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Safety of machinery — Mechanical safety data for physical contacts between moving machinery or moving parts of machinery and persons

Sécurité des machines — Données de sécurité mécanique pour les contacts physiques entre des machines en mouvement ou des parties mobiles de machines et des personnes

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

Introduction

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

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

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

— type-B1 standards on particular safety aspects (for example, safety distances, surface temperature, noise);

— type-B2 standards on safeguards (for example, two-hands control devices, interlocking devices, pressure-sensitive devices, guards);

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

This document is a type-B standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers (small, medium and large enterprises);

— health and safety bodies (regulators, accident prevention organizations, market surveillance etc.)

It is possible to be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e. g. for maintenance (small, medium and large enterprises);

— consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

In addition, this document is intended for standardization bodies elaborating type-C standards.

The requirements of this document can be supplemented or modified by a type-C standard.

For machines which are covered by the scope of a type-C standard and which have been designed and built according to the requirements of that standard, the requirements of that type-C standard take precedence.

Moving machines and machines with moving parts frequently operate in close proximity to or in the same physical space as people [e.g. train (access), lift doors, machine tools]. In most circumstances, the moving parts of the machine make no contact with people. Indeed, wherever possible steps are taken to prevent any contact.

There are however exceptions, for example closing powered doors or moving guards and in some cases moving parts of machine tools that contact the operator (e.g. parts of packaging machines). Where this is the case to prevent injury machine specific limits for the contacts are set by individual type-C standards.

With increased use of motor driven automation and the introduction of machines that operate with people collaboratively, machine-human contact caused by machine movements are becoming more likely and more common.

This document defines non-machine specific limits for contacts to prevent injury. It does not set a single limit that ensures safety but provides different values so that thresholds to match individual cases is allowed.

It defines values that meet the criteria for "inherently safe design" as specified in ISO 12100:2010, 6.2.2.2.

It also introduces the concept of groups to account for the complexity of conditions that occur when machines and people operate together to allow a balance between the frequency of contact, the possible risk and the societal benefit that is permissible from the use of a machine.

In the context of this document contact refers only to the direct mechanical effect on the person being contacted by the moving machine part. There is a possibility of other secondary or indirect effects due for example to

— the temperature of the contacting machine part,

— the potential for the contact to cause the person to fall or to be pushed into another hazard (see Annex E),

— other secondary effect such as electric shock.

These conditions are not within the scope of this document but along with ergonomic principles ought to be considered when designing a collaborative machine or defining how it is to be used.

Although it is not within the scope of this document the information contained herein can also be useful for other contact circumstances involving humans, for example falling or colliding with walls or other objects.

Safety of machinery — Mechanical safety data for physical contacts between moving machinery or moving parts of machinery and persons

1 Scope

This document specifies limits for physical contacts between the machine or parts of the machine and humans that are caused by movement of the machine as part of its intended use or foreseeable misuse.

This document covers all types of machines that are designed to function where people are allowed to be present and the machine is allowed to make physical contact with those people.

This document includes machines that contact people as part of their function and machines that do not require human contact. It encompasses interactions that are intentional or unintentional.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

ISO 13849 (all parts), *Safety of machinery — Safety-related parts of control systems*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
machine-human contact
physical contact between a human and any part or parts of a machine that results from movement of the machine or part of the machine

3.4
static or quasi-static contact
contact in which a force is continuously applied

3.5
dynamic contact
contact in which the force rapidly reaches a peak and then falls

Note 1 to entry: Dynamic contacts occur when the person or body part is free to react and move away from the contact or if the machine is able to react to reduce or move away from the contact.

3.6
moving machinery
any mechanical system or part of a mechanical system that is in motion

3.7
compliance
property of a system to deform under the action of a load

4 Risk assessment and risk reduction

4.1 General

This document supports risk evaluation and reduction process by providing inherently safe limits, links to risk reduction safeguards and instructions for use for conditions where contact with a human by the machine is identified.

Inherently safe design by definition (see ISO 12100:2010) includes the following protective measures:

a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard;

b) limiting the mass and/or velocity of the movable elements, and hence their kinetic energy.

This document specifies limits that it is possible to be applied in order to satisfy the definition of inherently safe design.

It includes links to safeguards and instructions for use for conditions where contact with a human by the machine is identified.

To apply this document, the procedure for risk assessment and risk reduction specified in ISO 12100 shall be followed. All conditions of use and foreseeable misuse shall be taken into account. See Figure 1.

NOTE Figure 1 is taken from ISO 12100. The text in relation to risk reduction questions have however been adjusted to show how it relates to this document by referring directly to contact.

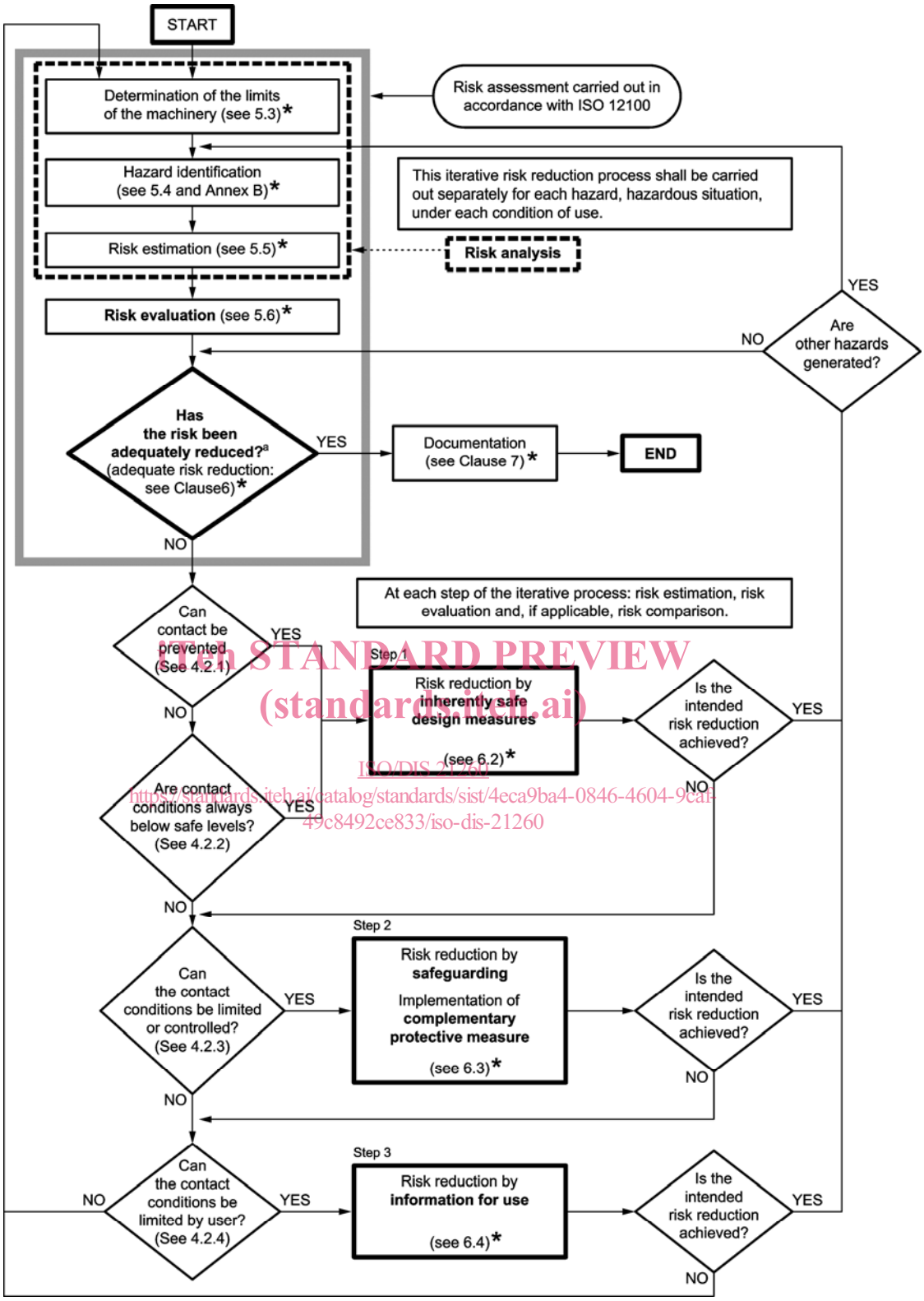

Figure 1 — Overview of risk assessment/risk reduction (see ISO 12100)

4.2 Strategy for risk reduction from ISO 12100

The strategy for risk reduction at the machine is given in ISO 12100:2010, 6.1, and further guidance is given in ISO 12100:2010, 6.2 (inherent design measures) and 6.3 (safeguarding and complementary protective measures). This strategy covers the whole life cycle of the machine. The risk reduction process for a machine requires that hazards are eliminated or reduced through a hierarchy of measures:

— hazard elimination or risk reduction by design (see ISO 12100:2010, 6.2);

— risk reduction by safeguarding and possibly complementary protective measures (see ISO 12100:2010, 6.3);

— risk reduction by the provision of information for use about the residual risk (see ISO 12100:2010, 6.4).

4.3 Risk reduction

4.3.1 Hazard elimination or risk reduction by design

As far as practicable, machine-human contacts shall be eliminated. Moving machines or parts of a machine that are incapable of generating contact conditions above the values defined in this document are considered to be inherently safe by design and these contact conditions are not required to be eliminated.

4.3.2 Risk reduction by safeguarding

4.3.2.1 General

For a moving machine or parts of a machine that are capable of generating contact conditions above the limits defined in this document, safeguards(s) shall be implemented are required to safely control and/or prevent the contact conditions. See ISO 12100 and ISO/TR 22100-2.

4.3.2.2 Sensors and control systems that limit contact conditions

Safe contact conditions are able to be achieved through the use of control systems designed to prevent the contact exceeding the values specified in this document. Through effectiveness of the control system it is possible to further enhance the use of compliant surfaces or compliant actuator systems that absorb energy.

Safety functions shall conform to ISO 13849-1 or IEC 62061.

See also 7.1 and 7.3.

4.3.3 Risk reduction by the provision of information for use about the residual risk

If a residual risk of contact above the limits given in this document remains, specific instructions or information for use covering the residual risk shall be provided.

NOTE The machine designer is permitted to develop a machine that is incapable of generating contact conditions above the values in this document by implementing a variety of passive and/or active protective measures in accordance with ISO 12100:2010. This includes the use of control systems designed to prevent the contact exceeding the values specified in this document. The effectiveness of the risk reduction can be further enhanced by the use of compliant surfaces or compliant actuator systems that absorb energy.

5 Methodology

If a type-C standard exists for the machine that includes contact limits, the limits specified by that type-C standard shall be used.

NOTE Type-C standards can specify limits directly or by reference to this document.

If there is no type-C standard or it does not include contact limits, the contact limits shall be determined using this document.

For a given machine a number of different human contacts may be possible. These may be by different moving parts of the machine or due to different modes of operation or other use conditions. To apply this document all possible contacts shall be taken into account.

For each contact the following steps (shown in Figure 2) shall be followed:

a) Identify human contact by a moving part of the machine.

b) If the contact could be with the eye or within 50 mm of the eye it is not permitted and shall be prevented or eliminated.

c) For other contacts, determine the contact classification group (see Clause 6).

d) Determine the allowable contact condition for the contact (see Clause 8).

e) Compare the actual or design contact condition with the allowable condition. If the allowable condition is not satisfied the design shall be revised until the contact condition is met.

Design changes are allowed to also affect the risk assessment which should be reviewed and if necessary repeated.

f) Repeat the process for each contact under foreseeable use and misuse conditions.