



BSI Standards Publication

Safety of woodworking machines — One side moulding machines with rotating tool

Part 3: Numerically controlled (NC) boring and routing machines

National foreword

This British Standard is the UK implementation of EN 848-3:2012. It supersedes BS EN 848-3:2007+A2:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MTE/23, Woodworking machines.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

**Safety of woodworking machines - One side moulding machines
with rotating tool - Part 3: Numerically controlled (NC) boring and
routing machines**

Sécurité des machines pour le travail du bois - Machines à
fraisier sur une face à outils rotatifs - Partie 3: Perceuses et
défonceuses à commande numérique

Sicherheit von Holzbearbeitungsmaschinen -
Fräsmaschinen für einseitige Bearbeitung mit drehendem
Werkzeug - Teil 3: NC-Bohr- und Fräsmaschinen

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Foreword

This document (EN 848-3:2012) has been prepared by Technical Committee CEN/TC 142 "Woodworking machines - Safety", the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 848-3:2007+A2:2009.

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 the Machinery Directive.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

The main modification to the 2009 edition relates to the introduction of performance levels (PL) and curtains wear test.

Organisations contributing to the preparation of this document include the European Committee of Woodworking Machinery Manufacturers Association "EUMABOIS".

EN 848 consists of the following parts:

- EN 848-1, *Safety of woodworking machines — One side moulding machines with rotating tool — Part 1: Single spindle vertical moulding machines*;
- EN 848-2, *Safety of woodworking machines — One side moulding machines with rotating tool — Part 2: Single spindle hand fed/integrated fed routing machines*;
- EN 848-3, *Safety of woodworking machines — One side moulding machines with rotating tools — Part 3: Numerically controlled (NC) boring and routing machines* (the present document).

The European Standards produced by CEN/TC 142 are particular to woodworking machines and compliment the relevant A and B standards on the subject of general safety (see Introduction of EN ISO 12100:2010 for a description of A, B and C standards).

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

Introduction

This document has been prepared to be a harmonised standard to provide one means of conforming to the essential health and safety requirements of the Machinery Directive and associated EFTA Regulations.

This document is a type C standard as defined in EN ISO 12100:2010.

The machinery concerned and the extent to which hazards, hazardous situations and events covered are indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of other standards, for machines that have been designed and built according to the provisions of this type C standard.

The requirements of this document are directed to manufacturers and their authorised representatives of numerically controlled (NC) boring machines and routing machines. It is also useful for designers.

This also includes examples of information to be provided by the manufacturer to the user.

Common requirements for tooling are given in EN 847-1:2005+A1:2007 and EN 847-2:2001.

1 Scope

This European Standard specifies all significant hazards, hazardous situations and events as listed in Clause 4, which are relevant to NC boring machines, NC routing machines and NC combined boring/routing machines (as defined in 3.1) herein after referred to as "machines" designed to cut solid wood, chip board, fibreboard, plywood and also these materials where these are covered with plastic/light alloy laminate or edgings when they are used as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse.

Machines which are designed to work wood based materials may also be used for working hardened plastic materials with similar physical characteristics as wood.

This document also applies to machines fitted with:

- additional equipment for sawing, sanding, edge banding or assembly units and dowel devices;
- fixed or movable workpiece support;
- mechanical, pneumatic, hydraulic or vacuum workpiece clamping;
- automatic tool change facilities.

This document does not deal with the specific hazards of edge banding equipment fitted to NC boring machines, NC routing machines and NC combined boring/routing machines.

This document is only applicable to NC boring machines, NC routing machines and NC combined boring/routing machines which are designed to use milling tools with a cutting circle diameter below 16 mm or milling tools or saw-blades conforming to EN 847-1:2005+A1:2007 and EN 847-2:2001 and boring tools or sanding wheels.

This document is not applicable to NC boring machines, NC routing machines and NC combined boring/routing machines which are designed to use grinding wheels.

This document is not applicable to single spindle hand fed/integrated fed routing machines.

NOTE Single spindle hand fed/integrated fed routing machines are dealt with in EN 848-2:2007+A1:2009.

This document does not deal with the specific hazards of ejection through openings on machines where the distance between the work-piece support and the lower edge of the partial enclosure exceeds 400 mm.

This document is not applicable to NC boring machines, NC routing machines and NC combined boring/routing machines which are manufactured before the date of its publication as EN.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 847-1:2005+A1:2007, *Tools for woodworking — Safety requirements — Part 1: Milling tools, circular saw blades*

EN 847-2:2001, *Tools for woodworking — Safety requirements — Part 2: Requirements for the shank of shank mounted milling tools*

EN 894-1:1997+A1:2008, *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 894-2:1997+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3:2000+A1:2008, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 3: Control actuators*

EN 1005-1:2001+A1:2008, *Safety of machinery — Human physical performance — Part 1: Terms and definitions*

EN 1005-2:2003+A1:2008, *Safety of machinery — Human physical performance — Part 2: Manual handling of machinery and component parts of machinery*

EN 1005-3:2002+A1:2008, *Safety of machinery — Human physical performance — Part 3: Recommended force limits for machinery operation*

EN 1005-4:2005+A1:2008, *Safety of machinery — Human physical performance — Part 4: Evaluation of working postures and movements in relation to machinery*

EN 1037:1995+A1:2008, *Safety of machinery — Prevention of unexpected start-up*

EN 1088:1995+A2:2008, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

EN 1760-1:1997+A1:2009, *Safety of machinery — Pressure sensitive protective devices — Part 1: General principles for the design and testing of pressure sensitive mats and pressure sensitive floors*

EN 1760-3:2004+A1:2009, *Safety of machinery — Pressure sensitive protective devices — Part 3: General principles for the design and testing of pressure sensitive bumpers, plates, wires and similar devices*

EN 1837:1999+A1:2009, *Safety of machinery — Integral lighting of machines*

EN 12779:2004+A1:2009, *Safety of woodworking machines — Chip and dust extraction systems with fixed installation — Safety related performances and safety requirements*

EN 50370-1:2005, *Electromagnetic compatibility (EMC) — Product family standard for machine tools — Part 1: Emission*

EN 50370-2:2003, *Electromagnetic compatibility (EMC) — Product family standard for machine tools — Part 2: Immunity*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60439-1:1999¹⁾, *Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1:1999)*

EN 60529:1991²⁾, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60825-1:2007, *Safety of laser products — Part 1: Equipment classification and requirements (IEC 60825-1:2007)*

1) EN 60439-1:1999 is impacted by EN 60439-1:1999/A1:2004.

2) EN 60529:1991 is impacted by EN 60529:1991/A1:2000.

EN 61496-1:2004, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests* (IEC 61496-1:2004, modified)

CLC/TS 61496-2:2006, *Safety of machinery — Electro-sensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)* (IEC 61496-2:2006)

EN 61800-5-2:2007, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional* (IEC 61800-5-2:2007)

EN ISO 3743-1:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for small movable sources in reverberant fields — Part 1: Comparison method for a hard-walled test room* (ISO 3743-1:2010)

EN ISO 3743-2:2009, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, moveable sources in reverberant fields — Part 2: Methods for special reverberation test rooms* (ISO 3743-2:1994)

EN ISO 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane* (ISO 3744:2010)

EN ISO 3745:2009³⁾, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and semi-anechoic rooms* (ISO 3745:2003)

EN ISO 3746:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane* (ISO 3746:2010)

EN ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components* (ISO 4413:2010)

EN ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components* (ISO 4414:2010)

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment* (ISO 4871:1996)

EN ISO 9614-1:2009, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points* (ISO 9614-1:1993)

EN ISO 11202:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections* (ISO 11202:2010)

EN ISO 11204:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying accurate environmental corrections* (ISO 11204:2010)

EN ISO 11688-1:2009, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning* (ISO/TR 11688-1:1995)

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction* (ISO 12100:2010)

EN ISO 13849-1:2008, *Safety of machinery — Safety-related parts of controls systems — Part 1: General principles for design* (ISO 13849-1:2006)

³⁾ EN ISO 3745:2009 is superseded by EN ISO 3745:2012.

EN ISO 13850:2008, *Safety of machinery — Emergency stop — Principles for design (ISO 13850:2006)*

EN ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

ISO 7960:1995, *Airborne noise emitted by machine tools — Operating conditions for woodworking machines*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and the following apply.

3.1

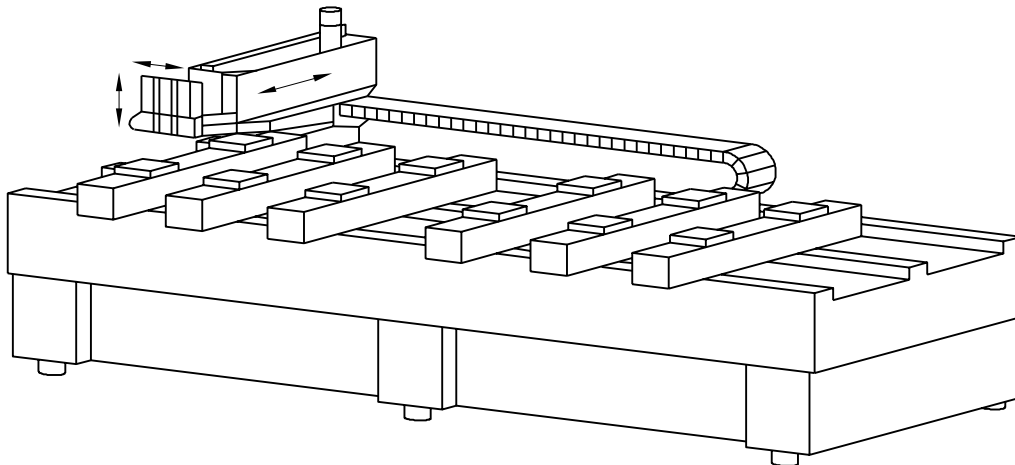
Numerically Controlled (NC) boring and routing machines

integrated fed machines designed for the machining of workpieces by the use of milling and/or boring tools having at least two orthogonal axes programmable by the user (e.g. X, Y) for positioning and/or machining, where the axes operate in accordance with a NC work programme

Note 1 to entry The machine can have:

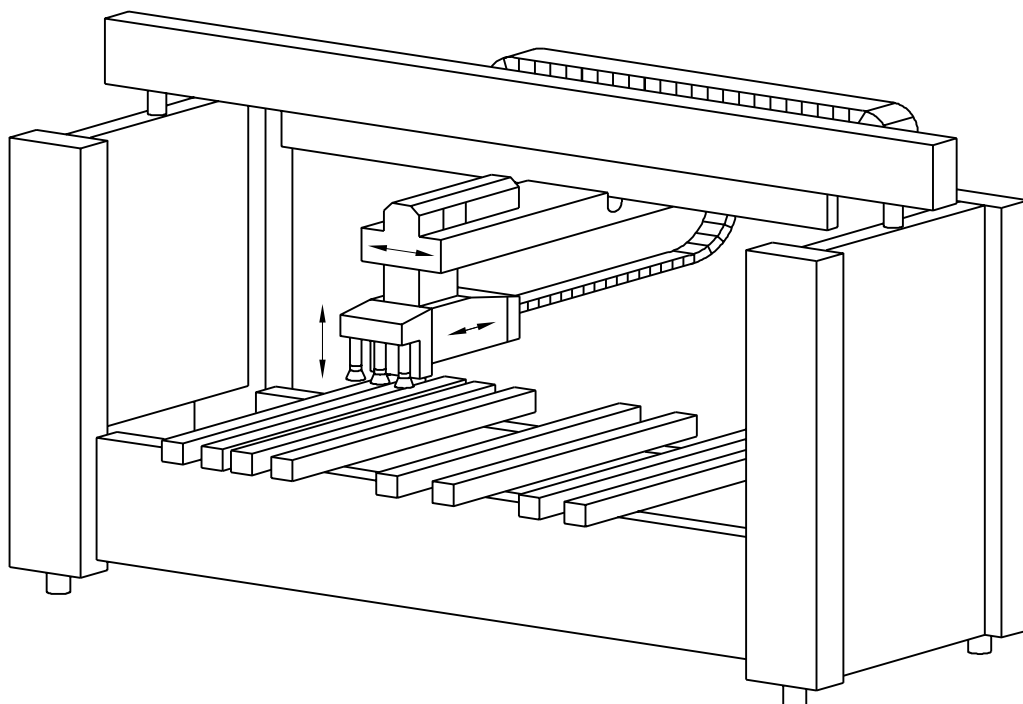
- a) additional equipment for sawing or sanding or assembly units and dowel devices;
- b) additional equipment for edge banding;
- c) fixed or movable workpiece support;
- d) mechanical, pneumatic, hydraulic or vacuum workpiece clamping;
- e) automatic tool change facilities.

Examples of different machine design are illustrated in Figures 1 to 9.



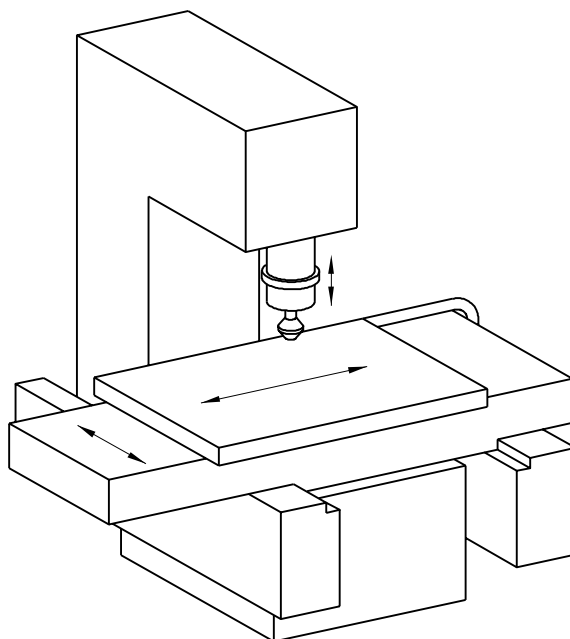
Safeguarding devices are not illustrated.

Figure 1 — Example 1 of a C frame machine (fixed table, moveable head)



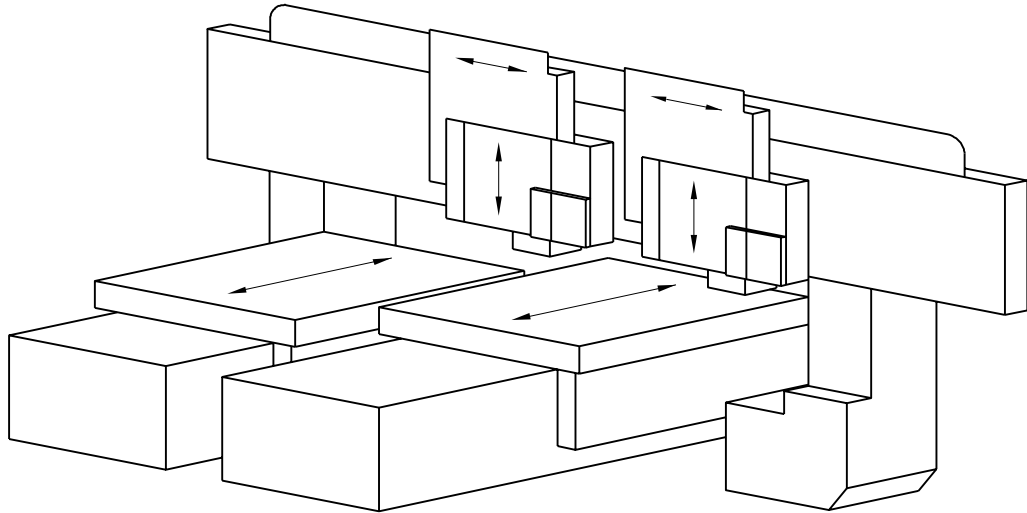
Safeguarding devices are not illustrated.

Figure 2 — Example 2 of a portal frame machine (fixed portal, fixed table moving head)



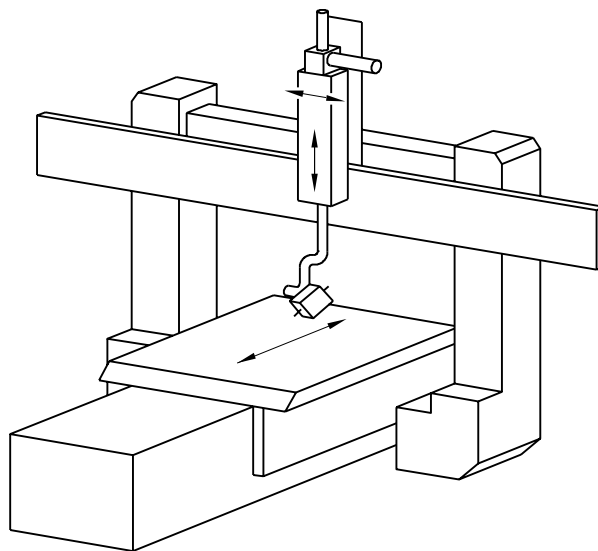
Safeguarding devices are not illustrated.

Figure 3 — Example 3 of an overhead router (moving table)



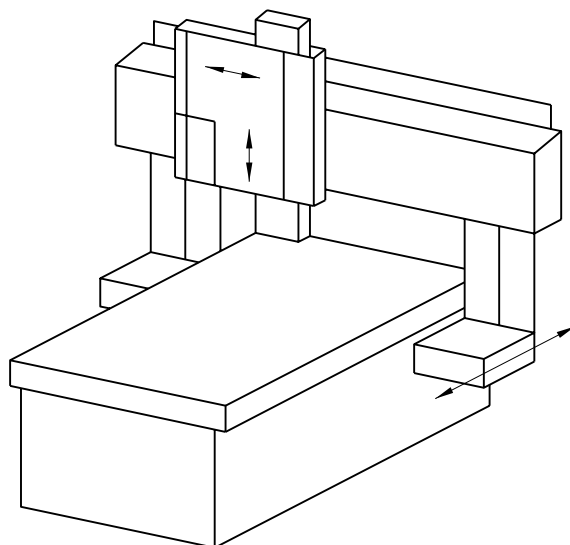
Safeguarding devices are not illustrated.

Figure 4 — Example 4 of an overhead router (moving tables, fixed portal, and moving heads)



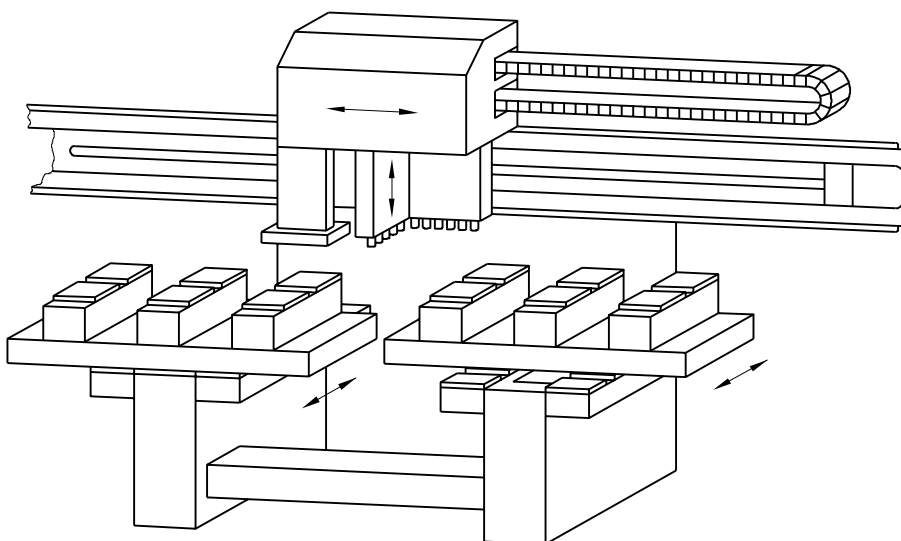
Safeguarding devices are not illustrated.

Figure 5 — Example 5 of a machining centre (moving table, fixed portal, moving head)



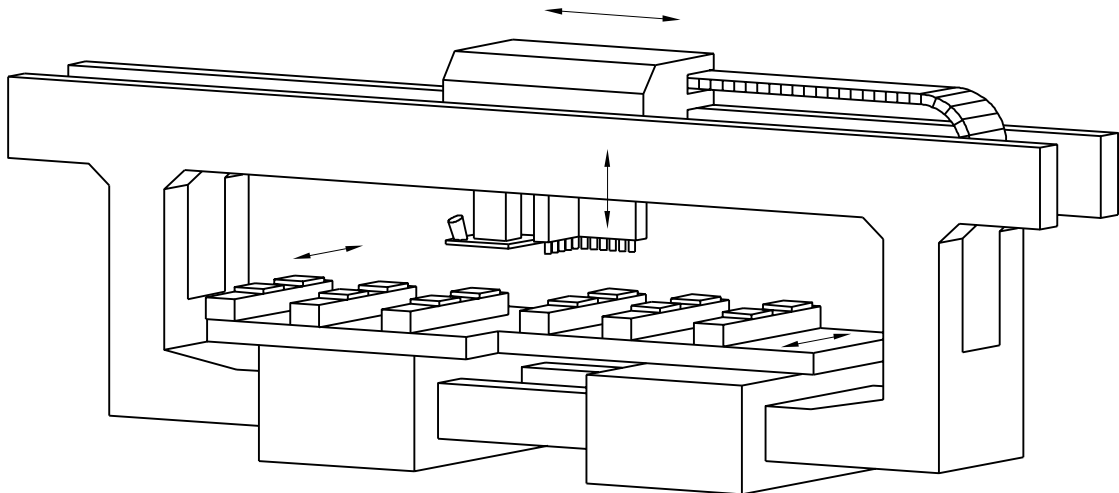
Safeguarding devices are not illustrated.

Figure 6 — Example 6 of an overhead router (fixed table, moving portal, moving head)



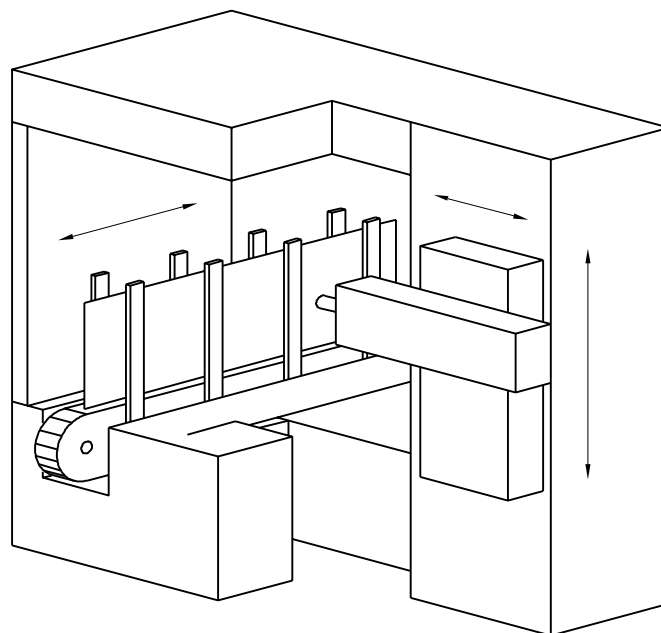
Safeguarding devices are not illustrated.

Figure 7 — Example 7 of a C frame boring machine (moving tables, fixed portal, moving heads)



Safeguarding devices are not illustrated.

Figure 8 — Example 8 of a portal frame boring machine (moving tables, fixed portal, moving heads)



Safeguarding devices are not illustrated.

Figure 9 — Example 9 of a vertical machine (moving support, fixed frame, moving heads)

3.2

boring tools

tools whose feed movement during machining is only in direction of their axis of rotation

3.3

sanding wheel

tool where the active part is made of coated abrasive

- 3.4**
grinding wheel
tool where the active part is made of bounded abrasive
- 3.5**
speed range
range between the lowest and the highest rotational speed for which the tool spindle or tool is designed to operate
- 3.6**
ejection
uncontrolled movement of the workpiece or parts of it or part of the tool from the machine during processing
- 3.7**
machine actuator
power mechanism used to effect motion of the machine
- 3.8**
machining mode of operation
automatic, programmed, sequential operation of the machine with the facility for manual or automatic loading/unloading of workpieces
- 3.9**
machine setting mode of operation
setting, programming, fault finding, program verification, testing and manually controlled (under power) non-sequential operation of the machine
- 3.10**
information of the supplier
statements, sales literature, leaflets or other documents where a manufacturer (supplier) declares either the compliance of the characteristics of e.g. a material or product or the conformity of a material or a product to a relevant standard
- 3.11**
Numerical Control (NC) Computerised Numerical Control (CNC)
automatic control of a process by a device that makes use of numerical data introduced while the process is in progress
- 3.12**
partial enclosure
combination of fixed and moveable guards, safety devices and curtains which encloses the defined machine danger zone which may or may not have apertures or a ceiling
- 3.13**
peripheral enclosure
combination of fixed and moveable guards which encloses the machine danger zone preventing access to it and also forms a means of safeguarding against ejected parts (e.g. wood dust and chips) which may or may not have a ceiling
- 3.14**
integrated feed on NC boring and routing machines
power operated feed mechanism for the work piece, the work piece support and/or the machine element with incorporated tool which is integrated with the machine
- 3.15**
operational stop
control through which the machine can be brought to a monitored and maintained safe stop but where the energy supply to the machine actuators need not be cut off when the machine or the dangerous parts of it are stopped

3.16

bumper

pressure sensitive protective device

Note 1 to entry See EN 1760-3:2004+A1:2009 and 3.26.

Note 2 to entry Pressure sensitive protective device comprise:

- a) sensor(s) which generate(s) a signal when pressure is applied to part of its outer surface, where:
 - 1) the cross section throughout the pressure sensitive area may be regular or irregular;
 - 2) the sensor is intended to detect a person or a part of his body (head, arm leg, etc.) when entering the protected zone;
- b) where necessary a control unit, which responds to the signal from the sensor and generates output signal(s) to the control system of the machine.

Note 3 to entry For some bumpers the sensors generate directly the output signal(s).

3.17

safety related part of a control system

SRP/CS

part or subpart(s) of a control system that responds to input signals and generates safety-related output signals

Note 1 to entry The combined safety-related parts of a control system start at the point where the safety-related signals are initiated (including e.g. the actuating cam and the roller of the position switch) and end at the output of the power control elements (including e.g. the main contacts of the contactor). This also includes monitoring systems (EN ISO 13849-1:2008, 3.1).

3.18

embedded software

SRESW

software that is part of the system supplied by the control manufacturer and which is not accessible for modification by the user of the machinery

Note 1 to entry Firmware or system software are examples of embedded software (EN ISO 13849-1:2008, 3.1.37).

Note 2 to entry Manufacturer means manufacturer of the system.

Note 3 to entry For example the operating system of a speed monitoring device.

3.19

application software

SRASW

software specific to the application, implemented by the machine manufacturer, and generally containing logic sequences, limits and expressions that control the appropriate inputs, outputs, calculations and decisions necessary to meet the SRP/CS requirements

[SOURCE: EN ISO 13849-1:2008, definition 3.1.36]

3.20

redundancy

application of more than one device or system, or part of a device or a system, with the objective of ensuring that, in the event of one failing to perform its function, another is available to perform that function

Note 1 to entry: See EN 60204-1:2006, 3.44, and EN ISO 12100:2010, 6.2.12.4.

3.21 monitoring

safety function which ensures that a safety measure is initiated if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed in such a way that hazards are generated

3.22 un-braked run-down time

time elapsed from the actuation of the stop control device for stopping until spindle standstill when the brake is not effective

3.23 braked run-down time

time elapsed from the actuation of the stop control device for stopping until spindle standstill when the brake is effective

3.24 electro-sensitive protective equipment

ESPE

non-mechanically actuated assembly of devices and/or components working together for protective tripping or presence-sensing purposes

Note 1 to entry: ESPE comprise as a minimum:

- a sensing function;
- a control / monitoring function;
- one or more output signal switching device(s).

Safety related control systems associated with the ESPE or the ESPE itself may include a secondary switching device, muting functions, stopping performance monitor, start interlock, re-start interlock, etc.

Note 2 to entry: Examples are light beam, capacitive, active infra-red, ultra-sonic and image monitoring equipment.

3.25 pressure sensitive protective equipment

PSPE

mechanically actuated assembly of devices and/or components working together for protective tripping or presence-sensing purposes

Note 1 to entry: PSPE comprise as a minimum:

- one or more sensing elements;
- a control unit where necessary;
- one or more output signal switching device(s).

Safety related control system associated with the PSPE or the PSPE itself can further include a secondary switching device, start interlock, re-start interlock, etc.

Note 2 to entry: Examples are pressure sensitive edges, pressure sensitive floors, pressure sensitive mats and pressure sensitive bars.

3.26 performance level

PL

discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions

[SOURCE: EN ISO 13849-1:2008, definition 3.1.23]

4 List of significant hazards

This clause contains all significant hazards, hazardous situations and events (see EN ISO 12100:2010), identified by risk assessment as significant for the machines as defined in the scope and which require action to eliminate or reduce the risk. This document deals with these significant hazards by defining safety requirements and/or measures or by reference to relevant standards:

These hazards are listed in Table 1.

Table 1 — List of significant hazards

No	Hazards, hazardous situations and hazardous events	EN ISO 12100:2010	Relevant clauses of this document
1	Mechanical hazards related to machine parts or workpiece due to:		
	a) shape	6.2.2.1, 6.2.2.2, 6.3	5.3.7, 5.3.8, 5.4.5
	b) relative location		5.2.2, 5.2.3, 5.2.5, 5.3.7
	c) mass and stability (potential energy of elements which may move under the effect of gravity)		5.2.10, 5.3.3, 5.4.5, 5.4.12
	d) mass and velocity (kinetic energy of elements in controlled or uncontrolled motion)		5.2.7, 5.3.7, 5.3.8
	e) mechanical strength		5.3.7.5, Annex B
	- accumulation of energy inside the machinery:		
	f) liquids or gases under pressure, or	6.2.10, 6.3.5.4	5.2.10, 5.4.7, 5.4.8, 5.4.13
	g) vacuum		5.3.8
1.1	Crushing hazard		5.3.4, 5.3.7.2, 6.3
1.2	Shearing hazard		5.3.7.2
1.3	Cutting or severing hazard		5.3.7.1.1, 5.3.7.1.2, 5.3.7.2
1.4	Entanglement hazard		5.3.3, 5.3.7
1.5	Drawing in or trapping hazard		5.3.7
1.6	Impact hazard		5.3.5
1.7	Stabbing or puncture hazard		5.3.7.2
1.8	Friction or abrasion hazard		5.3.7

No	Hazards, hazardous situations and hazardous events	EN ISO 12100:2010	Relevant clauses of this document
1.9	High pressure fluid injection or ejection hazard	6.2.10	5.3.8
2	Electrical hazards		
2.1	Contact of persons with live parts (direct contact)	6.2.9, 6.3.5.4	5.4.4
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	6.2.9	5.4.4
4 Hazards generated by noise, resulting in:			
4.1	Hearing loss (deafness), other physiological disorders (loss of balance, loss or awareness)	6.2.2.2, 6.3	5.4.2
4.2	Interference with speech communication, acoustic signals		5.4.2
6 Hazards generated by radiation			
6.1	Low frequency, radio frequency radiation, micro waves		5.4.10
6.5	Lasers	6.3.4.5	5.4.11
7 Hazards generated by materials and substances (and their constituent elements) processed, or used by the machinery:			
7.1	Hazards from contact with or inhalation of harmful fluids and dusts	6.2.3, 6.2.4	5.4.3
7.2	Fire hazard	6.2.4	5.4.1, 5.4.9
8 Hazards generated by neglecting ergonomic principles in machine design:			
8.1	Unhealthy postures or excessive efforts	6.2.7, 6.2.8, 6.2.11.12, 6.3.5.5, 6.3.5.6	5.2.2
8.2	Hand-arm or foot-leg anatomy	6.2.8	5.4.5
8.4	Local lighting	6.2.8.6	5.4.6, 6.3
8.5	Mental overload and underload, stress	6.2.8.5	5.4.5
8.6	Human error	6.2.8.1, 6.2.11.8, 6.2.11.10, 6.3.5.2, 6.4	5.2.7, 6.3
8.7	Design, location or identification of manual controls	6.2.8.7, 6.2.11.8	5.2.2
8.8	Design or location of visual display units	6.2.8, 6.4.2	5.2.2
9	Hazard combination	6.3.2.1	5.2.7
10 Unexpected start-up, unexpected overrun/overspeed (or any similar malfunction) from			

No	Hazards, hazardous situations and hazardous events	EN ISO 12100:2010	Relevant clauses of this document
10.1	Failure/ disorder of the control system	6.2.11, 6.3.5.4	5.2.8, 5.2.11
10.2	Uncontrolled restoration of energy supply after an interruption	6.2.11.4	5.2.10
10.3	External influences on electrical equipment	6.2.11.11	5.2.1, 5.4.4
10.5	Errors in the software	6.2.11.7	5.2.1
11	Impossibility of stopping the machine in the best possible conditions	6.2.11.1, 6.2.11.3, 6.3.5.2	5.2.4, 5.2.5, 5.4.13
12	Variations in the rotational speed of tools	6.2.2.2, 6.2.3	5.2.8
13	Failure of the power supply	6.2.11.1, 6.2.11.4	5.2.10
14	Failure of the control circuit	6.2.11, 6.3.5.4	5.2.1, 5.2.11
15	Errors of fitting	6.2.7, 6.4.5	6.3
16	Break-up during operation	6.2.3	5.3.2
17	Falling or ejected objects or fluids	6.2.3, 6.2.10	5.3.2, 5.3.3, 5.3.5, 5.3.7
18	Loss of stability/overturning of machinery	6.3.2.6	5.3.1, 5.3.2
19	Slip, trip and fall of persons (related to machinery)	6.3.5.6	5.3.5

5 Safety requirements and/or measures

5.1 General

The machine shall comply with the safety requirements and/or protective measures of Clause 5.

In addition, the machine should be designed according to the principles of EN ISO 12100:2010 for hazards relevant but not significant, which are not dealt with by this document (e.g. sharp edges of the machine frame).

NOTE For guidance in connection with risk reduction by design, see EN ISO 12100:2010, 6.2, and for safeguarding measures see EN ISO 12100:2010, 6.3.

5.2 Controls

5.2.1 Safety and reliability of control systems

5.2.1.1 General

For the purpose of this document, safety related part of a control system means the system which implements safety functions from the initial device, e.g. actuator, position detector or sensor up to and including the power control element of the final machine actuator, e.g. motor or brake. The safety functions are detailed below. The control system for these functions shall be designed so as to fulfil at least the stated PL in accordance with the requirements of EN ISO 13849-1:2008:

- for initiation of any movement: PL=c (see 5.2.3);
- for normal stopping: PL=c (see 5.2.4);
- for emergency stopping: PL=c (see 5.2.5);
- for standstill monitoring: PL=c (see 5.2.6, 5.2.8);
- for axes/spindle speed monitoring: PL=c (see 5.2.8);
- for tool release: PL=c or two independent systems in PL=b (see 5.3.3);
- for interlocking: PL=c (see 5.2.7, 5.2.9);
- for interlocking with guard locking: PL=c (see 5.3.7.4 and 5.3.7.1.2);
- for hold to run control or limited movement control: PL=c or PL=b if combined with an enabling device in PL=c (see 5.2.7.3);
- for workpiece powered clamping: PL=b (see 5.3.8);
- for mode selection: PL=c (see 5.2.7);
- for trip device: PL=c (see 5.3.7.1.2, 5.3.7.2 and 5.3.7.3);
- for braking function: PL=b with additional requirements (see 5.3.4);
- for axis position control: PL=c (see 5.3.7.2);
- for interlocking between the position of the curtains and the movements of any spindle: PL=c (see 5.3.7.1.2.4).

Verification: By checking the relevant drawings and/or circuit diagrams and inspection of the machine, evaluation of the achieved performance level according to EN ISO 13849-1:2008, 4.5.

5.2.1.2 Use protective devices

Protective devices shall be in accordance with the specific standards. For the devices listed below the following requirements apply:

- a) pressure sensitive mats shall be designed to detect persons weighing more than 35 kg, be fitted with a reset device and shall conform to the requirements of EN 1760-1:1997+A1:2009: The system as a whole (including sensor(s), control system and outlet interface, interlocking control system) shall conform at least to PL=c in accordance with the requirements of EN ISO 13849-1:2008;

- b) active opto-electronic protective devices (light barrier) shall as minimum be in accordance with type 2 as defined in CLC/TS 61496-2:2006 and the associated control system shall conform at least to PL=c in accordance with the requirements of EN ISO 13849-1:2008;
- c) proximity switches shall be in accordance with the requirements of EN 1088:1995+A2:2008, 6.2, and the related control system shall conform at least to PL=c in accordance with the requirements of EN ISO 13849-1:2008.

Verification: By checking the relevant drawings and/or circuit diagrams and inspection of the machine.

5.2.2 Position of controls

5.2.2.1 General

The main electrical control devices for the initiation of any movement, operational/normal stopping (if provided, see 5.2.6), emergency stop, mode selection shall be located at the operator's position adjacent to the control display (at the main control panel) at a height between 600 mm and 1 800 mm above the floor level.

Hold-to-run control devices and enabling devices for tool or axes movements shall be located on the main control panel and/or on a mobile set of controls connected to the machine by a fixed cable or wireless (if provided).

Any safeguarding equipment reset control device shall be located outside the protected zone. It shall either not be reachable from within the protected zone or not be effective if actuated from inside the protected zone (see 5.3.7.1.2.3, 5.3.7.2).

The emergency stop device shall be provided at each working station (see 6.3 g)) and in particular:

- a) at the main control panel;
- b) at the mobile control set (if provided);
- c) adjacent to all hold-to-run control;
- d) adjacent to all limited movement control;
- e) at the workpiece loading and unloading station;
- f) close to or inside the tool magazine, where this is separated from the machining area;
- g) inside any peripheral enclosure fitted with access door (see 5.3.7.1.2).

Cycle restart of the machine shall be interlocked with workpiece powered clamping.

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.2.2 Mobile control sets

Additional control devices for starting, operational/ normal stopping (if provided) may be duplicated/provided on mobile control sets with or without fixed cable connection taking account of the requirements of 5.2.5 for emergency stop.

No reset function control devices, no control devices for initiation of dangerous movements shall be permitted on wireless mobile control sets or mobile control sets with fixed cable connection.

When on a wireless control set the connection between the set and the machine is lost an emergency stop according to 5.2.5 shall be automatically activated.

NOTE Dangerous movement means movement affecting the safety of the operator or other persons, not the integrity of the machine.

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.3 Starting

Start or restart (including after operational stop) of machines shall be possible only when all safeguards described in 5.3.7 are in place and functional. Cycle start or restart when using powered workpiece clamping shall be possible only when all safeguards are in place and functional and when the powered workpiece clamping force has been activated.

This is achieved by the interlocking arrangement, including PL required, described in 5.2.7, 5.3.7 and 5.3.8. Cycle start or restart shall only be possible after actuation of a control device for the initiation of any movement provided for that purpose and protected against unintended actuation e.g. by shrouded control devices.

Mobile control sets with or without fixed cable connection may be equipped with cycle start control device(s) (see also 5.2.2.2).

The safety related part of the control system for initiation of any movement shall conform to at least PL =c in accordance with the requirements of EN ISO 13849-1:2008 and the requirements of EN 60204-1:2006, 9.2.5.2 apply.

NOTE No PL is required for starting and/or restarting functions.

The same control device e.g. push button can be used as initiation of any movement control device and safeguard(s) reset control devices if the danger zone is visible from the control position (see relevant clause(s)).

Closure of movable interlocked guards shall not lead to an automatic restart of hazardous movements. For each restart a deliberate action of the operator is required.

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.4 Normal stopping

A normal stop control system shall be provided for the machining and setting modes of operation, which when actuated shall fulfil the stopping sequences and shall disconnect power from all machine actuators except workpiece clamping unless STO in accordance with EN 61800-5-2:2007 is used.

When STO is provided in accordance with EN 61800-5-2:2007 no disconnection by contactor is required.

For normal stopping of PDS(SR) (power drive system, safety related) see EN 61800-5-2:2007, 4.2.2.2 "safe torque off (STO)" and 4.2.2.3 "safe stop 1 (SS1)".

The stop control circuit shall be of a category 1 in accordance with the requirements of EN 60204-1:2006, 9.2.2 to allow the actuation of the electrical brake (if fitted) and maintain clamping.

The stopping sequence for normal stopping shall be:

- a) stop axes movements;
- b) stop spindle rotation;

- c) for machines equipped with powered workpiece clamping: maintain workpiece clamping until the machine has come to a complete and safe stop;
- d) disconnect the machine actuators (except workpiece clamping) from all energy sources.

Powered workpiece clamping devices may be de-energised if no additional hazard will occur.

The safety related part of control system for normal stopping shall be at least PL=c in accordance with the requirements of EN ISO 13849-1:2008.

If a time delay device is used the time delay shall be at least in PL=c in accordance with the requirements of EN ISO 13849-1:2008 and at least equal to the run-down time. Either the time delay shall be fixed or the time delay adjustment device shall be sealed.

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.5 Emergency stop

Machines shall be fitted with an emergency stop control device which complies with the requirements of EN ISO 13850:2008 and additionally with the requirements of EN 60204-1:2006, 10.7. The emergency stop control device shall be at any time of self latching type.

When STO is provided in accordance with EN 61800-5-2:2007 no disconnection by contactor is required.

For emergency stop of PDS(SR) see EN 61800-5-2:2007, 4.2.2.2 "safe torque off (STO)" and 4.2.2.3 "safe stop 1 (SS1)".

Mobile control sets with or without fixed cable connection shall be equipped with an emergency stop control device. (See also 5.2.2.2.)

The emergency stop function shall comply with the requirements of EN 60204-1:2006, 9.2.5.4.2 and the emergency stop control circuit shall be of a category 1 in accordance with the requirements of EN 60204-1:2006, 9.2.2 to allow the actuation of the electrical brake and maintain clamping until the braking sequence is complete (see also 5.3.4).

When initiated the emergency stop sequence shall:

- a) stop the axes movements;
- b) stop spindle rotation;
- c) for machines equipped with powered workpiece clamping: maintain workpiece clamping until the machine has come to a complete and safe stop;
- d) disconnect the machine actuators (except workpiece clamping) from all energy sources.

Powered workpiece clamping devices may be de-energised if no additional hazard will occur.

The safety related part of control system for emergency stop shall be at least PL=c in accordance with the requirements of EN ISO 13849-1:2008.

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.6 Operational stop

If an operational stop function is provided for intervention in the machine while drive systems remain under control the following requirements shall apply:

The stop function provided (e.g. cycle stop) shall be of category 2 in accordance with the requirements of EN 60204-1:2006, 9.2.2, actuated in conjunction with standstill monitoring and the control system for standstill monitoring shall be at least PL=c in accordance with the requirements of EN ISO 13849-1:2008.

For operational stop of PDS(SR) see EN 61800-5-2:2007, 4.2.3.1 "safe operating stop (SOS)" and 4.2.2.4 "safe stop 2 (SS2)".

Any opening of a moveable guard or activation/triggering of the safety related control system of a protective device located in a zone where machining is under progress (see 5.3.7.1.1, 5.3.7.1.2 and 5.3.7.2) shall initiate either a normal stop (see 5.2.5) or an operational stop.

When the operational stopping sequence is initiated it shall:

- a) stop the axes movements;
- b) stop spindle rotation;
- c) for machines equipped with powered work piece clamping: maintain work piece clamping until the machine has come to a complete and safe stop.

Powered work piece clamping devices may be de-energised if no additional hazard will occur.

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.7 Mode selection switch

5.2.7.1 General

Where machines are designed to be operated during setting with the moveable interlocked guards and/or protective devices disabled, a mode selection switch shall be provided to select between the machining and setting modes of operation and the following conditions shall be met:

- a) the mode selection switch shall be lockable in each position and be located outside the hazards zone e.g. on the main control panel (see 5.2.2.1 for location of control devices);
- b) the control system for mode selection shall conform at least to PL=c in accordance with the requirements of EN ISO 13849-1:2008;
- c) the mode selection switch shall not allow more than one mode to be active at any one time;
- d) the safeguarding requirements given in 5.2.7.2 and 5.2.7.3 shall be effective in their respective mode of operation (see Figure 10);
- e) selecting any of the modes shall not initiate a starting command;
- f) when changing from machining mode to setting mode the machine shall be brought to a complete and safe stop.

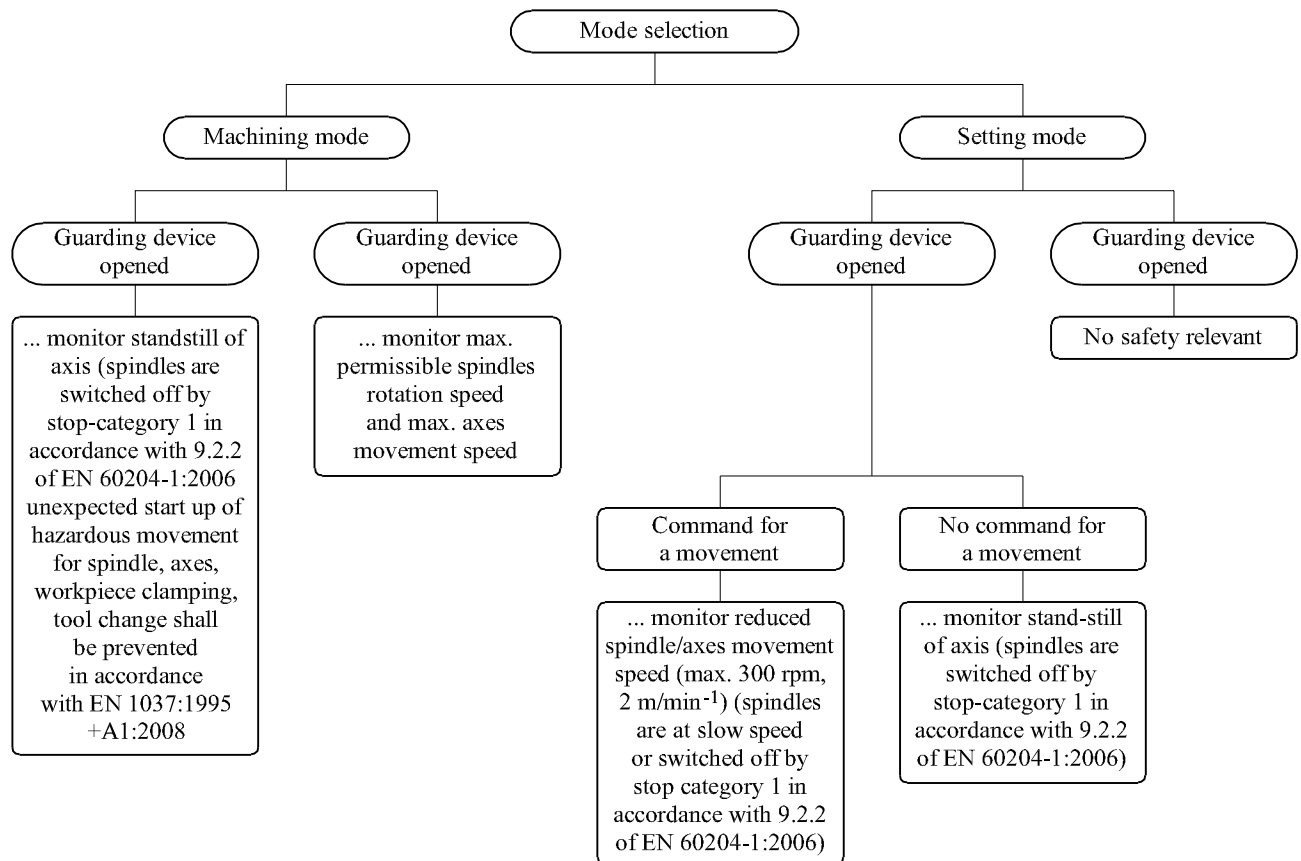


Figure 10 — Mode selection coherence synopsis

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and relevant functional testing of the machine.

5.2.7.2 Machining mode of operation

In machining mode, movement shall only be possible when the interlocked moveable guards (for definition, see EN 1088:1995+A2:2008, 3.2 and 3.3) and/or protective devices are in place and functional.

The safety related maximum speed of axes movement or spindle rotation shall fulfil the requirements of 5.2.8 for speed monitoring and control.

Verification: By checking the relevant drawings and/or circuit diagrams and inspection of the machine and functional testing of the machine.

5.2.7.3 Machine setting mode of operation

In machine setting mode of operation if the moveable guards are open and/or protective devices disabled, any hazardous movement shall only be possible when all the following requirements are met:

- spindle rotation, if provided, shall be controlled by a hold-to-run control/enabling device;
- any single axis movement shall be controlled by a hold to run control. The movement shall be limited to 2 m min⁻¹ speed or 10 mm increment. Both the hold to run control and speed limited movement control system shall be at least PL=c in accordance with the requirements of EN ISO 13849-1:2008. If the hold to run control device is combined with an enabling device in PL = c in accordance with the requirements of EN ISO 13849-1:2008 no additional requirements for the hold to run control device shall be met; and