SLOVENSKI STANDARD
SIST EN 894-3:2002+A1:2008

01-december-2008

Varnost strojev - Ergonomske zahteve za naļ rtovanje prikazovalnikov in krmilnih stikal - 3. del: Krmilna stikala

Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 3: Control actuators

Sicherheit von Maschinen - Ergonomische Anforderungen an die Gestaltung von Anzeigen und Stellteilen - Teil 3: Stellteile

Sécurité des machines - Exigences ergonomiques pour la conception des dispositifs de signalisation et des organes de service - Partie 3: Organes de service

Ta slovenski standard je istoveten z: **EN 894-3:2000+A1:2008**

ICS:

13.110	Varnost strojev	Safety of machinery
13.180	Ergonomija	Ergonomics

SIST EN 894-3:2002+A1:2008 **en,fr**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 894-3:2000+A1

October 2008

ICS 13.100; 13.180

Supersedes EN 894-3:2000

English Version

Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 3: Control actuators

Sécurité des machines - Exigences ergonomiques pour la conception des dispositifs de signalisation et des organes de service - Partie 3: Organes de service

Sicherheit von Maschinen - Ergonomische Anforderungen an die Gestaltung von Anzeigen und Stellteilen - Teil 3: Stellteile

This European Standard was approved by CEN on 3 February 2000 and includes Amendment 1 approved by CEN on 14 August 2008.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

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 CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 894-3:2000+A1:2008: E

Contents

Page

Foreword

This document (EN 894-3:2000+A1:2008) 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 April 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2008-08-14.

This document supersedes EN 894-3:2000.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟩A1⟨ ⟩A1⟨

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).

⟩A1⟨ For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟩A1⟨

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

1 Scope

This European Standard gives guidance on the selection, design and location of control actuators so that they are adapted to the requirements of the operators, are suitable for the control task in question and take account of the circumstances of their use.

It applies to manual control actuators used in equipment for occupational and private use. It is particularly important to observe the recommendations in this European Standard where operating a control actuator may lead to injury or damage to health, either directly or as a result of a human error.

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 292-1, 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 574, Safety of machinery - Two hand control devices -Functional aspects – Principles for design

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

EN 894 – 1, Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 1: General principles for human interactions with displays and control actuators.

EN 894 – 2, Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 2: Displays.

prEN 1005-3, Safety of machinery - Human physical strength - Part 3: Recommended force limits for machinery operation.

EN 1050, Safety of machinery - Risk assessment.

ISO 447, Machine tools - Direction of operation of controls.

IEC 60447, Man-machine interface (MMI) - Actuating principles.

3 Terms and definitions

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

3.1
control actuator
the part of the control actuating system that is directly actuated by the operator, e.g. by applying pressure [EN 894-1]

3.2
manual control actuator
a control actuator adjusted or manipulated by human hand to effect change in a system, e.g., push-button, knob, steering wheel. Touch sensitive actuation is not included.

3.3
control type
a range of control actuators with the same movement and grip characteristics, and fulfilling similar task requirements

3.4
control family
a group of control types

3.5
operator
the person or persons given the task of installing, operating, adjusting, maintaining, cleaning, repairing or transporting machinery [EN 292 -1]

3.6
task (work task)
an activity or activities required to achieve an intended outcome of the work system [EN 614-1]

3.7
control task
an activity where a control actuator is used to achieve a task goal.

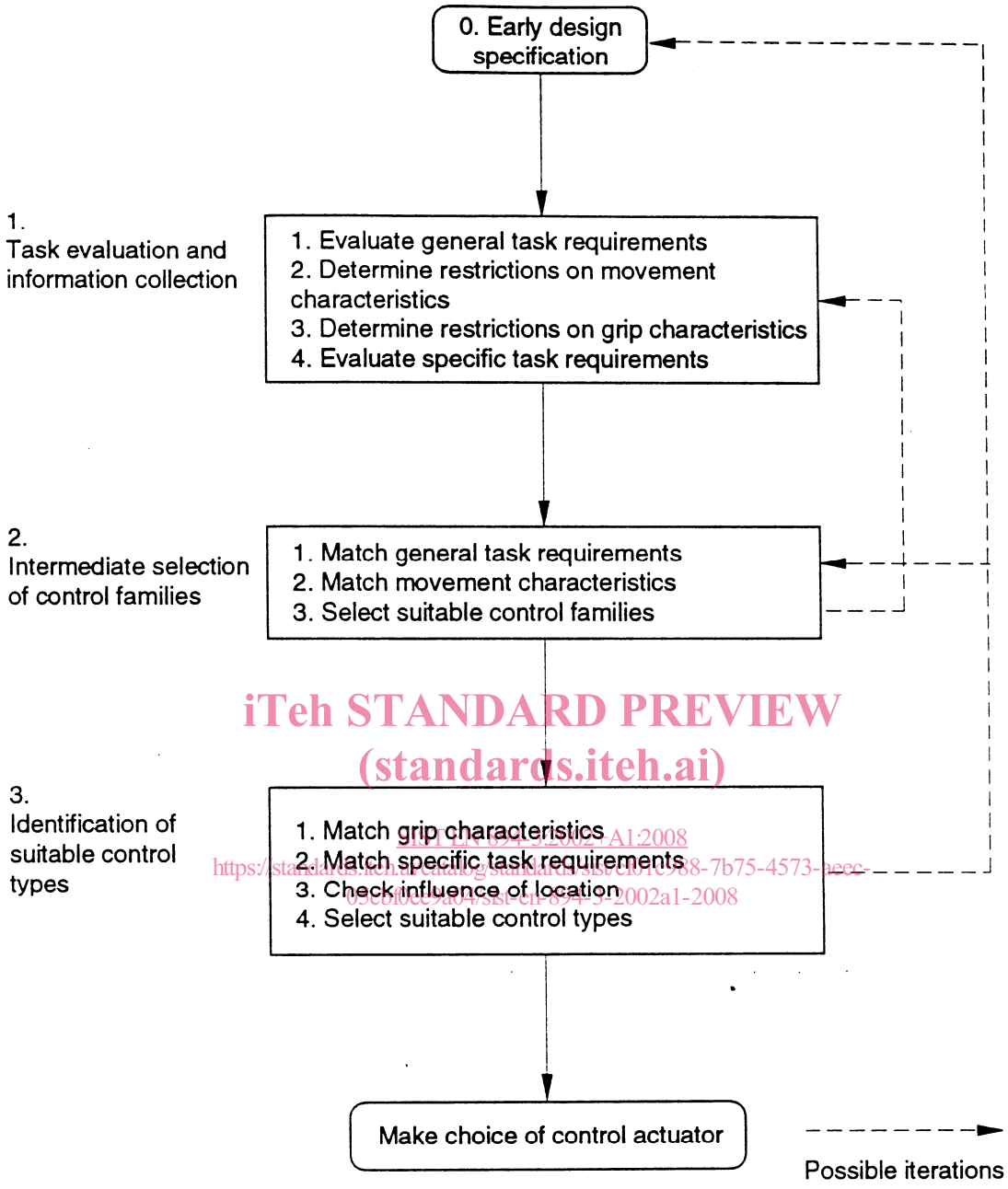

Figure 1 — Overall selection process for manual control actuators

4 Selection procedure

Many types of manual control actuators are available from push-buttons to hand wheels. Each type is suited to particular task requirements and to certain operator capabilities.
Environmental factors (e.g. illumination, vibration) and organisational factors (e.g. team work, workstation separation) also have to be considered.

To ensure safe and efficient operation, correct selection of control actuators is important. The following describes a systematic procedure that will enable designers and manufacturers to select manual control actuators meeting their specific requirements.

The selection procedure involves three steps which are carried out in an iterative manner.
These are:

— task evaluation and information collection;

— intermediate selection of control families;

— identification of suitable control types.

The main steps in the selection procedure are shown in figure 1. An example of a form for recording the results of the evaluation is shown in figure 2. Clause 5 describes the information that is required in order to select appropriate control actuators, clauses 6 and 7 then describe how this information is used in order to make the selection.

5 Task evaluation and information collection

5.1 Requirements and characteristics

The division of tasks between the operator and the equipment should have been determined early in the design process in accordance with the recommendations in EN 614 -1 and EN 894 -1.

There are general and specific requirements imposed by a task which normally cannot be changed. If it is not possible to find a suitable control actuator for a specified task then the allocation of this task or the task itself has to be reconsidered.

The task requirements considered in this European Standard are ones that experience has shown to be most important in selecting manual control actuators, as follows:

General task requirements

a) Accuracy required in positioning the manual control actuator **(accuracy**);

b) Speed of setting required **(speed);**

c) Force/torque requirements **(force).**

Specific task requirements

d) Need for visual checking of manual control actuator setting **(visual check);**

e) Need for tactile checking of setting **(tactile check);**

f) Need to avoid inadvertent operation **(inadvertent operate);**

g) Need to avoid hand slipping from manual control actuator **(friction);**

h) Need for operator to wear gloves **(use with gloves);**

i) Need for easy cleaning **(ease of cleaning).**

The general task requirements are used to identify classes of suitable control actuators. The specific task requirements are used in selecting individual control actuators within these classes. In order to evaluate the task requirements the classification scheme illustrated in table 1 should be used. This differentiates between 5 different levels from 0 to 4.

Table 1 — Classification scheme for evaluating task requirements

CODE	SYMBOL	Degree of requirements
0		Negligible
1		Low
2		Average
3		High
4		Very high

The task requirements do not need to be evaluated precisely, therefore the detailed evaluation procedure given in 5.2 and 5.3, show classification systems that have been found to be sufficiently accurate.

The characteristics of the various types of control actuator need to be considered to determine the available selection options. This standard gives information on both movement characteristics and grip characteristics. In many cases some of the characteristics will have been predetermined by the task requirements.

Movement characteristics:

j) Type of movement;

k) Axis of movement;

l) Direction of movement;

m) Continuity of movement;

n) Angle of rotation for continuous rotary movements > 180°

Grip characteristics:

o) Type of grip;

p) Part of hand applying force;

q) Method of applying force.

The above categories a - q are used throughout this standard. The shorter descriptions given in brackets after the full descriptions are used in table headings where space is limited.

DESCRIPTION OF INFORMATION	Subclause	Degree of Requirement (Classification)					Remarks
		0	1	2	3	4	
		○	◔	◑	◕	●	
General Task Requirements	5.2						
a) Accuracy	5.2.1						
b) Speed	5.2.2						
c) Force	5.2.3						
Specific task requirements	5.3						
d) Visual check	5.3.1						
e) Tactile check	5.3.2						
f) Inadvertent operate	5.3.3						
g) Friction	5.3.4						
h) Use with gloves	5.3.5						
i) Ease of cleaning	5.3.6						
Movement characteristics	5.4						
j) Type of movement	5.4.1	Linear			Rotary		
k) Axis of movement	5.4.2	x	y	z	x	y	z
l) Direction of movement	5.4.3	+/-	+/-	+/-	+/-	+/-	+/-
m) Continuity of movement	5.4.4	Continuous			Discrete		
n) Angle of rotation for continuous rotary movement > 180°	5.4.5	Yes			No		
Grip characteristics	5.5						
o) Type of grip (see fig 4)	5.5.1	Contact		Pinch		Clench	
p) Part of hand applying force	5.5.2	Finger			Hand		
q) Method of applying force	5.5.3	Normal			Tangential		

Figure 2 — Example of form for recording information used in the selection procedure for manual control actuators

5.2 Determination of general task requirements a) to c)

The following subclauses describe the procedures for completing the recording form in figure 2. The method for assigning each general task requirement to a class in table 1 is described. All acceptable requirements should be entered on the recording form (see figure 2).

5.2.1 Task requirement a:) Classification of accuracy (accuracy)

The accuracy required shall be assigned to one of the classes shown in table 1.

The accuracy required in the operation of a manual control actuator is determined by the task that has to be performed. Accuracy is influenced by a number of factors, the most important of which is continuity of movement required i.e. whether action of a manual control actuator takes place in discrete steps or continuously.

Adequate feedback of information to the operator is necessary to minimise mistakes in positioning.

High accuracy is inconsistent with high force application and this selection procedure takes this into account. Thus, a requirement for high force and high accuracy together will not lead to the successful selection of a suitable manual control actuator.

Where control actuators are used frequently or for long durations accuracy requirements are increased.

Accuracy in positioning relates to the accuracy of positioning a manual control actuator itself. Accuracy in the positioning of the controlled component may be increased by mechanical means e.g. gears. In this case a high accuracy of positioning of the controlled component may be achieved by use of a manual control actuator capable of only low accuracy.

5.2.1.1 Discrete manual control actuator movements

A discrete manual control actuator movement is one where the manual control actuator can only be moved to a number of fixed positions e.g. rotary switch, on/off switch. The error in selecting the correct position increases with the number of discrete positions. Thus two positions shall be rated as "negligible" requirements whilst 24 positions shall be rated as "high" requirements. Manual control actuators with more than 24 discrete positions should be avoided.

Accuracy can be improved by, for example, feedback to the operator of information on the current value of the controlled variable, by clear labelling of manual control actuator positions, by placing the manual control actuator where it can be easily seen and moved.

For manual control actuators a visual indication of the function of each position should be provided either by labels or a display.

Positions should not be indicated by numbers (1, 2 etc) or letters (A, B etc) to indicate a function, since this requires the operator to remember the related functions and leads to mistakes. Labels 1,2 etc. may be used where the value of the variable controlled varies from position to position at least on an ordinal scale. This becomes more important as the number of discrete positions increases. Labels and displays shall be designed in accordance with the requirements in EN 894 -2.

When selecting control actuators whose functions are critical for avoiding injury or damage to health it is especially important that these requirements are followed.

5.2.1.2 Continuous manual control actuator movements

Where movement of a manual control actuator corresponds to a continuous change in a controlled variable, the extent to which the variable deviates from the required value is a measure of error. The probability of making an error depends mainly on the time allowed to complete the task (speed), availability of feedback of information to the operator, and operating force.

For continuous control actuator movements, appropriate feedback of information to the operator shall be provided, for example by indicating the direction and speed of the component controlled. This may be achieved by a display, by movements of other objects relative to the operator e.g. movement of the surroundings when driving a vehicle, movement of a lathe tool, or by other suitable means.

Where tasks have to be completed at speed e.g. continuous tracking of a target, high accuracy can only be achieved by provision of low force demands as well as visual feedback of information. For continuous tracking tasks the requirements for accuracy in positioning the manual control actuator shall be rated as "very high" requirements.

The direction of movement of manual control actuators relative to the controlled component shall be in accordance with ISO 447 (for machine tools), IEC 60447 (for electrical equipment) and EN 894 -2.

5.2.2 Task requirement b): Classification of speed (speed)

The speed of operation required shall be assigned to one of the classes shown in table 1.

The time to complete a manual control actuator movement is composed of two components: time to reach and grasp the manual control actuator and time to make the control movement. The former of these depends on the position of the manual control actuator relative to the operator and the type of grip necessary for its operation. In general, manual control actuators requiring contact grip are quicker to operate than manual control actuators requiring pinch grip which are quicker than manual control actuators requiring clench grip. For emergency situations it is essential for actuation to be as quick as possible. A mushroom shaped actuator operated by hand contact is therefore recommended for emergency stop functions on machinery.

High speed of operation is inconsistent with a high force requirement, and the highest speeds can only be obtained when the force is lowest. Thus for continuous tasks, such as keyboard operation, where high speed is necessary the operating force should be kept low. The specification of high speed and high force requirement together will not lead to the successful selection of a suitable manual control actuator.

5.2.3 Task requirement c): Classification of force/torque (force)

Control actuators may be used to move parts of a machine. In some circumstances large forces may be needed to move these parts. Some machine designs allow mechanical or power assistance to minimise the load on the operator when using the control actuator. Where this is not possible the magnitude of the force or torque required to operate the manual control actuator shall be assigned to one of the classes shown in table 2. The symbols in this table are used later in the evaluation process, therefore it is recommended that the appropriate symbol be recorded.

Where control actuators are used frequently or for long durations force requirements are increased.

Table 2 — Classification of force/torque for the selection of manual control actuators

CODE	SYMBOL	FORCE (N) OR TORQUE (N.m)	DEGREE OF REQUIREMENTS
0	○	<10 N <0,5 N.m	Negligible
1	◔	≥10 to <25 N ≥0,5 to <1,50 N.m	Low
2	◑	≥25 to <50 N ≥1,50 to <3,0 N.m	Average
3	◕	≥50 to <80 N ≥3,0 to <5,0 N.m	High
4	●	≥80 to <120 N ≥5,0 to <50 N.m	Very high