INTERNATIONAL STANDARD

ISO 13855

First edition
2002-02-01

Safety of machinery — Positioning of protective equipment with respect to the approach speeds of parts of the human body

Sécurité des machines — Positionnement des dispositifs de protection par rapport à la vitesse d'approche des parties du corps

Reference number
ISO 13855:2002(E)

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Printed 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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13855 was prepared by Technical Committee ISO/TC 199, *Safety of machinery*.

Annexes A, B and C of this International Standard are for information only.

Introduction

The effectiveness of certain types of protective equipment described in this International Standard to minimize risk relies, in part, on the relevant parts of that equipment being correctly positioned in relation to the danger zone. In deciding on these positions, a number of aspects are to be taken into account, such as:

— the need to identify hazards and to assess risks;

— the practical experiences of users, including accident statistics and existing national standards;

— the state of the art and possible future technical developments;

— the type of equipment to be used;

— the response times of protective equipment used;

— the time taken to ensure the safe condition of the machine following operation of the protective equipment, for example to stop the machine;

— the bio-mechanical and anthropometric data of body parts;

— the path taken by the body part when moving from the sensing or actuating means towards the danger zone;

— the possible presence of a person between the device and the danger zone;

— the possibility of undetected access to the danger zone.

If these aspects are further developed, the current state of the art, reflected in this International Standard, will be updated.

This International Standard gives guidance based on the assumption that the correct device has been chosen either by reference to the appropriate Type-C standard or by carrying out a risk assessment.

The calculated distances, when implemented, will provide sufficient protection for persons against the risks caused by approaching a danger zone which generate any of the following mechanical hazards, such as: crushing, shearing, cutting or severing, entanglement, drawing-in or trapping, friction or abrasion, stabbing or puncture and impact.

Protection against the risks from mechanical hazards arising from the ejection of solid or fluid materials and non-mechanical hazards such as toxic emissions, electricity, radiation etc. are not covered by this International Standard.

The distances are derived from data that take into account population groups likely to be found in European countries and are consequently applicable to those groups.

NOTE 1 If this International Standard is to be used for non-industrial purposes, then the designer should take into account that this data is based on industrial experience.

NOTE 2 Until specific data is available for approach speeds for children, this International Standard uses adult speeds and lower detection factors, where relevant, to calculate the distances that could be within the reach of children.

This International Standard has been prepared to be a harmonized standard in the sense of the Machinery Directive of the European Union and associated regulations of the European Free Trade Association (EFTA). This International Standard is based on EN 999:1998, published by the European Committee for Standardization (CEN).

Safety of machinery — Positioning of protective equipment with respect to the approach speeds of parts of the human body

1 Scope

This International Standard provides parameters based on values for hand/arm and approach speeds and the methodology to determine the minimum distances from sensing or actuating devices of protective equipment to a danger zone.

These specific devices are:

a) trip devices as defined in EN 292-1:1991, 3.23.5 (specifically electro-sensitive protective equipment, pressure sensitive mats), including those used additionally to initiate operation;

b) two-hand control devices as defined in EN 292-1:1991, 3.23.4 and covered by ISO 13851.

NOTE For the purposes of this International Standard, hold-to-run controls, which are designed to be actuated with one hand, are not considered to be protective equipment.

This International Standard does not apply to protective equipment which is intended to be moved, without tools, nearer to the danger zone than the calculated distance, e.g. pendant two-hand control devices.

The minimum distances derived from this International Standard do not apply to protective equipment used to detect the presence of persons within an area already protected by a guard or electro-sensitive protective equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/TR 12100-1:1992, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology*

ISO/TR 12100-2:1992, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles and specifications*

ISO 13851[1)], *Safety of machinery — Two-hand control devices — Functional aspects and design principles*

ISO 13852:1996, *Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs*

ISO 14121:1999, *Safety of machinery — Principles of risk assessment*

IEC 61496-1:1997, *Safety of machinery — Electrosensitive protective equipment — Part 1: General requirements and tests*

1) To be published.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO/TR 12100-1 and ISO/TR 12100-2 and the following apply.

3.1
actuation
〈of protective equipment〉 physical initation of the protective equipment when it detects movement of the body or a part of the body

3.2
overall system stopping performance
T
time or travel occurring from the actuation of the sensing function to the cessation of hazardous motion, or to the machine assuming a safe condition, comprising a minimum of two phases:

$$T = t_1 + t_2$$

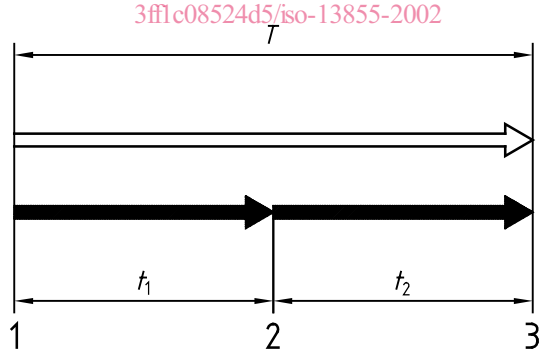
where

t_1 is the maximum time between the actuation of the sensing function and the output signal switching devices being in the off state,

t_2 is the maximum response time of the machine, i.e. the time required to stop the machine or remove the risks after receiving the output signal from the protective equipment. t_2 is influenced by various factors, e.g. temperature, switching time of valves, ageing of components.

[IEC 61496-1:1997, 3.20]

NOTE The relationship of t_1 and t_2 is given in Figure 1. t_1 and t_2 are functions of the protective equipment and the machine respectively and are determined by design and measurement.



Key

1 Actuating of protective equipment
2 Operation of protective equipment
3 Elimination of risk

Figure 1 — Relationship between t_1 and t_2

3.3
detection capability
d
sensing function parameter limit specified by the supplier that will cause actuation of the electro-sensitive protective equipment (ESPE)

[IEC 61496-1:1997, 3.6]

3.4
electro-sensitive protective equipment
ESPE
assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising as a minimum a sensing device, controlling/monitoring devices and output signal switching devices

[IEC 61496-1:1997, 3.1]

4 Methodology

Figure 2 provides a schematic representation of the methodology for determining the correct position of sensing or actuating devices of protective equipment in accordance with this International Standard, which is as follows.

a) Identify the hazards and assess the risks (see ISO/TR 12100-1 and ISO 14121).

b) If a Type-C standard exists for the machine, select one of the specified types of protective equipment from that machine-specific standard, and then use the distance specified by that European standard.

c) If there is no Type-C standard or if the Type-C standard does not specify any minimum distances, then use the formulae in this International Standard to calculate the minimum distance for the protective equipment selected. The selection of the appropriate type of protective equipment should be made in accordance with the relevant Type-A and Type-B standards.

d) Incorporate the distance in the machine design.

e) Ensure that the device has been installed in such a manner that access to the danger zone will not be possible without detection by the device.

f) Check if the determined position will allow persons to be between the sensing devices of the protective equipment and the danger zone without being detected. In this case, supplementary measures may be required depending on the risk.

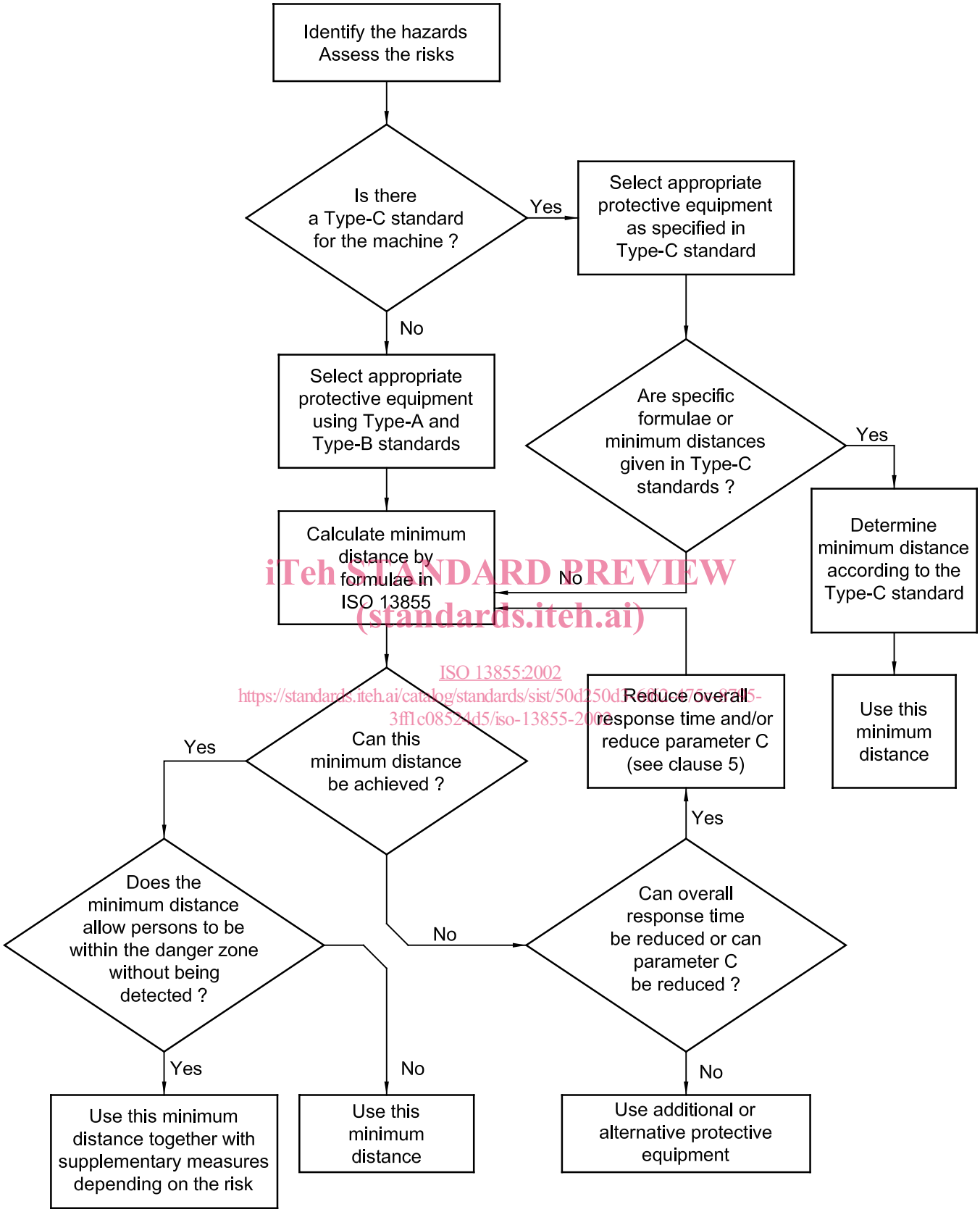


Figure 2 — Schematic of methodology

5 General formula for the calculation of minimum distances

The minimum distance, in millimetres, from the danger zone to the detection point, line, plane or zone shall be calculated by using the following general formula:

$$S = (K \times T) + C \quad (1)$$

where

K is a parameter in millimetres per second, derived from data on approach speeds of the body or parts of the body (see also annex B);

T is the overall system stopping performance in seconds (see 3.2);

C is an additional distance in millimetres, based on intrusion towards the danger zone prior to actuation of the protective equipment.

For worked examples see annex A.

6 Calculation of minimum distances for electro-sensitive protective equipment employing active opto-electronic protective devices

Users of this International Standard shall select and use electro-sensitive protective equipment for a machine in accordance with the appropriate Type-C standard for that particular machine. If no Type-C standard exists, they shall undertake a risk assessment according to ISO 14121.

This clause considers three main applications based on the direction of approach to the detection zone[2]:

a) normal approach (see Figure 3);

b) parallel approach (see Figure 4);

c) angled approach (see Figure 5).

Where it is foreseeable that any gaps adjacent to or within the detection zone of the electro-sensitive protective equipment will allow access to the danger zone, this should be taken into account in the correct positioning of the protective equipment and additional safeguards considered.

Access to the danger zone by reaching over or round the electro-sensitive protective equipment, together with any other protective equipment and additional safeguards, shall be prevented.

2) For the definition of detection zone, see IEC 61496-1.