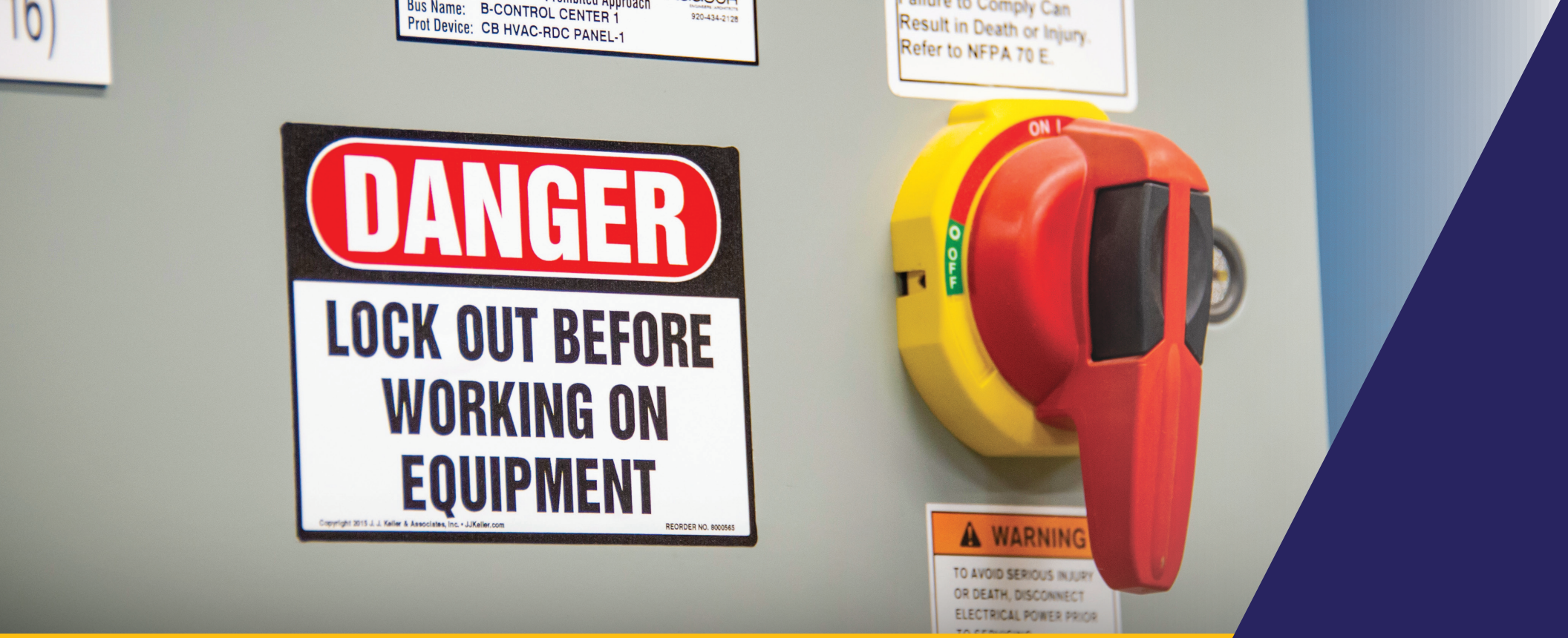

MACHINE SAFEGUARDING, LOTO, AND ELECTRICAL SAFETY:

Integral and Interrelated

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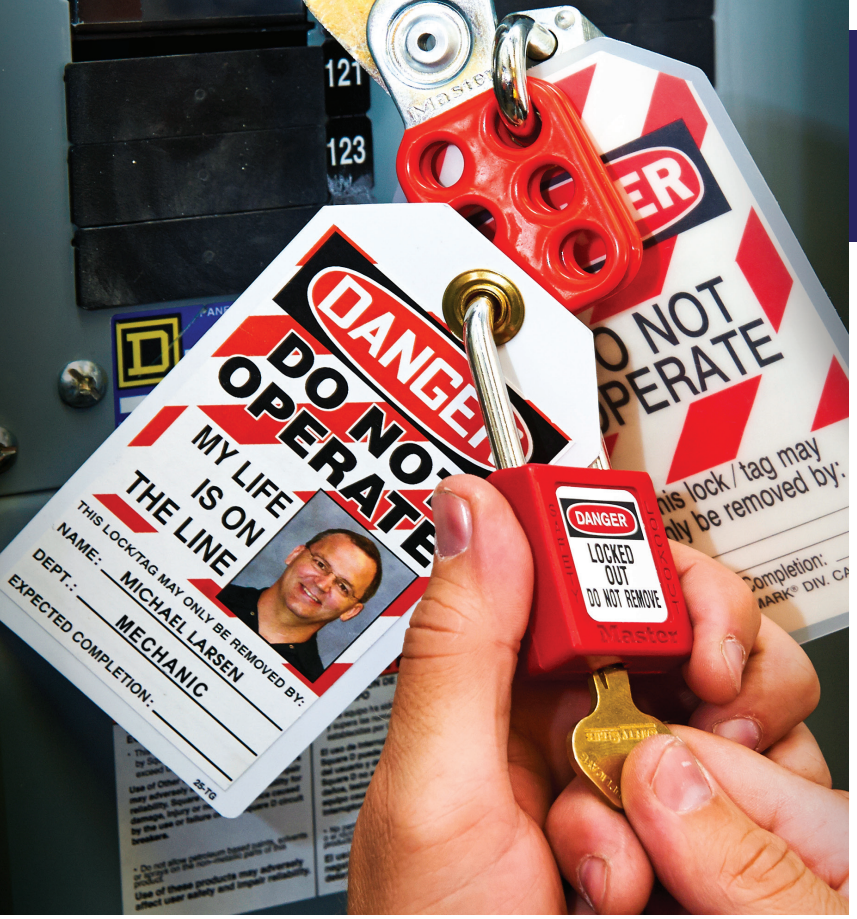


MACHINE SAFEGUARDING, LOTO, AND ELECTRICAL SAFETY:

Integral and Interrelated

Photos and videos of industrial production from the early- to mid-1900s offer blatant examples of unsafe working conditions. No responsible employer would think of operating a shop by using the machines and methods of earlier times.

INTEGRATE MACHINE GUARDING, LOCKOUT/TAGOUT (LOTO), AND ELECTRICAL SAFETY TO PREVENT INJURIES AND FATALITIES.

Today's safer workplaces exist due in part to the promulgation of OSHA standards for:

- Machine safeguarding;
- Lockout/tagout (LOTO) during service and maintenance; and
- Electrical safety during machine installation, service and maintenance, and disassembly.

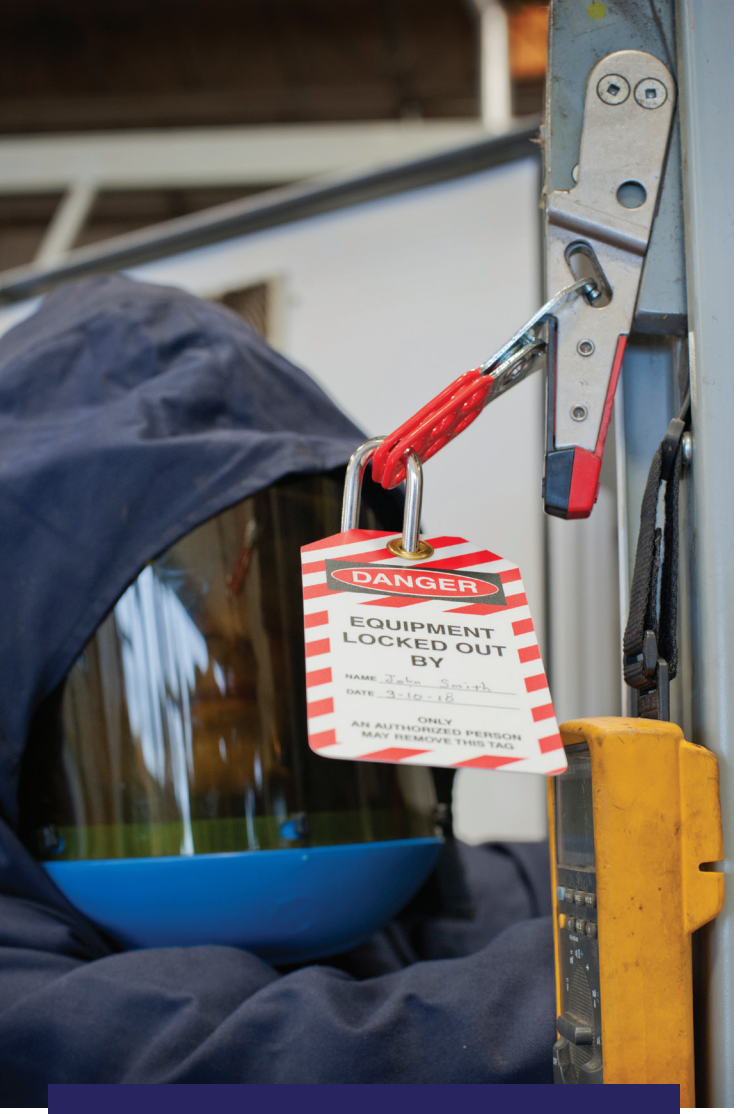
Understanding the interrelationship between these three elements of machine use can lead to a more robust safety program.

MACHINE GUARDING

Machine guards and safeguarding devices allow workers to operate machinery with significantly less risk for injury.

HAZARD ANALYSIS

New equipment is usually safeguarded, but on-site equipment modifications often create a need for additional or modified guarding methods. The need for machine guarding is identified by conducting a hazard analysis on both new and modified machinery.



MACHINE SAFEGUARDING METHODS:

- BARRIER GUARDS
- RESTRAINT DEVICES
- AUTOMATION

The following types of machine hazards are identified during the hazard analysis:

- **POINT-OF-OPERATION** — these are points where work is performed on the material (i.e., cutting, boring, shaping, forming, grinding, etc.);
- **POWER TRANSMISSION** — parts that move energy through the machine (i.e., flywheels, pulleys, belts, connecting rods, couplings, cams, spindles, chains, gears, etc.); and
- **OTHER MOVING PARTS** — these include reciprocating, rotating, and transverse moving parts; feed mechanisms; chips and flying material; sparks; etc.

These classifications often overlap. The key is to understand how the machine operates, identify the hazards, and determine how to appropriately guard for each hazard.

SAFEGUARDING METHODS

There are several different methods of machine safeguarding:

- **GUARDS** — Barriers which prevent access to danger areas. Guards come in three types: fixed (cannot be removed easily — these provide the most protection), interlocked (shut off or disengage power when removed — these are designed to be occasionally removed), and adjustable (adjust for different machine set-ups).
- **DEVICES** — Stop a machine or prevent it from starting until the operator is in a safe position. These are used mostly for point-of-operation hazards. Devices come in five types: presence-sensing (light, radio frequency, etc.), pullback, restraint, safety controls (tripwires, two-hand trips, etc.), and gates.
- **AUTOMATED FEEDING AND EJECTION METHODS** — Limit hazards associated with feeding stock into or ejecting material from a machine. These methods come in three types: automatic feed or ejection, semi-automatic feed or ejection, and robotic.

Often, hand tools are used to feed stock into a machine or to hold material in place while the machine works on it. Using the tool helps keep hands away from a point-of-operation hazard. Other types of work practice safeguarding aids include using awareness barriers (chains, warning lights, alarms, safety signs, etc.) and portable protective shields.

RELATIONSHIP TO LOTO AND ELECTRICAL SAFETY

Machine safeguards may only be removed during repair and maintenance activities. Employees who are authorized to do the repairs follow a strict LOTO program to ensure that a machine will not start unexpectedly during repairs or maintenance. LOTO plays an essential role in the prevention and control of machine-related injuries. One of the most important pieces of knowledge for machine operators is to be able to recognize the need for LOTO.

Electrical wiring is also guarded to prevent direct contact. Typically this is accomplished through the use of cover plates and insulation. Electrical equipment also uses safety devices such as ground connections, circuit breakers, and ground-fault circuit interrupters to prevent fires, shocks, and electrocutions.

LOTO

When something goes wrong with a machine, or even when it is time for regular service, it is a prime time for amputations and other injuries to occur. Any time a guard or safeguarding device is removed, the hazards are exposed.

Lockout means that procedures are followed to completely disconnect the machine from its power sources and the energy control devices are locked in the “off” or “safe” position. A tag is used instead of a lock if a lockout device

does not fit on the energy isolating device (tagout) and additional steps are taken to keep the machine from starting. Each person who works on locked-out or tagged-out equipment must have specialized training on how to follow the procedures and verify that the machine is deenergized during the repair job.

HAZARD ANALYSIS

OSHA's general industry standard on the control of hazardous energy (LOTO) "covers the servicing and maintenance of machines and equipment in which the unexpected energization or start up of the machines or equipment, or release of stored energy, could harm employees."

SERVICING AND/OR MAINTENANCE ENCOMPASSES MACHINE CONSTRUCTING, INSTALLING, SETTING UP, ADJUSTING, INSPECTING, AND MODIFYING.

There are two areas to consider when analyzing LOTO hazards. First is the recognition of the tasks the workers are performing. Do they meet the definition of "servicing and/or maintenance"? The other is identifying the necessary procedures to accomplish lockout or tagout for the machine. Does the equipment need different LOTO procedures for different types of servicing, or will one procedure cover any machine maintenance activities?

The end result of a hazard analysis for LOTO is a procedure with enough detail for the person performing the servicing to ensure that the machine will stay off while he is doing the maintenance or repair work.

PROGRAMS, PROCEDURES, AND POLICIES

While there are only three elements to the overall program, the documented LOTO procedures developed as a result of the hazard assessment, a training program appropriate for the workers' involvement in LOTO, and periodic inspections of LOTO procedures can be extensive and complicated.

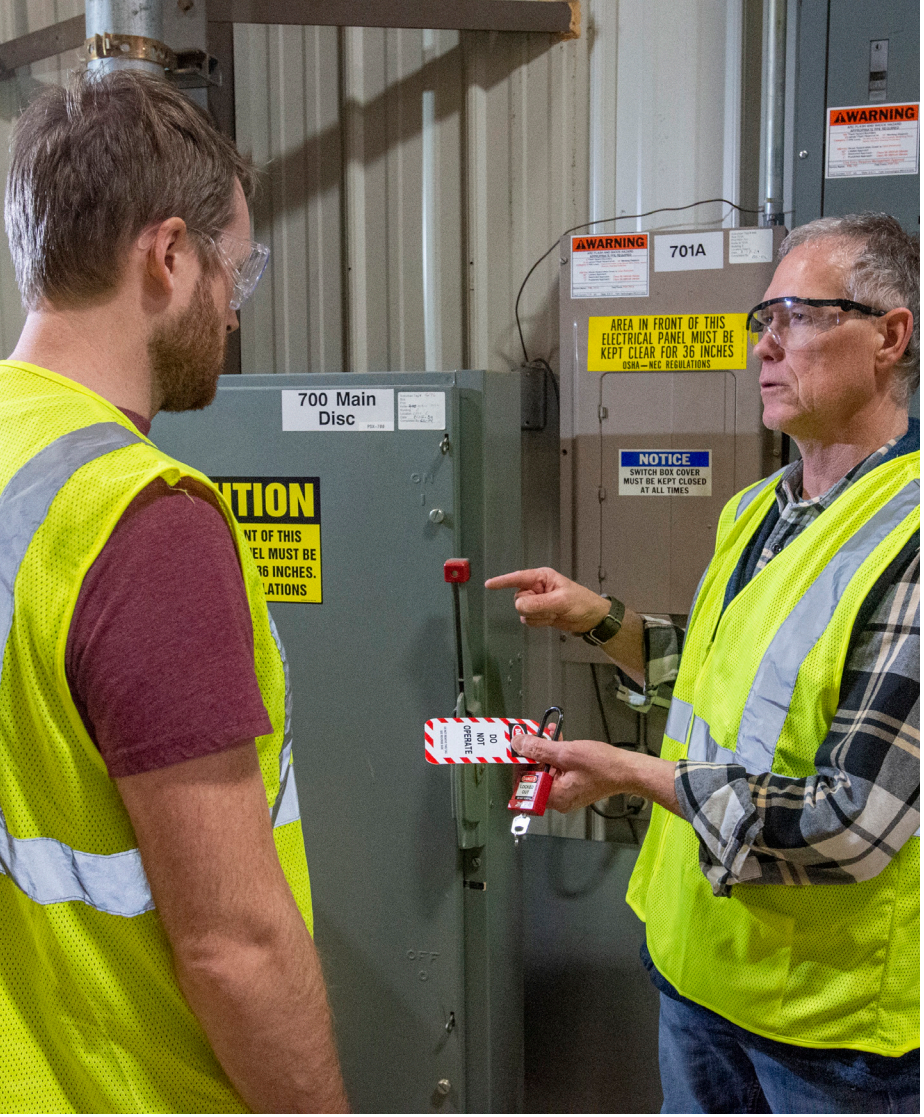
Each LOTO procedure must describe how to accomplish the following basic steps:

- Prepare for shutdown (review the procedure and identify the machine's energy sources),
- Shutdown (following the normal operating procedures),
- Notification of employees affected by the lockout or tagout (typically machine operators),
- Equipment isolation (cutting off the power supplies at the energy isolation devices),
- Applying LOTO devices (affixing locks or tags to the energy isolating devices to keep them in the "off" position),
- Releasing stored energy (such as built-up air pressure), and
- Verification that the machine is isolated (by trying to start the machine using normal operating controls).

Similar machines can share a LOTO procedure, but it must identify the machines to which it applies and note significant machine-specific differences.

For purposes of LOTO procedure grouping, machines and equipment may be grouped together under one shared procedure if they all are listed or identified in the scope of the shared procedure and if they all have the same or similar:

- Type and magnitude of energy;
- Procedural steps for shutting down, isolating, blocking, securing, and dissipating stored energy;
- Procedural steps for the placement, removal, and transfer of the lockout or tagout devices and the responsibility for them; and
- Requirements for testing a machine or equipment to determine and verify the effectiveness of LOTO devices and other control measures.



TRAINING

LOTO procedures must be detailed because they are the recipe authorized employees follow when they lock or tag out the equipment. LOTO training requirements are performance oriented, but they are much more extensive than the nearly nonexistent training requirements for machine safeguarding. The extent of LOTO training depends on the employee's role.

An "authorized employee" is a person "who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing covered servicing or maintenance." Each authorized employee is to "receive training in the recognition of applicable hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control." These workers are typically mechanics, but be wary of situations in which an "affected employee" becomes an authorized one.

An "affected employee" is one "whose job requires him or 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 or her to work in an area in which such servicing or maintenance is being performed." Each affected employee is to "be instructed in the purpose and use of the energy control procedures." Affected employees are notified before the machines they operate or work near are locked or tagged out. They become "authorized employees" if they make adjustments or otherwise help the authorized employees. A good practice is to ensure affected employees stay clear of equipment under LOTO.

The provision that often applies to workers who do not operate machines or repair equipment is: “All other employees whose work operations are or may be in an area where energy control procedures may be utilized, shall be instructed about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment which are locked or tagged out.” These may be office workers who venture out on the shop floor to check on orders, supplies, etc.

When a tagout system is used instead of lockout, employees must be trained on the limitations of tagout such as:

- Tags are essentially warning devices affixed to energy isolating devices. They do not provide the physical restraint that is provided by a lock.
- When a tag is attached to an energy isolating means, it is not to be removed without the authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.
- Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.

INSPECTION

One reason employers group similar machines under one general, shared LOTO procedure is the periodic inspection requirement at §1910.147(c)(6).

OSHA interprets the periodic inspection requirement to mean that each energy control procedure must be separately inspected at least annually. Energy control procedures used less frequently than once a year need be inspected only when used.

The periodic inspections for lockout are to “include a review, between the inspector and each authorized employee, of that employee’s responsibilities under the energy control procedure being inspected.” Each of those authorized employees does not need to be observed performing the procedure as part of the inspection. However, the inspection is to include a visual observation. Affected employees are included in the review when tagout is used for energy control.

Periodic LOTO inspections must include an observation of the procedure in use, but every authorized employee does not need to perform every procedure.

OSHA's guidance in Chapter 3 of its directive, CPL 02-00-147, The Control of Hazardous Energy — Enforcement Policy and Inspection Procedures states: "An employer may group distinct procedures associated with similar machines or equipment and consider the group of distinct procedures to be a single procedure for purposes of conducting a periodic inspection if the machines or equipment in the group have the same or similar types of control measures. ...

"Grouping energy control procedures for same or similar machines or equipment for inspection purposes may streamline the inspection and review process since there will be a smaller number of procedure groups than individual procedures. Thus, an employer may elect to group procedures as described above, and then inspect a representative number of such employees implementing one procedure within each group. This approach is acceptable as long as the inspection sampling reasonably reflects plant servicing and/or maintenance operations and hazardous energy control practices for the procedures being inspected."

EXCEPTIONS TO LOTO

Sometimes machine safeguarding offers enough protection even if a guard is opened or a machine operator places part of his body in a point of operation.

Minor servicing activities that are performed during normal production operations (such as lubricating, cleaning, releasing jams, and making machine adjustments) do not require LOTO if the activity is routine, repetitive, and integral to the production operation. In this situation, there must be alternative safeguards in place to provide effective protection.

Lock AND tag deenergized parts.

ROUTINE, REPETITIVE, INTEGRAL MINOR SERVICING ACTIVITIES PERFORMED DURING NORMAL OPERATIONS DO NOT REQUIRE LOTO.

Machine operators and authorized employees must have a solid understanding of the definitions for servicing and/or maintenance and normal production operations before attempting to use the minor servicing exception.

Concerning electrical safety, under §1910.147(a)(1)(ii), the LOTO standard states that it does not cover "exposure to electrical hazards from work on, near, or with conductors or equipment in electric-utilization installations, which is covered by subpart S" of part 1910. However, LOTO does play a key role in keeping qualified persons safe from electrical shock and electrocution hazards.

The LOTO standard at §1910.147 does not apply when employees work on or near exposed electrically energized parts, but electrical safety standards do apply.

ELECTRIC LOTO

Similar to protecting employees from mechanical hazards through the use of LOTO procedures outlined in §1910.147, the electrical safety requirements include lockout/tagout provisions.

HAZARD ANALYSIS

Electrical hazards are generally contained by the proper installation and use of cover plates, electrical insulation, grounding, etc. Properly installed electrical components do not present electric shock and electrocution hazards due to these protections.

The electrical safety standard's LOTO provisions apply when employees are exposed to the hazards of shock, electrocution, etc. Typically, this is when the electrical parts are exposed (i.e., a cover plate has been removed from an outlet to replace a broken receptacle — or a new machine is being installed and its wiring needs to be hooked up). In these scenarios, removing a cover plate or installing the equipment exposes the worker to the wiring — the worker could be injured or killed from contact with exposed live wires. In this case, the electrical safety lockout/tagout provisions at §1910.333(b) would apply. OSHA refers to these requirements as "working on or near exposed deenergized parts."

PROGRAMS, PROCEDURES, AND POLICIES

Deenergized parts are required to be locked and tagged. This is different than mechanical lockout in which either a lock or a tag is applied.

There are exemptions to using both locks and tags for electrical lockout:

- If a tag is used without a lock, it must be supplemented by at least one additional safety measure that provides a level of safety equivalent to that obtained by the use of a lock. Examples of additional safety measures include the removal of an isolating circuit element, blocking of a controlling switch, or opening of an extra disconnecting device.
- A lock may be placed without a tag only under the following conditions:
  - Only one circuit or piece of equipment is deenergized, and
  - The lockout period does not extend beyond the work shift, and
  - Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure.

WITH SOME EXCEPTIONS, OSHA REQUIRES BOTH LOCKS AND TAGS TO BE APPLIED FOR ELECTRICAL LOTO.

In mechanical LOTO, the authorized employee who applied the locks or tags verifies the machine is safe by trying to operate the controls. For electrical LOTO this step must be done by a qualified person.

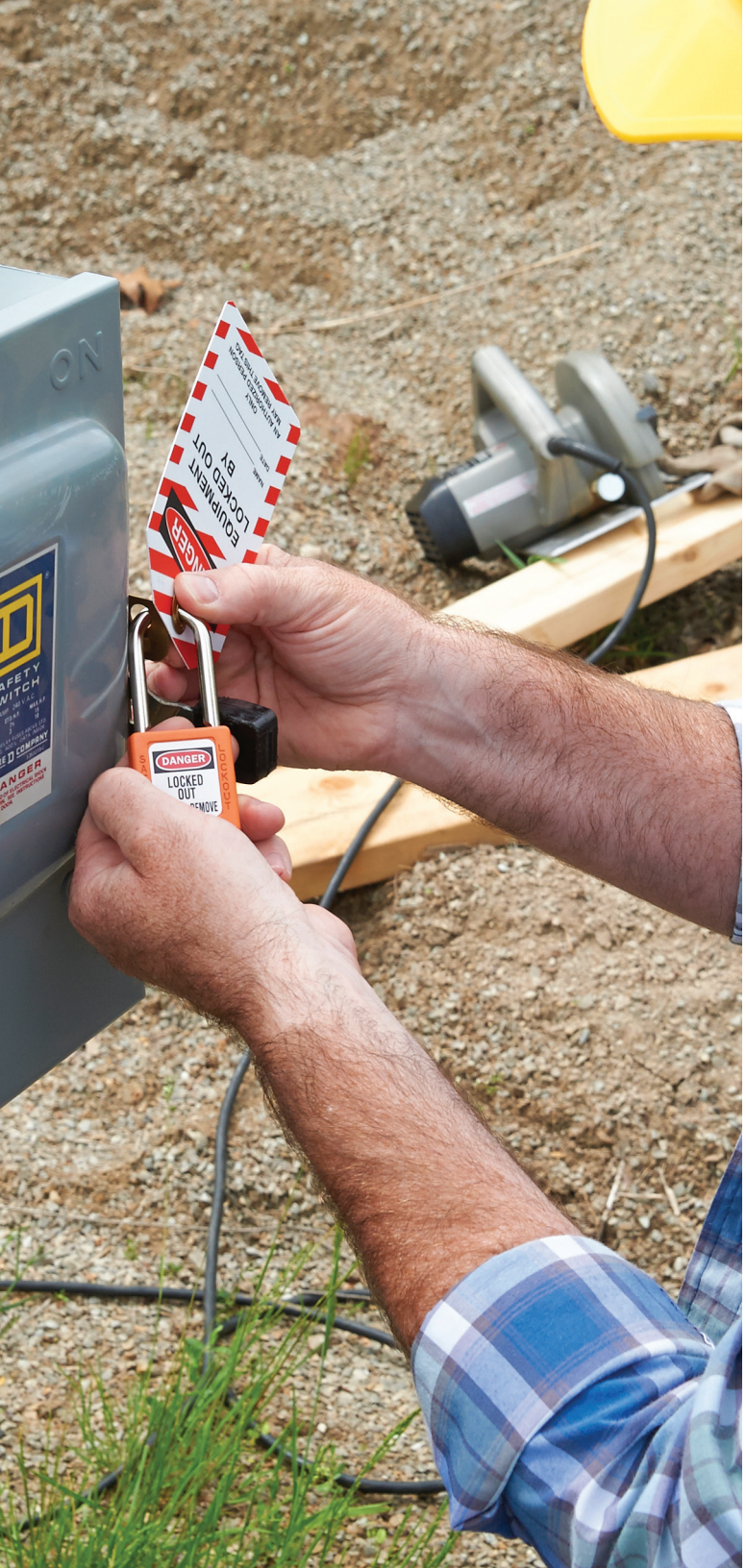
Similar to mechanical LOTO, the qualified person tries to activate the equipment to ensure it cannot be restarted. However, the qualified person must use test equipment to ensure that electrical parts and circuit elements have been deenergized. The qualified person must also inspect and check that the testing equipment is operating properly.

Before mechanical LOTO is removed, the authorized employee removes tools, etc. from the machine, replaces the guards, and makes sure all employees are safely positioned. Again, this is more complicated for electrical lockout. Before electrical equipment or circuits are reenergized, even temporarily, a qualified person must conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed, and potentially exposed employees must be warned to stay clear of circuits and equipment prior to reenergizing.

TRAINING

OSHA's electrical safety training requirements are at §1910.332. The general, performance-oriented requirements state the training is to be "of the classroom or on-the-job type. The degree of training provided shall be determined by the risk to the employee."

The qualified person plays a crucial role during electrical LOTO procedures. The definition of "Qualified person" is at §1910.399: "Qualified person. One who has received training in and has demonstrated skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.



QUALIFIED PERSONS PLAY A BIG ROLE IN ELECTRICAL LOTO. THEY ARE TRAINED TO KNOW HOW TO WORK ON OR NEAR EXPOSED ENERGIZED PARTS.

"Note 1 to the definition of 'qualified person': Whether an employee is considered to be a 'qualified person' will depend upon various circumstances in the workplace. For example, it is possible and, in fact, likely for an individual to be considered 'qualified' with regard to certain equipment in the workplace, but 'unqualified' as to other equipment. (See §1910.332(b)(3) for training requirements that specifically apply to qualified persons.)

"Note 2 to the definition of 'qualified person:' An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties."

Many local electric codes adopt the National Electric Code published by the National Fire Protection Association, NFPA 70; and some jurisdictions require licensing for electricians. Always follow local code and licensing requirements. Remember, OSHA sets the minimum standards.

INSPECTION

The electrical safety standard's LOTO provisions do not include requirements for periodic inspections. However, there is nothing to prohibit employers from this practice, and the inspections can be patterned after the periodic inspection requirements in the mechanical LOTO standard at §1910.147(c)(6).

RELATIONSHIP TO MECHANICAL LOTO AND SAFEGUARDING

Despite the differences, electrical LOTO can be incorporated into the employer's mechanical LOTO program. Note 2 under the requirements for working on or near

exposed deenergized parts at §1910.333(b)(2) states that the procedures must address the electrical safety hazards, and the procedures must incorporate the requirements for using a qualified person to verify deenergization and for taking extra precautions if using a tag without a lock (as outlined in §1910.333(b)(2)).

MECHANICAL LOTO PROCEDURES CAN BE USED TO MEET ELECTRICAL LOTO REQUIREMENTS IF THEY ALSO ADDRESS THE ELECTRICAL SAFETY HAZARDS.

The electrical safety lockout/tagout provisions differ from the mechanical LOTO standard in that the electrical safety rule requires a qualified person to verify the deenergization of the circuits. OSHA includes this requirement because the wiring is exposed. OSHA notes (at §1910.332) that qualified persons are "those permitted to work on or near exposed energized parts."

On the other hand, the mechanical LOTO standard concentrates on preventing injuries due to unexpected energization of machines or equipment when employees have removed a guard or have parts of their bodies in a machine's point of operation. When electrical conductors are not exposed, workers do not risk electrical hazards (shock, electrocution, etc.). The electrical supply to a machine still has to be locked out (following §1910.147), for example, when employees remove a machine's guard to change a belt or replace a gear. The electrical supply could activate motors, etc. that would move machine parts and potentially injure the workers. In this case, it is the movement of machine parts that could cause the injury, not the electrical hazards.

The standard for Electrical Safety-Related Work Practices (§§1910.331–.339) allows compliance with §1910.147(c) through (f) to constitute compliance with §1910.333(b)(2). However, the procedures must address the electrical safety hazards, and the procedures must incorporate the requirements for using a qualified person to verify deenergization and for taking extra precautions if using a tag without a lock.

Policies, training, and inspections should present a clear message of when machine safeguarding is adequate protection and when LOTO is required.

CONCLUSION

Machine operators will always be on the front line for hazards. With modern practices, many injuries still happen because the operator did not properly adjust a guard or removed a guard (or electrical cover plate) without taking the proper precautions. Aside from ensuring the equipment they use is equipped with the proper mechanical and electrical safeguards, employers must ensure operators can recognize the need to shut down and lock out the machine for service and maintenance. Policies, training, and inspections should present a clear message of when machine safeguarding is adequate protection and when LOTO is required.

Machine safeguarding, electrical guarding, and procedures to ensure safety during equipment servicing and maintenance are what make modern production so much safer than the horrid conditions tolerated decades ago.

HOW CAN WE HELP?

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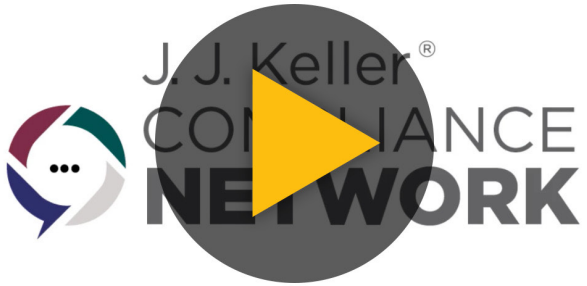

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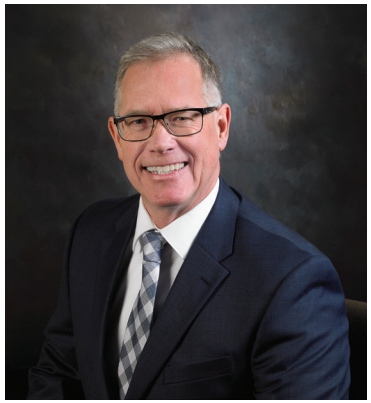

Mark Stromme joined J. J. Keller & Associates, Inc. in 1994 and is a Sr. Editor–Workplace Safety. He is an OSHA Outreach Construction Trainer and a Walkway Auditor Certificate Holder, with expertise in walkway auditing, cranes, scissor/aerial lifts, electrical safety, fall protection, confined spaces, scaffolding, lockout/tagout, and Canadian safety regulations. He has written dozens of trade publication articles for ISHN, Construction Business Owner, Transportation Management Engineering, BIC, EHS Today, Modern Contractor Solutions, Occupational Safety Health, Tow Professional, Fuel Marketer News, Constructech, and Workplace Materials Handling & Safety.

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