

SECTION 8: LOCKOUT/TAGOUT (LOTO) PROCEDURES

Regulatory Basis: 29 CFR 1926.416 and 29 CFR 1926.417 (Construction Electrical Safety); 29 CFR 1910.147 (General-Industry Machinery Energy Control); 29 CFR 1910.333 (General-Industry Electrical Work Practices)

8.1 Scope

Lockout/Tagout (LOTO) applies to ALL servicing, maintenance, and repair of HVAC and plumbing equipment where the unexpected energization, startup, or release of stored energy could cause injury. This includes:

- Air handling units (AHUs) and fan coil units
- Condensing units and chillers
- Boilers and water heaters
- Pumps (circulating pumps, condensate pumps, sump pumps)
- Cooling towers
- Compressors
- Electrical panels and disconnects serving HVAC/plumbing equipment
- Pressurized refrigerant and water systems
- Steam systems

Work regime: For covered general-industry machinery servicing and maintenance, apply the energy-control requirements of 29 CFR 1910.147(c)-(f) to servicing and maintenance within the scope of 29 CFR 1910.147(a)(1)-(2). General-industry exposure to electrical hazards from work on, near, or with conductors or equipment in electric-utilization installations is governed by Subpart S and excluded from 29 CFR 1910.147 (29 CFR 1910.147(a)(1)(ii)(D)). Company electrical method: Use the direct procedure specified below under 29 CFR 1910.333(b)(2) for work exposing employees to contact with parts of fixed electric equipment or circuits which have been deenergized.

For construction, tag controls to be deactivated (29 CFR 1926.417(a)). Render deenergized equipment/circuits inoperative and attach tags at all points where they can be energized (29 CFR 1926.417(b)). Identify the equipment/circuits plainly on the tags (29 CFR 1926.417(c)).

Company pre-work method: In the Energy Control / LOTO Template - HVAC/Plumbing, record the task regime, equipment, energy sources, applicable procedure and assigned personnel; the supervisor holds work until those facts and controls are verified. The examples below supplement the sequence in Section 8.2 and do not release this hold.

Stored energy sources for HVAC/Plumbing work:

- Electrical energy (voltage in motors, controls, heating elements)
- Refrigerant pressure (high-side and low-side pressure)
- Water pressure (domestic water, chilled water, heating water systems)
- Steam pressure (steam systems, condensate)
- Pneumatic pressure (control air)
- Thermal energy (hot surfaces, boilers, water heaters)
- Gravitational energy (suspended components)

8.2 LOTO Steps - Sequence

REQUIRED SEQUENCE before servicing any HVAC/Plumbing equipment, with the electrical order below:

For general-industry work exposing employees to contact with deenergized parts of fixed electric equipment or circuits, follow the electrical requirements in the order in which they are presented (29 CFR 1910.333(b)(2)).

Legal order, general-industry electrical work (29 CFR 1910.333(b)(2)): after steps 1-4 below, release stored electric energy and block or relieve stored non-electrical energy in devices that could reenergize electric circuit parts, as stated in the general-industry electrical bullet of step 7 (29 CFR 1910.333(b)(2)(ii)(C)-(D)), before applying the electrical locks and tags in steps 5-6; then perform the step 8 verification before step 9 work. The other step 7 controls follow steps 5-6 as numbered. Company's chosen method: The Electrical-work supplement in the Energy Control / LOTO Template - HVAC/Plumbing governs the electrical stages of this sequence and every equipment example in Section 8.6.

Company's chosen method: Record the resolved electrical and machinery order in the equipment procedure and hold work until the supervisor and qualified electrical reviewer verify it; retain the numbered order below for general-industry machinery energy control.

1. Notify all affected employees that equipment will be de-energized
2. Identify all energy sources (electrical, refrigerant, water, steam, etc.)
 - Construction: Before work, determine by inquiry, direct observation or instruments whether any exposed or concealed energized circuit could bring any person, tool or machine into physical or electrical contact, including circuits outside the isolated equipment (29 CFR 1926.416(a)(3)). Post and maintain warning signs where such a circuit exists (29 CFR 1926.416(a)(3)). Advise employees of the circuit location, hazards and protective measures (29 CFR 1926.416(a)(3)). Do not permit work close enough for contact unless protected by deenergizing and grounding the circuit or guarding it effectively by insulation or other means (29 CFR 1926.416(a)(1)). Where the exact location of underground powerlines is unknown, provide insulated protective gloves for employees using jack-hammers, bars or other hand tools that may contact a line (29 CFR 1926.416(a)(2)).
 - Company assessment method: Record the circuit assessment and protection decision in the Energy Control / LOTO Template - HVAC/Plumbing; if no contact exposure exists, record that determination, and if contact is possible or uncertain, hold work until assessment and protective measures are complete.
3. Shut down the equipment using the normal stopping procedure
4. Isolate each energy source:
 - Electrical: open the disconnect switch; move circuit breaker to OFF
 - General-industry electrical work: Determine safe deenergizing procedures before deenergizing (29 CFR 1910.333(b)(2)(ii)(A)). Disconnect all electric energy sources; control circuit devices may not be the sole means of deenergizing, and interlocks may not substitute for lockout/tagging (29 CFR 1910.333(b)(2)(ii)(B)).
 - Company policy (exceeds 29 CFR 1910.333(b)(2)(iii)(C), (E); 29 CFR 1910.147(c)(2)-(3)): Use both a lock and a tag at every isolation point on all work; do not use the tag-only or lock-only exceptions, and stop if an isolator cannot accept the lock.
 - Water/steam: close the isolation valve; note valve location and orientation
 - Refrigerant: recover refrigerant; service valves may isolate refrigerant to a system receiver only with subsequent recovery/evacuation of the part to be opened as required in step 7.
 - Pneumatic: close supply valve and bleed off stored air
5. Apply lockout device to each energy isolation point (one lock per authorized employee - your personal lock)
 - General-industry electrical work: Only after the step 7 electrical stored-energy controls (29 CFR 1910.333(b)(2)(ii)(C)-(D)), place a lock and a tag on each disconnecting means used to deenergize the circuits and equipment to be worked on (29 CFR 1910.333(b)(2), (b)(2)(iii)(A)).
6. Apply tagout tag at each lockout point identifying who applied the lock, date, and purpose

7. Release/restrain residual energy:

- Refrigerant: do not knowingly vent or release refrigerant (40 CFR 82.154(a)(1)). Company rule (beyond 40 CFR 82): no venting of any refrigerant, including exempt substitutes. Recover/evacuate refrigerant in the part to be opened with certified recovery/recycling equipment to the required level under 40 CFR 82.156; verify that level on gauges before opening (40 CFR 82.154(b); 82.156(a)).
 - Drain water from isolated sections as needed
 - Allow hot components to cool before touching
 - Block suspended components (fan blades, etc.) to prevent movement
 - General-industry electrical work: Release stored electrical energy that might endanger personnel; discharge capacitors and short-circuit and ground high capacitance elements if their stored electrical energy might endanger personnel (29 CFR 1910.333(b)(2)(ii)(C)). Treat capacitors and associated equipment as energized while handling them to meet this requirement (29 CFR 1910.333(b)(2)(ii)(C), Note). Block or relieve stored non-electrical energy that could reenergize electrical parts (29 CFR 1910.333(b)(2)(ii)(D)). Company policy (exceeds 29 CFR 1926.417): Apply these stored-energy controls to construction electrical isolation as well. Company method: Record the applicable discharge, short-circuiting and grounding method, or the determination that no such hazardous stored energy exists, in the equipment procedure; hold contact until the controls and verification in the next step are complete.
8. Verify zero energy state: attempt to restart the equipment; verify no voltage present (test with meter); verify zero water/refrigerant/steam pressure with gauge
- General-industry electrical work: Before equipment is treated as deenergized, a qualified person must operate the controls or otherwise verify that it cannot restart (29 CFR 1910.333(b)(2)(iv)(A)). A qualified person must use test equipment to test all circuit elements and electrical parts to which employees will be exposed, verify they are deenergized, and check for inadvertently induced voltage or unrelated voltage backfeed (29 CFR 1910.333(b)(2)(iv)(B)). For circuits over 600 volts, nominal, check test-equipment operation immediately before and immediately after that test (29 CFR 1910.333(b)(2)(iv)(B)).
 - General-industry machinery: If stored energy could reaccumulate to a hazardous level, continue verification of isolation until servicing or maintenance is completed or the possibility of accumulation no longer exists (29 CFR 1910.147(d)(5)(ii)). Company policy (exceeds 29 CFR 1926.417): Apply the same continuing verification to construction servicing when that possibility exists. Company method: Record whether reaccumulation is possible and the continuing verification method and responsible authorized employee in the equipment procedure; hold work if that assessment or method is unresolved.
9. Begin work - complete the initial controls and verification in steps 1-8 before starting; continue isolation verification where required during servicing (29 CFR 1910.147(d)(5)(ii), (d)(6); 29 CFR 1910.333(b)(2)(iv)).

8.3 LOTO Hardware

- Padlocks: Each authorized employee has their own assigned padlock with unique key. Only that employee has the key. Locks are not interchangeable.
- Hasp: Multi-lock hasp used when multiple employees work on the same equipment - each employee applies their own lock to the hasp
- Lockout tags: Red "DANGER - DO NOT OPERATE" tags - applied along with lock, not instead of lock; for general-industry electrical work, each tag must prohibit unauthorized operation of the disconnecting means and unauthorized removal of the tag (29 CFR 1910.333(b)(2)(iii)(B)).
- Lockout stations: LOTO hardware stored in accessible location: Job trailer entrance, wall-mounted LOTO station

Demo Company LLC maintains the following LOTO hardware at minimum: _____ personal padlocks, _____ hasps, _____ lockout tags, _____ lockout devices for specific equipment types (valve lockouts, electrical plug lockouts).

General-industry machinery hardware:

- Lockout and tagout devices must be singularly identified, be the only devices used for controlling energy, and not be used for other purposes (29 CFR 1910.147(c)(5)(ii)).
- Locks and tags must withstand their environment for the maximum expected exposure time (29 CFR 1910.147(c)(5)(ii)(A)(1)).
- Tags must remain intact and legible in weather and wet/damp locations, and must not deteriorate in corrosive environments (29 CFR 1910.147(c)(5)(ii)(A)(2)-(3)).
- Standardize lockout and tagout devices within the facility by at least one of color, shape or size, and standardize tag print and format (29 CFR 1910.147(c)(5)(ii)(B)).
- Locks must resist removal without excessive force or unusual techniques, such as bolt cutters or other metal-cutting tools (29 CFR 1910.147(c)(5)(ii)(C)(1)).
- Tags and attachments must prevent inadvertent or accidental removal; attachments must be non-reusable, attachable by hand, self-locking and non-releasable, with minimum unlocking strength of at least 50 pounds and the general design and basic characteristics at least equivalent to a one-piece, all-environment-tolerant nylon cable tie (29 CFR 1910.147(c)(5)(ii)(C)(2)).
- After January 2, 1990, replacement or major repair, renovation or modification of machinery/equipment, and installation of new machinery/equipment, require energy isolating devices designed to accept a lockout device (29 CFR 1910.147(c)(2)(iii)).

General-industry electrical locks: A lock and a tag go on each disconnecting means used to deenergize circuits and equipment to be worked on; attach the lock so that the disconnecting means cannot be operated without undue force or tools (29 CFR 1910.333(b)(2)(iii)(A)). Company procurement method: Before use, the Safety Officer verifies device specifications, environmental suitability, isolator lockability and required tag wording and records acceptance in the Energy Control / LOTO Template - HVAC/Plumbing; hold use of nonconforming or unverified devices.

8.4 Restoring Equipment to Service

1. Inspect work area - confirm all tools, materials, and personnel are clear of the equipment; for general-industry machinery, confirm before device removal and energy restoration that components are operationally intact (29 CFR 1910.147(e)(1)).
- For general-industry electrical work, a qualified person must perform the tests and visual inspections needed to verify removal of all tools, electrical jumpers, shorts, grounds and similar devices so circuits/equipment can be safely energized (29 CFR 1910.333(b)(2)(v)(A)).
2. Notify all affected employees that equipment will be re-energized; for general-industry electrical work, warn employees exposed to reenergization hazards to stay clear of the circuits and equipment (29 CFR 1910.333(b)(2)(v)(B)).
3. For general-industry machinery, each lockout/tagout device must be removed by the employee who applied it, subject to the controlled-removal exception in Section 8.7 (29 CFR 1910.147(e)(3)). For general-industry electrical work, remove each lock/tag by the applying employee or under that employee's direct supervision, subject to the absent-employee procedure in Section 8.7 (29 CFR 1910.333(b)(2)(v)(C)).
- For general-industry machinery, after removing devices and before startup, notify affected employees that the lockout/tagout devices have been removed (29 CFR 1910.147(c)(9), (e)(2)(ii)).
4. For general-industry electrical work, visually determine that all employees are clear after device removal and before reenergizing (29 CFR 1910.333(b)(2)(v)(D)). Restore energy in the order set by the equipment procedure and the manufacturer's start-up instructions; do not energize a compressor while its refrigerant circuit is open or under vacuum.
5. Verify safe operation before leaving

For general-industry machinery testing or positioning that requires temporary device removal and energization, first clear tools/materials, remove employees, remove devices under the applicable rules in Section 8.4 and Section 8.7, then energize for the test or positioning; deenergize all systems and reapply the controls in

Section 8.2 before continuing service (29 CFR 1910.147(f)(1)(i)-(v)). For general-industry electrical reenergization, the ordered checks in Section 8.4 apply even to temporary energization (29 CFR 1910.333(b)(2)(v)). Company planning method: Record any test/positioning sequence in the task procedure before work; an unresolved sequence keeps the task on hold.

8.5 Group LOTO (Multiple Employees)

When multiple technicians work on the same equipment:

- Use a lockout hasp - one hasp per isolation point
- Each employee applies their own personal lock to the hasp
- Equipment cannot be re-energized until ALL employees have removed their locks
- One employee is designated LOTO coordinator and is responsible for the overall LOTO permit
- For general-industry group servicing, vest primary responsibility in an authorized employee for the defined group (29 CFR 1910.147(f)(3)(ii)(A)). Provide for that authorized employee to ascertain each group member's exposure status under the equipment lockout/tagout (29 CFR 1910.147(f)(3)(ii)(B)). When multiple crews, crafts or departments are involved, assign overall control responsibility to an authorized employee to coordinate affected workers and ensure continuity of protection (29 CFR 1910.147(f)(3)(ii)(C)). Company method: Record the assigned authorized coordinator, group members and individual exposure status on the Energy Control / LOTO Template - HVAC/Plumbing before releasing group work.

8.6 Equipment-Specific LOTO Procedures

Develop and use energy-control procedures for all covered general-industry servicing and maintenance, regardless of frequency; document them unless every condition of the documentation exception is met (29 CFR 1910.147(c)(4)(i)). Company policy (exceeds 29 CFR 1910.147(c)(4)(i), Exception; 29 CFR 1926.417): Document every equipment/task procedure, including construction work; do not use the documentation exception. Company method: Complete the supplied Energy Control / LOTO Template - HVAC/Plumbing for each task and incorporate the equipment-specific instructions and the applicable sequence in Section 8.2 and Section 8.4; shared instructions may cover multiple machines only if they address each machine's actual isolation and verification needs. The supervisor reviews and releases the completed procedure before work; unresolved sources, isolation points, qualifications or controls keep work on hold. Each procedure must identify:

- Equipment description and location
- Each energy source, its type and magnitude
- Specific steps for isolating and securing each energy source
- PPE required
- Methods to verify zero energy state
- Scope, purpose, authorization, rules, techniques and means to enforce compliance, including the intended use of the procedure (29 CFR 1910.147(c)(4)(ii), (c)(4)(ii)(A))
- Specific shutdown, isolation, blocking and securing steps (29 CFR 1910.147(c)(4)(ii)(B))
- Specific placement, removal and transfer steps for devices and responsibility for them (29 CFR 1910.147(c)(4)(ii)(C))
- Specific testing requirements to verify the effectiveness of locks, tags and other controls (29 CFR 1910.147(c)(4)(ii)(D))

For general-industry electrical work, maintain the written procedure and make it available for inspection by employees and the Assistant Secretary of Labor and authorized representatives (29 CFR 1910.333(b)(2)(i)). Company record method: Keep the completed task sheet with its equipment instructions available to the crew and retain the reviewed copy with the LOTO records; use that sheet as the LOTO log for Section 8.7.

Company's chosen method: For general-industry electrical work, apply the governing electrical order in Section 8.2 to each equipment example below; resolve the electrical stages in the completed Energy Control / LOTO Template - HVAC/Plumbing before releasing work.

Rooftop Unit (RTU) - Packaged HVAC

Energy sources: Electrical (208/230/460V 3-phase supply), refrigerant pressure (high-side up to 600 psig for R-410A), natural gas (if gas heat), condensate drain (gravity)

LOTO sequence:

1. Shut down unit at thermostat/building automation system
2. Open and lock the rooftop disconnect switch - apply personal padlock
3. Verify zero voltage at unit terminals with live-dead-live meter test
4. Close and lock gas shutoff valve upstream of unit (if gas heat) - apply valve lockout with personal padlock
5. Allow refrigerant pressures to equalize (monitor gauges - wait until high-side and low-side stabilize)
6. If opening refrigerant circuit: recover refrigerant per Section 6 before breaking connections
7. Verify zero energy: attempt start at thermostat (confirm no response), verify 0V at disconnect; if the refrigerant circuit is to be opened, verify on gauges before opening that the required evacuation level has been reached (40 CFR 82.156(a))
8. Block fan blades if working near supply fan to prevent wind-driven rotation

Lockout devices: Circuit breaker lockout on disconnect, ball valve lockout on gas supply, plug lockout on condensate pump (if applicable)

Chiller (Air-Cooled or Water-Cooled)

Energy sources: Electrical (208-480V 3-phase, often 100+ amps), refrigerant pressure (high-side and low-side - pressures vary by refrigerant; R-410A high-side can exceed 400 psig), chilled water (pressurized piping loop), condenser water (water-cooled units - pressurized piping loop)

LOTO sequence:

1. Shut down chiller at the chiller controller - allow controlled shutdown sequence to complete
2. Open and lock main electrical disconnect - apply personal padlock
3. If chiller has a separate control-power disconnect, lock that as well
4. Close and lock chilled water isolation valves (supply and return) - apply chain valve lockouts with personal padlocks
5. Close and lock condenser water isolation valves (water-cooled units) - apply chain valve lockouts
6. Verify zero voltage at main power terminals with live-dead-live meter test
7. Follow the stored-energy controls and pre-contact verification in Section 8.2, including capacitor discharge and, where hazardous stored energy requires it, short-circuiting and grounding high capacitance elements; treat capacitors and associated equipment as energized while handling them for discharge (29 CFR 1910.333(b)(2)(ii)(C), Note).
8. Verify zero water pressure between isolation valves by opening drain valve
9. If opening the refrigerant circuit: before breaking any connection, use recovery equipment certified under 40 CFR 82.158 to evacuate the chiller, or the part isolated to a system receiver, to the level 40 CFR 82.156(a) requires (the Table 1 level, or the alternative in 40 CFR 82.156(a)(1) or (a)(2) where that paragraph applies), and verify that level on gauges before opening

Lockout devices: Circuit breaker lockout or disconnect switch lockout on power supply, chain valve lockouts on chilled water and condenser water isolation valves, plug lockout on oil heater (if separate circuit)

Boiler (Gas-Fired Hot Water or Steam)

Energy sources: Electrical (120V or 208/240V control and burner circuits), natural gas (supply pressure typically 5-14" WC), hot water pressure (30-80 psi in hydronic systems), steam pressure (up to 15 psi low-pressure steam), thermal energy (water temperature up to 200 deg F hot water, 250 deg F+ steam)

LOTO sequence:

1. Shut down boiler at operating control - allow burner to complete purge cycle
2. Close and lock the manual gas shutoff valve upstream of the boiler - apply valve lockout with personal padlock
3. Open and lock the electrical disconnect for the burner/control circuit - apply personal padlock
4. Verify zero voltage at burner terminals with live-dead-live meter test
5. Close and lock hot water or steam isolation valves - apply chain valve lockouts with personal padlocks
6. Allow adequate cool-down time before opening the system - water/steam temperature must drop below 120 deg F before draining or opening piping; this may take several hours for large boilers
7. Bleed pressure to 0 psi before opening any connections - verify on boiler pressure gauge
8. If draining: open drain valve slowly; route discharge to appropriate drain; beware of residual hot water

Lockout devices: Valve lockout on gas supply, circuit breaker lockout on electrical, chain valve lockouts on water/steam isolation valves

Air Handling Unit (AHU) - Built-Up System

Energy sources: Electrical (208/480V 3-phase for supply and return fans, variable frequency drives), chilled water (pressurized piping), hot water or steam (heating coil supply - pressurized), control air (pneumatic controls - 15-25 psi), condensate drain

LOTO sequence:

1. Shut down AHU at the building automation system or local disconnect
2. Open and lock the main electrical disconnect(s) - large AHUs may have separate disconnects for supply fan, return fan, and VFDs - lock ALL of them
3. Verify zero voltage at each motor terminal with live-dead-live meter test
4. VFD capacitor discharge: Follow the manufacturer instructions together with the stored-energy controls and pre-contact verification in Section 8.2; elapsed time alone does not release the hold.
5. Close and lock chilled water isolation valves - apply chain valve lockouts
6. Close and lock hot water or steam isolation valves - apply chain valve lockouts
7. If pneumatic controls: close and lock control air supply valve; bleed air from actuators to prevent unexpected damper/valve movement
8. Block or secure fan blades and dampers to prevent movement (gravity, wind, or draft-driven rotation)
9. Verify zero energy: 0V at all disconnects, 0 psi on water gauges between isolation valves, 0 psi on pneumatic gauges

Lockout devices: Circuit breaker lockouts on all disconnects (supply fan, return fan, VFD), chain valve lockouts on chilled water and hot water/steam isolation valves, valve lockout on pneumatic air supply

Standard LOTO Hardware Inventory

Demo Company LLC maintains the following lockout devices:

- Personal padlocks: One uniquely keyed padlock per authorized employee - red body, employee name engraved or labeled; only that employee holds the key
- Lockout hasps: 6-hole hasps for group lockout - one hasp per isolation point when multiple technicians are involved
- Circuit breaker lockouts: Single-pole and multi-pole breaker lockouts sized for installed breakers (standard and wide-toggle types)
- Disconnect switch lockouts: Rotary disconnect lockouts and wall switch lockouts

- Valve lockouts: Gate valve lockouts (1"-6.5"), ball valve lockouts (¼-turn), chain valve lockouts for large butterfly and gate valves on chilled water/hydronic piping
- Plug lockouts: Large and small plug lockouts for cord-connected equipment (condensate pumps, portable fans, power tools)
- Pneumatic lockouts: Pneumatic quick-disconnect lockouts for control air lines
- Lockout tags: Red "DANGER - DO NOT OPERATE" tags - applied alongside every lock; apply the electrical warning criteria in Section 8.3.
- Lockout station: Wall-mounted lockout station stocked with the above devices at: Job trailer entrance, wall-mounted LOTO station

Inventory verification: Linda Park inspects lockout station inventory quarterly and replenishes as needed. Damaged or illegible locks/tags are replaced immediately.

General-Industry Procedure Inspection

Inspect each energy-control procedure at least annually to ensure the procedure and standard are followed (29 CFR 1910.147(c)(6)(i)). An authorized employee other than those using the procedure being inspected must perform the inspection (29 CFR 1910.147(c)(6)(i)(A)). Correct deviations or inadequacies identified (29 CFR 1910.147(c)(6)(i)(B)). For lockout, the inspector must review each authorized employee's responsibilities with that employee (29 CFR 1910.147(c)(6)(i)(C)). Certify completion by identifying the machine/equipment, inspection date, employees included and inspector (29 CFR 1910.147(c)(6)(ii)). Company record method: The Safety Officer schedules the inspection and retains the certification and corrections with the equipment procedure; before releasing work, check that status and hold use if an inspection is due, the status is unresolved, or an uncorrected inadequacy prevents safe isolation. Inventory checks do not replace this inspection.