SLOVENSKI STANDARD
SIST EN 999:2000

01-junij-2000

Varnost strojev - Postavitev varovalne opreme glede na hitrost približevanja delov ļ loveģkega telesa

Safety of machinery - The positioning of protective equipment in respect of approach speeds of parts of the human body

Sicherheit von Maschinen - Anordnung von Schutzeinrichtungen im Hinblick auf Annäherungsgeschwindigkeiten von Körperteilen

Sécurité des machines - Positionnement des équipements de protection en fonction de la vitesse d'approche des parties du corps

Ta slovenski standard je istoveten z: **EN 999:1998**

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13.110	Varnost strojev	Safety of machinery

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English version

Safety of machinery - The positioning of protective equipment in respect of approach speeds of parts of the human body

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 114 "Safety of machinery", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 1999, and conflicting national standards shall be withdrawn at the latest by April 1999.

It is a Type B1 standard and is intended to be an accompaniment to the European Standards EN 292-1 and EN 292-2.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

0 Introduction

The effectiveness of certain types of protective equipment described in this 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 will need to be taken into account such as:

- a need for the identification of hazards and an assessment of all the risks;
- practical experiences of users including accident statistics and existing national standards;
- the state of the art and possible future technical developments;
- type of equipment to be used;
- response times of protective equipment used;
- time taken to ensure the safe condition of the machine following operation of the protective equipment, e.g. to stop the machine;
- bio-mechanical and anthropometric data of body parts;
- path taken by 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 standard, will be improved.

1 Scope

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

1.2 These specific devices are:

- trip devices as defined in 3.23.5 of EN 292-1 : 1991 (specifically electro-sensitive protective equipment, including those used additionally to initiate operation, and pressure sensitive mats).
- two-hand control devices as defined in 3.23.4 of EN 292-1 : 1991 and covered by EN 574.

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

1.3 This 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.

1.4 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 standard.

1.5 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 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 standard uses adult speeds and lower detection factors, where relevant, to calculate the distances that could be within the reach of children.

1.6 This 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.

1.7 The minimum distances derived from this 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

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 292-1 : 1991	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology
EN 292-2	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications
EN 294 : 1992	Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs
EN 574	Safety of machinery - Two-hand control devices - Functional aspects, principles for design
EN 1050	Safety of machinery - Principles for risk assessment
EN 61496-1 : 1997	Safety of machinery - Electro-sensitive protective equipment - Part 1: General requirements and tests (IEC 61496-1:1997)

3 Definitions

For the purposes of this standard the following definitions apply. Other definitions are given in EN 292-1 and EN 292-2.

3.1 Actuation (of protective equipment): Physical initiation of the protective equipment when it detects movement of the body or a part of the body.

3.2 Overall system stopping performance: 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.

[based on 3.20 of EN 61496-1 : 1997]

The overall system stopping performance comprises a minimum of two phases.

$T = t_1 + t_2$, where

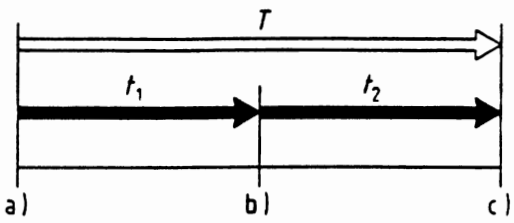
T is the overall system stopping performance,

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.

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.



a) Actuating of protective equipment
b) Operation of protective equipment
c) Elimination of risk

Figure 1: Relationship between t_1 and t_2

3.3 Detection capability: The sensing function parameter limit specified by the supplier that will cause actuation of the electro-sensitive protective equipment (ESPE).

[3.4 of EN 61496-1 : 1997]

NOTE: Symbol d is used throughout the standard.

3.4 Electro-sensitive protective equipment (ESPE): An assembly of devices and/or components, working together for protective tripping or presence-sensing purposes and comprising as a minimum:

- a sensing device;
- controling/monitoring devices;
- output signal switching devices.

[3.1 of EN 61496-1 : 1997]

4 Methodology

Figure 2 provides a schematic representation of the methodology for determining the correct position of sensing or actuating devices of protective equipment using this standard which is as follows:

a) Identify the hazards and assess the risks (see EN 292-1 and EN 1050).

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 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 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 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.

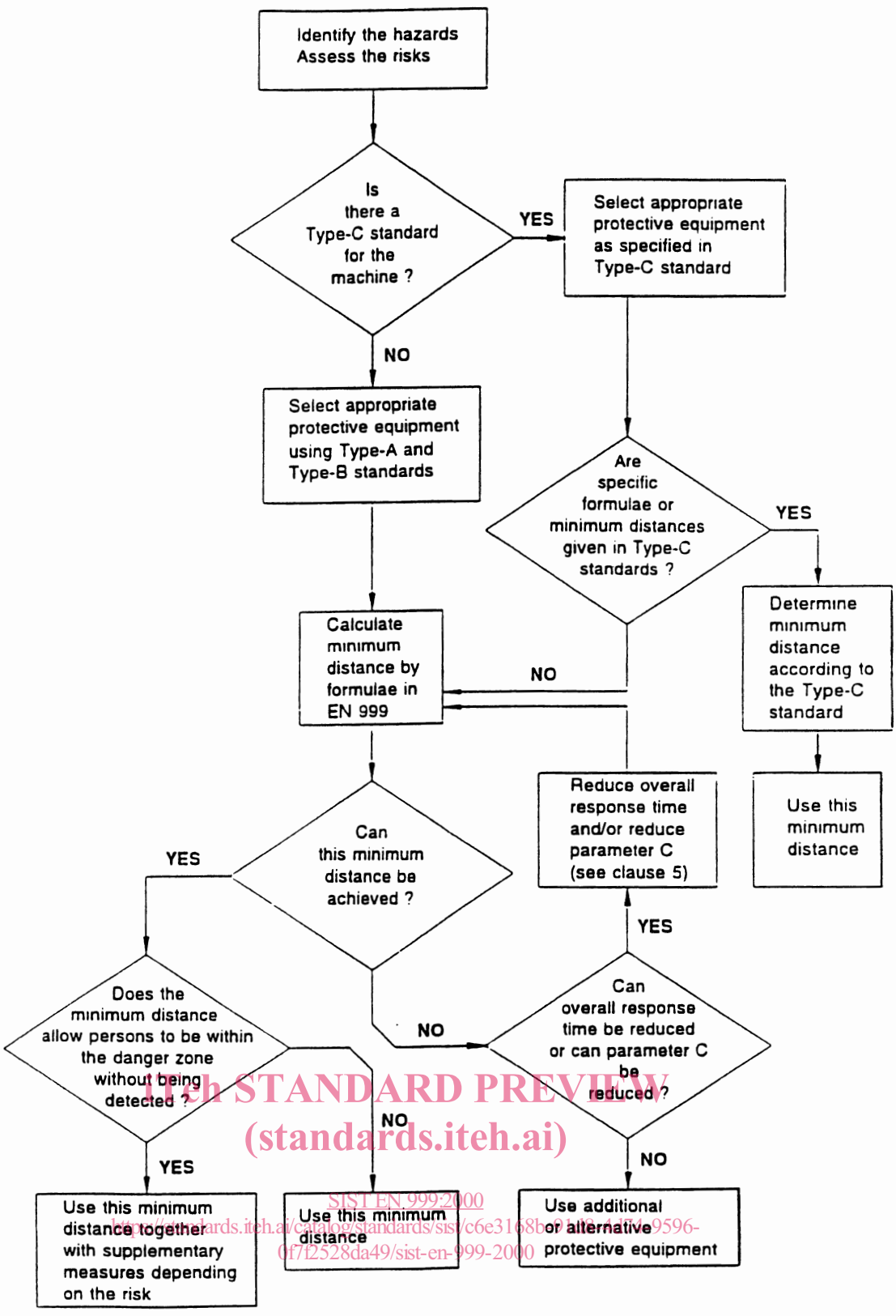


Figure 2: Schematic of methodology

5 General formula for the calculation of minimum distances

The minimum distance from the danger zone shall be calculated by using the general formula (1).

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

where:

- S is the minimum distance in millimetres, from the danger zone to the detection point, line, plane or zone;
- 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 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 EN 1050.

This clause considers three main applications based on the direction of approach to the detection zone[1]):

- normal approach (see figure 3);
- parallel approach (see figure 4);
- 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 then 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.

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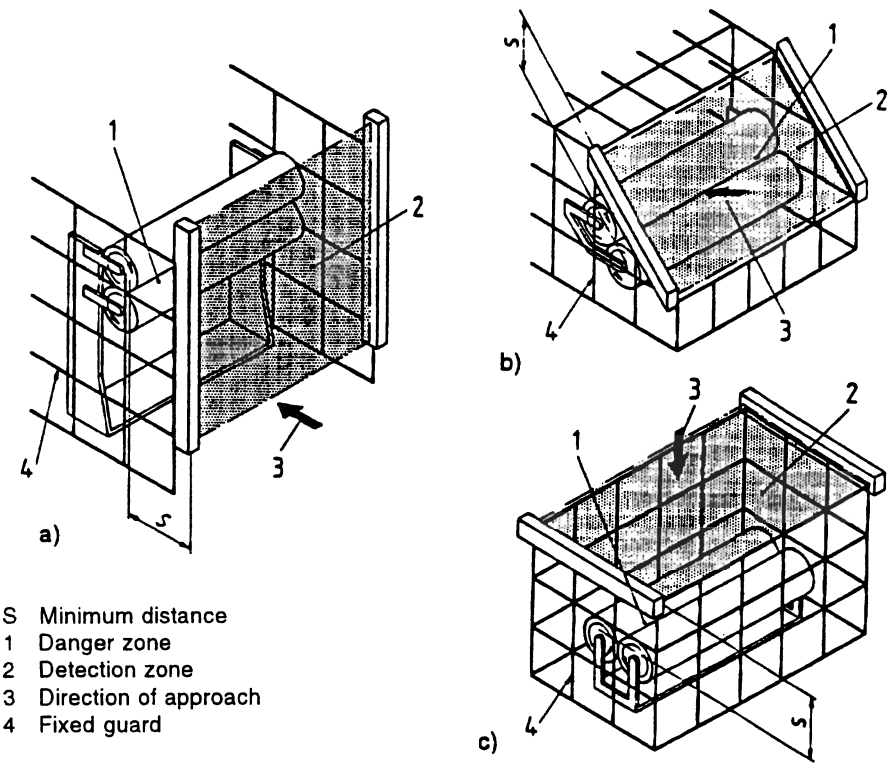
[1]) Definition see EN 61496-1

6.1 Direction of approach normal to the detection zone



S Minimum distance
1 Danger zone
2 Detection zone
3 Direction of approach
4 Fixed guard

Figure 3: Three examples of normal approach

6.1.1 Electro-sensitive protective equipment employing active opto-electronic protective devices with a maximum detection capability of 40 mm diameter

The minimum distance from the detection zone to the danger zone shall not be less than that calculated using formula (2).

$$S = (K \times T) + C \quad (\textit{see clause } 5) \qquad (1)$$

where:

K = 2000 mm/s;

C = 8 (d - 14 mm) but not less than 0;

d is the detection capability of the device in millimetres.

i.e.:

$$S = (2000\ mm/s \times T) + 8\ (d - 14\ mm) \qquad (2)$$

This formula applies for all minimum distances of S up to and including 500 mm.The minimum value of S shall not be less than 100 mm.

If S is found to be greater than 500 mm using formula (2), then formula (3) can be used. In this case the minimum value of S shall not be less than 500 mm.

$$S = (K \times T) + C \quad (\textit{see clause } 5) \qquad (1)$$

where:

K = 1600 mm/s;

C = 8 (d - 14 mm) but not less than 0.

i.e.:

$$S = (1600\ mm/s \times T) + 8\ (d - 14\ mm) \qquad (3)$$

Where it is foreseeable that electro-sensitive protective equipment employing active opto-electronic protective devices will be used in non-industrial applications, e.g. in the presence of children, the minimum distance S calculated with formula (2) shall be increased by at least 75 mm. It shall be noted that in such cases formula (3) is not applicable.

6.1.2 Electro-sensitive protective equipment employing active opto-electronic protective devices used for reinitiation of machine operation

Electro-sensitive protective equipment employing active opto-electronic protective devices used for reinitiation of machine operation shall have a detection capability equal to or less than 30 mm, formula (2) (see 6.1.1) shall apply and the minimum distance S shall be greater than 150 mm.

If the detection capability is equal to or less than 14 mm, formula (2) shall apply and the minimum distance S shall be greater than 100 mm.

NOTE 1: Conditions for using electro-sensitive protective equipment in the reinitiation of machine operation are given in EN 292-1 and EN 292-2[2]) and relevant Type C standards.

NOTE 2: Additional requirements for electro-sensitive protective equipment are given in EN 61496-1.

6.1.3 Electro-sensitive protective equipment employing active opto-electronic protective devices with detection capability greater than 40 mm and less than or equal to 70 mm

Such pieces of equipment will not detect intrusion of the hands and therefore shall only be used where the risk assessment indicates that detection of intrusion of the hands is not necessary.

This equipment shall be installed in accordance with the following parameters.

The minimum distance from the detection zone to the danger zone is in part dependent on the part of body to be detected and shall be calculated using formula (4).

$$S = (K \times T) + C \quad (see\ clause\ 5) \qquad (1)$$

where:

K = 1600 mm/s;

C = 850 mm.

i.e.:

$$S = (1600\ mm/s \times T) + 850\ mm \qquad (4)$$

The risk of inadvertent access shall be taken into account during the risk assessment stage but in all cases, the height of the uppermost beam shall be ≥ 900 mm and the height of the lowest beam shall be ≤ 300 mm.

Where it is foreseeable that electro-sensitive protective equipment will be used in non-industrial applications, e.g. in the presence of children, the height of the lowest beam shall be ≤ 200 mm.

6.1.4 Multiple separate beams

Multiple separate beams, e.g. a combination of 2, 3 or 4 separate beams, are often used to detect intrusion of the whole body rather than parts of the body.

If the risk assessment indicates that separate beams are appropriate, they shall be positioned at a minimum distance from the danger zone in accordance with formula (4) (see 6.1.3).

During risk assessment, methods which can possibly be used to bypass such equipment shall be taken into account, e.g.:

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[2]) These requirements are under preparation and will be contained in the revision of EN 292-1 and EN 292-2