so that their stored energy will not result in inadvertent movement. Bleed valves must be locked "open".

Figure 8. From left: Blocking an Equipment Press (photo 1); Pipe Blinding Flange (photo 2); Support Stands used for Blocks (photo 3)

Tags

TAGS ARE NOT USED ALONE unless there is no method to safely isolate energy sources. Tags or signs are used in addition to locks. Tags or "tagout devices" are capable of enduring at least 50 pounds of pull. One tag is placed by the Project Manager or Lead Trades-person at each lock-out location. Tags state the:

- Reason for the lockout.
- Name of the person(s) who is/are working on the equipment.
- How the person who placed the tag may be contacted.
- Date and time the tag was put in place.

Figure 9. Examples of Tags

Authorizing Personnel

Only persons who are "Authorized" may conduct Energy Isolation / Lock out-Tag out processes. A person must be "Authorized" by their Supervisor when their duties include performing cleaning, repairing, servicing, setting-up and adjusting operations on equipment requiring Energy Isolation for safe work activities. The Supervisor determines their qualifications for "authorization" based upon the Supervisor's knowledge of the authorized person's skills, and the energy sources on the equipment. All "Authorized Person(s)" must be trained as outlined in the "Training" section of this program, be provided appropriate tools to conduct Lock out / Tag out, and follow all procedures outlined in this program. Authorized Person(s) may develop energy isolation procedures and conduct annual audits on existing procedures as detailed below.

An "Authorized Person" is an individual formally recognized and documented as:

1. Having completed required classroom, trades or other training on Energy Isolation, and
2. Having sufficient understanding of Energy Isolation safe-work practices and equipment to be able to recognize and positively control any hazards that may be present, and
3. Possessing the work experience and formal training necessary to execute work according to recognized and accepted Energy Isolation safe-work practices, and
4. Having completed orientation to a specific equipment's Energy Isolation procedure, or
5. Having developed and reviewed an Energy Isolation procedure for specific equipment that is subsequently reviewed and approved by another "Authorized Person" or their Supervisor.

A person may be considered "Authorized" with respect to certain equipment and safe-work methods on specific equipment, but not 'Authorized' for another equipment/location within the same Department. It is the responsibility of the "Authorized Person's" Supervisor to determine limitations of "Authorization" for each and every person working under their direction, and document this on the "Authorized Person's" record by completing Attachment 3 and maintaining a copy in the "Authorized Person's" permanent file.

Periodic Inspection / Annual Audit

EH&S conducts annual audits of equipment-specific energy control procedure(s) developed by Departments to evaluate their continued effectiveness and determine necessity for updating the written procedure(s) or safety equipment. These inspections must:

1. Be performed by an "Authorized Person" not routinely 'using' the hazardous energy control procedures being audited.
2. Identify the equipment on which the hazardous energy control procedure was being utilized, 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.
3. Include a random interview(s) between the auditor and "Affected Persons" and "Authorized Persons" of their responsibilities under the hazardous energy control procedure being audited.
4. Physically audit signage and energy isolation locks, tags and other equipment.
5. Generate recommendations to the Department for procedure improvement or training as the audit may uncover.
6. Be documented by the Department that the audits have been performed on Attachment 1 or a similar document.

Procedures:

Equipment-Specific Energy Isolation Procedures

Use the Energy Isolation Procedure template (Attachment #2) and complete Steps 1 and 2 on the template to survey energy sources on specific equipment. Then, complete Steps 3 and 4 to prepare a written LOTO procedure sequence for that equipment for de-energizing, lockout, testing, and start-up of any equipment requiring energy isolation under this program. Always follow the Rules for Using Energy Isolation – LOTO Procedure, and other standard procedures below unless other safer work procedures are developed for a specific piece of equipment.

When surveying and/or training for an equipment-specific lockout procedure:

- All "Affected Persons" must understand what equipment Energy Isolation – LOTO means, when the equipment in their work area will be "locked / tagged out", and to never try to start equipment when locked / tagged out.
- The "Supervisor" and "Authorized Person(s)" must be trained in this written procedure and fully knowledgeable of the hazardous energies related to the specific equipment.
- "Authorized Person(s)" reassigned to different equipment must be trained on that specific equipment.

Figure 10. Equipment-Specific Energy Isolation Procedure shown in file on front of Equipment Control Panel.

Rules for Using Energy Isolation – LOTO Procedure

Several basic safety rules are applied during every energy isolation situation. These are:

1. Only "Authorized Persons" may work on, or conduct, Energy Isolation Procedures on equipment.
2. All equipment must be blocked and locked out to protect against accidental or inadvertent operation when such operation could cause injury to personnel.
3. Never attempt to operate any switch, valve, or other energy isolating device bearing a lock.
4. Never remove a blocking device until all personnel, tools and obstructions have been cleared from the area, and all equipment guards have been properly reinstalled.
5. If the equipment or system must remain energized during work, contact the Office of Environment, Health & Safety (EH&S) Safety Engineering to assist in developing adequate alternative hazard control measures, such as the use of suitable temporary barriers, special tools and personal protective equipment.

Standard Energy Isolation LOTO Procedure

1. All maintenance personnel are issued a suitable lock (or locks for multiple energy sources). Each lock has the individual worker's name or other identification on it. Each worker has the only key to the lock / lock set.
2. The Authorized Person checks to be sure that no one is operating the machinery BEFORE turning off energy sources. All persons in the area, and especially the machine operator and project supervisor, are informed before the energy sources are being turned off because unexpected sudden loss of power could cause an accident.
3. Steam, air, and hydraulic piping or tanks must be bled, drained, and/or brought to atmospheric pressure and locked "open" to assure no pressure or vacuum in piping or in reservoir tanks.
4. Gas cylinders must be locked 'closed' and if possible disconnected from distribution piping.
5. Any mechanical component that could roll, shift or otherwise move, such as springs, counterweights, wheels, fan blades, etc. must be barred or blocked.
6. Each person who will be working on the machinery must put a lock on each of the machine's lockout device(s). Each lock must remain on the machine until the work is completed. Only the worker who placed the lock may remove their lock.
7. The Supervisor or "Authorized Person" places a tag on each lock-out location.

8. All energy sources which could activate the machine must be locked or blocked out following an equipment-specific Energy Isolation Procedure developed for that equipment. (Attachment 2, Page 1)
9. All disconnects must be tested to be sure that all energy sources to the machine are off.
10. Electrical circuits must be checked by qualified persons with proper and calibrated electrical testing equipment. Stored energy in electrical capacitors must be safely discharged.
11. CAUTION: Return disconnects and operating controls to the "off" position after each test.
12. Attach accident prevention tags which give the reason for placing the lock/tag, the name of the person placing the lock/tag, how they may be contacted, and the date and time the lock/tag was placed.

Testing / Adjusting Equipment during Lockout

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

1. Clear all personnel to safety.
2. Clear away tools and materials from equipment.
3. Remove lockout devices and re-energize systems, following the established safe procedure.
4. Proceed with tryout or test.
5. Shut off all energy sources once again, purge all systems, and lockout energy sources prior to continuing work.

Equipment design and performance limitations may dictate that effective alternative worker protection be provided when the established lockout procedure is not feasible. If machinery must be capable of movement in order to perform a maintenance task, workers must use extension tools, personal protective equipment and other means to protect themselves from moving parts and potential injury.

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

Each lock is removed by the authorized person that applied it, or under his/her direct supervision. If the authorized person is absent from the work place then the lock or tag can be removed by a qualified person designated to perform this task provided that the immediate supervisor:

1. Verifies that the authorized person is not present and therefore unable to remove the lock;
2. Makes all reasonable efforts to inform the authorized person that the lockout/tagout device has been removed; and
3. Ensures that the authorized person knows the lockout/tagout device has been removed before work resumes.

Finally, notify any "Affected Person(s)" that the equipment has been restored to its operational state.

Joint Projects

If University personnel and contractor personnel are working on the same piece of equipment, then the University provides the hasps that the University personnel installs their locks on, and the Contractor provides their hasps that their personnel installs their locks on. Each work team installs their own hasp and locks on each energy source.

7. Training Requirements

All persons identified in the "Roles / Responsibilities" section of this program must receive documented training on their required work practices and responsibilities in application of this program. DSCs identify person(s) requiring training, and initiate training either through their enrollment in the UC Berkeley Learning Center on the EH&S website, or by phoning EH&S (642-3073) and arranging for training to occur. Initial training is given within 3 months of program adoption for all current personnel, and within one month upon new hire via the Learning Center website and/or Department-provided training program. Update training on this program is to be given whenever this program changes, if it's application to specific equipment changes, or if Department operations or equipment / energy hazards change such that personnel must have retraining to conduct safe work.

8. Record Keeping Requirements

DSC keeps training / authorization records of all department personnel trained on this program. Training records include the name of the person trained, date of training, an outline of training content, and a signature of the trained individual. Training and authorization are documented on Attachment 3 form and kept in the person's permanent file for the duration of the person's employment / authorization at UCB plus 3 years.

DSC may keep an up-to-date Equipment Inventory and LOTO Procedure Audit Tracking List (Attachment 1) of all department-controlled equipment that falls under requirements of this program. Inventory lists are made available for review by EH&S, regulatory agencies, and use by PP-CS and other departments or contractors who may need access to the list for planning and training safe work practices.

DSC provides blank templates of Equipment-Specific Energy Isolation Procedure (Attachment 2) to "Authorized Person(s)" within the Department for documenting Energy Isolation Procedures. Hard copies of completed Equipment-Specific Energy Isolation Procedures are kept on file at the equipment, and by the DSC, with electronic copies provided to EH&S for inclusion in a campus Energy Isolation – LOTO Procedure library. DSC also provides a completed Energy Isolation – LOTO Procedure for a specific piece of equipment to any UCB staff, personnel or Contractor conducting work on or around such equipment upon request.

9. References

EH&S Phone: 510-642-3073 **or** **http://ehs.berkeley.edu/**

The following Title 8 CalOSHA codes are referenced in this program:

- 2320.4. De-energized Equipment or Systems. http://www.dir.ca.gov/title8/2320_4.html
- 2320.5. Energizing (Re-energizing) Equipment or Systems. http://www.dir.ca.gov/title8/2320_5.html
- 2320.6. Accident Prevention Tags. http://www.dir.ca.gov/title8/2320_6.html
- 2530.43. Automatic Restarting. http://www.dir.ca.gov/title8/2530_43.html
- 2530.86. Motor Not in Sight from Controller. http://www.dir.ca.gov/title8/2530_86.html

- 3203. Injury and Illness Prevention Program http://www.dir.ca.gov/title8/3203.html
- 3314. The Control of Hazardous Energy for the Cleaning, Repairing, Servicing, Setting-Up, and Adjusting Operations of Prime Movers, Machinery and Equipment, Including Lockout/Tagout http://www.dir.ca.gov/title8/3314.html
- 6004. Accident Prevention Tag http://www.dir.ca.gov/title8/6004.html
- Requirements for working on energized electrical systems are prescribed in Sections 2320.9 and 2940 of the California General Industry Electrical Code.
    - 2320.9 http://www.dir.ca.gov/title8/2320_9.html
    - 2940 http://www.dir.ca.gov/title8/2940.html

10. Attachments

1. Template – Equipment Inventory and Energy Isolation Procedures Tracking / Audit Log
2. Template – Energy Isolation – LOTO Procedure for Individual Equipment
3. Template – Training Record and Authorization of Personnel

Attachment 1 - Equipment Inventory and Energy Isolation Procedures Tracking / Audit Log

_____ Department List

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, CalOSHA requires that an initial survey of all energy sources to the equipment must 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, PP-CS, EH&S, or the Contractor who will be working on the equipment, and documented on Attachment 2, Steps 1 and 2. Procedures are developed by completing Attachment 2 Steps 3 and 4, and then applying standard energy isolation process steps specific to equipment. To track equipment in the program, enter equipment inventory and energy supply data as shown. Note the date when the Attachment 2 procedure was completed and include initials of the Authorized Person who completed the procedure. Note date when the Attachment 2 procedure was audited by an Authorized Person and include initials of auditor. All procedures must be audited at least annually.

Equipment Name	Location	Energy Sources	Magnitude	Procedure Date Initials	Audit Date Initials
Example: *Piston Air Compressor #3*	*Level 1, Machine Room* *Hildebrandt 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*	*4/15/10* *JNG*	*4/05/11* *GWB*
Example: *Vacuum Vane Pump #1*	*Level B2, Machine Room* *Stanley Hall*	*Electricity – Main* *Electricity – Control* *Vacuum* *Domestic Water* *Rotating Equipment* *Heat*	*3 Phase, 30 Amps, 480 volts* *1 Phase, 15 Amps, 120 volts* *24 Hg" tank / piping* *80 psi.* *Pump-motor coupler* *Exhaust Pipe 190 degrees F*	*3/6/09* *RBW*	*2/28/10* *GWB*

(over)

YEAR: _____ DSC NAME: _____ PAGE ____ OF ____

Equipment Name	Location	Energy Sources	Magnitude	Procedure Date Initials	Audit Date Initials

YEAR: _____ DSC NAME: _____ PAGE ____ OF ____

Attachment 2 - Equipment-Specific Energy Isolation Procedure

Equip. Name: _____ Location: _____ Dept: _____

Describe scope of work here:

Instructions: Follow the steps to create a written sequence for de-energizing, lockout, testing, and start-up of equipment requiring energy isolation. Use completed procedure for safety meetings / training for the equipment-specific lockout process. Discuss with workers how equipment energy isolation – LOTO is applied to this specific equipment during these planned job / tasks. Also, discuss communication methods on the job site.

Step 1 **Survey and Check off [X] all Energy Sources**

Step 2

A: Note magnitude / type of each energy source.
B: Note device or location of each disconnecting source.▼

		ENERGY SOURCE	2A: MAGNITUDE / TYPE	2B: ISOLATION DEVICE/LOCATION
		ELECTRICITY– Main power circuit	Amps: Volts: # Phase:	
		ELECTRICITY– Control circuit(s)	Amps: Volts: # Phase:	
		BATTERY / SOLAR / ALT POWER	Amps: Volts: AC/DC/PH:	
		COMPRESSED AIR / GASES	PSI: Gas Type:	
		STEAM / CONDENSATE	PSI: Source:	
		FLUID UNDER PRESSURE	PSI: Source:	
		HEAT / COLD + / - C° or + / - F°	Temp: Source:	
		VACUUM CHAMBER / PIPING	Hg": Source:	
		FUEL(S) - SOLID / LIQUID / GAS	Volume: Fuel:	
		ROTATING WHEEL / FAN / DRIVE	Details:	
		SUSPENDED WEIGHT	Details:	
		MECHANICAL OTHER:	Details:	

Step 3

List sequence of Energy Isolation. Number 1 up to 12.

Instructions continued: Isolate energy sources in sequence. Assure each worker installs their own lock on each disconnect location. Supervisor/Authorized Person installs warning tags. Verify Energy Isolation prior to starting work. When testing / jogging equipment, follow program procedures on the back of this form. When restoring equipment to operation, reverse isolation sequence unless otherwise discussed / approved by the Project Supervisor. Use Personal Protective Equipment and safety equipment as noted below during work activities. Contact EH&S for technical support and special concerns at 510-642-3073.

Step 4 – Check off [X] and circle all PPE and safety equipment to be used for Energy Isolation.

PPE to be worn during work

- ☐ GOGGLES / FACE SHIELD / WELD GEAR
- ☐ BOOTS – STEEL TOE / RUBBER / OTHER
- ☐ GLOVES – LEATHER / RUBBER / INSULATED
- ☐ SAFETY HARNESS / LANYARD & LINE
- ☐ RESPIRATOR – DUST / CHEMICAL
- ☐ THERMAL – HEAT / COLD PROTECTION
- ☐ APRON / WET GEAR / OTHER
- ☐ OTHER: _____

Safety Equipment to be used during work

- ☐ FIRE EXTINGUISHER / FIRE WATCHER
- ☐ LINES BLINDED & TAGGED
- ☐ VALVES / SWITCHES - LOCKED & TAGGED
- ☐ REMOVE FLAMMABLES / COMBUSTIBLES
- ☐ BLEEDERS LOCKED OPEN & TAGGED
- ☐ SHIELDS – ARC CURTAIN / HEAT BLANKET
- ☐ BLOCKS / BARS / BARRICADES
- ☐ TOOLS - LONG HANDLE / INSULATED

PROCEDURE PREPAREDBY:

_____ _____ _____
PRINT NAME SIGNATURE DATE

ANNUAL REVIEW COMPLETED BY:

_____ _____ _____
PRINT NAME SIGNATURE DATE

Standard Energy Isolation LOTO Procedure

1. All maintenance personnel are issued a suitable lock (or locks for multiple energy sources). Each lock has the individual worker's name or other identification on it. Each worker has the only key to the lock / lock set.
2. The Authorized Person checks to be sure that no one is operating the machinery BEFORE turning off energy sources. All persons in the area, and especially the machine operator and project supervisor, are informed before the energy sources are being turned off because unexpected sudden loss of power could cause an accident.
3. Steam, air, and hydraulic piping or tanks must be bled, drained, and/or brought to atmospheric pressure and locked "open" to assure no pressure or vacuum in piping or in reservoir tanks.
4. Gas cylinders must be locked 'closed' and if possible disconnected from distribution piping.
5. Any mechanical component that could roll, shift or otherwise move, such as springs, counterweights, wheels, fan blades, etc. must be barred or blocked.
6. Each person who will be working on the machinery must put a lock on each of the machine's lockout device(s). Each lock must remain on the machine until the work is completed. Only the worker who placed the lock may remove their lock.
7. The Supervisor or "Authorized Person" places a tag on each lock-out location.
8. All energy sources which could activate the machine must be locked or blocked out following an equipment-specific Energy Isolation Procedure developed for that equipment. (Other side)
9. All disconnects must be tested to be sure that all energy sources to the machine are off.
10. Electrical circuits must be checked by qualified persons with proper and calibrated electrical testing equipment. Stored energy in electrical capacitors must be safely discharged.
11. CAUTION: Return disconnects and operating controls to the "off" position after each test.
12. Attach accident prevention tags which give the reason for placing the lock/tag, the name of the person placing the lock/tag, how they may be contacted, and the date and time the lock/tag was placed.

Testing / Adjusting Equipment during Lockout

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

1. Clear all personnel to safety.
2. Clear away tools and materials from equipment.
3. Remove lockout devices and re-energize systems, following the established safe procedure.
4. Proceed with tryout or test.
5. Shut off all energy sources once again, purge all systems, and lockout energy sources prior to continuing work.

Equipment design and performance limitations may dictate that effective alternative worker protection be provided when the established lockout procedure is not feasible. If machinery must be capable of movement in order to perform a maintenance task, workers must use extension tools, personal protective equipment and other means to protect themselves from moving parts and potential injury.

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

Each lock is removed by the authorized person that applied it, or under his/her direct supervision. If the authorized person is absent from the work place then the lock or tag can be removed by a qualified person designated to perform this task provided that the immediate supervisor:

1. Verifies that the authorized person is not present and therefore unable to remove the lock;
2. Makes all reasonable efforts to inform the authorized person that the lockout/tagout device has been removed; and
3. Ensures that the authorized person knows the lockout/tagout device has been removed before work resumes.

Finally, notify any "Affected Person(s)" that the equipment has been restored to its operational state.

Joint Projects

If University personnel and contractor personnel will be working on the same piece of equipment, then the University provides the hasps that the University personnel will install their locks on, and the Contractor provides their hasps that their personnel will install their locks on. Each work team will install their own hasp and locks on each energy source.

UC Berkeley Energy Isolation Program – Lock out / Tag out

Attachment 3 - Energy Isolation-LOTO – Training Record of "Authorized Person"

To: Personnel File for _____
(Employee name – please print)
From: _____ **Date: _____**
(PI / Supervisor name – please print)

TO BE COMPLETED BY THE PI / SUPERVISOR OF THE "AUTHORIZED PERSON" who will be conducting Energy Isolation – Lock out Tag out work:

Re: This document confirms required Qualification of the above named person to perform:
(Check all that apply) *(Attach additional pages if more space is needed)*

☐ Energy Isolation operations and work on the following equipment / locations:
- ☐ All locations and equipment under my supervision
- ☐ All locations and equipment in our Department's jurisdiction
- ☐ All locations and equipment as this person's job duties may dictate
- ☐ Specific equipment / locations as listed: _____
_____
_____
_____

☐ Energy Isolation work with the following energy sources (check all that apply):
- ☐ All Energy Sources below
- ☐ Compressed Air ☐ Other Compressed Gases _____
- ☐ Cryogenic Fluids / Gases
- ☐ Electricity (<50 volts) ☐ Electricity (50 – 600 Volts) ☐ Electricity (>600 volts)
- ☐ Flammable materials ☐ Flammable gases ☐ Flammable fluids ☐ Flammable solids
- ☐ Fluids under pressure ☐ Hydraulic systems (<150 psi) ☐ Hydraulic systems (>150psi)
- ☐ Hot Fluids / Gases ☐ Steam
- ☐ Mechanical Equipment – Springs / Counterweights / Fly Wheels / Fan Blades / Blocks
- ☐ Other (describe): _____
_____

This designation of "Authorized Person" is based on evidence of safe performance of all duties related to Energy Isolation through: *(Check all that apply)*

☐ Training on UCB Energy Isolation Program conducted (including any skill checks or tests).
☐ Experience – This person has been safely performing, and has demonstrated skill in safe Energy Isolation procedures, for _____ years (minimum of five years).
☐ Instruction – This person has received instruction from me or another person who is authorized in Energy Isolation, and who has observed this person's work while performing Energy Isolation operations, and confirms that the above named person has the knowledge and skills to perform Energy Isolation work safely.

If, for any reason, as their supervisor, I think that this person is not performing work safely, this authorization will be revoked. Below are signature(s) of responsible person(s) verifying training and/or experience:

PI / Supervisor Signature: _____ Date**: _____**

Authorized Person's Signature _____ Date**: _____**

CC: PI / Supervisor file;
Authorized Person's Permanent File;
DSC file