



SLOVENSKI STANDARD
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Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles

Sicherheit von Maschinen - Ergonomische Gestaltungsgrundsätze - Teil 1: Begriffe und allgemeine Leitsätze

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Sécurité des machines - Principes ergonomiques de conception - Partie 1: Terminologie et principes généraux

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EUROPEAN STANDARD

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principes généraux

Sicherheit von Maschinen - Ergonomische
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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This European Standard was prepared by the Technical Committee CEN/TC 122 "Ergonomics" of which the secretariat is held by DIN.

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 or EC Directive(s).

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of an identical text or by endorsement, at the latest by August 1995, and conflicting national standards shall be withdrawn at the latest by August 1995.

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

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0 Introduction

Ergonomically designed work systems enhance safety, effectiveness and efficiency, improve human working and living conditions, and counteract adverse effects on human health and performance. Good ergonomic design therefore exerts a favourable influence on the work system, and on the reliability of the human being within it.

In this European Standard the term "ergonomics" refers to a multidisciplinary field of science and its application. In applying ergonomics to the design of work systems it is important to take human capabilities, skills, limitations and needs into account when exploring the interaction between people, technology and work environment.

The work system is derived from a concept that combines the operators, work equipment (including machinery), work space, work environment, work process, work task, the management and organization and interactions between them. It can vary in complexity from a workshop with a single operator using hand held equipment to a process plant and its operators.

Work equipment is only one component of the work system and should not be considered in isolation. Good design starts with the operator and takes into account how the operator is expected to interact with the work equipment and how the work equipment fits into the system as a whole. This is particularly important the more the work equipment is inter-dependent on other components of the system.

Compliance with harmonized standards prepared by CEN/CENELEC enables manufacturers to meet the requirements of European legislation and agreements. EN 292 Part 1 and Part 2 contain the concepts and general principles to guide designers and manufacturers in achieving safety for machinery for occupational and private purposes.

This European Standard is one of the range of European Standards covering specific topics identified in EN 292 Part 1 and Part 2 as important to the safety of machinery.

1 Scope

This European Standard establishes the ergonomics principles to be followed during the process of design of work equipment, especially machinery. Although the principles in this European Standard are orientated towards equipment for occupational use, they are applicable also to equipment for private use.

This European Standard applies to the interactions between the operator and the work equipment when installing, operating, adjusting, maintaining, cleaning, repairing or transporting equipment and outlines the principles to be followed in taking the health and safety of the operator fully into account.

The ergonomics principles given in this European Standard fully apply to all ranges of individual ability. Information on dimensions will need to be interpreted to suit the intended population.

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 reference 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 292-2:1991 Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications
- prEN 547-1:1991 Safety of machinery - Human body dimensions - Part 1: Principles for determining the dimensions required for openings for whole body access into machinery
- prEN 547-2:1991 Safety of machinery - Human body dimensions - Part 2: Principles for determining the dimensions required for access openings
- EN 563:1994 Safety of machinery - Temperatures of touchable surfaces; Ergonomics data to establish temperature limit values for hot surfaces
- prEN 894-1:1992 Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 1: Human interactions with displays and control actuators
- prEN 894-2:1992 Safety of machinery - Ergonomics requirements for the design of displays and control actuators; Part 2: Displays
- prEN 894-3:1992 Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 3: Control actuators
- prEN 1005-1:1993 Safety of machinery - Human physical performance - Part 1: Terms and definitions
- prEN 1005-2:1993 Safety of machinery - Human physical performance - Part 2: Manual handling of objects associated to machinery
- prEN 1005-3:1993 Safety of machinery - Human physical performance - Part 3: Recommended force limits for machinery operation

3 Definitions

For the purposes of this European Standard, the following definitions apply:

3.1 Operator

The person or persons given the task of installing, operating, adjusting, maintaining, cleaning, repairing or transporting machinery (EN 292-1).

3.2 Work task

An activity or activities required to achieve an intended outcome of the work system.

3.3 Work equipment

Machinery, tools, vehicles, devices, furniture, installations and other components used in the work system.

3.4 Work space

A volume allocated to one or more persons in the work system to complete the work task.

3.5 Work environment

Physical, chemical, biological, organisational, social and cultural factors surrounding a person in his or her work space.

3.6 Workplace

For a given worker, the combination of work equipment in a work space, surrounded by the work environment, constitutes the workplace of that worker.

3.7 Work system

The work system comprises one or more persons and work equipment acting together to perform the system task, at the work space, in the work environment, under the conditions imposed by the work tasks.

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3.8 Job design

The organisation and sequence in time and space of an individual's tasks.

3.9 Work organisation

The interaction of people in a work system or work systems.

3.10 Work stress (or external load)

The sum of those external conditions and demands in the work system which act to disturb a person's physiological and/or psychological state.

3.11 Work strain (or internal reaction)

The effect of the work stress upon a person in relation to his/her individual characteristics and abilities.

3.12 Work fatigue

The local or general non-pathological manifestation of work strain, completely reversible with rest.

3.13 Work activity

Any activity performed by the worker to achieve the intended outcome of the work system.

3.14 Control actuator

The part of the control actuating system that directly responds to an action of the operator, e.g. by the operator applying pressure (prEN 894-1:1992).

4 General principles

The following sub-clauses give information on some of the ergonomic factors that shall be taken into account when designing a machine.

To be able to achieve an efficient, healthy and safe interaction of operators with work equipment, ergonomics principles, as well as technical safety requirements, shall be taken into account during the design process.

The observance of ergonomics principles applies not only to the intended use of work equipment, but also to its installation, adjustment, maintenance, cleaning, repair and transport. Design details may influence one another, so any interactions between them should be considered during the design process. For this reason, design focusses essentially on the interaction between the operator and the work equipment, and hence the division of functions and labour between the operator and the work equipment. The objective is to design the work system to be consistent with human capabilities, limitations and needs. Consequently, this requires a task analysis in the design process.

4.1 Design considering anthropometry and biomechanics

4.1.1 Body dimensions

Work equipment shall be designed with proper regard to the body dimensions of the expected population of operators, taking into account:

- body dimensions (both static and dynamic with appropriate clothing and/or personal protective equipment) of adults, children and the elderly;
- ranges of body dimensions and joint movements;
- safety distances;
- dimensions for access (for use, repair and maintenance) using e.g. anthropometric templates, models and computer-aided models.

In the design of work equipment the following principles shall be taken into account:

- a) the operating height or other functional dimensions of equipment shall fit the operator and the type of work being performed, for example by being adjustable;
- b) the type, location and adjustability of any seating provided shall be appropriate to the dimensions of the operator, and to the tasks the operator performs;
- c) sufficient space shall be provided for all the body parts, to allow the task to be performed with good working postures and movements and to facilitate access and changes in posture;

- d) the handles and pedals of equipment shall suit the functional anatomy of the hand or foot, and the dimensions of the operator population. For hand held equipment handles shall be so designed to ensure that the operator is able to grip the equipment correctly and to perform the expected movements;
- e) frequently used control actuators, grips and pedals shall be placed within easy reach of the hands and/or feet when the operator is in one of the normal operating positions. Other important control actuators, e.g. emergency stops, shall be within easy reach of the operator, whereas less frequently used control actuators shall merely be within reach, unless the task requires otherwise.

When designing work equipment to conform to the expected operator population, at least the 5th to 95th percentiles shall be used. Where health and safety aspects are important, wider percentile ranges shall be used, according to the risk assessment, at least to the 1st and/or 99th percentiles. As equipment is designed for use by both men and women, the relevant percentiles for women and for men shall be used (see prEN 547-1 and prEN 547-2).

When determining clearance (such as those for leg room), 95th percentile values shall be used. For reach (e.g. operator reach), 5th percentile values shall be used. Where the work equipment dimensions are adjustable, the range available shall cover the 5th to the 95th percentiles.

NOTE: It is generally better in terms of health, safety and efficiency, to design to fit as wide a range of the expected operator population as possible. Factors such as sufficient leg room will also ensure operator comfort. Future European Standards will contain anthropometric data on the European population, and information on how it should be used. Special consideration will be needed when equipment is being designed for use by disabled people.

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4.1.2 Posture

The operator's working posture shall be such that it does not have any injurious effects on the individual.

In the design of work equipment, the following principles shall be taken into account:

- a) awkward postures, e.g. twisting and bending, and prolonged activities leading to body fatigue shall be avoided. Changes in posture shall be possible;
- b) machinery shall preferably enable occasional alterations in the operator's working position between sitting, standing and walking. Sitting shall generally be preferred to standing as a main working position;
- c) suitable body posture and appropriate support for the body shall be ensured. Supports shall be dimensioned and positioned in order to avoid unbalanced postures. The body posture shall be consistent with the force requirements. Technical aids shall be provided to achieve sufficient leverage and prevent physical overload. To satisfy this requirement for hand held equipment, it is important that changes in grip during use are avoided by correct positioning of the handles.

4.1.3 Body movements

Work equipment shall be designed to allow the body or parts of the body to move in accordance with their natural paths and rhythms of motion. In particular, the operator shall not be required to make frequent or prolonged movements involving extreme joint angles.

In the design of work equipment, the following principles shall be taken into account:

- a) work equipment shall not constrain the operator to remain immobile when using it;
- b) the design of work equipment shall be such that repetitive (identical) movements that lead to impairment, illness or injury shall be avoided;
- c) movements requiring high precision and accuracy shall require low force for their execution;
- d) aids (such as hoists, rails, stops, etc.) shall be provided for manual handling requiring high precision. The work space shall have adequate dimensions for such aids;
- e) the application of forces requiring twisting movements or extreme joint positions of the hand/arm shall be avoided.

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4.1.4 Physical strength

The demands the work equipment makes on the operator's physical strength during work shall be kept to an acceptable level (see prEN 1005-1, prEN 1005-2 and prEN 1005-3). This level will depend on the weight, shape, size, weight distribution and position of the objects being handled; on the duration and frequency of force application; on the operator's posture (sitting or standing) and movement paths; on the rules and methods of working; and on the specific characteristics of the intended operator populations (e.g. sex, age, health, physique and training).

In the design of work equipment, the following principles shall be taken into account:

- a) where the necessary physical force to be applied cannot be exerted by muscle groups capable of meeting the strength demands, mechanical aids shall be provided;
- b) prolonged static muscle tension (such as that caused by the arms and hands being held aloft) shall be avoided. The weight of hand held equipment may be an important cause of muscle fatigue when prolonged periods of use are required and its effects should be reduced, e.g. by supporting the equipment on a suspension system;
- c) the application of physical force shall be reduced wherever possible by utilising the force of gravity or by other measures;
- d) control actuators, grips, handles and pedals of work equipment shall be designed, selected and arranged so that the necessary application of physical force is low, unless the application of this general principle has a negative effect on health and safety;