INTERNATIONAL STANDARD

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# Safety of machinery — Emergency stop — Principles for design

*Sécurité des machines — Arrêt d'urgence — Principes de conception*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13850 was prepared by Technical Committee ISO/TC 199, *Safety of machinery*, and Technical Committee IEC/TC 44, *Safety of machinery — Electrotechnical aspects*.

This second edition cancels and replaces the first edition (ISO 13850:1996), which has been technically revised. Notably, it incorporates the following significant changes:

a) resetting of the emergency stop command is required to be manual (see 4.1.6);

b) emergency stop devices are required to use mechanical latching (see 4.4.3).

# Introduction

The structure of safety standards in the field of machinery is as follows.

a) Type-A standards (basis standards) give basic concepts, principles for design, and general aspects that can be applied to machinery.

b) Type-B standards (generic safety standards) deal with one or more safety aspect(s) or one or more type(s) of safeguard that can be used across a wide range of machinery:

   — type-B1 standards on particular safety aspects (e.g. safety distances, surface temperature, noise);

   — type-B2 standards on safeguards (e.g. two-hands controls, interlocking devices, pressure sensitive devices, guards).

c) Type-C standards (machinery safety standards) deal with detailed safety requirements for a particular machine or group of machines.

This International Standard is a type-B2 standard as stated in ISO 12100-1.

When provisions of a type-C standard are different from those which are stated in type-A or type-B standards, the provisions of the type-C standard take precedence over the provisions of the other standards for machines that have been designed and built according to the provisions of the type-C standard.

# Safety of machinery — Emergency stop — Principles for design

## 1 Scope

This International Standard specifies functional requirements and design principles for the emergency stop function on machinery, independent of the type of energy used to control the function.

It is applicable to all machinery except for:

— machines in which the provision of emergency stop would not lessen the risk;

— hand-held portable machines and hand-guided machines.

It does not deal with functions such as reversal or limitation of motion, deflection, shielding, braking or disconnecting, which can be part of the emergency stop function.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60204-1:2005 *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60947-5-5:2005, *Low-voltage switchgear and controlgear — Part 5-5: Control circuit devices and switching elements — Electrical emergency stop device with mechanical latching function*

IEC 60417-DB:2002, *Graphical symbols for use on equipment* (on-line database)

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1**
**emergency stop**
**emergency stop function**
function that is intended to

— avert arising, or reduce existing, hazards to persons, damage to machinery or to work in progress,

— be initiated by a single human action

NOTE 1 Hazards, for the purposes of this International Standard, are those which can arise from

— functional irregularities (e.g. machinery malfunction, unacceptable properties of the material processed, human error),

— normal operation.

NOTE 2 Adapted from ISO 12100-1:2003, definition 3.37.

**3.2**
**emergency stop device**
manually actuated control device used to initiate an emergency stop function

[IEC 60947-5-5:2005, definition 3.2]

**3.3**
**machine actuator**
power mechanism used to effect motion of the machine

[IEC 60204-1:2005, definition 3.36]

**3.4**
**safety function**
function of a machine whose failure can result in an immediate increase of risk(s)

[ISO 12100–1:2003, definition 3.28]

# 4 Safety requirements

## 4.1 General requirements

**4.1.1** The emergency stop function shall be available and operational at all times and override all other functions and operations in all operating modes of the machine without impairing any facilities designed to release trapped persons. It shall not be possible for any start command (intended, unintended or unexpected) to be effective on those operations stopped by the initiation of the emergency stop function until the emergency stop function is manually reset.

When emergency stop devices can be disconnected (e.g. portable teaching pendants) or when machinery can be partially isolated, care should be taken to avoid confusion between active and inactive control devices.

**4.1.2** The emergency stop function shall not be applied as a substitute for safeguarding measures and other safety functions but should be designed for use as a complementary protective measure. The emergency stop function shall not impair the effectiveness of protective devices or of devices with other safety functions.

NOTE For this purpose, it can be necessary to ensure the continuing operation of auxiliary equipment such as magnetic chucks or braking devices.

**4.1.3** The emergency stop function shall be so designed that, after actuation of the emergency stop actuator, hazardous movements and operations of the machine are stopped in an appropriate manner, without creating additional hazards and without any further intervention by any person, according to the risk assessment.

An “appropriate manner” can include

— choice of an optimal deceleration rate,

— selection of the stop category (see 4.1.4), and

— employment of a predetermined shutdown sequence.

The emergency stop function shall be so designed that a decision to use the emergency stop device does not require the machine operator to consider the resultant effects.

**4.1.4** The emergency stop shall function in accordance with either of the following stop categories.

**Stop category 0**

Stopping by means of

— immediate removal of power to the machine actuator(s), or

— mechanical disconnection (declutching) between the hazardous elements and their machine actuator(s) and, if necessary, braking.

**Stop category 1**

A controlled stop with power to the machine actuator(s) available to achieve the stop and then removal of power when the stop is achieved.

Examples of the removal of power include

— switching off the electrical power to the electric motor(s) of the machine,

— declutching the movable elements of the machine from the source of mechanical energy, and

— blocking the fluid power supply to the hydraulic/pneumatic machine actuators of the machine.

**4.1.5** The choice of either stop category 0 or 1, according to 4.1.4, shall be determined by the risk assessment of the machine (see also IEC 60204-1:2005, 9.2.5.4.2).

NOTE Requirements for safety-related functions can be found in ISO 13849-1 and IEC 62061, among others.

**4.1.6** Once active operation of the emergency stop device has ceased following an emergency stop command, the effect of this command shall be sustained until it is manually reset. Reset shall be possible only at that location where the emergency stop command was initiated. The reset of the command shall not restart the machinery but only permit restarting. It shall not be possible to restart the machine until a manual reset of the emergency stop device has been performed at each location at which the emergency stop was activated.

## 4.2 Electrical emergency stop equipment requirements

Electrical equipment used for emergency stop shall be in accordance with the relevant requirements of IEC 60204-1. For the requirements relating to emergency stop devices, see 4.4 and IEC 60947-5-5.

## 4.3 Operating conditions, environmental influences

The components, devices and elements used to achieve the emergency stop function shall be selected, assembled, interconnected and protected such that they are able to operate correctly under the expected operating conditions and environmental influences, including taking into consideration

— the frequency of operation and need for periodic testing, for example, in the case of infrequent operation, and

— the effects due to, for example, vibration, shock, temperature, dust, foreign bodies, moisture, corrosive materials and fluids.

## 4.4 Emergency stop device

**4.4.1** The emergency stop device shall be designed to be easily actuated by the operator and others who could need to actuate it.

The types of actuators that may be used include the following:

— mushroom-type pushbuttons;

— wires, ropes, bars;

— handles;

— in specific applications, foot-pedals without a protective cover.

**4.4.2** An emergency stop device shall be located at each operator control station, except where the risk assessment indicates that this is not necessary, as well as at other locations, as determined by the risk assessment. It shall be positioned such that it is readily accessible and capable of non-hazardous actuation by the operator and others who could need to actuate it. Measures against inadvertent actuation should not impair its accessibility.

**4.4.3** The emergency stop device shall apply the principle of direct opening action with mechanical latching. Electrical emergency stop devices shall be in accordance with IEC 60947-5-5.

NOTE An example of the application of this principle is an emergency stop device employing electrical contacts having direct opening action. According to IEC 60947-5-1:2003, Annex K, direct opening action (of a contact element) is the achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (for example, not dependent upon springs).

**4.4.4** In the case of failure in the emergency stop device (including sustaining function), generation of the stop command shall have priority over the sustaining function. Resetting (e.g. disengaging) of the emergency stop shall only be possible as the result of a manual action at the location where the emergency stop was activated.

**4.4.5** The actuator of the emergency stop device shall be coloured RED. As far as a background exists behind the actuator and as far as it is practicable, the background shall be coloured YELLOW.

NOTE When using wires or ropes, it can be useful to improve their visibility by attaching marker flags to them (see also IEC 60204-1:2005, 10.7.3).

**4.4.6** Where labels are provided, the symbol IEC 60417-5638 (DB:2002-10) shall be used, see Figure 1.

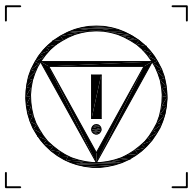

**Figure 1 — Symbol (5638) for emergency stop**

## 4.5 Use of wires or ropes as actuators

**4.5.1** When wires or ropes are used as the actuators of emergency stop devices, they shall be designed and positioned for ease of use. For this purpose, consideration shall be given to

— the amount of deflection necessary for generating the emergency stop command,

— the maximum deflection possible,

— the minimum clearance between the wire or the rope and the nearest object in the vicinity,

— making wires or ropes visible for the operators (e.g. by use of marker flags), and

— the force to be applied, and its direction in relation to the wire or rope, to actuate the emergency stop device.

NOTE When it is likely that actuation will be attempted by pulling the wire along its axis, it is necessary to ensure that pulling the wire in either direction will generate the emergency stop command.

See also IEC 60947-5-5.

**4.5.2** Measures shall be implemented to avoid hazards caused by breakage or disengagement of the wire or rope (see 4.4.4).

**4.5.3** The means to reset the emergency stop device should be placed so that the whole length of the wire or rope is visible from the location of the resetting means.

**4.5.4** The instructions for use shall state that, after actuation and before resetting, the machinery shall be inspected along the whole length of the wire or rope in order to detect the reason for activation.

# Bibliography

[1] ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

[2] ISO 13849-1, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

[3] IEC 60947-5-1:2003, *Low-voltage switchgear and controlgear — Part 5-1: Control circuit devices and switching elements — Electromechanical control circuit devices*

[4] IEC 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

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