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Application of Lockout and Tagout devices

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Release Signatures:

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Intellectual Property Statement

Change History

Issue	Change description	Changed by	Date
1.0	First Issue	Matheus Hagemann	25-11-2020
2.0	Changed business unit owner, Deleted MVE (Manufacturing Engineering Verification) scope, deleted employee inspection form, Use of Two Pole Tester to check for absence of energy, Updated new Posted Procedure template.	Matheus Hagemann	01-03-2022

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1. Introduction

1.1 Purpose

This process establishes the minimum requirements for the lockout of energy using isolating devices whenever maintenance, servicing, installation / commissioning is being performed on machines or equipment. It shall be used to ensure that the machine or equipment is stopped and isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance.

1.2 Scope

This document is applicable to Lilium GmbH and its facilities and locations inside Germany. It does not demonstrate a compliance to a Part 21 Annex I Subpart G requirement and therefore is out of scope to any external Part 21G Audit activity.

1.3 Definition of Terms

Term	Definition
Lockout	The practice of using keyed or combination security devices ("locks") to prevent the unwanted activation of mechanical or electrical equipment.
Tagout	The practice of using tags in conjunction with locks to increase the visibility and awareness that equipment shall not to be energized or activated until such devices are removed.
Activation / energization	Energy that sets machinery into motion by starting, switching, pushing, moving, or otherwise engaging power sources for such equipment. Completing a circuit that provides a flow of electricity that is the main or secondary power source for machinery/equipment.
Energy control procedures	Specific equipment lockout tagout procedures must be available for all repetitive work. Where there is no specific equipment procedure, the generic lockout tagout procedure shall be followed.
Hazardous motion and energy	Hazardous motion that may result even after power sources are disconnected. Examples are coiled springs, raised hydraulic equipment, and any source energy (e.g. electricity) that may cause injury. Hazards may be caused by equipment under mechanical stress or gravity that may abruptly release and cause injury.
Hazard	A source of possible injury or damage to health.
Risk	Refers to a combination of both the likelihood of injury occurrence and the severity.
Lockout box	A lockable storage box capable of securing keys to lockout devices.
Lockout device	A device that utilizes an affirmative means such as tags, locks, hasps, chains, and other hardware to secure an energy-isolating device in a safe position and prevent the operation or energizing of hazardous energy sources.
Live electrical work	All work according to VDE 0105-100 6.3 on electrical equipment within a system whose voltage-free state is not established and not ensured by applying the 5 safety rules for the duration of the work. (For Live Electrical Work the working procedure according to VDE 0105-100 6.3 must be observed).

1.4 Acronyms

Acronym	Definition
AC	Alternating Current
DC	Direct Current
EFK	Elektrofachkraft (Qualified Electrician)
HSO	Health & Safety Officer
LOTO	Stands for: Lock out Tag Out
PPE	Personal Protective Equipment
VEFK	Verantwortliche Elektrofachkraft (Responsible competent Electrician)

1.5 Reference to Other Documents

Document Ref	Document name
LG-EM-0050	General Requirements for handling Lockout and Tagout devices
LG-EM-1001	LOTO Posted Procedure

1.6 Roles and Responsibilities

Role	Definition
Health & Safety Officer - HSO	The HSO's role is to track safety organizations' principles and be aware of current safety products that reduce unsafe practices. The HSO investigates accidents, injuries, and near misses. The HSO has the authority to track and monitor workplace safety, identify hazards as well as correct them.
Elektrofachkraft EFK	A qualified electrician has knowledge and experience in the electrical field, and the relevant ability to assess tasks and recognize possible dangers.
Verantwortliche Elektrofachkraft - vEFK	The vEFK takes on technical and supervisory responsibility, assuming responsibility and technical management for an area of the company. Being responsible for compliance with the safety regulations.

2. General

The purpose of this document is to ensure that the machine or equipment is stopped and isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance activities.

LOTO (Lockout/Tagout) is a safety strategy that eliminates all existing energy and potential energy from a machine, using all isolating devices presented in that machine (switch(es), valve(s), or other energy isolating devices (see Appendix A for examples of typical LOTO devices) that can be locked or tagged out.

It ensures that there is no accidental release of energy (e.g. a power start-up) while a worker is conducting maintenance activities or is otherwise required to be in or near dangerous areas.

3. Procedure to logout / tagout the source of energy

The below activities shall follow the Lockout/Tagout procedure:

- Maintenance
- Installation and/or Commissioning of a machine
- Services made by Contractors

The technicians that will perform the application of the LOTO devices shall be trained.

To monitor the LOTO technical trainings, the Lilium academy will be used and will ensure that the LOTO trainings are periodically conducted to each technician.

3.1 Procedure to turn off the source of energy

Step 1: Notification to all affected employees

- Before starting the LOTO process all affected employees shall be notified (e.g. by mail or verbally) of the timing of the work and how long the equipment may be unavailable

Step 2: Shut down equipment properly

- If the machine or equipment is operating, it needs to be shut down with the normal stopping procedure (e.g. press stop button, stop by the software)

Step 3: Disconnect all primary energy sources

- Operate the switch, disconnect the plug, operate the valve, or other energy isolating device(s) so that the equipment is isolated from energy source(s). Stored energy must be dissipated or restrained

Step 4: Physically ensure energy isolation

- Lockout and Tagout the energy isolating devices with appropriate equipment and assigned individual lock(s) and tag(s).
- If more than one person is required to lockout or tagout the equipment/machine, each one shall place his/her own personal Lockout and Tagout device on the energy isolating device(s)
- The technicians must keep the key in their pocket for the duration of all the work and do not allocate it to any deputies

Step 5: Verify absence of energy

- Ensure that no personnel are exposed and check the disconnected energy sources; operating the normal controls to make sure that the equipment will not work.

- If electricity is the only energy source, it is necessary to use a Two Pole Tester (DIN EN 61243-3 / VDE 0682-401:2015-08) to check it. It needs to be ensured that the Two Pole Tester is working correctly as follows:
  - Before using the Two Pole Tester to measure the free voltage in the machine, test it with a known source of energy (advised to use a 9V Battery).

At this point, the work is safe to be perform. Figure 1 illustrates the procedure to turn-off the source of energy.

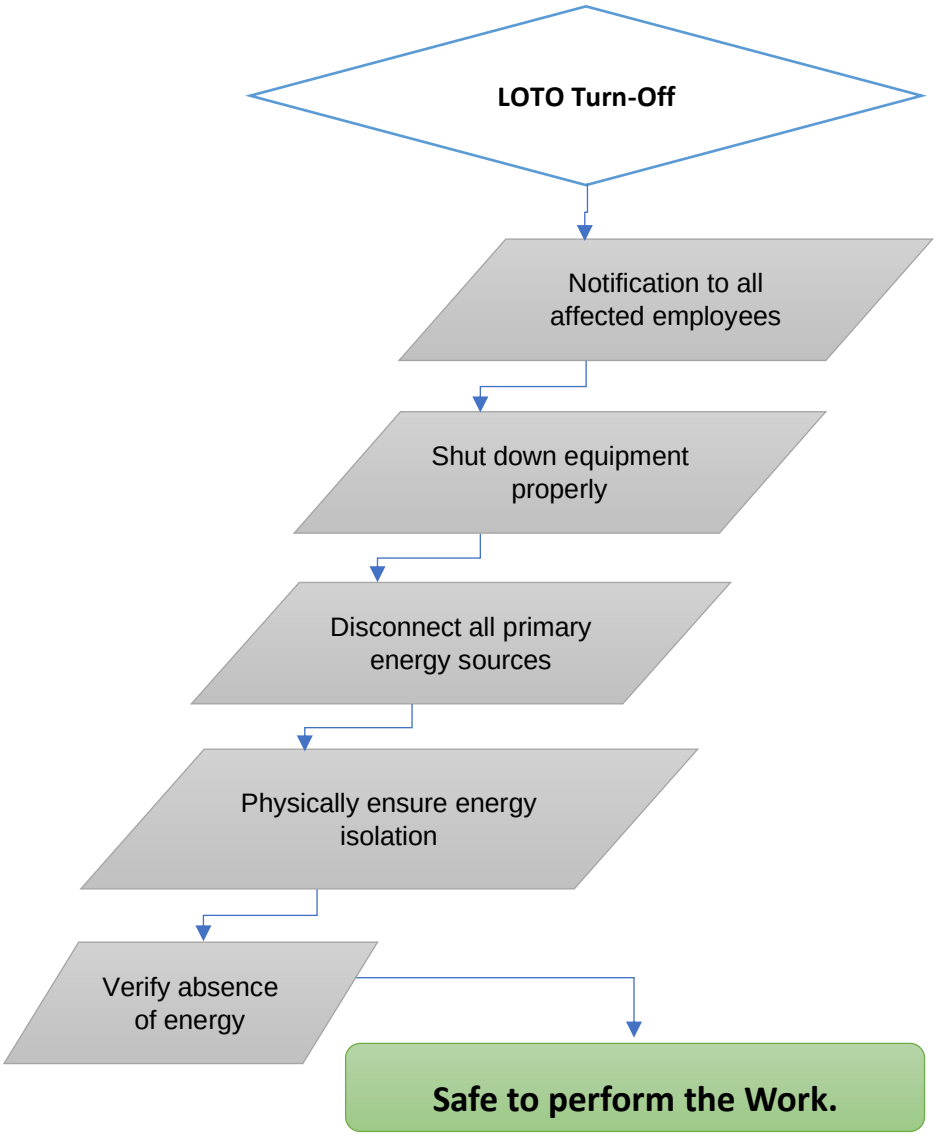


Figure 1: Flow Chart to turn-off the source of energy

3.2 Procedure to turn on the source of energy

Step 1: Reapply energy sources

- After the servicing and/or maintenance is completed, and equipment is ready for normal operations; check the area around the machines/equipment to ensure that no one is exposed to hazards.
- After all tools have been removed from the machine or equipment, guards have been reinstalled and employees are in clear view, remove all lockout or tagout devices. Operate the energy isolating devices to restore energy to the machine or equipment.

Step 2: Notify Affected Employees

- Make sure that the machine is working properly.
- Let the affected employees know that the equipment is reenergized.

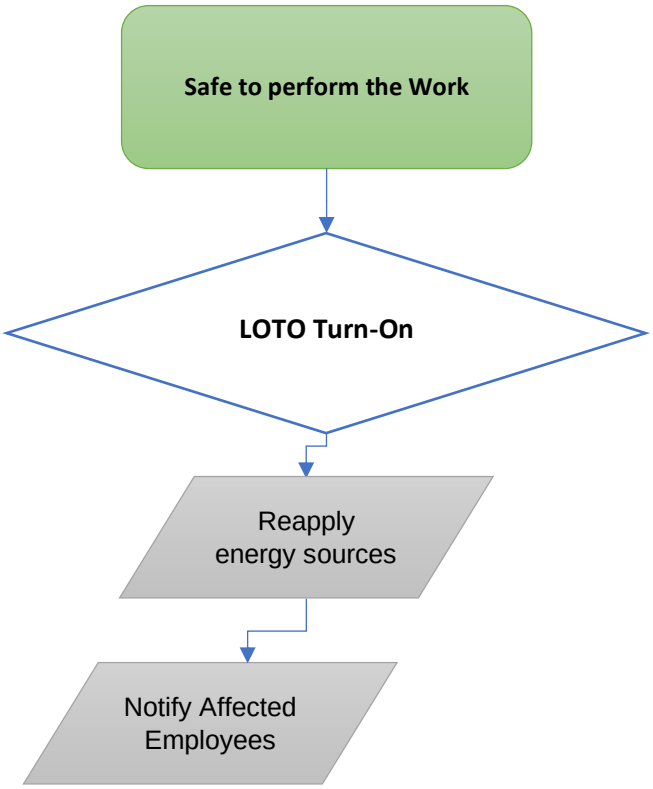


Figure 2: Flow Chart to turn-on the source of energy

4. Level of Energy Control

The basic LOTO procedures at Lilium eAircraft consist of fully lock out the system. It requires the energy sources to be isolated and locked out with personal Safety Padlocks. It is required to lockout all forms of energy that might have a source of energy (e.g. electrical, pneumatic, hydraulic, mechanical/kinetic, thermal, gravity, magnetic, radiation).

The level of the energy will be controlled with a LOTO Posted Procedure. This is a unique document made for each machine, presenting the Lockout points and the different levels of energy control (see template LG-EM-1001).

Some case examples of energy control are followed below:

Case example 1: When programming a Robot:

- Part of the machine will be locked out (e.g. pneumatic, hydraulic, switch of some specific stations)
- The power supplier for the Robot will be kept turn on, the operator will hold a Dead Man's Switch to make the tests, movements, adjustments, programming.
- The fastest Robot moving part allowed will be 150mm/s.

Case example 2: When troubleshooting the in-field sensors/signals/safety components:

- Keep the 24V DC turn on.

- Lockout the motors, robots, and any other parts that “Move”.

Case example 3: Maintenance adjusts in presses, pneumatic movements, servo position

- Keep the machine in Setup or Manual mode.
- If possible: reduce the strength and speed of the movements (e.g. If usually the machine works with 6 Bar, reduce it to 3 Bar / also low the speed of servomotors and the safety current limit).

Case example 4: When troubleshooting inside the electrical panel

- Make sure that the supplements of energy in field (in the machine) are turned off (pneumatic, hydraulic, engine switch breaker and drivers when possible). It is necessary to avoid any unwanted movement.

5. Installation and Commissioning of LOTO

If a new machine arrives, is modified, or brought from other facilities the below procedure and protocol must be followed until all checks are made by an electrician (EFK or vEFK):

Step 1: Lockout the machine

- To lockout the machine please refer to the process described in Chapter 3.1 and lockout the machine/equipment accordingly.

Step 2: Supply the machine with power:

- Supply the machine with the proper voltage, phases, grounding, as specified in the Electrical Project supplied by the supplier.
- After this step, it’s crucial to ask the Supplier’s technicians to verify if the electrical power supply is correctly installed before going to the next step

Step 3: Run the Test Protocol (Safety Acceptance Checklist):

- Together with the supplier’s technician, apply energy and run this checklist/protocol.
- To run the test protocol the following document must be used: LG-EM-1002 Equipment or Machine Safety Acceptance Checklist. This document has the aim to check all electrical points, safety, documentation, and other machinery-related topics.

6. Contractors

Contractors shall follow the same procedure described in chapter 5. Contractors also need to be qualified and instructed by their responsible manager about the LOTO process. Contractors are only allowed to start the work when approved by their responsible inside Lilium GmbH.

Appendix A: Examples of typical LOTO devices

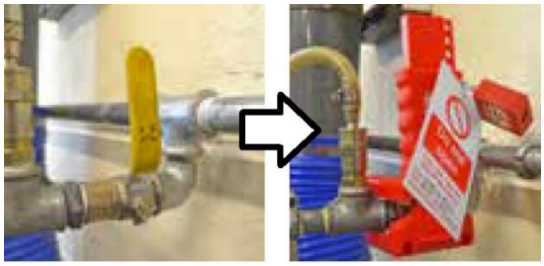
Cable Lockout

Circuit Breaker Lockout

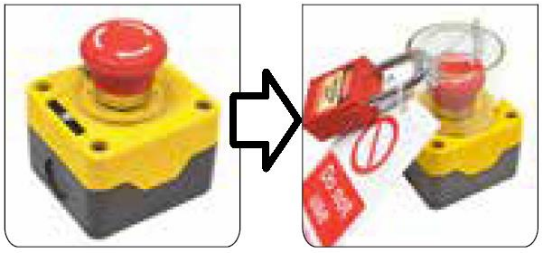
Gas Cylinder Lockout

Group Lockout Box

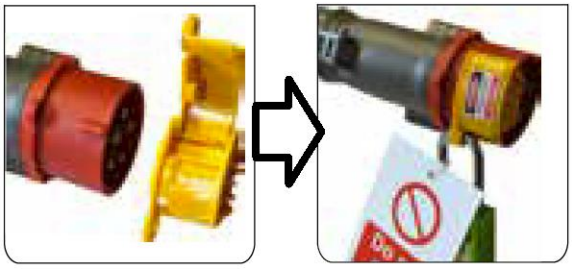
Ball Valve Lockouts



Button Lockout



Pin & Sleeve Plug Lockout



Heavy Duty A-Boards

Valve Lockout

Wall Switch Lockout

Plug Lockout

Lockout Hasp

Lockout (Padlock)

Tagout (Tags)