INTERNATIONAL STANDARD

ISO 13857

First edition
2008-03-01

Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs

Sécurité des machines — Distances de sécurité empêchant les membres supérieurs et inférieurs d'atteindre les zones dangereuses

Reference number
ISO 13857:2008(E)

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Published in Switzerland

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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 13857 was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

This first edition of ISO 13857 cancels and replaces ISO 13852:1996 and ISO 13853:1998, of which it constitutes a technical revision. Annex A, giving guidance on how to use Tables 1 and 2 with intermediate values, has been added, and the former Annex A of ISO 13853 has become Annex B.

Introduction

This document is a type B standard as stated in ISO 12100-1.

The provisions 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 provisions of that standard, the provisions of that type C standard take precedence over the provisions of this type B standard.

One method of eliminating or reducing risks caused by machinery is to make use of safety distances preventing hazard zones from being reached by the upper and lower limbs.

In specifying safety distances, a number of aspects have to be taken into consideration, such as

— reach situations occurring when machinery is being used,

— reliable surveys of anthropometric data, taking into account population groups likely to be found in the countries concerned,

— biomechanical factors, such as compression and stretching of parts of the body and limits of joint rotation,

— technical and practical aspects, and

— additional measures for particular groups of persons (e.g. persons with special needs), which could be required due to a deviation from the specified body dimensions.

Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs

1 Scope

This International Standard establishes values for safety distances in both industrial and non-industrial environments to prevent machinery hazard zones being reached. The safety distances are appropriate for protective structures. It also gives information about distances to impede free access by the lower limbs (see 4.3).

This International Standard covers people of 14 years and older (the 5^{th} percentile stature of 14 year olds is approximately 1 400 mm). In addition, for upper limbs only, it provides information for children older than 3 years (5^{th} percentile stature of 3 year olds is approximately 900 mm) where reaching through openings needs to be addressed.

NOTE 1 Data for preventing lower limb access for children is not considered.

The distances apply when adequate safety can be achieved by distance alone. Because safety distances depend on size, there will be some people of extreme dimensions who will be able to reach hazard zones even when the requirements of this International Standard are complied with.

NOTE 2 These safety distances will not provide sufficient protection against certain hazards, for example, radiation and emission of substances. For such hazards, additional or other measures need to be taken.

The clauses of the International Standard covering lower limbs apply when access by the upper limbs is not foreseeable according to the risk assessment.

The safety distances are intended to protect those persons trying to reach hazard zones under the conditions specified (see 4.1.1).

NOTE 3 This International Standard is not intended to provide measures against reaching a hazard zone by climbing over.

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.

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100-1 and the following apply.

3.1
protective structure
safeguard (e.g. a guard, an impeding device) or other physical obstruction (e.g. a part of a machine) which restricts the movement of the body and/or a part of it in order to prevent reaching hazard zones

3.2
safety distance
safe separation distance
s_r
minimum distance a protective structure is required to be placed from a hazard zone

4 Safety distances to prevent access by upper and lower limbs

4.1 General

4.1.1 Assumptions

The safety distances in this International Standard have been derived by making the following assumptions:

— the protective structures and any openings in them retain their shape and position;

— safety distances are measured from the surface restricting the body or the relevant part of the body;

— persons may force parts of the body over protective structures or through openings in an attempt to reach the hazard zone;

— the reference plane is a level at which persons would normally stand, but is not necessarily the floor (e.g. a working platform could be the reference plane);

— there is some contact with the reference plane while wearing shoes (use of high-soled shoes, climbing and jumping are not included);

— no aids such as chairs or ladders are used to change the reference plane;

— no aids such as rods or tools are used to extend the natural reach of the upper limbs.

4.1.2 Risk assessment

Before determining the safety distance that prevents people from reaching hazard zones it is necessary to decide whether to use values for high or low risk. Thus a risk assessment (see ISO 12100-1 and ISO 14121-1) shall be conducted. The risk assessment shall be based on the probability of occurrence of an injury and the foreseeable severity of that injury. An analysis of the technical and human elements on which the risk assessment is dependent is essential to achieving the appropriate selection of data from this International Standard. The risk assessment shall take into account all accesses. Where several tables are used, the most restricting values shall be taken (see examples in Annex A).

NOTE 1 Aspects of frequency, duration, energy, speed and shape of contact surface need to be taken into account when establishing the risk of injury (see ISO 14121-1).

Where there is a low risk, at least the values in Table 1 shall be used (see 4.2.2.1.1).

Where the risk is not low, Table 2, the high risk table, shall be used (see 4.2.2.1.2).

NOTE 2 Only risks arising from hazards such as friction or abrasion, where long-term or irreversible damage to the body is not foreseeable, can lead to low risks.

The safety distances (s_r) given in Table 7 apply to persons reaching through openings using the lower limbs in an attempt to reach a hazard zone.

If the requirements of this International Standard cannot be complied with, then other safety measures shall be used.

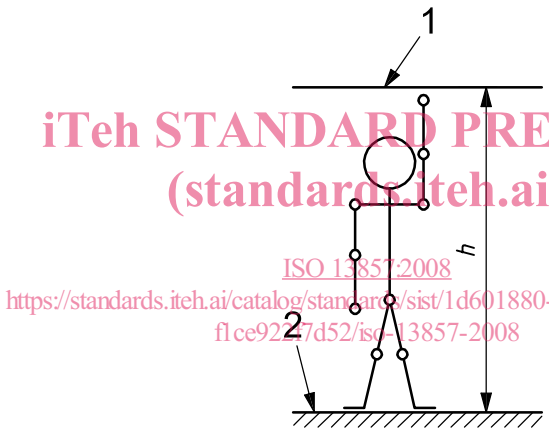
4.2 Safety distances to prevent access by upper limbs

4.2.1 Reaching upwards

4.2.1.1 Figure 1 shows the safety distance for reaching upwards.

4.2.1.2 If there is a low risk from the hazard zone, then the height of the hazard zone, h, shall be 2 500 mm or more.

4.2.1.3 If there is a high risk (see 4.1.2) from the hazard zone, then the height of the hazard zone, h, shall be 2 700 mm or more.



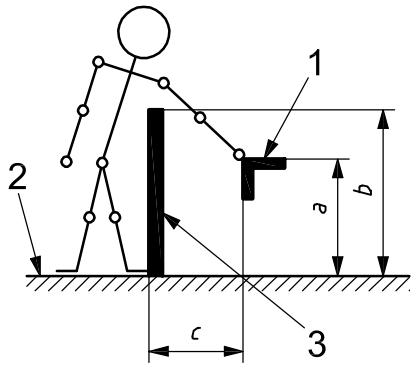
Key

1 hazard zone
2 reference plane
h height of hazard zone

Figure 1 — Reaching upwards

4.2.2 Reaching over protective structures

Figure 2 shows the safety distance for reaching over a protective structure.



Key

a	height of hazard zone	1	hazard zone (nearest point)
b	height of protective structure	2	reference plane
c	horizontal safety distance to hazard zone	3	protective structure

Figure 2 — Reaching over protective structure

4.2.2.1 Values

4.2.2.1.1 The values given in Table 1 shall be used to determine the corresponding dimension(s) of the height of the hazard zone, the height of protective structures and the horizontal safety distance to the hazard zone. If there is a low risk (see 4.1.2) from a hazard zone, the values given in Table 1 shall be used as minimum values.

There shall be no interpolation of the values given in Table 1. Consequently, when the known values of *a*, *b* or *c* are between two values in Table 1, the greater safety distance or higher protective structure or change in the height (higher or lower) of the hazard zone shall be used.

Annex A gives examples of the use of Tables 1 and 2.

Table 1 — Reaching over protective structures — Low risk

Dimensions in millimetres

Height of hazard zone [b] *a*	Height of protective structure [a] *b*								
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500
	Horizontal safety distance to hazard zone, *c*								
2 500	0	0	0	0	0	0	0	0	0
2 400	100	100	100	100	100	100	100	100	0
2 200	600	600	500	500	400	350	250	0	0
2 000	1 100	900	700	600	500	350	0	0	0
1 800	1 100	1 000	900	900	600	0	0	0	0
1 600	1 300	1 000	900	900	500	0	0	0	0
1 400	1 300	1 000	900	800	100	0	0	0	0
1 200	1 400	1 000	900	500	0	0	0	0	0
1 000	1 400	1 000	900	300	0	0	0	0	0
800	1 300	900	600	0	0	0	0	0	0
600	1 200	500	0	0	0	0	0	0	0
400	1 200	300	0	0	0	0	0	0	0
200	1 100	200	0	0	0	0	0	0	0
0	1 100	200	0	0	0	0	0	0	0

[a] Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

[b] For hazard zones above 2 500 mm, refer to 4.2.1.

4.2.2.1.2 The values given in Table 2 shall be used to determine the corresponding dimension(s) of the height of the hazard zone, the height of protective structures and the horizontal safety distance to the hazard zone. If there is a high risk (see 4.1.2) from a hazard zone, then the values given in Table 2 shall be used.

There shall be no interpolation of the values given in Table 2. Consequently, when the known values of *a*, *b* or *c* are between two values in Table 2, the greater safety distance or higher protective structure or change in the height (higher or lower) of the hazard zone shall be used.

Annex A gives examples of the use of Tables 1 and 2.