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Safety of machinery - Control methods of hazardous energy - Lockout/tagout

机械安全 危险能量控制方法 上锁/挂牌

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Safety of machinery - Control methods of hazardous energy - Lockout/tagout

1 Scope

This standard specifies requirements for the control of hazardous energy that may cause personal injury.

This standard also specifies the protection steps, technology, design, methods, performance indicators for controlling the accidental release of hazardous energy [1)], so as to avoid personal injury.

This standard applies to the design, manufacturing, installation, construction, repair, adjustment, inspection, dredging, setting, fault finding, testing, cleaning, disassembly, service, maintenance during the entire life cycle of the machine.

This standard does not apply to service or maintenance work on electrical equipment, that is connected to the power supply by wires and plugs, AND where the plugging and unplugging of the power plug is only under the personal control of the service or maintenance personnel. In this case, unplugging the power cord may control the possible injury, which is caused by accidentally energizing or accidentally starting the machine.

This standard also does not apply to pressure pipeline transmission and distribution systems involving water, steam, natural gas or petroleum products.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) is applicable to this standard.

GB 5226.1-2008 Electrical safety of machinery - Electrical equipment of machines - Part 1: General requirements

GB/T 15706-2012 Safety of machinery - General principles for design - Risk assessment and risk reduction

[1] From the perspective of the person exposed to the risk, any unexpected action, such as energization, starting and release of stored energy, is an accidental release of hazardous energy.

5 Design

5.1 Requirements for manufacturers

5.1.1 General requirements

The design, manufacture, installation of the machine shall facilitate the user to implement the control methods, which are specified in this standard. Any modification affecting energy isolation shall comply with this standard. A risk assessment shall be conducted during the design stage of the machine, to determine the requirements and design margins for energy isolation devices and systems. See Chapter 5 of GB/T 15706-2012 for risk assessment procedures.

5.1.2 Minimizing exposure

The manufacturer shall design the machine to be reliable, to ensure that excessive intervention is not required. Machines shall be designed so that, to the extent possible, personnel performing routine and recurring service and maintenance are not exposed to hazardous energy.

Note: This can be achieved by placing the controller outside the hazardous area, adding controllers in appropriate locations, providing external lubrication points, or providing guards.

5.1.3 Partially energized

For those functions that require partial energization, the manufacturer shall conduct a risk assessment, in accordance with Chapter 5 of GB/T 15706-2012, to determine the safest method of entering the machine. When it is necessary to maintain partial energization (such as to clamp workpieces, preserve information, maintain heat, or provide local lighting), other control methods shall be provided, to ensure the safety of personnel.

5.2 Energy isolation device

5.2.1 General requirements

To meet the requirements of 6.3, the design, construction, and installation of machines shall take into account energy isolation devices, according to their intended use. Energy isolation devices shall be able to control and/or dissipate hazardous energy. Energy isolation devices should be an integral part of the machine.

If the device is not integrated into the machine, the manufacturer shall recommend the type and installation location of the energy isolation device in the installation instructions.

5.2.2 Location

Energy isolation devices shall be installed in easily accessible locations. If feasible, it shall be located so that the locking device is easy to apply during repair and maintenance.

Note: The energy isolation device is preferably located outside the danger zone, in an adjacent walking area, at a height that is convenient for operation (i.e., not at a high place, not on a ladder, or under the machine).

5.2.3 Identification

All energy isolation devices shall be adequately identified or marked, unless their location and arrangement make their purpose obvious. The identification shall include the following:

a) The machine being served;

b) Type and magnitude of energy.

Note: The possibility of error is reduced, if the intended person does not rely on memory or experience to determine which isolators are used for which machines. If the machine nameplate contains the required identification of the energy isolation device, each energy isolation device should be marked or coded on the machine nameplate.

If safety conditions can be guaranteed, coding can also be used for identification.

Examples of identification (signage, embossing, engraving, platemaking, etc.):

No.3 press main power supply (480 V); No.2 natural gas pipeline; hydraulic pump output (5 MPa);

Compressed air (1 MPa) for No.A bracket.

5.2.4 Performance

Energy isolation devices shall be able to be locked or fixed in an effective isolation position.

Note: Examples of effective isolating devices include handle locks [operating levers with self-aligning locking tabs (holes)], ball valve locks, lock sleeves that only operate when the switch is in a safe position, wheels with locking tags and position indicators, hard block with locking tab alignment, etc.

5.2.5 Applicability

Each energy isolation device shall be evaluated to determine its applicability for its intended use.

5.7 Stored energy and residual energy

If stored or residual energy has been determined to be hazardous, means for safely dissipating or confining the stored or residual energy shall be integrated into the machine. Devices used to dissipate stored energy shall be designed with means or methods for verifying their location and status.

If it is determined that the shutdown process of the machine is dangerous, protective devices shall be installed, to prevent the danger or to prevent approaching the danger before the movement stops. The position of the safety protective device shall be determined according to GB/T 19876.

Note: For stored thermal energy or residual thermal energy, if a device that dissipates or restrains the stored energy or residual energy cannot be used, warnings and/or instructions may be used instead. If the presence and location of hazardous thermal energy are obvious, due to the function of the machine, warnings and instructions may be exempted.

5.8 Control integration

If other methods are used for setting up, troubleshooting or other tasks requiring de-energization or partial energization, a protection system shall be used, to ensure that the failure of individual components within the device or system can still stop or prevent hazardous movement or release of hazardous energy.

Note: Typical ways to accomplish this task are:

a) A hardware-based, reliable control safety interlocking system;

b) Multi-channel safety PLC for safety purposes and used in accordance with the manufacturer's instructions.

5.9 Safety protection devices

Safety protection devices shall be able to withstand all forces they experience multiplied by an appropriate safety factor; comply with corresponding standards, such as protection devices that meet GB/T 8196, interlocking devices that meet GB/T 18831, etc.

6 Hazardous energy control solutions

6.1 User responsibilities

6.1.1 Equipment

The user's machine shall meet the requirements of Chapter 5. If the user's machine does not meet the requirements of Chapter 5, the user shall modify and upgrade the machine, to comply with the requirements of Chapter 5.

Note 1: Machines that may need to be upgraded may also include newly purchased second-hand machines, machines designed to different standards, relocated original equipment.

If the user purchases components, parts of a machine or assembles multiple machines into a production line, the user shall fulfill the manufacturer's responsibilities and meet the requirements of Chapter 4. The user's machine shall be equipped with an energy isolation device, to allow authorized individual to implement the hazardous energy control solution in 6.3.

Note 2: A single isolating device, that provides energy to multiple operations or machines simultaneously, although meeting the requirements, may still create situations that encourage personnel not to fulfill the requirements of this standard. In this case, additional isolation devices or other methods may be required.

6.1.2 Solution

Users shall develop a written solution for hazardous energy control; refine the requirements of 6.3 or 6.4. The purpose of the solution is to ensure that before the authorized individual perform the installation, construction, repair, adjustment, inspection, unclogging, setting, troubleshooting, testing, cleaning, disassembly, service, maintenance of machinery, that could unexpectedly energize, start, or release stored energy and cause injury, the risk of exposure to hazard is eliminated or minimized (see Figure 1).

Note: Users should consider warnings and special instructions provided by the manufacturer.

see Appendix B for the lockout/tagout procedure. To provide effective protection, lockout/tagout shall include the following elements:

a) Investigation of all hazardous energies;

b) Identification of energy isolation devices;

c) Selection and procurement of protective materials and hardware;

d) Assignment of duties and responsibilities;

e) Determination of shutdown, de-energization, energization, starting sequences;

f) Written operating procedures for the machine;

g) Personnel training;

h) Review of solution elements.

If the energy isolation device can be locked, it shall be locked, unless the user can demonstrate that effective protection of personnel can be provided by using only a tagout solution. An energy isolation device can be locked, if it is attached with a hasp or has a lockable accessory structure, OR if it has a built-in locking mechanism. Energy isolation devices may also be locked, if there is no need to dismantle, rebuild or replace the energy isolation device, or permanently alter its energy control capabilities.

If the energy isolation device cannot be locked and the risk assessment results indicate that it is feasible, a tagout solution can be used.

If a lockable energy isolation device uses a tagout device, the tagout device shall be attached to the same location as the lockout device; the user shall demonstrate that the tagout solution can achieve an effective level of safety.

When demonstrating the effective level of safety achieved by the tagout solution, the user shall demonstrate full compliance with all tagout-related provisions of this standard. Additional protective measures shall include (but are not limited to) removing isolating circuit components, blocking control switches, opening additional disconnection devices, or removing the valve stem, to reduce the possibility of accidental energization.

6.3.2 Hazardous energy control procedures

6.3.2.1 General requirements

An important element of the overall hazardous energy solution is the development of procedures. Detailed procedures for the control of hazardous energy during service or maintenance shall be developed and documented, for each unique machine or group of machines. These procedures shall be posted or otherwise readily accessible for

inspection and use by authorized individual.

Note 1: See Appendix C for examples of energy control solution for complex special machines. In addition, see Appendix D for examples of nameplates (graphical procedures).

When a workshop or factory has multiple machines of the same type or multiple identical systems or production lines, one procedure can also be used for all machines.

Note 2: For example: a printing company has six identical four-color sheet-fed printing presses, it may use one procedure to cover these six printing presses. Likewise, a bottling company with two identical bottling lines might use one procedure to cover both lines.

If the machine has only one energy supply and is easily identified and isolated, no written procedure is required.

6.3.2.2 Elements of control procedures

Hazardous energy control procedures shall clearly and specifically outline the requirements for effective isolation of machinery. The procedure shall include all of the following:

a) Identification of the machine;

b) A list of all required energy isolation devices and locations;

c) Specific procedural steps to close, isolate, block, immobilize or release stored energy or residual energy;

d) Specific steps for placing and removing lockout/tagout devices;

e) Verify that specific requirements for isolation and de-energization are completed.

6.3.2.3 Control procedure management

6.3.2.3.1 General requirements

For new machines, changes to existing machines, correction of identified hazardous energy control deficiencies, improvements of possible hazardous energy control, the user shall develop a plan, to determine whether procedures need to be developed or revised.

Users shall establish a responsibility mechanism, to ensure that procedures accurately reflect current requirements and can effectively control the dangerous energy of machines.

The procedure shall be easily available to authorized individual in the form of printed or electronic files, OR in the form of machine nameplates.

corrosive environments), the construction and printing of the tagout device shall be such, that such exposure will not result in a degradation of the quality of the tag or the illegibility of the information on the tag;

f) When the machine is energized, the tagout device shall give "danger" warnings and legends for this dangerous situation, such as: do not start, do not turn on, do not close, do not power on, do not operate, etc.

6.3.2.5 Energy isolation

Lockout and tagout shall only be done by authorized individual.

6.3.3 Energy control elements

6.3.3.1 General requirements

Energy control elements shall include the following actions; meanwhile it shall be performed in the order of 6.3.3.2 ~ 6.3.3.10.

6.3.3.2 Preparing for shutdown

Authorized individual shall properly understand the applied procedures; obtain necessary protective materials and hardware; determine notification requirements and related matters; assess the consequences of machine shutdown.

6.3.3.3 Notify relevant personnel

Personnel who may be affected by the machine shutdown shall be notified, before and after the application and removal of lockout devices or tagout devices.

6.3.3.4 Machine shutdown

Machines shall be shut down or de-energized through specially established hazardous energy control procedures.

Note: Special machine shutdown procedures are necessary, to avoid additional or greater risks to personnel due to machine shutdown.

6.3.3.5 Isolation of machines

All energy isolation devices, which are used to control the energy required by the machine to complete its intended tasks, shall ensure that the machine can be isolated from the energy source.

For complex machines, if it is necessary to isolate the power or movement of specific components while maintaining the energy supply to the control system, auxiliary equipment and other devices and components, THEN, lockable area (local) energy isolation devices shall be used.

Note: Hazardous energy may exist in adjacent machines, in which case appropriate energy isolation or other safety-related measures may be required.

6.3.3.6 Use of lockout or tagout devices

A lockout or tagout device shall be attached to each energy isolation device by authorized individual.

When using a lockout device, ensure that the energy isolation device remains in the "safe" or "off" position.

When a tagout device is used, it shall be such that it clearly indicates that operation or movement of the energy isolation device in the "safe" or "off" position is prohibited.

When a tagout device is used with a lockable energy isolation device, the tag of the tagout device shall be fixed in the locked position of the energy isolation device.

If the tag cannot be attached directly to the energy isolation device, it shall be placed as close to the energy isolation device as possible and in a safe place, so that it can be immediately seen by anyone attempting to operate the machine. In addition, a tag shall also be installed at the operator's control position, to remind the staff that the machine is in a de-energized state.

6.3.3.7 Partial de-energization

Based on operational and safety perspectives, energy may be split into different components, devices, zones or operating units, by adding secondary energy isolation devices downstream of the primary energy isolation device. While allowing the required partial operations, cycles or transfer, the user may only need to protect some areas to meet the needs of operation and maintenance work. Users shall install these devices in accordance with the requirements of relevant standards, such as GB 5226.1.

6.3.3.8 Control of stored energy

Potentially hazardous residual energy, stored energy or potential energy shall be released, interrupted, limited or otherwise controlled.

Note: To prevent re-accumulation of energy, additional measures may be necessary.

6.3.3.9 Verification of isolation

Before starting work on a machine that has been locked out or tagged out, authorized individual shall verify that energy isolation and de-energization have been completed.

Note: Verification can be accomplished by testing circuits, cycles, visual inspection locations, manual attempts, OR by monitoring movement or flow, observing exhaust or water, instruments, indicator lights, or other available means. It is preferred to use one or more of these techniques to maximize verification of isolation effectiveness.

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