

OSHA's Lockout/Tagout Standards: A Review of Key Requirements

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This article reviews key elements of OSHA standards designed to control the unexpected release of hazardous energy or startup of machines or equipment, and prevent injury to employees performing servicing or maintenance. OSHA has many standards that require lockout/tagout (LOTO) of machines and equipment during maintenance and servicing. Some are generic in nature and cover a broad spectrum of facilities and processes; others are industry-specific. Most focus on facilities in general industry and do not cover employees in the agriculture, construction or maritime industries. In some cases, they overlap or apply concurrently. National data indicate that many occupational fatalities occur each year because employees are caught in running equipment or machinery. The number of such fatalities has increased, from 159 in 1992 to 163 in 1999. Nonfatal injuries involving days away from work when workers are caught in running equipment or machinery represents a larger portion of the total number of injuries in 1999 than in 1992 as well; it consisted of 1.64 percent of total injuries in 1992 compared to 1.78 percent of total injuries in 1999.

Since promulgating 29 CFR 1910.147, Control of Hazardous Energy Source (Lockout/Tagout), in September 1989, OSHA has issued two more standards with comprehensive lockout/tagout (LOTO) requirements: Electrical Safety-Related Work Practices: Final Rule, 29 CFR 1910.333(b)(2), Lockout and Tagging, which was published in August 1990; and the Final Rule for Electric Power Generation, Transmission and Distribution: Electrical Protective Equipment, which was published in January 1994.

1910.333(b)(2) contains requirements for training, work practices, use of equipment and safeguards for employees exposed to potential electrical hazards. It covers work on, near or with premises-electric-conductors and optical fiber cables when installed along with conductors.

The Final Rule for Electric Power Generation, Transmission and Distribution incorporates specific LOTO requirements for power generation and related equipment in paragraph (d), Hazardous Energy Control (Lockout/Tagout) Procedures. Requirements for a clearance procedure are contained in paragraph (m), De-Energizing Lines and Equipment for Transmission and Distribution Lines.

In addition, many OSHA standards, both general and specific in nature, contain LOTO requirements. This article discusses key elements of these standards, as well as any similarities and differences. Relevant statistics are also reviewed to

determine the most frequent event of exposure, worker activity, industry and nature of injury or illness.

STATISTICS

The purpose of LOTO standards is to prevent injury to employees from the release of stored hazardous energy during servicing and maintenance of machines and equipment. In the preamble to the LOTO standard, OSHA estimated that 144 fatalities and 33,432 lost-workday injuries had occurred in 1984 due to inadequate LOTO procedures.

Table 1 presents a summary of the occupational fatalities suffered by employees who are caught in running equipment or machinery. As shown, the total number of such fatalities has actually increased since 1992. As Table 2 indicates, most of these fatalities involved machinery. While approximately half of the fatalities occurred while employees were using or operating equipment or machinery, many occurred during servicing and maintenance operations (Table 3).

Industry-specific data indicate that employee fatalities caused by getting caught in running equipment or machinery are more frequent in the manufacturing sector (Table 4). However, more than one-third of these injuries occurred in the agriculture and construction industries where 29 CFR 1910.147 does not apply.

Table 5 presents nonfatal occupational injury and illness data involving days away from work when employees got caught in running equipment and ma-

TABLE 1 Fatal Occupational Injuries: Employees Caught in Running Equipment or Machinery

Year	1992	1993	1994	1995	1996	1997	1998	1999
No. of Cases	159	151	147	131	146	189	129	163
% of Total Fatalities	2.6	2.4	2.2	2.1	2.4	3.0	2.1	2.7

Source: BLS



**Lockout/tagout
at a circuit
breaker.**

equipment, when unplugged and the plug is under the employee's exclusive control;

6) Hot tap, when alternative, equally effective procedures are followed.

Definitions

The standard defines terms such as affected employee, authorized employee, capable of being locked out, energized, energy-isolating device, energy source, hot tap, lockout, lockout device, normal production operations, servicing and/or maintenance, setting up, tagout and tagout device.

General Requirements

The standard requires an employer to implement an energy control program to ensure that machines and equipment are isolated from the energy source and rendered inoperable before servicing/maintenance. This program must encompass specific energy control procedures, training and periodic inspections.

The general requirement paragraph explains when to use lockout procedures and when tagout is allowed. Additional precautions called "full employee protection" must be observed when tagout is chosen over lockout. The standard prescribes the outline for the LOTO procedure and provides more-detailed requirements for specific elements of an effective LOTO procedure.

This paragraph also contains basic requirements for protective materials and hardware, inspection and certification of LOTO procedures, role of the authorized person performing the procedure, and training provisions for authorized, affected and other employees.

Application of Control

The minimum performance procedures for LOTO are contained in 29 CFR 1910.147(d). Prior to performing maintenance or service of machines and equipment, the authorized employee must

chinery. As these data reveal, severe injuries such as fractures and amputations remain high. Table 6 shows that the total number of cases of nonfatal injuries involving days away from work resulting from workers being caught in machinery remains high. Currently, they represent a larger portion of the total number of injuries. Table 7 presents LOTO-related fatal and nonfatal occupational injuries investigated by federal OSHA from 1990 through 2000.

Following are summaries of OSHA standards that contain LOTO requirements.

29 CFR 1910.147 CONTROL OF HAZARDOUS ENERGY (LOTO)

Scope

This general industry standard is designed to protect employees from injury by preventing the unexpected energization, start-up or release of stored energy. It covers servicing and maintenance of

machines and equipment, including energy in piping systems where the unexpected energization or start-up of the machines or equipment, or the release of stored energy could cause injury.

Workplace activities covered include constructing, installing, setting up, adjusting, inspecting, modifying, lubricating, cleaning, unjamming, making tool changes and servicing of machines and equipment. The standard does not cover:

- 1) construction, agriculture and maritime employment;
- 2) power generation, transmission and distribution, including related equipment for communication or metering under the exclusive control of electric utilities (covered under 1910.269);
- 3) workplace wiring systems, including fixed electric equipment and circuits, that have been de-energized (covered under 1910.333(b));
- 4) oil and gas well drilling/servicing;
- 5) cord and plug connected electric

TABLE 2 Fatal Occupational Injuries: Employees Caught in Running Equipment or Machinery by Event of Exposure 1992-1999

Event of Exposure	1992	1993	1994	1995	1996	1997	1998	1999
Vehicles (truck, tractor, forklift, etc.)	18	17	15	17	16	16	20	22
Machinery (agricultural, construction, logging, mining, conveyors, woodworking, special process)	129	126	125	111	125	162	105	134
Other (not elsewhere classified)	12	8	7	3	5	11	4	7
TOTAL	159	151	147	131	146	189	129	163

Source: BLS

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TABLE 3 Fatal Occupational Injuries: Employees Caught in Running Equipment or Machinery by Worker Activity 1992-1999

WORKER ACTIVITY	1992	1993	1994	1995	1996	1997	1998	1999
Transportation	9	5	9	7	9	10	7	11
Using or operating tools, machinery	75	74	70	56	75	91	51	66
Constructing, repairing, cleaning	48	41	44	55	48	68	55	72
Material handling operations	8	13	9	5	7	11	8	9
Other physical activity	0	0	5	0	0	6	6	0
Other (not elsewhere classified)	19	18	10	8	7	3	2	5
TOTAL	159	151	147	131	146	189	129	163

Source: BLS

29 CFR 1910.269(D)

HAZARDOUS ENERGY CONTROL (LOTO) PROCEDURES

This standard applies to power generation, including related equipment for communication or metering. According to Appendix B of OSHA Instruction CPL 2-1.18A, everything on the load side of the disconnects for the output side of a generator step-up transformers is considered part of the transmission system and is covered under 1910.269(m), De-Energizing Lines and Equipment. Everything else in the substation, including the electrical installation back to the generator, is part of the generating installation, which is covered under 1910.269(d), LOTO for Power Generation. Definitions for terms stated in this paragraph, including related equipment for communication or metering, are in paragraph 1910.269(x).

The standard contains general requirements for an energy control program, specific energy control procedures, training and periodic inspections. These provisions are substantially identical to 1910.147, as are those for the application of controls and the release from LOTO.

The standard contains other requirements identical to 1910.147. However, where energy-isolating devices are installed in a location under the exclusive control of a system operator, the standard allows the system operator, in accordance with an established procedure that will afford authorized employees protection equivalent to that provided by the imple-

mentation of a personal LOTO device, to place and remove LOTO devices instead of the authorized employee. A procedure to identify the authorized employee must be established and utilized by the system operator and employees. This procedure will use a system such as signed orders, passwords, master locks or tags, or receipts to ensure that only the authorized employee requests placement and removal of LOTO devices by the system operator.

29 CFR 1910.333(B)(2) LOCKOUT & TAGGING

This general industry standard applies to employees who work on or near exposed de-energized parts of premises wiring systems, including fixed electric equipment and circuits that have been de-energized. Definitions of terms—such as premises wiring and qualified person—are included in paragraph 1910.399.

The standard requires a qualified person to use equipment operating controls, test circuit elements and electrical parts of equipment, and verify that circuit elements and electrical parts of equipment are de-energized prior to maintenance.

In addition, the employer must establish and implement a written LOTO procedure. However, the employer may use a copy of the 1910.333(b)(2) paragraph to comply with this provision. Circuits and electrical equipment must be de-energized in a safe, orderly manner and be disconnected from all electric energy

prepare for shutdown by reviewing information such as the type and the magnitude of energy, controls and hazards. Shut down must be performed in an orderly manner. Energy-isolation devices must be located and operated to achieve isolation from all energy sources. The LOTO devices must be affixed to the energy-isolating devices maintained in a safe (off) position. Stored energy must be relieved or rendered safe. The authorized employee must verify that machines and equipment are isolated from energy sources and are at zero-level energy before maintenance begins.

Release from LOTO

The LOTO procedure must contain clear instructions covering procedures for re-energizing machines and equipment after completion of maintenance. The equipment must be inspected to verify that components are properly fastened and jumpers or grounds, if applied for maintenance purposes, are removed. Employees performing the procedure must be safely positioned before removing the LOTO devices. Affected employees not participating in the procedure must be notified that the devices have been removed.

Additional Requirements

This section contains four important requirements. An energy control program must include:

1) steps necessary to protect employees engaged in testing and positioning of machines and equipment during the LOTO process;

2) a requirement for contract employers and host employers to inform each other of respective LOTO procedures and ensure that their employees observe the other employer's procedure;

3) a group LOTO procedure; if used, this procedure must be as protective as that requiring implementation of a personal LOTO device;

4) provisions to address shift or personnel changes to ensure that the continuity of LOTO protection and the orderly transfer of LOTO devices is observed.

TABLE 4 Fatal Occupational Injuries: Employees Caught in Running Equipment or Machinery by Industry 1992-1999

INDUSTRY	1992	1993	1994	1995	1996	1997	1998	1999
Agriculture, Forestry & Fishing	50	53	41	38	47	50	36	38
Mining	5	7	8	5	10	11	8	6
Construction	15	13	11	13	11	17	14	24
Manufacturing	66	56	61	49	52	78	47	69
Transportation, Public Utilities	6	7	5	7	6	11	7	6
Wholesale Trade	5	0	10	5	10	11	7	5
Services	0	6	0	5	6	7	0	7
Government	7	0	6	5	0	0	5	6
Other (not elsewhere classified)	5	9	5	4	4	4	5	2
TOTAL	159	151	147	131	146	189	129	163

Source: BLS

sources. All stored energy must be released. Capacitors must be discharged and grounded.

The standard requires that a lock and a tag be placed on every disconnecting means. However, it states conditions under which a lock only or a tag only can be used. A qualified employee must verify that equipment and circuits are de-energized by operating controls and testing circuit elements.

A qualified employee must conduct a visual inspection of the work area and test the circuit and equipment prior to re-energization. Employees must be safely positioned before locks and tags are removed.

OTHER LOTO STANDARDS IN GENERAL INDUSTRY

29 CFR 1910.147(a)(3)(ii) states that where specific general industry standards contain LOTO requirements they must be used and supplemented by the LOTO procedural and training requirements of 1910.147. Specific general industry standards include:

Powered Industrial Trucks

Paragraph 1910.178(q)(4) requires the battery to be disconnected before repairs to the electrical system.

Overhead & Gantry Cranes

Paragraph 1910.179(g)(5), Switches, requires electrical disconnects for the runway conductor, cab-operated cranes and floor-operated cranes to be accessible and designed to accept a lock when placed in an open position.

Paragraph 1910.179(l)(2) contains provisions to protect employees engaged in the maintenance and servicing of overhead cranes. The repair area should have the least interference possible from other cranes. Controllers must be turned off and the main disconnect locked in the open position. Other necessary precautions such as warning signs and rail stops must be used as necessary.

Derricks

Paragraph 1910.181(f)(2) contains provisions to protect employees engaged in servicing/maintaining derricks.

Woodworking Machinery

Paragraph 1910.213(a)(10) requires that all power-driven woodworking machines be equipped with a lockable disconnect. Paragraph 1910.213(b)(5) requires that controls on machines operated by electric motors be rendered inoperative during repairs and adjustment.

TABLE 5 Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work by Nature of Injury, Illness 1992-1999

NATURE OF INJURY, ILLNESS	Caught in Running Equipment or Machinery							
	1992	1993	1994	1995	1996	1997	1998	1999
Sprains, strains	1,411	1,040	1,051	963	920	839	1,002	861
Fractures	4,959	4,293	4,918	4,497	3,213	3,747	3,653	4,456
Cuts, Lacerations, Punctures	12,288	10,928	11,798	12,175	8,698	10,063	11,418	9,909
Bruises, Contusions	3,818	2,925	2,998	2,854	2,004	2,590	1,864	2,304
Amputations	5,250	4,845	5,504	4,427	4,134	4,349	5,037	4,414
Multiple Injuries	2,797	2,942	2,293	1,987	1,988	1,894	1,994	2,396
Soreness, Pain	292	402	567	471	397	387	664	671
All Other	7,400	6,950	7,337	7,252	6,704	6,330	6,155	5,335
TOTAL	38,215	34,325	36,466	34,626	28,058	30,199	31,787	30,346

Source: BLS

Mechanical Power Presses

Paragraph 1910.217(b)(8)(i) requires that the power press control system be equipped with a main disconnect that can be locked in the off position. Paragraph 1910.217(d)(9)(iv) requires the use of safety blocks by the diesetter during die adjustment or repair of dies in the press.

Forging Machines, 1910.218

The standard contains many requirements to protect employees engaged in the maintenance and servicing of hammers, presses, upsetters and other forging equipment. Equipment must be equipped with disconnects that can be locked in the open (off) position or rendered inoperable. Appropriately designed blocks or wedges must be provided and used when necessary. Steam and air hammers must be equipped with a quick-closing emergency valve at a convenient location. The valve must be closed and locked during repair or maintenance of the hammer.

Welding, Cutting & Brazing

Paragraph 1910.255(a)(1) requires that the resistance welding machines be equipped with a safety-type disconnecting switch or a circuit breaker or a circuit interrupter conveniently located so that the power can be turned off to the machine and equipment during servicing.

Pulp, Paper & Paperboard Mills, 1910.261

Under paragraph 1910.261(b)(1), Safe Practices, this standard requires the main power disconnects and valves for equipment be locked out or blocked off to protect employees engaged in equipment maintenance inspection, cleaning, adjusting or servicing. Paragraph 1910.261(g)(15)(i) requires the valve controlling lines leading into the digester to be locked out and tagged during inspection or repair of the digester. Paragraph 1910.261(j)(5)(iii) requires control valves leading to pulpers to be locked out and tagged out or blanked off and tagged prior to cleaning, inspecting or any other work that requires a person to enter into

the pulper. Paragraph 1910.261(k)(2)(ii) requires drives to be equipped with lock-out devices at the power switch.

Textiles, 1910.262

Under General Safety Requirements (1910.262(c)), textile machines must be equipped with individual mechanical or electrical means for stopping such machines. The standard contains provisions for locking valves that control the flow of steam, injurious gases or liquids to J-Box and Kier prior to entry.

Bakery Equipment, 1910.263

Paragraph 1910.263(l) states that prior to working on electrical equipment or entry into an oven, means for locking the main switch in the open position must be provided.

Sawmills, 1910.265

Under paragraph 1910.265(c)(13), hydraulic equipment must be rendered safe prior to servicing and maintenance. Means to secure equipment must be provided. In addition, under paragraph 1910.265(c)(26), the main control switches to mechanical stackers must be designed so they can be locked in the open position.

Grain Handling, 1910.272

Paragraph 1910.272(g) requires LOTO provisions for mechanical, electrical, hydraulic and electrical equipment to protect employees entering grain storage structures where they become exposed to hazardous energy. Under paragraph 1910.272(h), an auger or other grain transport equipment must be de-energized, disconnected and locked out and tagged out or rendered safe prior to allowing employees to walk or stand on the grain that might collapse in a flat storage tank. Employees must receive training on LOTO procedures.

Wiring Methods, 1910.305

Paragraph 1910.305(j)(4)(ii), Disconnecting Means, requires controller disconnecting means not in sight of the

TABLE 6 Nonfatal Occupational Injuries Involving Days Away from Work Resulting from Workers Being Caught in Machinery, Private Industry 1992-1999

YEAR	1992	1993	1994	1995	1996	1997	1998	1999
Number of Cases	38,215	34,325	36,466	34,626	28,058	30,199	31,787	30,346
% of Total Injuries	1.64	1.52	1.63	1.70	1.49	1.65	1.83	1.78

Source: BLS

controller to be designed so they can be locked in the open position.

**29 CFR PART 1926
CONSTRUCTION STANDARDS
Lockout & Tagging of Circuits
(1926.417)**

The standard requires controls, equipment and circuits to be de-energized and tagged out prior to being worked on. Paragraph 1926.555(a)(7) requires conveyors to be locked out or otherwise rendered inoperable and tagged out to protect maintenance employees from potential exposure to hazardous energy.

MARITIME SAFETY & HEALTH STANDARDS

To protect employees in ship repair and shipbuilding from radiation, 1915.95(a) requires the radar and radio to be secured or made incapable of radiation and tagged before employees are allowed to work on masts, king posts or other similar equipment where they may become exposed to radiation.

Paragraph 1915.162, Ship's Boilers, requires shut down, isolation, locking and tagging of valves to the boiler to protect employees working on the boiler from hazards created by high temperature mediums such as steam, water or oil.

Paragraph 1915.181, Electrical Circuits and Distribution Boards, requires circuits to be de-energized, tagged and tested before working on electrical machinery.

Part 1910 Subpart S, Electrical, is incorporated by reference in Part 1917, Marine Terminals and Part 1918, Safety and Health Regulations for Longshoring. Therefore, 1910.333(b)(2), Lockout and Tagging, applies to those industries.

CONSENSUS INDUSTRY STANDARDS

ANSI Z244.1-1982, Personnel Protection, LOTO of Energy Sources, Minimum Safety Requirements, was referenced in development of 1910.147. The ANSI standard requires use of a LOTO policy and procedure to protect employees engaged in servicing/maintaining equipment and processes from unexpected energization, start-up or release of stored energy.

The ANSI standard is a performance standard that applies to all maintenance and repair activities where release of energy may expose employees to harm from the uncontrolled release of hazardous energy. Since it covers all situa-

TABLE 7 LOTO-Related Fatal & Nonfatal Occupational Injuries Investigated by OSHA 1990-2000

YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Fatal	15	11	12	10	16	7	9	9	10	4	8
Nonfatal	18	35	29	26	36	34	20	12	27	15	16
TOTAL	33	46	41	36	52	41	29	21	37	19	24

Source: BLS

tions where LOTO is required, it can be used as a basis for industry recognition of a hazard that threatens employees. Such recognition is an essential element in substantiating a violation of the General Duty Clause of the OSH Act.

CONCLUSION

Most facilities covered by OSHA's general industry standards (Part 1910) must implement an LOTO program that encompasses procedures and training. In many cases, a facility or process may be covered by a specific LOTO standard that must be supplemented by procedural and training requirements as stated in the generic LOTO standard 1910.147.

Despite the many regulations, many employees continue to be fatally or severely injured each year as the result of getting caught in machines and equipment. Many of these injuries and fatalities can be prevented by implementing sound LOTO procedures (Windau 35-38).

In FY2000, OSHA issued citations for 4,149 alleged violations of 1910.147. Approximately one-third of these violations were issued for the lack of an energy control procedure or program.

Regardless of industry coverage under the various standards, employers are primarily responsible for protecting employees from recognized hazards. Implementing general machine guarding and an LOTO program with emphasis on procedures, training and periodic inspections will prevent injuries and save lives. ■

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