SLOVENSKI STANDARD
SIST EN 1005-3:2002

01-november-2002

Varnost strojev - Človeške fizične zmogljivosti - 3. del: Priporočene mejne vrednosti potrebne sile za upravljanje strojev

Safety of machinery - Human physical performance - Part 3: Recommended force limits for machinery operation

Sicherheit von Maschinen - Menschliche körperliche Leistung - Teil 3: Empfohlene Kraftgrenzen bei Maschinenbetätigung

Sécurité des machines - Performance physique humaine - Partie 3: Limites des forces recommandées pour l'utilisation de machines

Ta slovenski standard je istoveten z: **EN 1005-3:2002**

ICS:

13.110	Varnost strojev	Safety of machinery
13.180	Ergonomija	Ergonomics

SIST EN 1005-3:2002 **en**

EUROPEAN STANDARD

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English version

Safety of machinery - Human physical performance - Part 3: Recommended force limits for machinery operation

Sécurité des machines - Performance physique humaine - Partie 3: Limites des forces recommandées pour l'utilisation de machines

Sicherheit von Maschinen - Menschliche körperliche Leistung - Teil 3: Empfohlene Kraftgrenzen bei Maschinenbetätigung

This European Standard was approved by CEN on 8 November 2001.

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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 Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 122 "Ergonomics", 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of an identical text or by endorsement, at the latest by July 2002, and conflicting national standards shall be withdrawn at the latest by July 2002.

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

For relationship with EC Directive(s), see informative annex ZA, which is an integral part of this document.

EN 1005 consists of the following parts, under the general title "Safety of machinery - Human physical performance":

- Part 1: Terms and definitions;
- Part 2[1)]: Manual handling of machinery and component parts of machinery;
- Part 3: Recommended force limits for machinery operation;
- Part 4[1)]: Evaluation of working postures and movements in relation to machinery;
- Part 5[1)]: Risk assessment for repetitive handling at high frequency.

Annexes A and B are for information only.

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

[1)] This European Standard is under preparation by CEN/TC 122/WG 4 "Biomechanics".

Introduction

Within the life cycle of a machine from construction to dismantling, various machine-related actions require muscular force exertion. Muscular force exertion causes strain to the musculo-skeletal system. Unfavourable musculo-skeletal strain corresponds to the risk of fatigue, discomfort and musculo-skeletal disorders. The manufacturer of a machine is in a position to control these health risks by optimising the required forces, while taking into account the frequency, duration and variation of force exertion.

The calculation procedure and the recommended limits in this standard aim to reduce the health risk for the operator as well as to increase the flexibility and possibility for a larger population to operate the machines which increases efficiency and profitability.

This standard has been prepared to be harmonised standard in the sense of the Machinery Directive and associated EFTA regulations.

This standard is written in conformity with EN 1050 and gives the user hazard identification for harm through musculo-skeletal disorders and tools for qualitative and, to an extent, a quantitative risk assessment. The tools for the risk assessment also implicate how to do the risk reduction. This standard does not deal with risks connected to accidents.

The recommendations provided by this standard are based on available scientific evidence concerning the physiology and epidemiology of manual work. The knowledge is, however, scarce and the suggested limits are subject to changes according to future research. In accordance with the rules for CEN/CENELEC-standards Part 2, 4.9.3, European Standards are reviewed at intervals not exceeding five years.

This European Standard is a type B standard as stated in EN 1070.

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

NOTE 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.

1 Scope

This European Standard presents guidance to the manufacturer of machinery or its component parts and the writer of C-standards in controlling health risks due to machine-related muscular force exertion.

This standard specifies recommended force limits for actions during machinery operation including construction, transport and commissioning (assembly, installation, adjustment), use (operation, cleaning, fault finding, maintenance, setting, teaching or process changeover) decommissioning, disposal and dismantling. The standard applies primarily to machines which are manufactured after the date of issue of the standard.

This standard applies on one hand to machinery for professional use operated by the adult working population, who are healthy workers with ordinary physical capacity, and on the other hand to machinery for domestic use operated by the whole population including youth and old people.

The recommendations are derived from research on European population.

This document is not applicable to specify the machinery which are manufactured before the date of publication of this document by CEN.

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 (including amendments).

EN 614-1, *Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles.*

EN 1005-1:2001, *Safety of machinery - Human physical performance - Part 1: Terms and definitions.*

EN 1070, Safety of machinery – Terminology.

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 614-1, EN 1005-1:2001 and EN 1070 apply.

4 Recommendations

4.1 General recommendations and information

The manufacturer should first consider EN 292-2:1991, annex A and EN 614-1 and EN 614-2 and then use the procedure for determining force limits presented below.

It is crucially important that the operator is in control of the operation sequences and the pace of the machinery. Furthermore, machines shall be designed in a way so that actions demanding force exertion can be performed optimally with respect to the posture of body and limbs and the direction of force application. In addition machines shall be designed to allow for variations in movements and force exertions.

The risk assessment procedure conveyed by this standard should formally be carried out for each action occurring during handling of the machinery. It may be noted, however, that infrequently occurring actions with low force demands may be assessed on an overview base.

Actions related to the handling of control actuators are considered in EN 894-3, however the present standard provides additional important information related to physical capacity and safety of the operator.

4.2 Risk assessment of action forces

The risk assessment in the present standard is based on the force generating capacity of the intended users, and follows a three-step procedure as illustrated in Figure 1.

In step A, the maximal isometric force generating capacity is determined for relevant actions within specified intended user populations. Within the scope of this standard the determination of maximal forces can be carried out according to three alternative methods.

In step B, the force generating in step A capacity is reduced, according to the circumstances under which the force is to be generated (velocity, frequency and duration of action). The reduction is achieved by a set of multipliers. Basically, the output is a force that may be delivered without substantial fatigue.

In step C, the risk associated with the intended use of the machinery is assessed. The risk evaluation is accomplished using risk multipliers, reducing the maximal attainable force from step B to values associated with different levels of risk.

The risk assessment focuses on musculo-skeletal disorders, and is preferentially based on the assumption that decreasing fatigue during work is effective in reducing disorders.

The recommended force limits are applicable to most men and women in a general population in optimal action posture and under ideal circumstances. The limits are calculated for an optimal range of motion of the joints involved in the respective actions.

It is recommended to let force limits for professional users correspond to the 15th percentile of the whole adult population, i.e. males and females between 20 years and 65 years of age. Force limits for machines intended for domestic use should correspond to the 1st percentile of the same adult population. The adult population is used as reference since reliable force data are scarce or unavailable for youth and aged individuals. Limits established by the procedure in this standard will essentially reduce hazards for at least 85 % of the intended user population.

The manufacturer should be aware that the force evaluation presented by the standard may be used also as a guidance when making instructions for the use of the machinery.

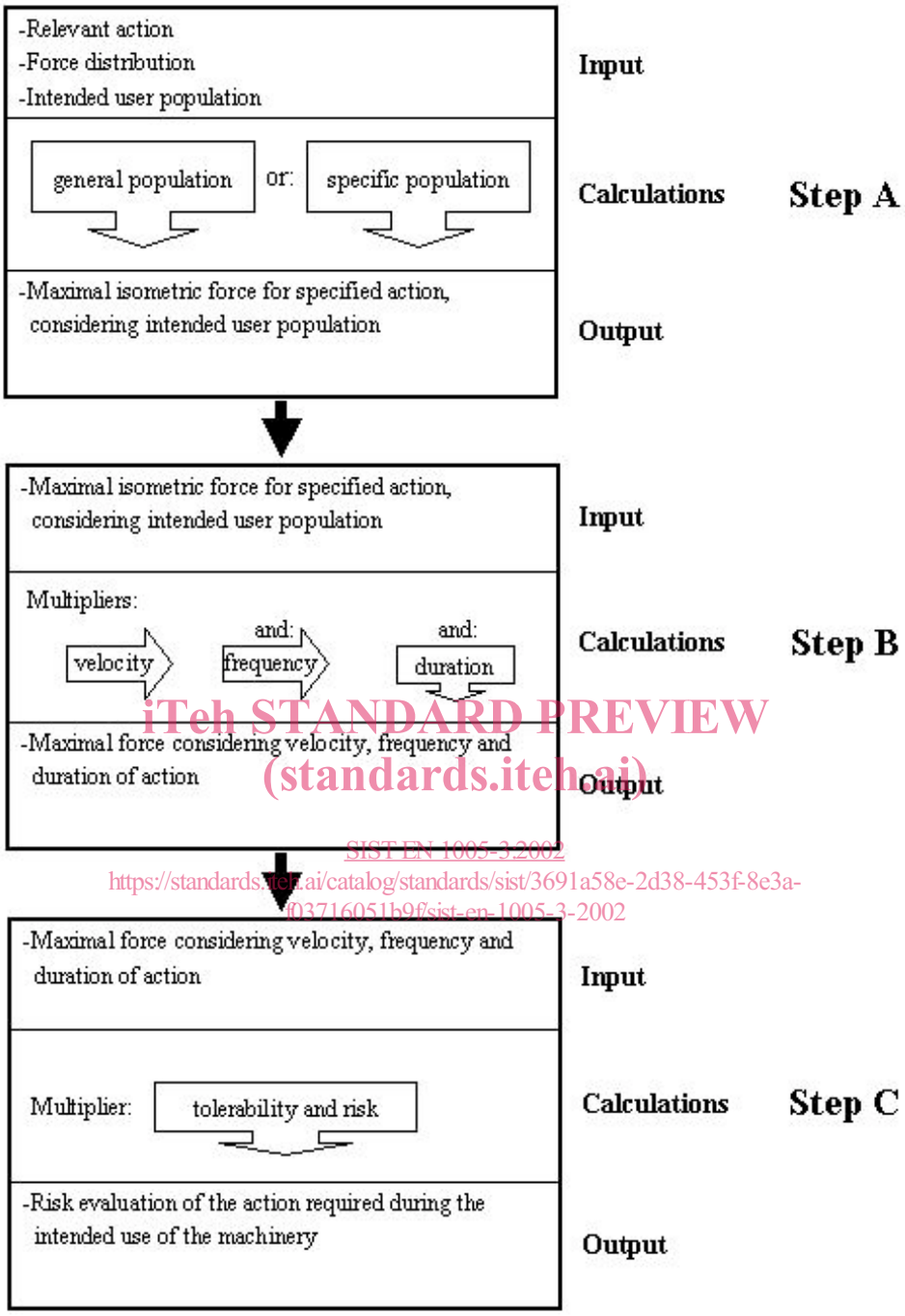


Figure 1 — Illustration of the step procedure leading to risk evaluation of action forces during machinery use for specified intended user populations

4.2.1 Step A: Determination of basic force generating capacity

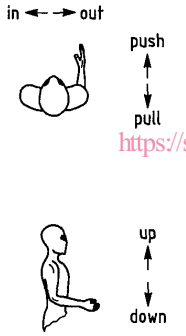
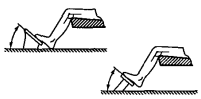
Output: maximal isometric force $F_{B,}$ for specified actions, with consideration to intended user population.

Step A may be realised by one of three alternatives:

Alternative 1

Finding pre-calculated values of F_B in Table 1, if available. These limits represent the general European working population in the given mix in age and gender (Eur 12, 1993). Pre-calculations were done by alternative 3. These values are calculated for optimal working postures as illustrated in the table. The manufacturer shall be aware that physical strength, in particular at arm work, is strongly related to working postures and to the direction of force application.

Table 1 — Maximal isometric force F_B. Pre-calculated isometric force capacity limits for some common activity for professional and domestic use. The values apply to optimal working conditions.

Activity		Professional use F_B in N	Domestic use F_B in N
	Hand work (one hand):		
	Power grip	250	184
	Arm work (sitting posture, one arm):		
	- upwards	50	31
	- downwards	75	44
	- outwards	55	31
	- inwards	75	49
	- pushing		
	- with trunk support	275	186
	- without trunk support	62	30
	- pulling		
	- with trunk support	225	169
	- without trunk support	55	28
	Whole body work (standing posture):		
	- pushing	200	119
	- pulling	145	96
	Pedal work (sitting posture, with trunk support):		
	- ankle action	250	154
	- leg action	475	308

Alternative 2

Calculating F_B by an easy procedure as described in annex A. Alternative 2 is a rough approximation assuming equal representation of males and females and may be applied:

— if the intended user population is similar to the general European population, or

— if a specific demographic profile of the intended user population is not available.

Alternative 2 refers to strength data of the general female population.

Limits may be calculated realising the following basic steps:

— define relevant actions and force directions;

— obtain isometric strength distributions of the general adult and healthy European population at relevant actions;

— decide whether the machinery is intended for professional or domestic use;

— determine F_B, i.e. the 15th strength percentile for professional use or the 1st percentile for domestic use.

For further information and a suggested calculation procedure see annex A. Note that annex A is informative, not normative.

Alternative 3

Allowing precise calculation of F_B by an advanced procedure in annex B.

The amount of F_B exactly reflects the envisaged target population. Consequently alternative 3 applies:

— if the envisaged target population is known in its specific mix in age and gender.

Alternative 3 refers to strength data of a specified subgroup, females between 20 years and 30 years.

Limits may be calculated realising the following basic steps:

— define relevant actions and force directions;

— get strength distribution parameters (average and standard deviation) of a particular reference group (females between 20 years and 30 years);

— get distributions of age and gender of the intended user population as shaped by its demographic profile;

— determine F_B , i.e. the 15th force percentile for professional use of the 1st percentile for domestic use.

For further information and a suggested calculation procedure see annex B. Note that annex B is informative, not normative.

4.2.2 Step B: Determination of adjusted capacity

Output: maximal force for intended user population, taking into consideration velocity, frequency and duration of action.

4.2.2.1 Velocity multiplier m_V

The maximum force generating capacity is reduced in fast, contractive movements. This is covered by the velocity multiplier m_V determined in Table 2.