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French standard

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Safety of woodworking machines

One side moulding machines with rotating tools

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

F : Sécurité des machines pour le travail du bois — Machines à fraiser sur une face, à outil rotatif — Partie 3 : Perceuses et défonceuses à commande numérique
D : Sicherheit von Holzbearbeitungsmaschinen — Fräsmaschinen für einseitige Bearbeitung mit drehendem Werkzeug — Teil 3: NC-Bohr- und Fräsmaschinen

French standard approved

by decision of the Director General of AFNOR on May 20, 2007 taking effect on June 20, 2007.

Replaces the approved standard NF EN 848-3, dated December 1999.

Correspondence. The European standard EN 848-3:2007 has the status of French standard.

Analysis

This document was prepared in order to help conforming to the requirements of the Machinery Directive 98/37/EC, amended by Directive 98/79/EC. It determines the safety requirements of numerically controlled (NC) boring and routing machines.

Descriptors

Technical International Thesaurus: woodworking machinery, milling machines, drilling machines (tools), numerical control, safety of machines, accident prevention, definitions, protection against mechanical hazards, safety devices, information, use, marking, acoustic measurements, engine noise.

Modifications

With respect to the replaced document:

- addition of definitions and specifications concerning the control systems based on programmable electronic systems (PES);
- deletion of the not applicable significant hazards in Table 1 of the Clause 4;
- addition of an impact test method in Annex .

Corrections



National foreword

References to French standards

The correspondence between the standards figuring in the clause "Normative references" and the identical French standards is as follows:

EN 294	: NF EN 294 (classification index: E 09-010)
EN 847-1	: NF EN 847-1 (classification index: E 73-521-1)
EN 847-2	: NF EN 847-2 (classification index: E 73-521-2)
EN 894-1	: NF EN 894-1 (classification index: X 35-101-1)
EN 894-2	: NF EN 894-2 (classification index: X 35-101-2)
EN 894-3	: NF EN 894-3 (classification index: X 35-101-3)
EN 982	: NF EN 982 (classification index: E 48-202)
EN 983	: NF EN 983 (classification index: E 49-202)
EN 1005-1	: NF EN 1005-1 (classification index : X 35-106-1)
EN 1005-2	: NF EN 1005-2 (classification index: X 35-106-2)
EN 1005-3	: NF EN 1005-3 (classification index: X 35-106-3)
EN 1005-4	: NF EN 1005-4 (classification index: X 35-106-4)
EN 1037	: NF EN 1037 (classification index: E 09-053-2)
EN 1088	: NF EN 1088 (classification index: E 09-051)
EN 1760-1	: NF EN 1760-1 (classification index: E 09-040)
EN 1760-3	: NF EN 1760-3 (classification index: E 09-042)
EN 1837	: NF EN 1837 (classification index: X 90-001)
EN 50178	: NF EN 50178 (classification index: C 53-200)
EN 50370-1	: NF EN 50370-1 (classification index: C 91-370-1)
EN 50370-2	: NF EN 50370-2 (classification index: C 91-370-2)
EN 60204-1	: NF EN 60204-1 (classification index: C 79-130)
EN 60439-1	: NF EN 60439-1 (classification index: C 63-421)
EN 60529	: NF EN 60529 (classification index: C 20-010)
EN 60825-1	: NF EN 60825-1 (classification index: C 43-805)
EN 61496-1	: NF EN 61496-1 (classification index: C 79-151)
CLC/TS 61496-2	: UTE C 79-152
EN 61508-3	: NF EN 61508-3 (classification index: C 46-063)
EN ISO 3743-1	: NF EN ISO 3743-1 (classification index: S 31-024-1)
EN ISO 3743-2	: NF EN ISO 3743-2 (classification index: S 31-024-2)
EN ISO 3744	: NF EN ISO 3744 (classification index: S 31-025)
EN ISO 3745	: NF EN ISO 3745 (classification index: S 31-026)
EN ISO 3746	: NF EN ISO 3746 (classification index: S 31-027)
EN ISO 4871	: NF EN ISO 4871 (classification index: S 31-075)
EN ISO 9614-1	: NF EN ISO 9614-1 (classification index: S 31-100-1)
EN ISO 11202	: NF EN ISO 11202 (classification index: S 31-502)
EN ISO 11204	: NF EN ISO 11204 (classification index: S 31-504)

<i>EN ISO 11688-1</i>	<i>: NF EN ISO 11688-1 (classification index: S 31-510-1)</i>
<i>EN ISO 12100-1</i>	<i>: NF EN ISO 12100-1 (classification index: E 09-001-1)</i>
<i>EN ISO 12100-2</i>	<i>: NF EN ISO 12100-2 (classification index: E 09-001-2)</i>
<i>EN ISO 13849-1</i>	<i>: NF EN ISO 13849-1 (classification index: E 09-025-1)</i>
<i>EN ISO 13849-2</i>	<i>: NF EN ISO 13849-2 (classification index: E 09-025-2)</i>
<i>EN ISO 13850</i>	<i>: NF EN ISO 13850 (classification index: E 09-053)</i>





English Version

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

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

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

This European Standard was approved by CEN on 17 February 2007.

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

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Contents

Page

Foreword.....	4
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	9
3.1 General.....	9
3.2 Definitions	9
4 List of significant hazards	17
5 Safety requirements and/or measures	20
5.1 General.....	20
5.2 Controls	21
5.2.1 Safety and reliability of control systems.....	21
5.2.2 Position of controls	22
5.2.3 Starting	23
5.2.4 Normal stopping	23
5.2.5 Emergency stop	24
5.2.6 Operational stop	25
5.2.7 Mode selection switch.....	25
5.2.8 Speed monitoring and control.....	27
5.2.9 Interlocking of guards, protective devices, movements and functions.....	29
5.2.10 Failure of the power supply	29
5.2.11 Failure of the control circuits	30
5.3 Protection against mechanical hazards	30
5.3.1 Stability	30
5.3.2 Risk of break-up during operation	30
5.3.3 Tool holder	30
5.3.4 Braking tool spindle	31
5.3.5 Devices to minimise the risk of ejection	32
5.3.6 Workpiece supports and guides	32
5.3.7 Prevention of access to moving parts and devices to minimise the effect of ejection.....	32
5.3.8 Clamping device	43
5.4 Protection against non mechanical hazards	44
5.4.1 Fire	44
5.4.2 Noise	44
5.4.3 Emission of chips and dust	46
5.4.4 Electricity.....	46
5.4.5 Ergonomics and handling.....	46
5.4.6 Lighting.....	47
5.4.7 Pneumatics.....	47
5.4.8 Hydraulics.....	47
5.4.9 Static electricity	47
5.4.10 Electromagnetic compatibility.....	47
5.4.11 Lasers	47
5.4.12 Unintended movements	48
5.4.13 Supply disconnecting devices	48
5.4.14 Maintenance	48
6 Information for use	48
6.1 Warning devices	48

6.2	Marking.....	49
6.3	Instruction handbook.....	49
Annex A (informative) Use of well tried components.....		54
Annex B (normative) Operating conditions for noise measurement.....		55
B.1	General	55
B.2	Operating conditions for routing units of NC routing machines and NC combined boring/routing machines	55
B.2.1	General	55
B.2.2	Noise measurements	56
B.2.3	General data sheet	58
B.3	Operating conditions for boring units of NC boring machines and NC combined boring/routing machines	60
B.3.1	General	60
B.3.2	Noise measurements	61
B.3.3	General data sheet	63
Annex C (normative) Curtains on NC routing and NC combined boring and routing machines – Impact test method.....		66
C.1	General	66
C.2	Test method	66
C.2.1	Preliminary remarks	66
C.2.2	Testing equipment.....	66
C.2.3	Test procedure.....	68
C.3	Results.....	69
C.4	Assessment	69
C.5	Test report.....	69
Annex D (informative) Test equipment for impact test		70
Annex E (normative) Braking tests		71
E.1	Conditions for brake tests	71
E.2	Tests	71
E.2.1	Un-braked run-down time.....	71
E.2.2	Braked run-down time.....	71
Annex F (normative) Use of electronic components		73
F.1	General	73
F.2	SRECS	73
F.2.1	Components, hardware.....	73
F.2.2	Safety related software	74
F.2.3	Validation.....	74
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC.....		76
Bibliography.....		79



Foreword

This document (EN 848-3:2007) 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 September 2007, and conflicting national standards shall be withdrawn at the latest by September 2007.

This document supersedes EN 848-3:1999.

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.

Organisations contributing to the preparation of this European Standard include the European Manufacturers Association "EUMABOIS".

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 12100-1:2003 for a description of A, B and C standards).

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.



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 12100-1:2003.

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 and EN 847-2:2001.



1 Scope

This document deals with the 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 3.2.1) 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 laminate or edgings when they are used as intended and under the conditions foreseen by the manufacturer.

This document also applies to machines fitted with:

- a) additional equipment for sawing, sanding and edge banding;
- b) fixed or movable workpiece support;
- c) mechanical, pneumatic, hydraulic or vacuum workpiece clamping;
- d) 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 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.

This document does not deal with the specific hazards of ejection through curtains on machines with feeding openings of which the distance between the workpiece support and the lower part of the partial enclosure in the direction of the feed 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 294:1992, *Safety of machinery — Safety distance to prevent danger zones being reached by the upper limbs*

EN 847-1:2005, *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, *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, *Safety of machinery — Ergonomics requirements for the design of displays and control actuators — Part 2: Displays*

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

EN 982:1996, *Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*

EN 983:1996, *Safety of machinery — Safety requirements for fluid power systems and their components — Pneumatics*

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

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

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

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

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

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

EN 1760-1:1997, *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, *Safety of machinery — Pressure sensitive protective devices — Part 3 : General principles for the design and testing of pressure sensing bumpers, plates, wires and similar devices*

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

EN 50178:1997, *Electronic equipment for use in power installations*

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

EN 60529:1991, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60825-1:1994, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide (IEC 60825-1:1993)*

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 61508-3:2001, *Functional safety of electrical/electronic/programmable electronic safety related systems — Part 3: Software requirements* (IEC 61508-3:1998 + Corrigendum 1999)

EN ISO 3743-1:1995, *Acoustics — Determination of sound power levels of noise sources — Engineering methods for small, moveable sources in reverberant fields — Part 1: Comparison method for hard-walled test rooms* (ISO 3743-1:1994)

EN ISO 3743-2:1996, *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 3744:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane* (ISO 3744:1994)

EN ISO 3745:2003, *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 3746:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane* (ISO 3746:1995)

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

EN ISO 9614-1:1995, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points* (ISO 9614-1:1993)

EN ISO 11202:1995/AC:1997, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a workstation and at other specified positions — Survey method in situ* (ISO 11202:1995)

EN ISO 11204:1995/AC:1997, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a workstation and at other specified positions — Method requiring environmental corrections* (ISO 11204:1995)

EN ISO 11688-1:1998/AC:1998, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning* (ISO/TR 11688-1:1995)

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology* (ISO 12100-1:2003)

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles* (ISO 12100-2:2003)

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

EN ISO 13849-2:2003, *Safety of machinery — Safety-related parts of controls systems — Part 2: Validation* (ISO 13849-2:2003)

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



3 Terms and definitions

3.1 General

For the purposes of this document, the terms and definitions given in EN ISO 12100-1:2003 and the following apply.

3.2 Definitions

3.2.1

Numerically Controlled (NC) boring and routing machines

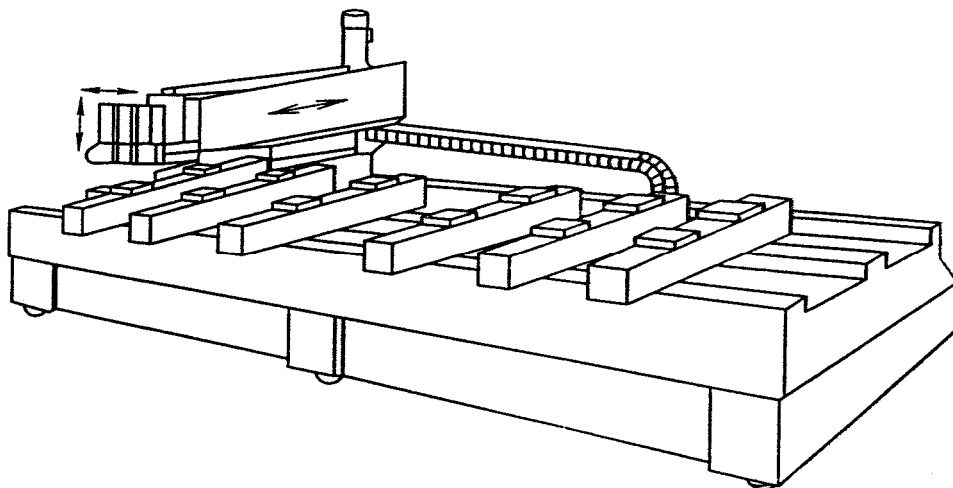
integrated fed machines designed for the machining of workpieces by the use of milling and/or boring tools. These machines have at least two square axes programmable by the user (e.g. X, Y) for positioning and/or machining. The axes operate in accordance with a NC work programme

NOTE The machine can have:

- a) additional equipment for sawing or sanding;
- 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.

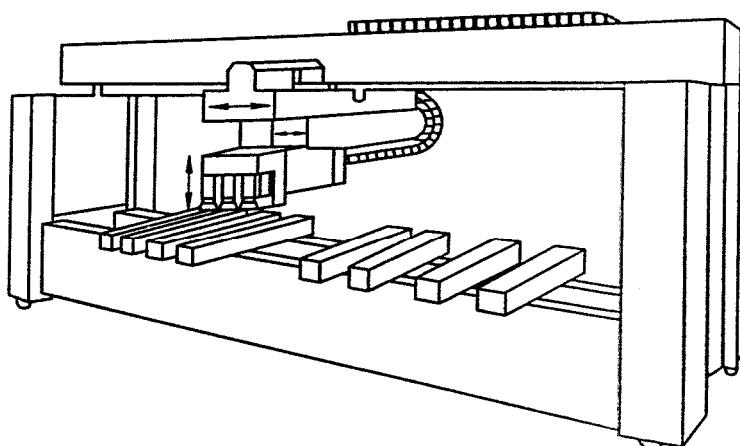
Examples of different machine design are illustrated in Figures 1 to 9.





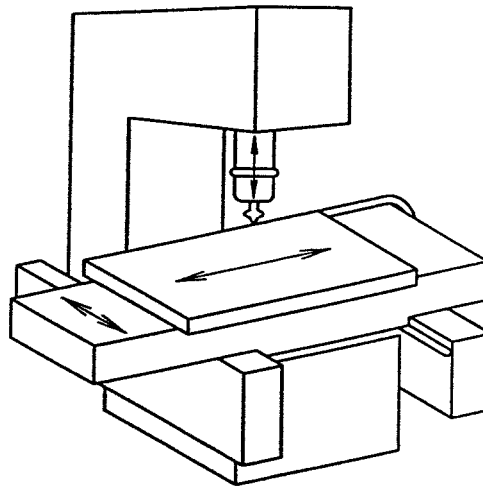
Safeguarding devices are not illustrated

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



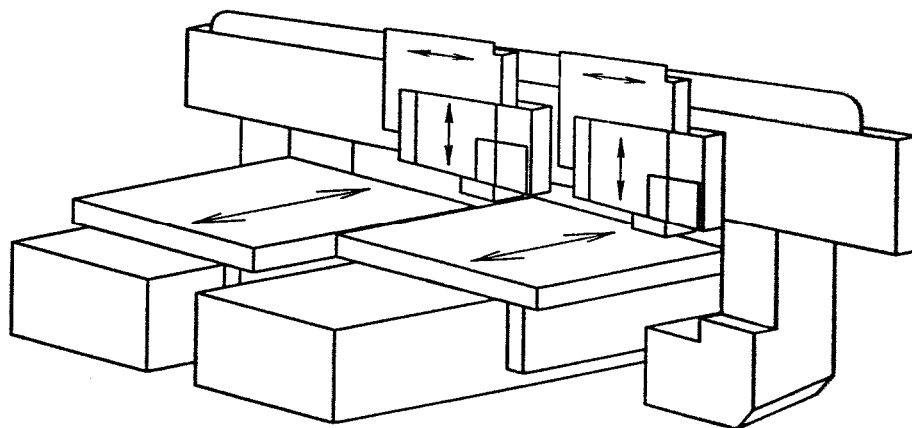
Safeguarding devices are not illustrated

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



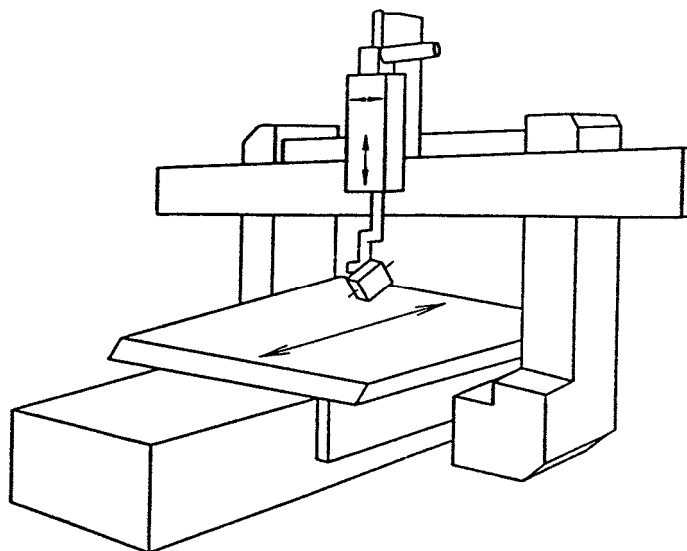
Safeguarding devices are not illustrated

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



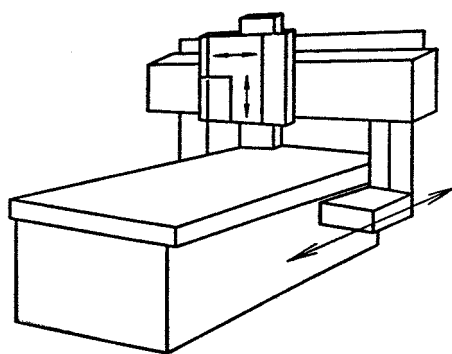
Safeguarding devices are not illustrated

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



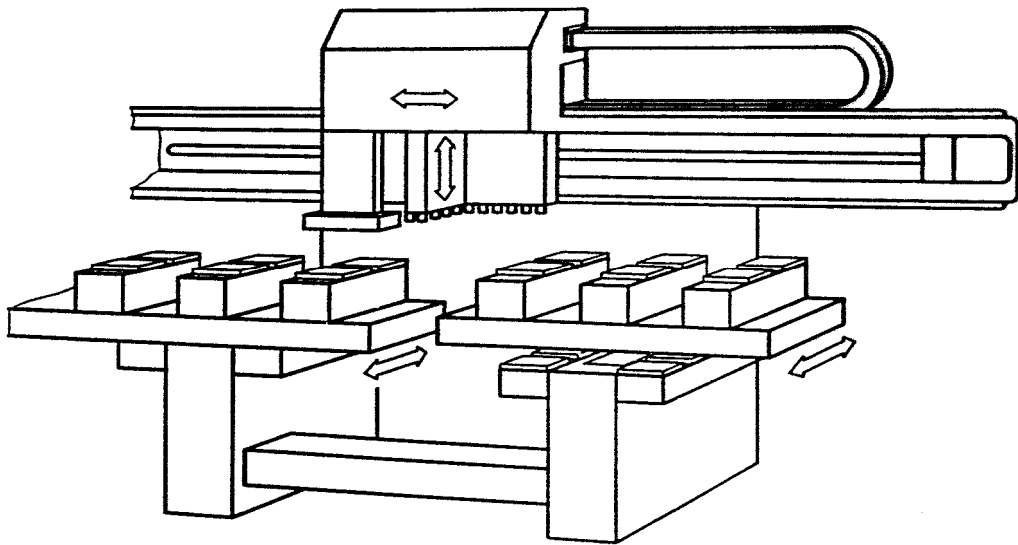
Safeguarding devices are not illustrated

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



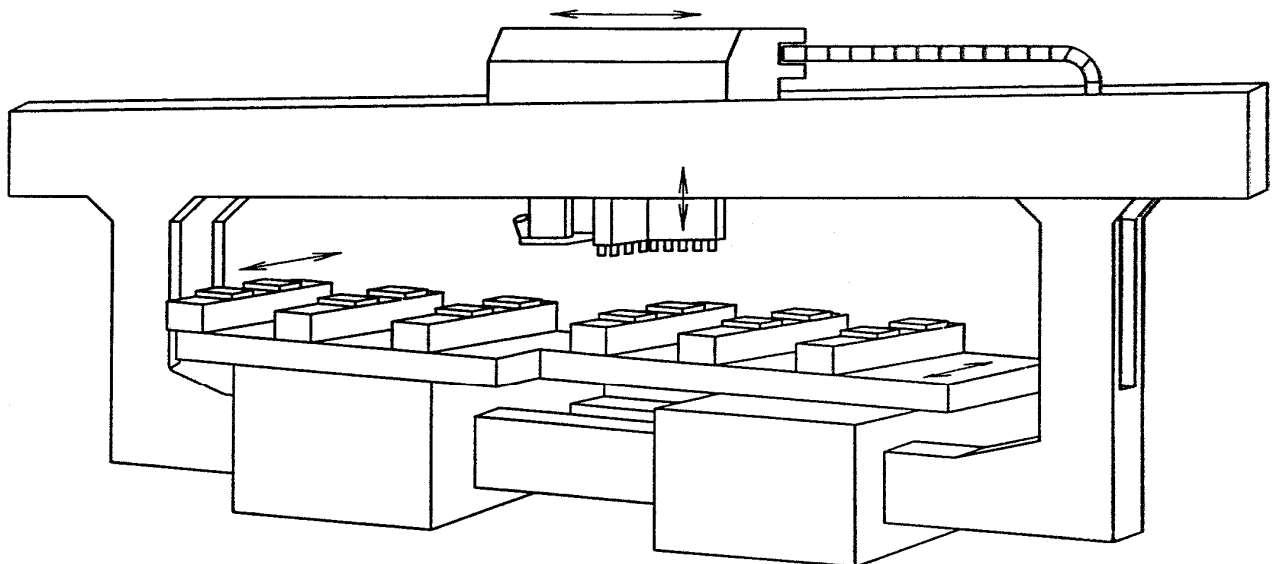
Safeguarding devices are not illustrated

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



Safeguarding devices are not illustrated

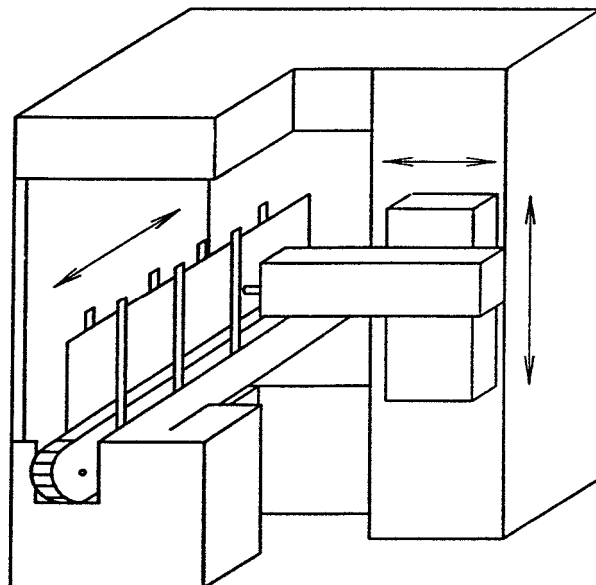
Figure 7 — Example 7 of a C frame boring machine (moving tables, fixed portal, moving heads)



Safeguarding devices are not illustrated

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

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Safeguarding devices are not illustrated

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

3.2.2

boring tools

tools intended/designed for feed only along/parallel their axis of rotation

3.2.3

sanding wheel

tool where the active part is made of coated abrasive

3.2.4

grinding wheel

tool where the active part is made of bounded abrasive

3.2.5

speed range

range between the lowest and the highest rotational speed for which the tool spindle or tool is designed to operate

3.2.6

ejection

uncontrolled movement of the workpiece or parts of it or part of the tool from the machine during processing

3.2.7

machine actuator

power mechanism used to effect motion of the machine

3.2.8**machining mode of operation**

automatic, programmed, sequential operation of the machine with the facility for manual or automatic loading/unloading of workpieces

3.2.9**machine setting mode of operation**

setting, programming, fault finding, program verification, testing and manually controlled (under power) non-sequential operation of the machine

3.2.10**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

3.2.11**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

3.2.12**complete enclosure**

combination of fixed and moveable guards which when closed completely encloses the machine preventing access to it as well may form a means to safeguard against ejected parts (e.g. wood dust and chips)

3.2.13**partial enclosure**

combination of fixed and moveable guards, safety devices and curtains which encloses the defined machine danger zone. It may or may not have apertures or a ceiling

3.2.14**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). It may or may not have a ceiling

3.2.15**integrated feed on NC boring and routing machines**

feed mechanism for the workpiece support or tool which is integrated with the machine and where the workpiece support or machine element with incorporated tool are held and controlled mechanically during the machining operation

3.2.16**operational stop**

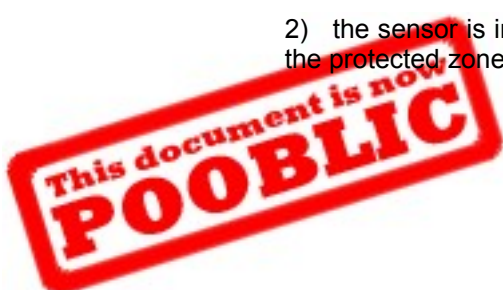
control through which the machine can be brought to a safe stop but where the energy supply to the machine actuators need not be cut off when the machine or the dangerous parts of it, are stopped

3.2.17**bumper**

pressure sensitive protective device (see EN 1760-3:2004 and 3.2.27) comprising:

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 For some bumpers the sensors generate directly the output signal(s).

3.2.18

safety related PLC

programmable logic controller dedicated to safety related application designed in the required category according to EN ISO 13849-1:2006

3.2.19

safety related electrical control system (SRECS)

electrical part of a control system whose failure can result in a immediate increase of the risk(s) (3.2.4 of EN 62061:2005)

3.2.20

embedded software

software that is part of the system supplied by the manufacturer that is not normally accessible for modification

NOTE 1 Firmware or system software are examples of embedded software (see 3.2.47 of EN 62061:2005).

NOTE 2 Manufacturer means manufacturer of the system.

NOTE 3 For example the operating system of a speed monitoring device.

3.2.21

application software

software specific to the application that is specifically implemented by the designer of the SRECS generally containing logic sequences, limits and expressions that control the appropriate inputs, outputs, calculations and decisions necessary to meet SRECS functional requirements (see 3.2.46 of EN 62061:2005)

NOTE For example the PLC program to run a machine.

3.2.22

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 (see 3.44 of EN 60204-1:2006 and 4.12.3 of EN ISO 12100-2:2003)

3.2.23

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

3.2.24

un-braked run-down time

time elapsed from the actuation of the stop control, but not the braking device (if fitted) up to spindle standstill

3.2.25

braked run-down time

time elapsed from the actuation of the stop control and the brake device up to spindle standstill

3.2.26

electro-sensitive protective equipment (ESPE)

non-mechanically actuated assembly of devices and/or components working together for protective tripping or presence-sensing purposes comprising 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 Examples are light beam, capacitive, active infra-red, ultra-sonic and image monitoring equipment.

3.2.27

pressure sensitive protective equipment (PSPE)

mechanically actuated assembly of devices and/or components working together for protective tripping or presence-sensing purposes comprising as a minimum:

- one or more sensing elements;
- a control unit;
- 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 Examples are pressure sensitive edges, pressure sensitive floors, pressure sensitive mats and pressure sensitive bars.

4 List of significant hazards

This clause contains the significant hazards, hazardous situations and events (see EN 1050:1996), as far as they are dealt with in this document, 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 in accordance with Annex A of EN 1050:1996.



Table 1 — List of significant hazards

No	Hazards, hazardous situations and hazardous events	EN ISO 12100		Relevant clauses of this document
		Part 1:2003	Part 2:2003	
1	Mechanical hazards related to machine parts or workpiece due to:			
	a) shape	4.2	4.2.1, 4.2.2, 5	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 C
	- accumulation of energy inside the machinery:			
	f) liquids or gases under pressure, or	4.2	4.10, 5.5.4	5.2.10, 5.4.7, 5.4.8, 5.4.13
	g) vacuum			5.3.8
1.1	Crushing hazard	4.2.1		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
1.9	High pressure fluid injection or ejection hazard			5.3.8
2	Electrical hazards			
2.1	Contact of persons with live parts (direct contact)	4.3	4.9, 5.5.4	5.4.4
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	4.3	4.9	5.4.4
(to be continued)				

Table 1 — List of significant hazards (*continued*)

No	Hazards, hazardous situations and hazardous events	EN ISO 12100		Relevant clauses of this document
		Part 1:2003	Part 2:2003	
4 Hazards generated by noise, resulting in:				
4.1	Hearing loss (deafness), other physiological disorders (loss of balance, loss or awareness)	4.5	4.2.2, 5	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	4.7		5.4.10
6.5	Lasers	4.7		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	4.8	4.3b, 4.4	5.4.3
7.2	Fire hazard	4.8	4.4	5.4.1, 5.4.9
8 Hazards generated by neglecting ergonomic principles in machine design:				
8.1	Unhealthy postures or excessive efforts	4.9	4.7, 4.8.2, 4.11.2, 5.5.5, 5.5.6	5.2.2
8.2	Hand-arm or foot-leg anatomy	4.9	4.8.3	5.4.5
8.4	Local lighting		4.8.6	5.4.6, 6.3
8.5	Mental overload and underload, stress	4.9	4.8.5	5.4.5
8.6	Human error	4.9	4.8.1, 4.11.8, 4.11.10, 5.5.2, 6	5.2.7, 6.3
8.7	Design, location or identification of manual controls		4.8.7, 4.11.8	5.2.2
8.8	Design or location of visual display units		4.8.2, 6.2	5.2.2
9	Hazard combination	4.11		5.2.7
(to be continued)				



Table 1 — List of significant hazards (*concluded*)

No	Hazards, hazardous situations and hazardous events	EN ISO 12100		Relevant clauses of this document
		Part 1:2003	Part 2: 2003	
10 Unexpected start-up, unexpected overrun/overspeed (or any similar malfunction) from				
10.1	Failure/ disorder of the control system		4.11, 5.5.4	5.2.8, 5.2.11
10.2	Uncontrolled restoration of energy supply after an interruption		4.11.4	5.2.10
10.3	External influences on electrical equipment		4.11.11	5.4.4, Annex F
10.5	errors in the software	4.9	4.11.7	Annex F
11	Impossibility of stopping the machine in the best possible conditions		4.11.1, 4.11.3, 5.5.2	5.2.4, 5.2.5, 5.4.13
12	Variations in the rotational speed of tools		4.2.2, 4.3	5.2.8
13	Failure of the power supply		4.11, 4.11.4	5.2.10
14	Failure of the control circuit		4.11, 5.5.4	5.2.11, Annex F
15	Errors of fitting	4.9	4.7, 6.5	6.3
16	Break-up during operation	4.2.2	4.3	5.3.2
17	Falling or ejected objects or fluids	4.2.2	4.3	5.3.2, 5.3.3, 5.3.5, 5.3.7
18	Loss of stability/overturning of machinery	4.2.2	5.2.6	5.3.1, 5.3.2
19	Slip, trip and fall of persons (related to machinery)	4.10	5.5.6	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.

NOTE 1 In addition, the machine should be designed according to the principles of EN ISO 12100:2003 for hazards relevant but not significant, which are not dealt with by this document (e.g. sharp edges of the machine frame).

NOTE 2 For guidance in connection with risk reduction by design, see Clause 4 of EN ISO 12100-2:2003, and for safeguarding measures see Clause 5 of EN ISO 12100-2:2003.

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. Safety related parts of the control system of this machine comprise parts concerning the following functions and they shall fulfil the requirements of the categories given below in accordance with the requirements of EN ISO 13849-1:2006:

- for starting: category 1 or 3 (see 5.2.3);
- for normal stopping: category 1 or 3 (see 5.2.4);
- for emergency stopping: category 1 or 3 (see 5.2.5);
- for standstill monitoring: category 1 or 3 (see 5.2.6, 5.2.8);
- for axes/spindle speed change/monitoring: category 3 or two independent systems category 2 (see 5.2.8);
- for tool release: category 1 or two independent systems category B (see 5.3.3);
- for interlocking: category 1 or 3 (see 5.2.6, 5.2.7, 5.3.3, 5.3.7.1.2, 5.3.7.4 and 5.3.8);
- for interlocking with guard locking: category 1 or 3 (see 5.3.7.4 and 5.3.7.1.2);
- for hold to run control or limited movement control: category 3 or category B if combined with an enabling device in accordance with 9.2.5.2 of EN 60204-1:2006 conforming to category 1 or 3 (see 5.2.7.3);
- for workpiece powered clamping: category B (see 5.3.8);
- for mode selection: category 1 or 3 (see 5.2.7);
- for trip device: category 1, 2 or 3 (see 5.3.7.1.2, 5.3.7.2 and 5.3.7.3);
- for braking: category 2 (see 5.3.4);
- for axis position control: category 1 or 3 (see 5.3.7.2);
- for interlocking between the position of the curtains and the movements of any spindle: category 1 or 3 (see 5.3.7.1.2.4).

Where more than one category is given further information about the necessary type is specified in the quoted clauses.

Any combination of safety related parts of control systems of different categories which achieve at least the same level of fault resistance is acceptable in accordance with the requirements of 6.3 of EN ISO 13849-1:2006.

Where category B is required all categories fulfil the requirements, where category 1 is required categories 3 and 4 also fulfil the requirement. Where category 2 is required, categories 3 and 4 also fulfil the requirement, where category 3 is required category 4 also fulfils the requirement.



NOTE 6.3 of EN ISO 13849-1:2006 give useful information on combination of safety-related parts with the same or different categories.

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

5.2.1.2 Use of well tried components and protective devices

5.2.1.2.1 Well tried components

Examples of well tried components are given in Annex A.

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

5.2.1.2.2 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 and either:
 - 1) be fitted with presence sensor conforming to category 1 in accordance with the requirements of EN ISO 13849-1:2006 and the associated safety related control system of category 3 in accordance with the requirements of EN ISO 13849-1:2006, or
 - 2) the system as a whole (including sensor(s), control system and outlet interface, interlocking control circuit) shall conform to category 2 in accordance with the requirements of EN ISO 13849-1:2006 and shall be tested at least at each cycle start;
- 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 shall be tested together with the associated control circuits at least at each starting of the machine;
- c) proximity switches shall be in accordance with the requirements of 6.2 of EN 1088:1995 and the related control system shall conform to category 3 in accordance with 6.2.6 of EN ISO 13849-1:2006.

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

5.2.1.3 Use of electronic components

If electronic components are used the requirements given in Annex F shall be met.

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

5.2.2 Position of controls

The main electrical control devices that are starting, 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 distance of at least 600 mm and not exceeding 1 800 mm from the floor level.

Additional control devices for starting, operational/ normal stopping (if provided) may be duplicated/provided on mobile control sets with fixed cable connection taking account of the requirements of 5.2.3 for starting and 5.2.4 for normal stop.

Any safeguarding equipment reset control device shall be located outside the protected zone and shall 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 permanently connected by fixed cable control panel (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).

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and 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. Start or restart of machines equipped with 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 described in 5.2.7, 5.3.7 and 5.3.8. Start or restart shall only be possible by actuation of the start control device provided for that purpose and shall be protected against unintended actuation e.g. by shrouded control devices.

Mobile control sets with fixed cable connection shall be equipped with start control device(s).

Machine starting shall conform to the requirements of 9.2.5.2 of EN 60204-1:2006.

Except for cycle start the control circuit for starting or restarting shall be in accordance with the requirements of EN ISO 13849-1:2006 and at least:

- a) category 1 if the control circuit is hardwired;
- b) category 3 if the control circuit contains electronic components.

With the exception of cycle start only one set of starting control devices shall be active at one time.

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 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.

Mobile control sets with fixed cable connection shall be equipped with a normal stop control device.



The stop control circuit shall be of a category 1 in accordance with the requirements of 9.2.2 of EN 60204-1:2006 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 control circuit for normal stopping shall be in accordance with the requirements of EN ISO 13849-1:2006 and at least:

- 1) category 1 if the control circuit is hardwired;
- 2) category 3 if the control circuit contains electronic components.

The design of the control circuits shall be such as to satisfy the normal stopping sequence. If a time delay device is used the time delay shall be 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 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 13850:2006 and additionally with the requirements of 10.7 of EN 60204-1:2006. The emergency stop control device shall be at any time of self latching type.

The emergency stop function shall comply with the requirements of 9.2.5.4.2 of EN 60204-1:2006 and the emergency stop control circuit shall be of a category 1 in accordance with the requirements of 9.2.2 of EN 60204-1:2006 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 control circuit for emergency stop shall be in accordance with the requirements of EN ISO 13849-1:2006 and at least:

- 1) category 1 if the control circuit is hardwired;

- 2) category 3 if the control circuit contains electronic components.

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 9.2.2 of EN 60204-1:2006, actuated in conjunction with standstill monitoring and the control system for standstill monitoring shall be in accordance with the requirements of EN ISO 13849-1:2006 and at least:

- a) category 1 if no dangerous moving parts are accessible e.g. machining head in a safe position, or
- b) category 3 if dangerous moving parts are accessible.

NOTE For example the operational stop control system can be of dual channel type including the transducer, with diversity, where one channel controls the other at least at each cycle start.

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:

- 1) stop the axes movements;
- 2) stop spindle rotation;
- 3) 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.

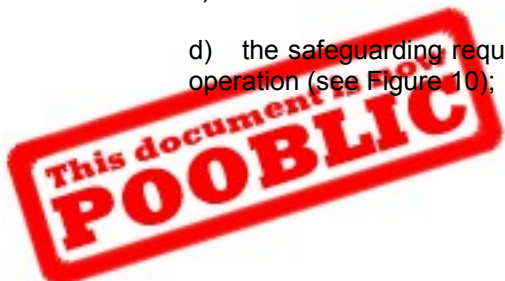
Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and functional testing of the machine

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 for location of control devices);
- b) the control system for mode selection shall conform to category 1 in accordance with the requirements of EN ISO 13849-1:2006 if the circuit is hardwired and to category 3 in accordance with the requirements of EN ISO 13849-1:2006 if the control circuit contains electronic components;
- 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) it shall not be possible to change from one mode to another mode before the machine has been brought to a complete and safe stop.

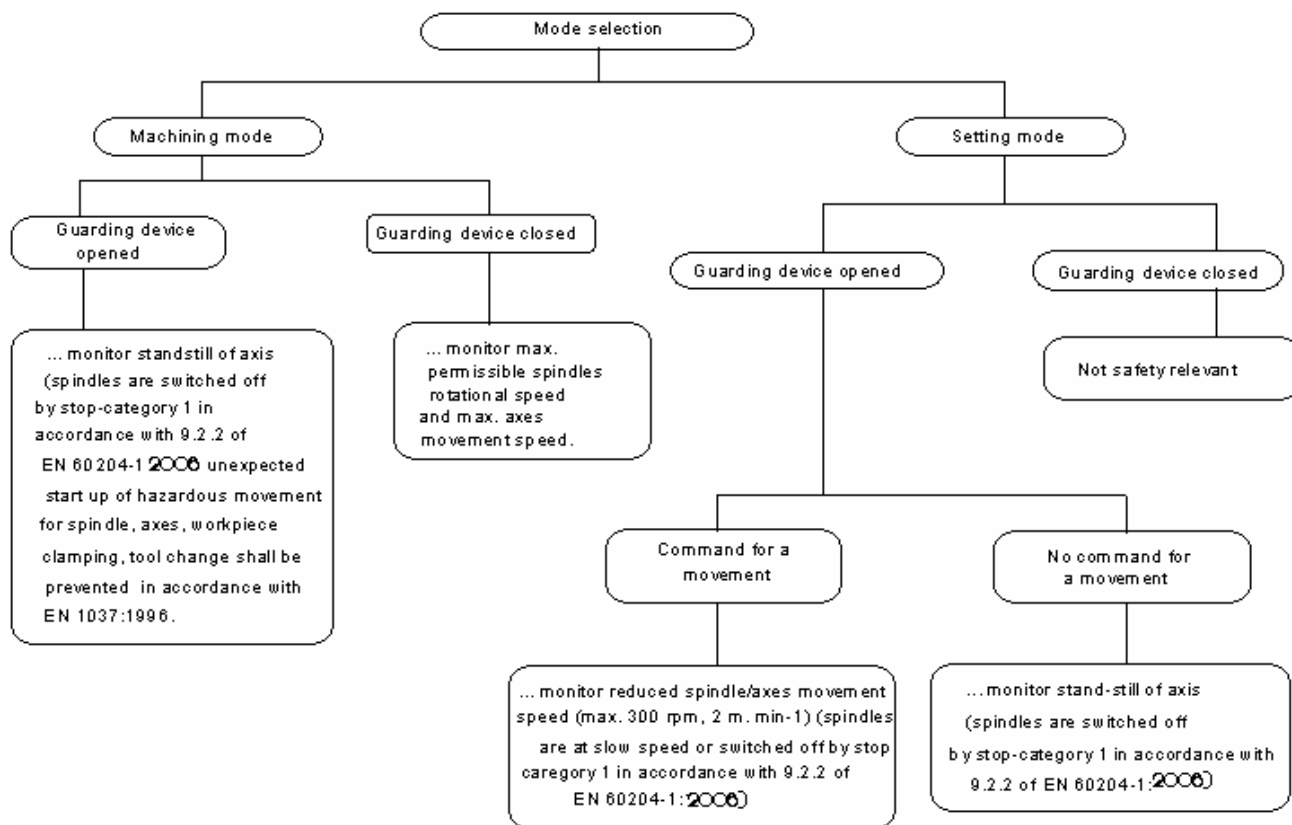


Figure 10 — Mode selection coherence synopsis

Verification: By checking the relevant drawings and/or circuit diagrams, inspection of the machine and 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 3.2 and 3.3 of EN 1088:1995) 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 the following requirements are met:

- a) spindle rotation, if provided, shall be controlled by a hold-to-run control/enabling device;

- b) 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/increment monitoring shall be of category 3 in accordance with the requirements of EN ISO 13849-1:2006. If this is technically not possible alternatively the speed/increment monitoring can be of category B in accordance with the requirements of EN ISO 13849-1:2006 in conjunction with hold-to-run and enabling device, both of category 3 in accordance with the requirements of EN ISO 13849-1:2006 and
- c) if tool rotation is provided it shall be limited to a maximum of 300 min^{-1} and
- d) tool rotation shall stop in less than 2 rotations after release of the hold-to-run control;
- e) maximum speed monitoring in accordance with 5.2.8 shall be provided for spindle rotation (if provided) and axes movements and
- f) detection of a fault in maximum speed monitoring shall stop all movements of the machine in accordance with the requirements of category 1 of 9.2.2 of EN 60204-1:2006 and
- g) 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 (if provided);
- h) restart of the machine shall be interlocked with workpiece powered clamping;
- i) automatic restart of the machine shall be prevented in accordance with 5.3.7.2 and the requirements of Clause 6 of EN 1037:1995;
- j) automatic tool change mechanism shall be protected against unexpected movements at least in category 1 in accordance with the requirements of EN ISO 13849-1:2006.

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

5.2.8 Speed monitoring and control

Unless the tool characteristics are automatically read from the tool, the tool maximum rotational speed and diameter shall be required from the supervisor by the control system and shall be inserted by the operator (e.g. through a code) either at the tool change loading or at the manual insertion in the spindle to allow for comparison by the supervisor with the programmed data in accordance with 9.4.2 of EN 60204-1:2006.

On machines fitted with an automatic electric control device for spindle rotational speed changing (e.g. a static frequency inverter), the spindle speed shall be monitored such that the actual rotational speed can not exceed the selected speed by more than 10 % (e.g. by means of an auxiliary electrical circuit). The actual speed of the spindle shall be automatically compared with the selected speed continuously. The processor used for this purpose shall have an external watch dog function.

If the actual spindle rotational speed exceeds the selected rotational speed by more than 10 %, the drive motor shall be stopped automatically. This stop shall be of category 1 in accordance with the requirements of 9.2.2 of EN 60204-1:2006. In addition the following measures shall be taken against loss or falsification of data:

- a) the following measures against loss of the data for tools and selected speed stored in the machine control:
 - 1) the safety related data for the machine tools (e.g. maximum rotational speed) shall be stored either in 2 independent memory chips or stored twice in one single chip (one time inverse);
 - 2) after input of the safety related data for the tools the data shall be confirmed by the operator;



- 3) the two data shall be compared at each switching on of the isolator, at each fetch of the data, at least once per shift. If the two data are not identical spindle motor start shall not be possible or if running the spindle motor shall be stopped and a warning signal given;
- b) appropriate measures against falsification in data transfer between manual control, data stored in the machine control, display for the data and control of the inverter:

For example:

- 1) selected spindle speed shall be stored in the control of the inverter;
- 2) selected speed transmitted to the control of the inverter shall be read back and monitored on the display for checking by the operator.

In machining mode and in setting mode with axes moving and/or tool rotating at reduced speeds the control system to avoid over speed shall be either:

- 1) two independent control systems conforming to category 2 in accordance with the requirements of EN ISO 13849-1:2006 tested at least at each cycle start, or
- 2) one control system conforming to category 3 in accordance with the requirements of EN ISO 13849-1:2006.

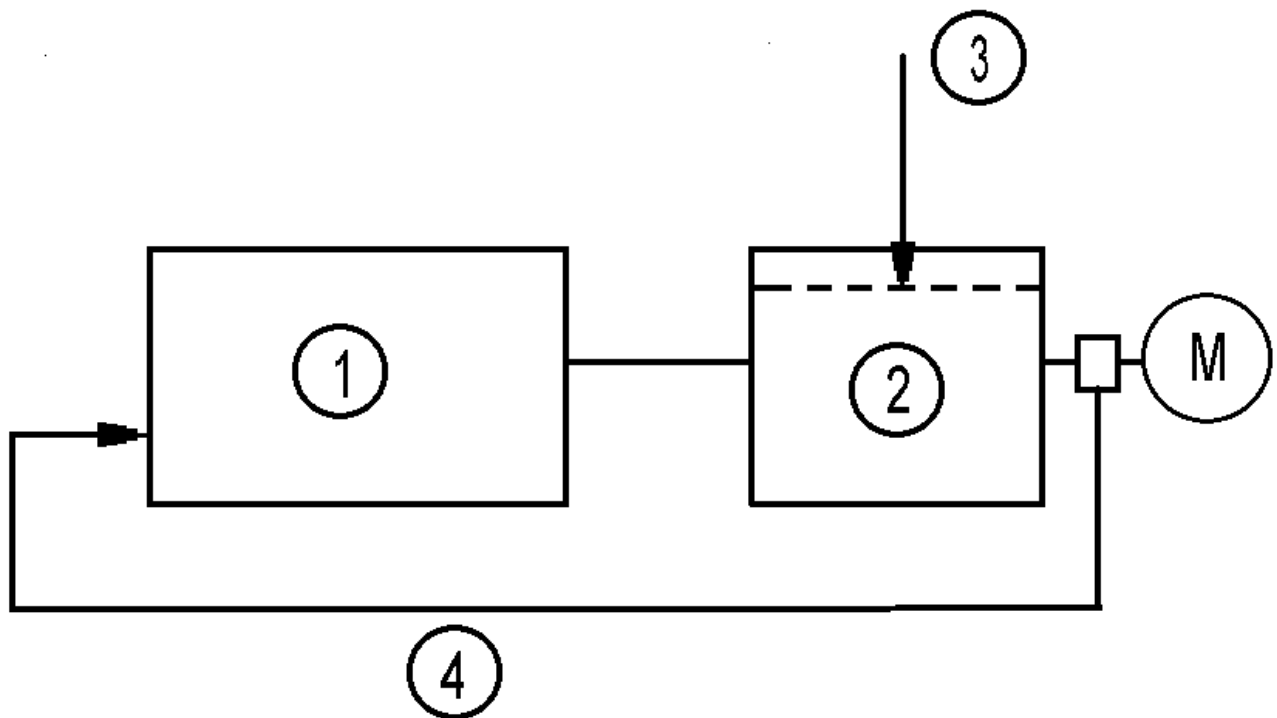
This is also valid for standstill monitoring.

The sensor for determination of the spindle/ axes speed may consist of a single channel if all foreseeable faults will be detected and result in a safe state of the machine. For example one means of fault detection may consist in testing at least at each spindle/ axis start. If an error is indicated the drive unit shall not be capable to be switched on.

Failure of the sensor shall not create over speed.

EXAMPLE If static frequency inverters are used, the actual spindle rotational speed or axis speed can be read by a sensor on the motor/ spindle or indirectly from an exit frequency of the inverter given to the motor on condition that no changeable gearing exists between the inverter and motor. In that case the actual spindle rotational speed or axis speed or frequency inverter exit frequency is compared with the selected frequency (e.g. within the PLC or the NC) (see Figure 11).

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



Key

- 1 Programmable Electronic System (PES)
- 2 inverter
- 3 1st internal loop
- 4 2nd external loop

Figure 11 — Example of safety related control system for speed monitoring without variable speed device between inverter and motor

5.2.9 Interlocking of guards, protective devices, movements and functions

If not otherwise specified in this standard the interlocking circuit of guards, protective devices, movements and functions shall be in accordance with the requirements of EN ISO 13849-1:2006 and of:

- 1) category 1 in if the control circuit is hardwired;
- 2) category 3 if the control circuit contains electronic components.

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

5.2.10 Failure of the power supply

In the case of supply interruption for electrically driven machines, automatic restart after the restoration of the supply voltage shall be prevented in accordance with the requirements of paragraphs 1 and 3 of 7.5 in EN 60204-1:2006).

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

5.2.11 Failure of the control circuits

The requirements of Clause 6 of EN 1037:1995 apply and in addition:

The control circuits shall be designed so that a line rupture in any circuit (e.g. broken wire, pipe or hose) will not result in the loss of a safety function e.g. unexpected start and shall conform to EN 60204-1:2006, EN 982:1996 and EN 983:1996.

Also see 5.2.1.

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

5.3 Protection against mechanical hazards

5.3.1 Stability

It shall be possible to fix the machines and auxiliary equipment to a suitable stable horizontal structure e.g. floor. Facilities for fixing are e.g. fixing holes in the machine frame and auxiliary equipment frame (also see 6.3).

Dangerous movements of the machine or part of it caused by gravity, pressure etc. shall be avoided e.g. by mechanical blocking devices capable of withstanding the maximum load for which the machine is designed.

Verification: By checking relevant drawings and inspection of the machine.

5.3.2 Risk of break-up during operation

Risk of break-up during operation shall be prevented for fall arrester in accordance with 5.4.12, for enclosures in accordance with 5.3.7.1.2 and for guards in accordance with 5.3.7.5. (See also 6.3.)

Verification: By checking relevant drawings and inspection of the machine.

5.3.3 Tool holder

The tool fixing device shall be such, that the tools do not become loose during start up, operation, rundown and braking.

Hydrostatic tool fixing devices which are an integral part of the spindle or which are permanently connected with it shall have an additional mechanical device to prevent loosening of the tool in case of leakage in the hydrostatic system (also see 6.3).

Milling tool spindle run-out shall not exceed 0,02 mm.

Tool release shall only be possible if the spindle is stopped and restart is prevented.

The control system for interlocking between tool release and spindle rotation shall be at least category 1 in accordance with the requirements of EN ISO 13849-1:2006 or consist of 2 independent systems of category B in accordance with the requirements of EN ISO 13849-1:2006.

As an exception tool release function can be of category B in accordance with the requirements of EN ISO 13849-1:2006 if there is an additional mechanical system which prevents releasing the tool during rotation.

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

5.3.4 Braking tool spindle

5.3.4.1 General

An automatic electrical brake shall be provided for the tool spindle(s) where the un-braked run-down time exceeds 10 s.

The braked run-down time shall be less than 10 s.

NOTE In the case of failure of the power supply this run-down time may be exceeded.

Electrical braking systems shall not perform their function by reverse current braking.

Where electrical braking systems not containing electronic components are used the control system for braking shall be designed in accordance with the requirements of category 1 of EN ISO 13849-1:2006.

Where electrical braking systems containing electronic components are used the control system for braking shall be designed in accordance with the requirements of category 2 of EN ISO 13849-1:2006. The control system shall be tested automatically, periodically, at each tool change, e.g. by monitoring the braked run down time and/or by monitoring the braking current circuit during starting (short braking). Zero speed signal may be detected in accordance with the requirements of category B of EN ISO 13849-1:2006. The test shall work:

- a) independently from the control system for braking;
- b) independently from the intention of the operator;
- c) at least during stopping the spindle.

A test shall be performed with the tool present in the spindle and consist for example of a check the exit frequency of the inverter to verify that the braking time is less than 10 s. If 10 s is reached or exceeded or the inverter indicates a fault condition an operational stop or the emergency stop (see 5.2.5) category 1 in accordance with the requirements of EN 60204-1:2006 shall be initiated and the corresponding information shall be displayed (see 6.1).

If the test fails it shall only be possible to restart the machine after confirmation from the operator.

Verification: For the determination of un-braked run-down time and braked rundown time, if relevant, see the appropriate test given in Annex E.

5.3.4.2 Brake release

Where a control is provided to release the spindle brake in order to enable its rotation by hand and adjustment of the tool, release of the brake shall only be possible when the spindle(s) has(have) stopped turning (e.g. by time delay between of the actuation control and brake release) and restart is prevented.

It shall not be possible to start the machine before the control to brake, the spindle has been reset. Reset of the control for brake shall not initiate a start-up of the machine.

The safety related part of the control system for brake release shall conform to category B in accordance with the requirements of EN ISO 13849-1:2006.

Verification: By checking the relevant drawings, inspection of the machine and functional testing of the machine.



5.3.4.3 Nature of the brake

Brakes and their function shall perform either by direct current injection or by static frequency inverter braking.

Verification: By checking the relevant drawings, inspection of the machine and functional testing of the machine.

5.3.5 Devices to minimise the risk of ejection

To minimise the risk of ejection of off-cuts the machine shall be fitted with means to either clamp or machine off-cuts (see 6.3).

NOTE The requirements to minimise the risk of ejection of tool parts are given in 5.3.2, 5.3.3 and 5.3.7.

Verification: By checking the relevant drawings and inspection of the machine.

5.3.6 Workpiece supports and guides

Access to hazard zone i.e. machining zone from below the workpiece support shall be prevented.

NOTE The requirements for workpiece clamping are given in 5.3.8.

See also 6.3.

Verification: By checking the relevant drawings and inspection of the machine.

5.3.7 Prevention of access to moving parts and devices to minimise the effect of ejection

5.3.7.1 Guarding of tools

5.3.7.1.1 NC boring machines

Boring machines designed to use only boring tools shall be guarded by:

- a) fixed guards and/or fixed distance guards or moveable interlocked guards conforming to 5.2 of EN 1088:1995, the safety distance of which shall conform to EN 294:1992 except Table 1 and Table 5, or
- b) trip devices e.g. light barrier, or
- c) any combination of a) and b).

Verification: By checking the relevant drawings, inspection of the machine and functional testing of the machine.

5.3.7.1.2 NC routing machines and NC combined boring/routing machines

5.3.7.1.2.1 General

On NC routing machines and NC combined boring/routing machines access to hazard zones from above the workpiece support shall be prevented either by a peripheral enclosure or by a partial enclosure in accordance with the requirements of 5.3.7.1.2.2 or 5.3.7.1.2.3 including where appropriate other safeguarding devices, like safety mats and light barriers or pressure sensitive bumpers in accordance with 5.3.7.2, 5.3.7.3 and 5.3.7.4.

Access to the tool(s) from below the workpiece support shall be prevented e.g. by fixed guards extending at least from the frame of the machine up-to the lowest surface on which the workpiece can be clamped.

Verification: By checking the relevant drawings, inspection of the machine and functional testing of the machine.

5.3.7.1.2.2 Peripheral enclosure

If fitted with a peripheral enclosure the following requirements shall be met:

The enclosure shall prevent access to the danger zone, ejection of part of the tool and any crushing or trapping hazard between fixed and moving machine parts up to at least 1 800 mm from the floor level.

Where it is necessary to enter the enclosure for setting, tool changing, cleaning or loading/unloading a door shall be provided and be interlocked with guard locking to the drives. Guard locking shall be achieved, by at least, an interlocking device with manually operated time delay device in accordance with Annex N of EN 1088:1995. The following additional requirements apply:

- a) audible or visual warning (e.g. a yellow light) of impending start up shall be given (see 6.1) and
- b) emergency stop device according to 5.2.5 shall be placed inside the enclosure to stop start up if needed and
- c) control device to reset the interlocking of the door conforming to 5.2.2 of EN ISO 13849-1:2006 shall be provided outside the enclosure, not reachable from inside the enclosure (with a clear view of the inside of it);
- d) machines shall be marked with: "use only milling tools with a cutting circle diameter below 16 mm or milling tools or saw-blades conforming to EN 847-1:2005 and EN 847-2:2001 and boring tools or sanding wheels".

The characteristics of the guards shall conform to 5.3.7.5.

The control circuit for interlocking with guard locking shall conform to the requirements of 5.2.9.

Verification: By checking the relevant drawings, measurements, inspection of the machine and functional testing of the machine.

5.3.7.1.2.3 Partial enclosure

5.3.7.1.2.3.1 General

If fitted with a partial enclosure the following requirements shall be met:

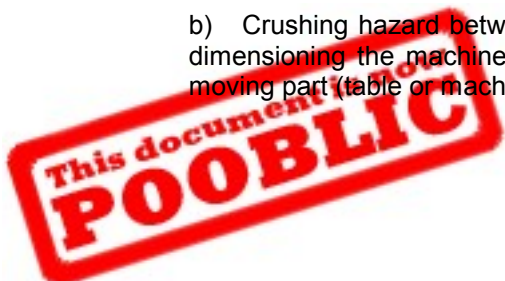
With the exception for the loading and/or unloading zone the requirements of 5.3.7.1.2.2 apply.

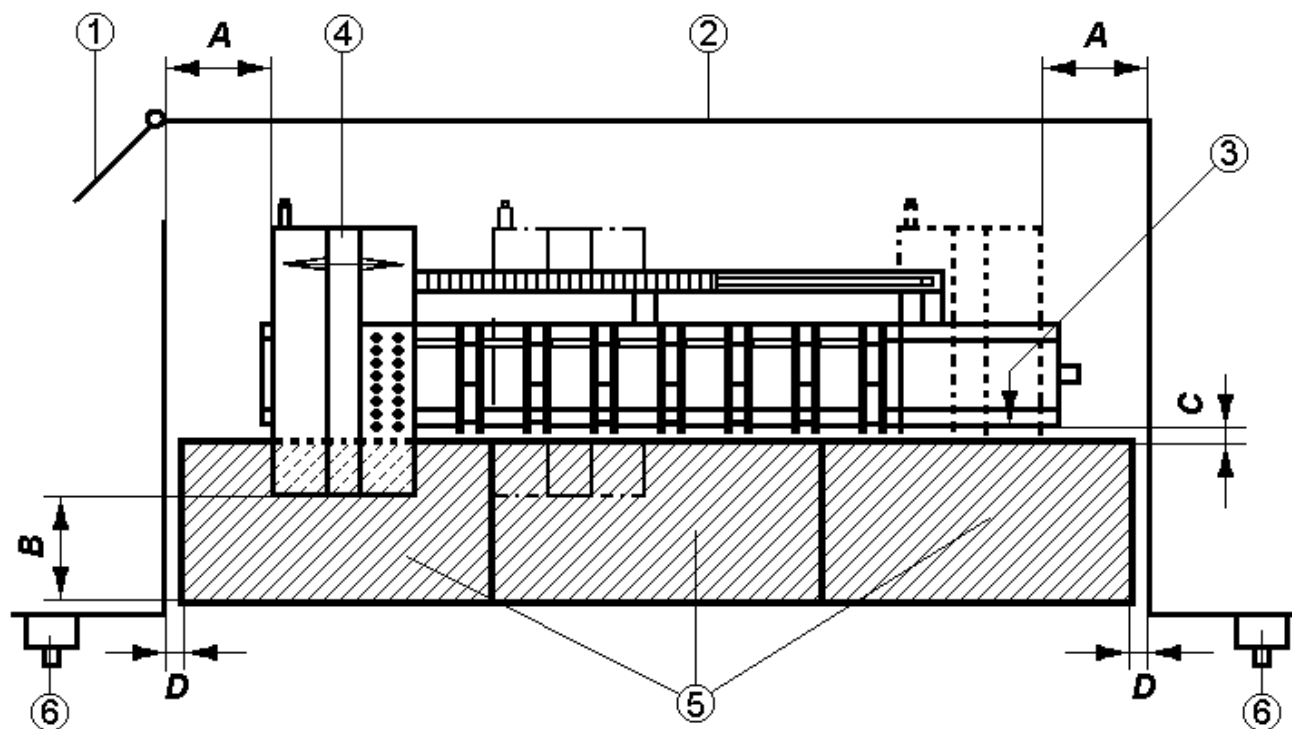
For the loading and/or unloading zone it shall not be possible for the operator to stand between the protected zone and the machine (see 5.3.7.1.2.3.2).

a) Access to the sides and rear zone of the machine from the loading/unloading zone protected by safety devices (e.g. pressure sensitive mats or light barrier according to 5.3.7.1.2.3.2) shall be prevented by either:

- 1) fixed guards, or
- 2) deterring/ impeding devices mounted at a height exceeding 700 mm and extending horizontally over a distance of at least 400 mm, or
- 3) light barrier.

b) Crushing hazard between moving parts (table or machining head) and fixed guards shall be avoided by dimensioning the machine such that a minimum distance of 500 mm between the extreme position of the moving part (table or machining head) and the fixed guards is ensured (see dimension A in Figure 12).





Key

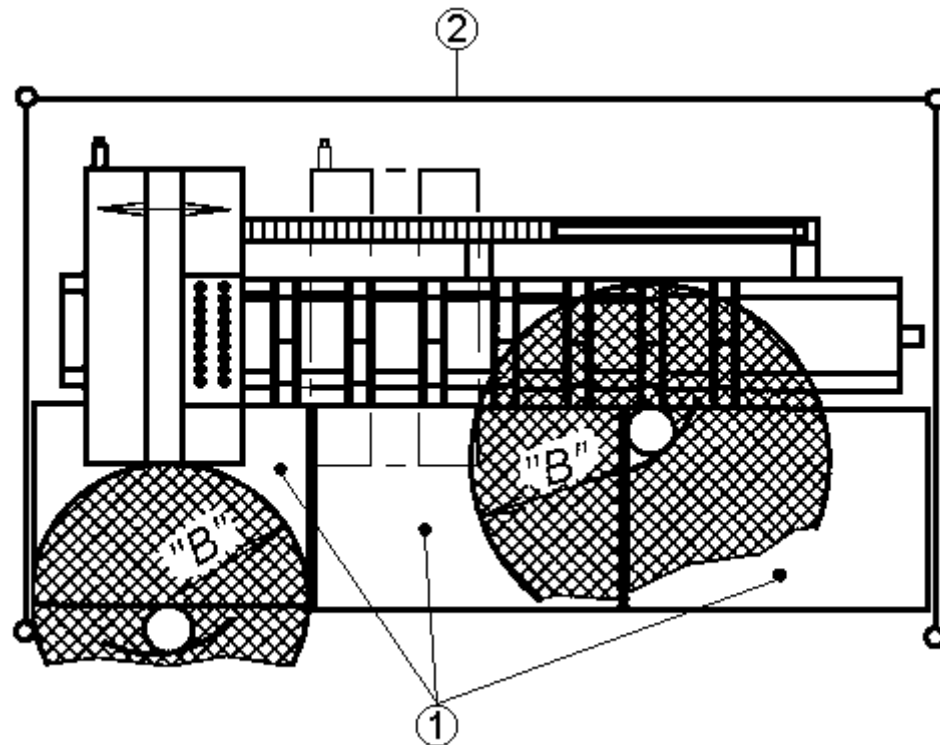
- 1 interlocked door
- 2 fixed guard
- 3 front edge of the table
- 4 machining head
- 5 active part of the pressure sensitive mat(s)
- 6 reset device
- A distance between machine and fixed guards
- B minimum extension of safety devices
- C maximum gap between machine and pressure sensitive mat
- D maximum gap between machine and fixed guards

Figure 12 — Position of guarding on machines with partial enclosure

c) When access to the danger zone on the front side of the machine (loading/unloading zone) is prevented by safety devices as light barriers or pressure sensitive mats the detection zone (light barrier) or effective sensing surface (pressure sensitive mats) shall extend at least 850 mm from any running tool being in the closest possible position to the operator, measured in horizontal direction (distance B of Figures 12 and 13). (see also 5.3.7.2)

When a person is detected the machining head shall stop before the distance of the nearest running tool to the detection zone (light barrier) or effective sensing surface (pressure sensitive mats) becomes less than 850 mm (see also 5.3.7.2).

When the safety device is divided to allow the machine working in one area whilst the other area is accessible for loading/unloading, interlocking of the machine head movement with the detection of a person in the loading/unloading zone shall be provided.



Key

- 1 pressure sensitive mats
- 2 fixed guard
- B minimum extension of safety devices

Figure 13 — Safety distances when fixed guards in combination with trip devices are used

d) Where the operator's position is not restricted by light barrier(s) or pressure sensitive mat(s) the guarding shall fulfil the requirements of 5.3.7.1.2.4 c) 1) (for crushing, shearing and impact hazards see also 5.3.7.2);

e) Machines shall be marked with: "use only milling tools with a cutting circle diameter below 16 mm or milling tools or saw-blades conforming to EN 847-1:2005 and EN 847-2:2001 and boring tools or sanding wheels". The ejection of parts of the tool shall be minimised in at least in the direction of two horizontal axes by:

- 1) fixed guards which shall fulfil the requirements of 5.3.7.5 and
- 2) curtains the extension of which covers only the loading/unloading opening (see 5.3.7.1.2.4).

f) All guards where applicable shall fulfil the requirements of 5.3.7.5.

- g) An extension table is not required, where no tool can run while it protrudes over the table limits and a safety distance Y of at least 850 mm is provided between the operator's position and the extreme position of the moving head (see 5.3.7.1.2.4).
- h) When using pressure sensitive bumpers as single safety device (see 5.3.7.2 and 5.3.7.3) (without safety devices as light barriers or pressure sensitive mats), the sensing surface of the bumpers shall extend at least 850 mm from any rotating tool inside the support being in the closest possible position to the operator, measured in horizontal direction (distance Y of Figure 14).

As an exception the safety distance can be reduced up to 550 mm, if the opening for the workpieces measured from the clamping surface and the upper edge of the opening of the support, is less than 200 mm.

The movement shall be stopped before a force of maximum 400 N is reached. The force shall be measured at maximum speed of the machining head using a fixed probe of 80 mm diameter positioned perpendicular to the direction of motion.

The control circuits for interlocking of machining head movement shall conform to the requirements of 5.2.9.

NOTE During the next revision of the standard it is intended to deal with requirements on tool identification.

Verification: By checking the relevant drawings, inspection of the machine, measurement, relevant tests and relevant functional testing of the machine.

5.3.7.1.2.3.2 Pressure sensitive mats and light barriers

5.3.7.1.2.3.2.1 Pressure sensitive mats

If pressure sensitive mats are used the following requirements apply:

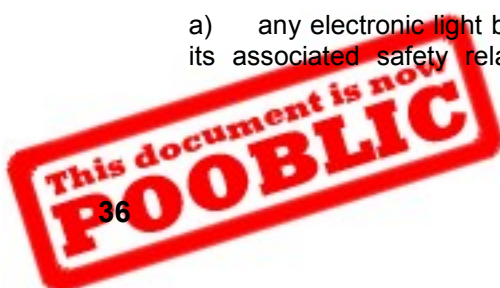
- a) any pressure sensitive mats shall be in accordance with the requirements of EN 1760-1:1997, be designed to detect persons weighing more than 35 kg and either:
 - 1) be equipped with sensor conforming to category 1 in accordance with the requirements of EN ISO 2006 and its associated safety related control system of category 3 in accordance with the requirements of EN ISO 13849-1:2006, or
 - 2) the system as a whole (including sensor(s), control circuits) shall conform to category 2 in accordance with the requirements of EN ISO 13849-1:2006 and shall be tested at least at each cycle start. If the test fails the machine shall stop automatically;
- b) if pressure sensitive mats are used, the distance C in Figure 12 between the active part of the mat and the machine at the mat level shall not exceed 100 mm and the distance D in Figure 12 between the active part of the mat and fixed guards at the mat level shall not exceed 80 mm;
- c) the reset control device shall be outside the protected zone and not reachable from inside this zone. The operator shall have a good view on the protected zone.

Verification: By checking the relevant drawings, inspection of the machine, measurement, relevant tests and relevant functional testing of the machine.

5.3.7.1.2.3.2.2 Light barriers

If light barriers are used the following requirements apply:

- a) any electronic light barrier shall be of at least Type 2 in accordance with EN 61496-1:2004 and its associated safety related control systems shall be at least category 2 in accordance with



EN ISO 13849-1:2006 and shall be tested at least at each cycle start. If the test fails the machine shall stop automatically;

- b) light barriers shall consist of at least two opto-electronic elements;
- c) pitch between two elements shall be equal or less than 172 mm;
- d) if mounted horizontally, the elements shall be situated at a height between 400 mm and 800 mm above the floor level;
- e) if mounted inclined, the elements shall be mounted at a height between 400 mm above the floor level away from the machine and 800 mm above the floor level close to the machine, the distance of 172 mm being measured on the horizontal projection;
- f) if mounted horizontally or inclined the distance *C* in Figure 12 between the active part of the light barriers and the machine at the light barrier levels shall not exceed 100 mm and the distance *D* in Figure 12 between the active part of the light barriers and fixed guards at the light barrier levels shall not exceed 80 mm;
- g) if mounted vertically, the lower elements shall be situated at a height of at most 300 mm above the floor level and the upper elements at a height of at least 900mm above the floor level;
- h) the reset control device shall be outside the protected zone and not reachable from inside this zone. The operator shall have a good view on the protected zone;
- i) accessible supporting parts shall be designed and situated in a way that they do not cause injury or create a tripping hazard.

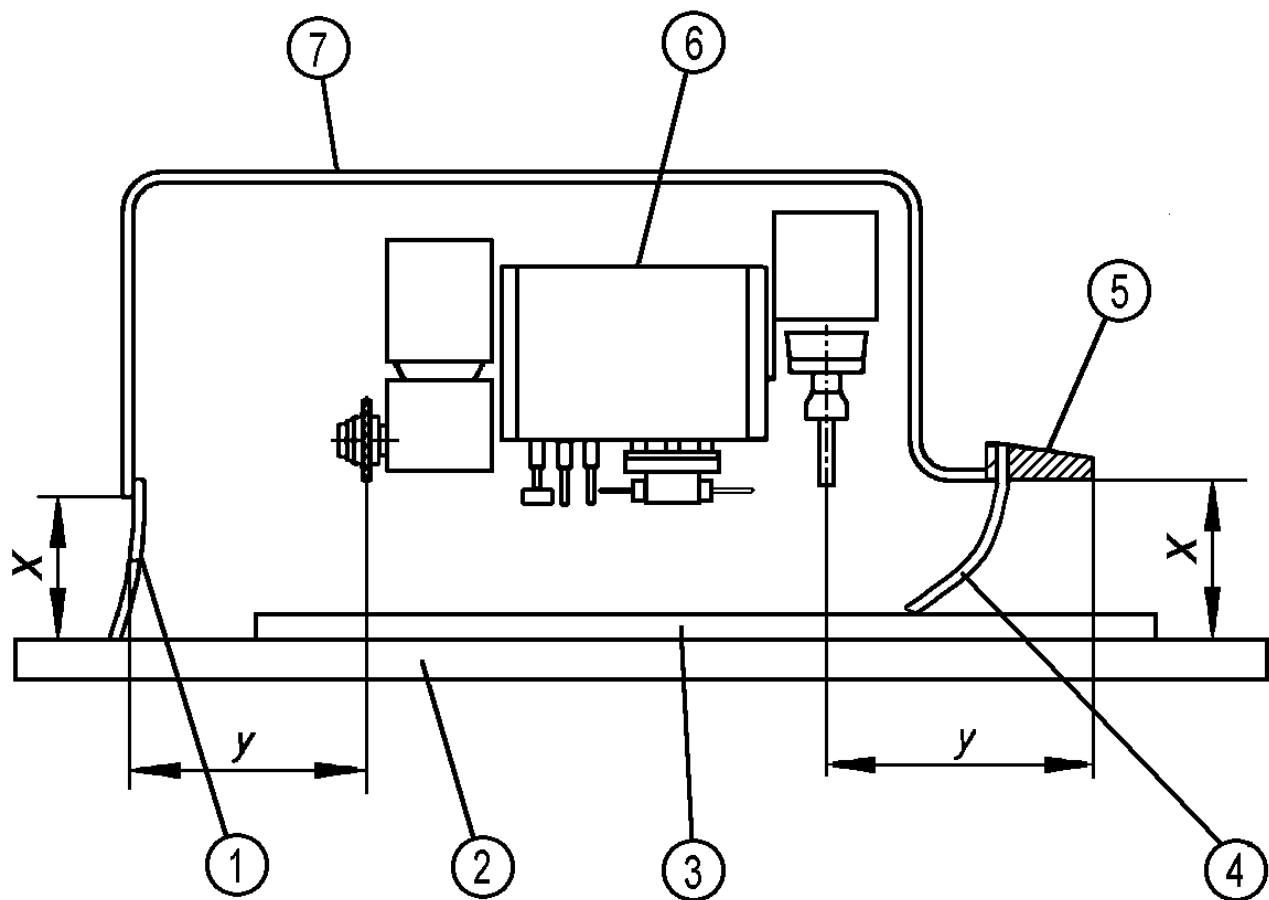
Verification: By checking the relevant drawings, inspection of the machine, measurement, relevant tests and relevant functional testing of the machine.

5.3.7.1.2.4 Openings and curtains

For openings and curtains the following requirements apply:

- a) curtains shall protect against ejection of parts of tools or parts of the workpiece from the opening strictly necessary for the machining in accordance with b);
- b) height of the opening measured between the lower part of the partial enclosure in the direction of feed and the workpiece support shall not exceed 400 mm;
- c) where it is possible to pass a hand through the curtains it shall not be possible to reach a dangerous moving part such as the running shaft/tool and crushing and/or trapping between moving parts inside the partial enclosure e.g. moving spindle or tool change device and fixed components. This is achieved if:
 - 1) the distance *Y* in Figure 14 between the plane of the opening guarded by the curtain and the moving part (shaft/tool or moving parts inside the partial enclosure e.g. moving spindle or tool change device) in its position closest to the plane of the opening guarded by the curtain shall be at least 550 mm for opening heights *X* in Figure 14 up to 200 mm and at least 850 mm for opening heights *X* in Figure 14 between 200 mm and 400 mm, or





Key

- 1 curtain
- 2 workpiece support
- 3 workpiece
- 4 curtain
- 5 trip device (pressure sensitive bumper)
- 6 head assembly
- 7 partial enclosure

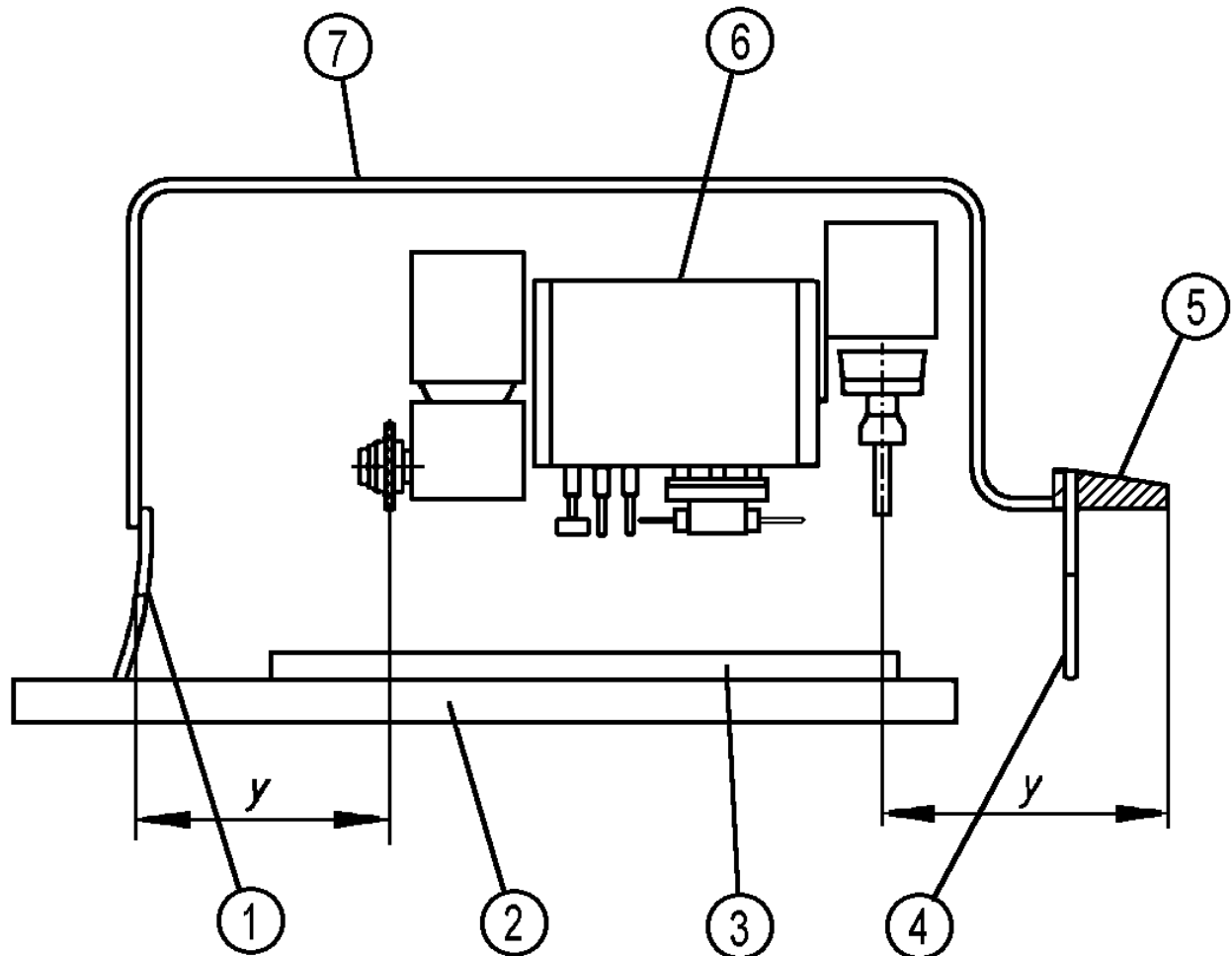
$X \leq 200 \text{ mm} \rightarrow Y \geq 550 \text{ mm}$

$200 \text{ mm} < X \leq 400 \text{ mm} \rightarrow Y \geq 850 \text{ mm}$

Figure 13 — Safety distances "Y" for partial enclosure around the head assembly

- 2) the position of the operator is limited by light barriers or pressure sensitive mats in accordance with the requirements of 5.3.7.1.2.3.1;

- d) the curtain free end on its whole length shall always lie in contact with the workpiece support or extension of it, unless access or ejection is prevented by other means (e.g. by a fixed and additional movable interlocked guards in accordance with 5.3.7.1.2.3.1 e1)) and shall extend to the lowest surface on which the workpiece can be clamped (for exception see 5.3.7.1.2.3. 1 h) and Figure 15);



Key

- 1 curtain
- 2 workpiece support
- 3 workpiece
- 4 curtain
- 5 trip device (pressure sensitive bumper)
- 6 head assembly
- 7 partial enclosure
- y safety distance

$Y \geq 850 \text{ mm}$

Figure 14 — Safety distances "Y" for partial enclosure protruding over a table

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- e) the curtain shall be located so that it cannot come in contact with the tool;
- f) the curtain shall be made of Poly-Vinyl-Chloride (PVC) strips with a minimum width of 40 mm and a maximum width of 60 mm;
- g) the curtain shall be made of at least three layers overlapping on one third or at least four layers overlapping on one half;
- h) the curtain shall be subject of an impact test and contain a 20 g projectile when hit at a speed of 70 m/s at the target point A as shown in Figure C.5 (also see Annex D).

Any curtain identical to a curtain that fulfils the requirement in h) with either more overlapping layers, or wider stripes, or shorter stripes is deemed to pass the test.

As an exception when the combine boring and routing machine during a work uses only boring tools, the curtains may be raised, if there is an interlocking between the curtains when they start moving from their guarding position and the rotations of any other spindle.

The control circuits for this interlocking shall conform to the requirements of 5.2.9.

Verification: By checking the relevant drawings, inspection of the machine, measurement, relevant tests described in Annex C and relevant functional testing of the machine.

5.3.7.2 Access to moving parts (except tools and drives)

Access to impact, crushing, shearing, drawing in and entanglement points shall be prevented by fixed guards the safety distance of which shall conform to the requirements of Table 3 or Table 4 of EN 294:1992 and/or by protective devices e.g. light barrier, pressure sensitive mats or bumpers.

- a) When using safety devices as light barriers or pressure sensitive mats the detection zone (light barrier) or effective sensing surface (pressure sensitive mats) shall extend at least 850 mm from any crushing, shearing, drawing in and entanglement point being in the closest possible position to the operator, measured in horizontal direction (distance *B* of Figure 12). Where only impact hazards from machining head or table exist the minimum extension of safety device can be reduced to at least 700 mm;
- b) when a person is detected the machining head shall stop before the distance of the nearest hazardous point to the detection zone (light barrier) or effective sensing surface (pressure sensitive mats) becomes less than the minimum extension of the safety device according to a);
- c) when the safety device is divided to allow the machine working in one area whilst the other area is accessible for loading/unloading, interlocking of the machine head movement with the detection of a person in the loading/unloading zone shall be provided;
- d) when using pressure sensitive bumpers as single safety device (see 5.3.7.3) (without safety devices as light barriers or pressure sensitive mats), the sensing surface of the bumpers shall extend at least 850 mm from any crushing, shearing, drawing in and entanglement point inside the support being in the closest possible position to the operator, measured in horizontal direction (distance *Y* of Figure 14). When a person is detected by the bumper the movement shall be stopped before a force of maximum 400 N is reached. The force shall be measured at maximum speed of the machining head using a fixed probe of 80 mm diameter positioned perpendicular to the direction of motion;
- e) as an exception the safety distance can be reduced up to 550 mm, if the opening for the work pieces measured from the clamping surface and the upper edge of the opening of the support, is less than 200 mm.

The space between clamping bars shall be guarded at the front and at the rear up to the lowest surface on which the workpiece can be clamped unless other fixed guards are provided to protect against crushing hazards and/or effect of ejection.

It shall not be possible for the operator to stand in the protected zone intended for loading/unloading with the machine running in this zone (also see 6.3 for the maximum dimensions of workpiece to be loaded/unloaded). The maximum distance between the floor and the fixed guard shall not exceed 300 mm.

When movable guards are in open position, unexpected start up of hazardous movement of spindle, axes, workpiece clamping and tool change mechanism shall be prevented in accordance with Clause 6 of EN 1037:1995.

Unexpected restart by the closure of a movable guard or the moving from a zone safeguarded by safety mats or light barriers shall be prevented.

The control circuit for prevention of restart shall be in accordance with the requirements of EN ISO 13849-1:2006 and at least:

- i) category 1 if the control circuit is hardwired;
- ii) category 3 if the control circuit contains electronic components.

A reset function control device shall be provided to re-initiate the safeguarding preventing the operator from gaining access to a zone where the risks of crushing, shearing, cutting and/or impact are present e.g. climbing or leaning on the table of the machine (see 5.3.5 and 5.3.7). The reset control device shall be located outside the safeguarded zone (see Figure 13). The reset function shall conform to the requirements of 5.2.2 of EN ISO 13849:2006 and only be effective if actuated from outside the safeguarded zone. As an exception the functioning of the relevant safeguarding for a safeguarded zone and the initiation of the cycle start in that safeguarded zone may be achieved by the same manual control device.

The control circuit for reset shall be in accordance with the requirements of EN ISO 13849-1:2006 and at least:

- I) category 1 if the control circuit is hardwired;
- II) category 3 if the control circuit contains electronic components.

If it is possible for the operator to stand in a protected zone with the machine in machining mode of operation it shall not be possible for the operator to actuate the enabling control allowing machining head to traverse from machining zone to the protected zone when standing in the protected zone. The machining head shall not be capable of moving from a machining section of the machine to a workpiece loading/unloading section of the machine without actuation of the enabling control to traverse.

Any electronic light barrier shall be of at least Type 2 in accordance with EN 61496-1:2006 and its associated safety related control systems shall be at least category 2 in accordance with EN ISO 13849-1:2006 and shall be tested at least at each cycle start. If the test fails the machine shall stop automatically.

Any pressure sensitive mats shall be in accordance with the requirements of EN 1760-1:1997, be designed to detect persons weighing more than 35 kg and either:

- 1) be equipped with sensor conforming to category 1 in accordance with the requirements of EN ISO 13849-1:2006 and its associated safety related control system of category 3 in accordance with the requirements of EN ISO 13849-1:2006, or
- 2) the system as a whole shall conform to category 2 in accordance with the requirements of EN ISO 13849-1:2006 and shall be tested at least at each cycle start. If the test fails the machine shall stop automatically.



Where only an impact hazard is foreseeable and the maximum axis speed is below 25 m min^{-1} no additional protective device is required where partial movable enclosure corners are rounded to at least 20 mm radius and no hazards exist from projecting parts e.g. screws.

Where the maximum axis speed exceeds 25 m min^{-1} and where an impact hazard exist (e.g. no light barrier or safety mat in accordance with 5.3.7.1.2.3.1 is provided) a trip device e.g. pressure sensitive bumpers according to 5.3.7.3 shall be provided.

Crushing hazard shall be prevented by protective devices, placed in such way that the safety distances conform to Table 3 or Table 4 of EN 294:1992. Crushing hazards may be reduced by restricting the machine heads travel e.g. by mechanical stops.

The rear of the machine shall be protected by a distance perimeter fence. Where pressure sensitive bumpers (see 5.3.7.3) are provided no additional protective device e.g. pressure sensitive mat(s) or light barrier(s) is required.

The control circuits for interlocking shall conform to the requirements of 5.2.9.

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

5.3.7.3 Pressure sensitive bumper

Pressure sensitive bumpers shall conform to the requirements of EN 1760-3:2004 and shall be such that the movement is stopped before impact force of 400 N is reached. The impact force shall be measured using a fixed probe of 80 mm diameter positioned square to the direction of motion.

The active part of the pressure sensitive bumper shall be of flexible material e.g. rubber and its width greater than 80 mm.

For pressure sensitive bumpers where the signal is not provided directly, the associated safety-related control systems shall be of category 3 in accordance with the requirements of EN ISO 13849-1:2006. For pressure sensitive bumpers where the signal is provided directly, the associated safety-related control systems may be reduced to category 1 in accordance with the requirements of EN ISO 13849-1:2006.

Pressure sensitive bumpers shall extend to the whole height of the machine-moving component up to a minimum height of 1.800 mm and from the edge inward up to 700 mm from the machine side.

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

5.3.7.4 Guarding of drives

Access to drive mechanisms (which include tool spindles, feed etc.) shall be prevented either by fixed guards or movable guards interlocked with the corresponding motor drives in accordance with the requirements of EN 1088:1995.

Where frequent access to the drives is provided for maintenance or adjustment purposes i.e. more than once per month, access shall be via an interlocked movable guard.

If it is possible to gain access to the tool with the guard open the guard shall be interlocked at least with an interlocking device with manually operated delay device in accordance with Annex N of EN 1088:1995.

The control circuits for interlocking shall conform to the requirements of 5.2.9.

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

5.3.7.5 Required characteristics of guards

Guards shall be manufactured from one or a combination of the following materials having at least the properties shown:

- a) steel with an ultimate tensile strength of at least 350 N mm^{-2} and a wall thickness of at least 2 mm;
- b) light alloy with characteristics in accordance with the requirements of Table 2;

Table 2 — Light alloy guard thickness and tensile strength

Minimum ultimate tensile strength N mm^{-2}	Minimum wall thickness mm
180	5
240	4
300	3

- c) polycarbonate of at least 5 mm thickness or other plastic material having an impact strength equal to or better than that of polycarbonate of 5 mm thickness;
- d) cast iron with an ultimate tensile strength of at least 200 N mm^{-2} and a minimum wall thickness of 5 mm.

Also see 5.3.7.1.2 and 6.3.

Verification: By checking the relevant drawings and measurements.

NOTE For the ultimate tensile strength a confirmation from the manufacturer of the material can be useful.

5.3.8 Clamping device

There shall be provision made for fixing a clamping device or devices to the machine (also see 6.3 f)). Where powered clamping is provided and where crushing hazards from workpiece clamping are not prevented by any of the means described in 5.3.7 above they shall be prevented by:

- a) two stage clamping with a maximum clamping force at the clamping device of 50 N for the first stage, followed by full clamping force actuated by a manual control, or
- b) reduction of the clamp/workpiece gap to 6 mm or less by a manually adjustable device and cylinder stroke limitation to a maximum of 10 mm, or
- c) limitation of the clamp closing speed to 10 mm s^{-1} or less, or
- d) guarding of the clamp by an adjustable guard attached to the clamping device to reduce the gap between the workpiece and the guard to 6 mm or less. The maximum extension of the clamp outside the guard shall not exceed 6 mm;
- e) any other method resulting in the same level of safeguarding.

The category of the control circuits for the monitoring of the first stage clamping force (see 5.3.8 a)) and the limitation of the clamp closing speed (see 5.3.8 c)) shall be at least category B in accordance with the requirements of EN ISO 13849-1:2006 (also see 5.2.1).

Where pneumatic or hydraulic clamping is provided additionally the requirements of EN 982:1996 or EN 983:1996 shall be met.



In the case of machines incorporating pneumatic/hydraulic clamping of the workpiece, provision shall be made to maintain the pneumatic/hydraulic pressure in the event of a failure in the pneumatic/hydraulic power supply e.g. by the use of a non-return valve.

Where powered (vacuum, pneumatic or hydraulic) clamping is provided the following requirements apply:

- 1) feed and spindle rotation and clamping of the workpiece being processed shall be interlocked so that axes and/or spindle movements cannot start and run until clamping pressure/vacuum is applied and release of clamping pressure/vacuum during rotation of the spindle is only possible if the machining head is in the rest position and the integrated feed has stopped;
- 2) where twin table or separate loading/unloading sections are provided the requirements for release of clamping pressure/vacuum only applies for the part of the machine where machining is under progress. Release of clamping pressure/vacuum on the table where no machining is in progress shall only be possible when the corresponding table has come to rest;
- 3) in the area where the workpiece is processed the release of clamping pressure/vacuum during rotation of the spindle shall only be possible if the machining head is in the rest position and the integrated feed has stopped;
- 4) for vacuum clamping:
 - i) the vacuum sensor shall conform at least to category B in accordance with the requirements of 6.2.3 of EN ISO 13849-1:2006;
 - ii) the vacuum sensor shall be adjustable and the lower limit shall be 25 % of the rated under pressure and shall be located as close as possible to the table;
 - iii) the loss of pressure shall initiate the machine operational stop or emergency stop (see 5.2.5 or 5.2.6).

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

5.4 Protection against non mechanical hazards

5.4.1 Fire

To minimise the risk from fire the requirements of 5.4.3, 5.4.4 and 5.4.9 shall be fulfilled.

Verification: By checking the relevant drawings, inspection of the machine and relevant functional testing of the machine.

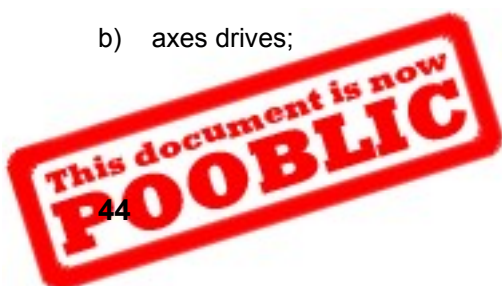
5.4.2 Noise

5.4.2.1 Noise reduction at the design stage

When designing machinery the information and technical measures to control noise at source given in EN ISO 11688-1:1998/AC:1998 shall be taken into account. Also the information given in EN ISO 11688-2:2001 may be taken into account.

The main noise sources are:

- a) tool spindles drives;
- b) axes drives;



- c) clamping, i.e.:
 - 1) vacuum system including vacuum pump (if provided);
 - 2) pneumatic system (if provided);
 - 3) hydraulic system (if provided).

5.4.2.2 Noise emission measurement

Operating conditions for noise measurement shall comply with the requirements of Annex B.

Mounting and operating conditions of the machine shall be identical for the determination of emission sound pressure levels at the work station and sound power levels.

Emission sound power levels shall be measured in accordance with the enveloping surface measuring method given in EN ISO 3746:1995 with the following modifications:

- a) environmental factor K_{2A} shall be equal to or less than 4 dB;
- b) difference between the background sound pressure level and the machine sound pressure level at each measuring point shall be equal to or greater than 6 dB. The correction formula for this difference (see 8.2 of EN ISO 3746:1995) shall apply up to a difference of 10 dB;
- c) only the parallelepiped measurement surface shall be used at 1 m from the reference surface;
- d) where the distance from the machine to an auxiliary unit is less than 2 m the auxiliary unit shall be included in the reference surface;
- e) measuring time requirement in 7.5.3 of EN ISO 3746:1995 referring to 30 s shall be excluded;
- f) accuracy of the test method shall be better than 3 dB;
- g) number of microphone positions shall be 9 in accordance with Annex B.

Alternatively, where the facilities exist and the measurement method applies to the machine type, emission sound power levels may also be measured in accordance with a method with higher precision i.e. EN ISO 3743-1:1995, EN ISO 3743-2:1996, EN ISO 3744:1995 and EN ISO 3745:2003 without the preceding modifications.

For determination of emission sound power level by the sound intensity method, use EN ISO 9614-1:1995, (subject to agreement between the supplier and the purchaser).

Emission sound pressure level at the workstation shall be measured in accordance with EN ISO 11202:1995 with the following modifications:

- 1) environmental factor K_{2A} and the local environmental factor K_{3A} shall be equal to or less than 4 dB;
- 2) difference between the background emission sound pressure level and the workstation sound pressure level shall be equal to or greater than 6 dB;
- 3) correction of the local environmental factor K_{3A} shall be calculated in accordance with the requirements of A.2 of EN ISO 11204:1995 with the reference restricted to EN ISO 3746:1996 instead of the method given in Annex A of EN ISO 11202:1995, or in accordance with EN ISO 3743-1:1995, EN ISO 3743-2:1996, EN ISO 3744:1995 or EN ISO 3745:2003 where one of these standards has been used as the measuring method.

For noise declaration 6.3 l) shall be met.



5.4.3 Emission of chips and dust

Provision shall be made for the extraction of dust and chips from the machine by providing outlets, so as to enable the machine to be connected to the user's dust extraction system.

Access to the tools through the chip and dust extraction outlet shall be prevented in accordance with the safety distances of Table 4 of EN 294:1992 (also see 6.3 o)).

To ensure that the chip and dust extracted from the point of origin are conveyed to the collection system, the design of hoods, ducts and baffles etc. shall be based on a conveying velocity of extracted air in the duct of 20 m s^{-1} for dry chips and 28 m s^{-1} for wet chips (moisture content 18 % or above).

Verification: By checking the relevant drawings and inspection of the machine.

5.4.4 Electricity

The requirements of EN 60204-1:2006 apply unless otherwise stated in this document.

In particular see Clause 6 of EN 60204-1:2006 for the prevention of electric shock and Clause 7 of EN 60204-1:2006 for protection against short circuiting and for protection against overloading. The degree of protection of all electric components shall be a minimum of IP 54 in accordance with EN 60529:1991.

Electrical enclosures shall not be exposed to risk from ejection of tools and workpieces. Live parts shall not be accessible in accordance with 6.2.2 of EN 60204-1:2006. Fire risk is not present where power circuits are protected against over current in accordance with 7.2.2 of EN 60204-1:2006.

In accordance with 18.2 and 18.6 of EN 60204-1:2006 the test for the continuity of the protective bonding circuit and functional tests apply.

Verification: By checking the relevant drawings, circuit diagrams, inspection of the machine and relevant continuity of protective bonding circuit and functional tests (specified in 18.2 and 18.6 EN 60204-1:2006).

NOTE For the components characteristics confirmation from the components' manufacturers can be useful.

5.4.5 Ergonomics and handling

The machine and its controls shall be designed according to ergonomic principles of EN 1005-4:2005 to enable work postures that are not fatiguing.

The height of the workpiece support should normally be between 750 mm and 900 mm above the floor level.

The positioning and labelling of control devices shall be in accordance with the ergonomic principles of EN 894-1:1997, EN 894-2:1997, EN 894-3:2000, EN 1005-1:2001, EN 1005-2:2003 and EN 1005-3:2002.

Parts of the machine weighing more than 25 kg and that need to be replaced/removed shall be equipped with means for safe handling or enable safe lifting, such as attachments to accommodate the fitting of a lifting device in accordance with EN 1005-2:2003.

Tanks containing hydraulic fluid, compressed air drainers and oilers shall be placed or oriented in such a way that the filler and drain pipes can be easily reached.

NOTE Useful information on ergonomics can also be found in EN 60204-1:2006, EN 614-1:2006, EN 614-2:2000 and EN 1005-3:2002.

Also see 5.2.2 and 6.3 g).

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

5.4.6 Lighting

Where necessary on the machine, work stations and the zones in which control devices, guards and protective devices are located shall be lit sufficiently to ensure that all work equipment and materials can be properly seen, and that eye strain is also avoided in accordance with EN 1837:1999.

Where lighting is required as determined by reference to EN 1837:1999 it shall be provided in accordance with 16.2 of EN 60204-1:2006.

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

5.4.7 Pneumatics

Pneumatic power systems and their components shall comply with EN 983:1996.

See also 5.2.1 and 5.3.8.

5.4.8 Hydraulics

Hydraulic power systems and their components shall comply with EN 982:1996.

See also 5.2.1, 5.3.8.

5.4.9 Static electricity

If the machine is fitted with flexible hoses for chip and dust extraction, the hoses shall be able to lead charge to earth potential.

Verification: By checking the relevant drawings and inspection of the machine.

5.4.10 Electromagnetic compatibility

The machine shall have sufficient immunity to electromagnetic disturbances to enable it to operate correctly in accordance with EN 60439-1:1999, EN 50370-1:2005 and EN 50370-2:2003.

NOTE Machines which incorporate CE-marked electrical components and where such components and cabling are installed in accordance with their respective manufacturers instructions, are generally considered to be protected against external electromagnetic interference.

For control systems with electronic components see Annex F.

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

5.4.11 Lasers

If the machine is fitted with a laser, the laser shall be of category 2, category 2 M or a lower risk category in accordance with the requirements of EN 60825-1:1994 (also see 6.3 k)).

All the provision of the laser manufacturer associated to the installing and the use of this laser shall be fulfilled and the instruction shall be repeated in the machine instruction manual. Warning label and advice on the use of eye protector if any shall be provided on the machine near operator position.

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



5.4.12 Unintended movements

Any hazardous movement by gravity shall be prevented e.g. by means of fall arresters capable to withstand the stresses to which they are subject.

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

5.4.13 Supply disconnecting devices

The principles of 4.10 and 5.5.4 of EN ISO 12100-2:2003 shall be observed and in addition:

Electrical isolators shall be in accordance with 5.3 of EN 60204-1:2006, except that the isolator shall not be type d) in 5.3.2 of EN 60204-1:2006.

On machines where pneumatic power is only used for workpiece clamping, isolation shall be possible at least through a quick action coupling according to 5.3.4.2.7 of EN 983:1996 which does not require a means of locking.

If pneumatic energy is also used for other purposes, it shall be possible to isolate the pneumatic supply by a manually operated lockable mechanical valve. The device shall include means permitting it only to be locked in the off position (e.g. by a padlock). Dumping pneumatic pressure shall not be by disconnection of a pipe.

The machine shall have means to isolate hydraulic power (if provided) according to EN 982:1996.

Where the machine has a hydraulic system that is powered by an integral electrically operated hydraulic pump, isolation of the hydraulic power is allowed by disconnecting the electrical supply. Where hydraulic energy is stored, e.g. in a reservoir or pipe, safe means for dumping of residual pressure shall be provided. Safe means can include a valve but does not include disconnection of any pipe.

The electric isolator shall have its function, location and operational position clearly identified, e.g. by a label or a pictogram. The label or pictogram shall be fitted in a position clearly visible in close proximity to the isolator on the machine (also see 6.2 e)).

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

5.4.14 Maintenance

The principles of 4.15 of EN ISO 12100-2:2003 shall be observed and in addition:

The information for maintenance listed in 6.5.1 under e) of EN ISO 12100-2:2003 shall be provided.

Also see 6.3 m), p).

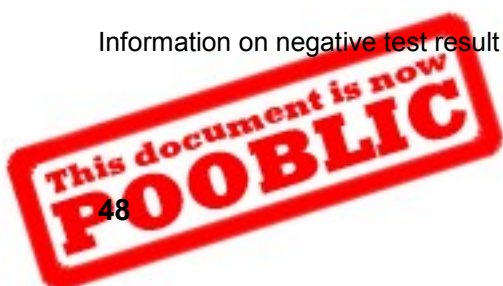
Verification: By checking the relevant drawings, handbook, inspection of the machine and functional testing on the machine.

6 Information for use

6.1 Warning devices

The principles of Clause 6 of EN ISO 12100-2:2003 shall be observed, the requirements of EN 847-1:2005, EN 847-2:2001 shall apply and in addition:

Information on negative test result of braking system shall be displayed.



An audible or visual warning (e.g. a yellow light) of impending start up of machines fitted with access door to peripheral enclosure shall be provided.

If the machine is equipped with a pneumatic supply and isolation of the pneumatic energy is not achieved by the electrical isolation a permanent warning label shall be placed in proximity to the electrical supply disconnection device, warning that the pneumatic supply is not isolated by isolation of the electrical supply.

The warnings shall either be in the language of the country in which the machine is to be used or wherever possible by using pictograms.

Also see 5.3.7.1.2.

Verification: By checking the relevant drawings and inspection of the machine.

6.2 Marking

The principles of 6.4 of EN ISO 12100-2:2003 shall be observed and in addition, the machine shall be permanently marked with:

- a) name and address of the machine manufacturer;
- b) designation of series or type;
- c) machine serial number if any;
- d) year of construction;
- e) where fitted with a hydraulic and/or pneumatic system with nominal pressure for the hydraulic and/or pneumatic circuits;
- f) rating information (mandatory for electro-technical products: voltage, frequency, power, in accordance with 16.4 of EN 60204-1:2006);
- g) where fitted with hydraulic and/or pneumatic isolators they shall have their function, location and operational position(s) clearly identified e.g. by a label or a pictogram.

Machines fitted with a peripheral enclosure which is fitted with an access door and on machines fitted with a partial enclosure shall be marked with a permanent warning label placed at the machining head warning that only milling tools with a cutting circle diameter below 16 mm or milling tools or saw-blades conforming to EN 847-1:2005 and EN 847-2:2001 and boring tools or sanding wheels shall be used.

The labels or pictograms for marking the nominal pressure and the isolators shall be fitted in a position in close proximity to the installed location of the relevant isolator on the machine.

All written information presented on the machine, including warnings shall be in the language of the country in which the machine is to be used.

NOTE Wherever possible it is recommended to use pictograms.

Verification: By checking the relevant drawings, inspection of the machine.

6.3 Instruction handbook

The safety instructions and information shall be in the language of the country where the machine is to be used.

The principles of 6.5 of EN ISO 12100-2:2003 shall be observed and in addition the instruction handbook shall at least include



- a) repetition of the markings, pictograms and other instructions on the machine as described in 6.1 and 6.2 and, if necessary, information about their meaning;
- b) intended use of the machine;
- c) maximum length, width and thickness of the workpiece;
- d) warning regarding residual risk. In particular the risk of off-cut ejection. It shall be recommended that the off-cut is clamped e.g. by mechanical clamp or the risk is completely avoided by machining. Such measures include:
 - 1) to take precautions to reduce the hazard of inhalation of harmful dusts (e.g. wearing a dust mask);
 - 2) to wear eye protection;
 - 3) to wear ear protection to prevent hearing loss and
 - 4) to wear gloves against the hazard of cutting when handling tools, feeding wood into the machine or doing maintenance;
 - 5) not to try removing chips whilst the tool is running and the machining head is not in the rest position;
 - 6) not to try using the machine unless all of the guards and other safety devices necessary for machining are in good working order;
- e) instruction for installation to ensure that the machine is stable and securely fixed to the floor or a stable structure and how this is to be done;
- f) instruction for setting the machine. This includes the precautions during setting as:
 - 1) a warning that before setting the machine it is necessary, to ensure that the tools used are sharpened, selected, maintained and adjusted in accordance with the tool manufacturer's instructions, to use special equipment for setting (e.g. gauges) where practicable and to take care when handling tools;
 - 2) that during setting it shall be verified that no contact exists between non rotating tools and any workpiece clamping device or machine element;
 - 3) instructions for clamping device mounting, setting and use;
 - 4) information regarding the required clamping pressure (e.g. vacuum and minimum clamping surfaces of the workpiece if the machine is fitted with vacuum clamping);
 - 5) adjustment method for the pressure devices and the method for fixing auxiliaries;
 - 6) method for choosing the spindle speed taking into account the work to be done and the tool used. The relationship between the tool diameter the cutting length and the maximum rotational speed of the spindle is important. Examples may be given for the most common cutting lengths;
 - 7) instruction for the use special equipment e.g. gauges for setting the tool when machine is at a stand still;
 - 8) instruction for adjustment and use of the safeguarding prescribed in 5.3.7.1;
- g) instruction for safe use in accordance with 6.5.1 d) of EN ISO 12100-2:2003 including indication of work station(s), necessary information for operators to be adequately trained in the adjustment and operation of the machine including the correct use. This includes taking precautions during machining such as:
 - 1) the hazards associated with the operation of the machine;

- 2) the principles of machine operation, correct use and adjustment of the jigs and guards;
- 3) the correct selection of tools for each operation. This includes the precautions during machining as:
 - iii) the range of milling tool diameters and thicknesses which are suitable for the machine;
 - iv) that only milling tools and/or saw blades manufactured in accordance with EN 847-1:2005 and EN 847-2:2001 shall be used;
- 4) information regarding the requirements for other tools e.g. boring tools, sanding wheels etc. that can be used on the machine;
- 5) the instruction for the selection of spindle speed taking into account the tool being used in order that the maximum permissible speed of the tool is not exceeded;
- 6) the instructions to minimise noise levels including:
 - i) condition of the tools;
 - ii) guards positioning so as to reduce noise levels;
 - v) choice of the tooling speed to reduce the noise levels;
- 7) recommendation on care to be taken when handling tools and on use of tool carriers wherever practicable;
- 8) the safe clamping of the workpiece when cutting;
- 9) instruction on those devices which shall be verified, how frequently the verification shall be carried out and by what method. This shall include at least the following:
 - i) emergency stop(s) - by functional test;
 - ii) interlocked guards - by opening each guard in turn to stop the machine and by proving the inability to start the machine with each guard in the open position;
 - iii) interlocked guards with guard locking - by proving an inability to open the guard as long the tool is rotating;
 - iv) curtains maintenance – by check of absence of damage (at least each month);
 - v) vacuum clamping – by functional test.
- 10) use of personal protective equipment e.g. for noise, inhalation of harmful dust and eye protection;
- 11) instructions that the dust extraction equipment is to be switched on before commencing machining;
- h) a warning that the selection of spindle speed shall be carefully considered by the user by taking into account the tool being used in order that the maximum permissible speed of the tool is not exceeded;
- i) for machines equipped with hydrostatic tool fixing facilities, only tool fixing devices with additional mechanical device to protect against loosening of the tool in case of leakage in the hydrostatic system shall be used;
- j) guidance for use including the type of wood and recommendations regarding the minimum workpiece clamping area;



- k) where a laser is fitted to the machine the laser manufacturer's instructions required by EN 60825-1:1994 shall be provided with a recommendation that no exchange with a different type of laser shall be done, that no additional optical equipment shall be used and that repair shall only be carried out by the laser manufacturer or other authorised persons;
- l) information concerning airborne noise emissions by the machinery, either the actual value or a value established on the basis of measurements made on identical machinery, measured in accordance with the methods given in 5.4.2.2:

A-weighted emission sound pressure levels at workstations;

A-weighted sound power level emitted by the machinery.

In the case of very large machinery (i.e. machines with at least one dimension exceeding 7 m), instead of the sound power level, the emission sound pressure levels at specified positions around the machinery may be indicated.

The declaration shall be accompanied by a statement of the measuring method used and the operating conditions applied during the test, and associated uncertainty K using the dual-number form of declaration in accordance with EN ISO 4871:1996 as follows:

4 dB when using EN ISO 3746:1995 and EN ISO 11202:1995;

2 dB when using EN ISO 3743-1:1995, EN ISO 3743-2:1996 or EN ISO 3744:1995;

1 dB when using EN ISO 3745:2003.

For example, for a sound power level $L_{WA} = 93$ dB (measured value)

Associated uncertainty $K = 4$ dB

Measured in accordance with EN ISO 3746:1995

If a verification of the declared noise emission values is required, it shall be conducted by using the same mounting, installation and operating conditions as those used for the initial determination of noise emission values. The noise declaration in the instruction handbook shall be accompanied by the following statement:

"The figures quoted are emission levels and are not necessarily safe working levels. Whilst there is a correlation between the emission and exposure levels, this cannot be used reliably to determine whether or not further precautions are required. Factors that influence the actual level of exposure of the work-force include the characteristics of the work room, the other sources of noise etc., i.e. the number of machines and other adjacent processes. Also the permissible exposure level can vary from country to country. This information, however, will enable the user of the machine to make a better evaluation of the hazard and risk".

- m) installation and maintenance requirements for the machine and its safety equipment e.g. curtains pressure sensitive bumpers and pressure sensitive mats including a list of those devices which shall be verified, how frequently the verification shall be carried out and by what method;
- n) information regarding the dust extraction equipment fitted to the machine as follows:
 - 1) airflow in $\text{m}^3 \text{h}^{-1}$;
 - 2) pressure drop at each dust extraction connection outlet at 20 m s^{-1} of air velocity;
 - 3) recommended conveying air velocity in the duct in m s^{-1} ;
 - 4) cross section dimensions and details of each connection.

- o) information that during indoor use the machine shall be connected to an external chip and dust extraction system;

NOTE External chip and dust extraction equipment with fixed installations are dealt with in EN 12779:2004.

- p) information on how to perform maintenance and that whenever possible maintenance shall be only done if the machine is isolated from all energy sources and involuntary restart is prevented;
- q) information about safe cleaning;
- r) if fitted with a pneumatic and/or hydraulic system the method for the safe dissipation of residual energy (see 5.4.13);

Verification: By checking the instruction handbook and the relevant drawings.



Annex A (informative)

Use of well tried components

In particular the requirements of the following relevant standards should be applied when considering safety related parts to be well-tried in accordance with the requirements of 6.2.4 of EN ISO 13849-1:2006:

- a) for electrical components (see also Tables D.1 to D.17 of EN ISO 13849-2:2003):
 - 1) EN 60947-5-1:2004 (section 3) for control switches with positive opening operation used as mechanically actuated position detectors for interlocking of guards and for relays used in auxiliary circuits;
 - 2) EN 60947-4-1:2001 for electromechanical contractors and motor starters used in mains circuits;
 - 3) HD 22.1 S4:2002 for rubber insulated cables;
 - 4) HD 21.1 S4:2002 for polyvinyl chloride cables if these cables are additionally protected against mechanical damage by positioning (e.g. inside frames).
- b) electrical control circuits if they also are in accordance with the first four measures listed in 9.4.2.1 of EN 60204-1:2006 (see also Tables D.1 and D.2 of EN ISO 13849-2:2003);
- c) mechanical components if, for example they operate in the positive mode in accordance with the description given in 4.5 of EN ISO 12100-2:2003;
- d) mechanically actuated position detectors for guards if they are actuated in the positive mode and their arrangement/fastening and the cam design/mounting complies with 5.2 and 5.3 of EN 1088:1995 (see also Tables A.1 to A.5 of EN ISO 13849-2:2003);
- e) interlocking devices with guard locking if they are a minimum of conditional unlocking type in accordance with Annex M of EN 1088:1995;
- f) pneumatic and hydraulic components and systems if they comply with EN 983:1996 and EN 982:1996 respectively (see also Tables B.1 to B.18 and Tables C.1 to C.12 of EN ISO 13849-2:2003).

For all components exposed to environmental conditions, e.g. dust and/or gases, these conditions should be taken into account.

NOTE 1 Well tried electrical components are listed in Table D.3 of EN ISO 13849-2:2003.

NOTE 2 EN ISO 13849-2:2003 gives useful information on assessment of well-tried components, possible exclusion of faults etc.



Annex B (normative)

Operating conditions for noise measurement

B.1 General

For NC routing machines the operating conditions for noise measurements shall comply with the requirements of B.2.

For NC boring machines the operating conditions for noise measurements shall comply with the requirements of B.3.

For NC combined routing and boring machines two different measurements in accordance with 5.4.2.2 shall be performed and they shall comply with the requirements of B.2 and B.3 respectively.

For machines where the requirements of B.2, and B.3 are not applicable e.g. for spindle speed, or tool diameter, the detailed operating conditions used shall be given in the test report.

The mounting and operating conditions of the machine shall be identical for the determination of emission sound pressure levels at the operator's position and sound power levels.

B.2 Operating conditions for routing units of NC routing machines and NC combined boring/routing machines

B.2.1 General

This subclause contains a series of standard operating conditions to be applied in connection with measurement of noise from NC routing machines and NC combined boring/routing machines. Microphone positions are specified in order to allow the measurement of sound pressure level at the operator's position and for determining the sound power level of a machine of this type.

These standard conditions shall be complied with as closely as possible. If, in a specific situation, it is necessary to deviate from them, the actual conditions applied for the test shall be recorded where a blank space in the column "Condition chosen within permitted range or conditions deviating from standard" allows for such a situation.

All mandatory and standard safety attachments shall be mounted and in use during the tests.

The data sheet included in this annex may also be used to record operating condition information.

This subclause shall be used for the measurement of noise from machines as shown in Table B.1.

Table B.1 — Machine classification

Machine type	Machine classification number (as shown in ISO 7984:1988)
NC routing machines and NC combined boring/routing machines	12.315.19

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This subclause may also be applied to the measurement of noise from machines having a similar construction and function.

B.2.2 Noise measurements

B.2.2.1 Test conditions

The machine shall be tested under the following conditions:

- a) no load in accordance with specifications in this clause;
- b) loaded as specified in this annex. The measurement result is the average of a series of at least three operations, in accordance with 5.4.2. During the first and last part of the work cycle, when the tool enters or leaves the work piece, a higher level of noise may be emitted. These parts of the operating cycle shall not be included in the measurement;
- c) integrating sound level meters shall be used.

B.2.2.2 Microphone positions

B.2.2.2.1 Operator position

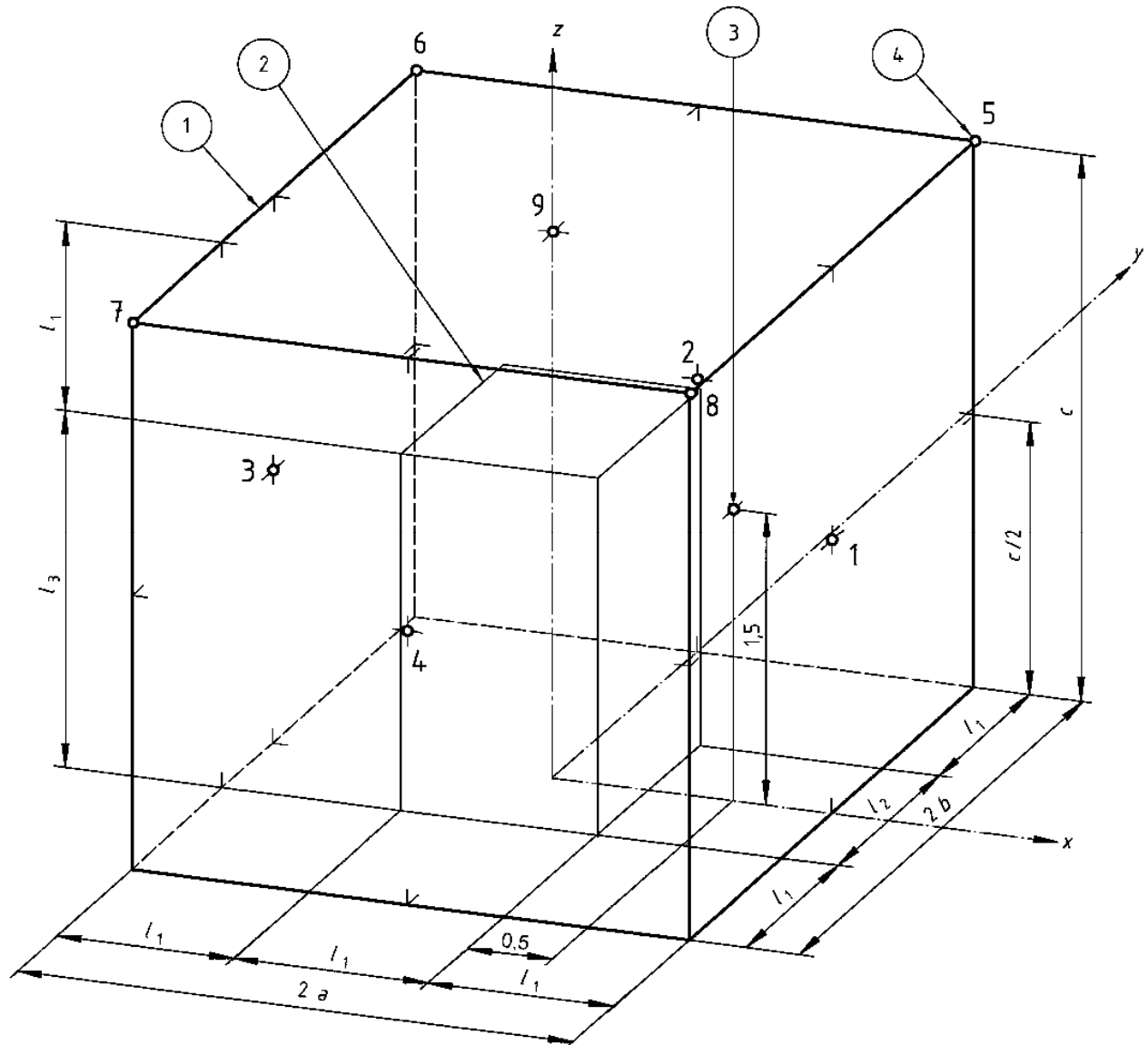
The microphone used to measure the emitted noise at the position of the operator shall be situated as follows:

- a) 1,5 m above floor level and
- b) for machines with change loading in front of the middle of the machining station, 0,5 m along the x-axis in front of the middle of the reference box (machine or enclosure surface), or
- c) 0,5 m in front of the front line of pressure sensitive mat or light barrier in front of the machining station.

B.2.2.2.2 Other microphone positions

The microphones used for the measurement of the sound power level emitted by the machine shall be situated as shown in Figure B.1.

Dimensions in meter

**Key**

- 1 measurement surface
- 2 reference box
- 3 operator position microphone location
- 4 measuring microphone positions

Figure B.1 — Microphone positions for noise measurement of routing units of NC routing machines and NC combined boring/routing machines

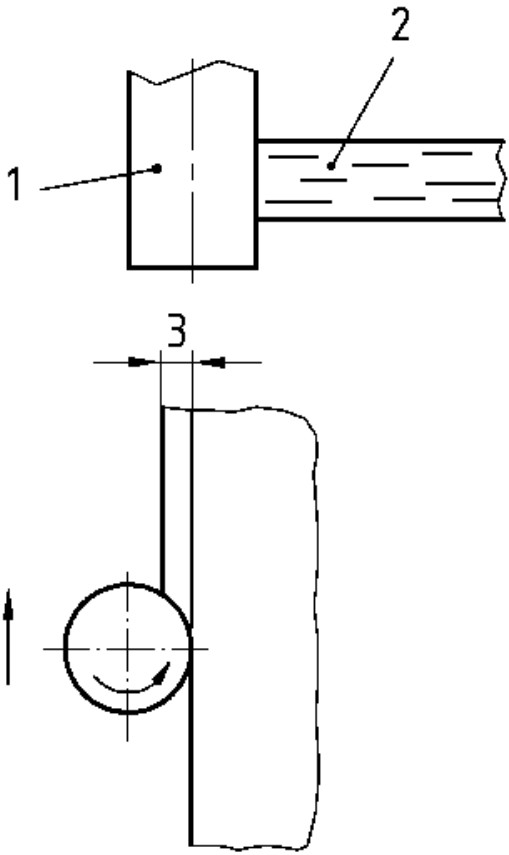
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B.2.3 General data sheet

Machine data	Make :																																										
	Model :																																										
	Year of manufacture :		Serial n° :																																								
	Overall dimensions of machine ^a																																										
	Length l ₁ : mm	Width l ₂ : mm	Height l ₃ : mm																																								
	<table border="1"> <thead> <tr> <th>Nominal spindle speed min⁻¹</th> <th>Spindle speed min⁻¹</th> <th>Head assembly</th> </tr> </thead> <tbody> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> </tbody> </table>			Nominal spindle speed min ⁻¹	Spindle speed min ⁻¹	Head assembly																																					
Nominal spindle speed min ⁻¹	Spindle speed min ⁻¹	Head assembly																																									
	☐ Attached frequency converter ☐ Separate frequency converter ☐ Attached static converter ☐ Change loading																																										
Machine installation	Remarks/description <table> <tr> <td>Machine installed according to manufacturer's recommendations</td> <td>yes</td> <td>☐</td> <td>.....</td> </tr> <tr> <td>Machine installed with dust extraction according to manufacturer's specifications</td> <td>no</td> <td>☐</td> <td>.....</td> </tr> <tr> <td>Machine mounted on vibration damping/isolation material</td> <td>yes</td> <td>☐</td> <td>.....</td> </tr> <tr> <td>Machine fitted in separate noise enclosure</td> <td>no</td> <td>☐</td> <td>.....</td> </tr> <tr> <td>Machine equipped with integral noise enclosure</td> <td>yes</td> <td>☐</td> <td>.....</td> </tr> <tr> <td></td> <td>no</td> <td>☐</td> <td>.....</td> </tr> <tr> <td>Machine equipped with noise reducing hood</td> <td>yes</td> <td>☐</td> <td>.....</td> </tr> <tr> <td></td> <td>no</td> <td>☐</td> <td>.....</td> </tr> <tr> <td>Other noise control measures</td> <td>yes</td> <td>☐</td> <td>.....</td> </tr> <tr> <td></td> <td>no</td> <td>☐</td> <td>.....</td> </tr> </table>			Machine installed according to manufacturer's recommendations	yes	☐		Machine installed with dust extraction according to manufacturer's specifications	no	☐		Machine mounted on vibration damping/isolation material	yes	☐		Machine fitted in separate noise enclosure	no	☐		Machine equipped with integral noise enclosure	yes	☐			no	☐		Machine equipped with noise reducing hood	yes	☐			no	☐		Other noise control measures	yes	☐			no	☐	
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Other noise control measures	yes	☐																																									
	no	☐																																									
^a Those elements which protrude from the machine and which are not likely to contribute to the noise emission (e.g. hand-wheels, levers) may be disregarded.																																											

(to be continued)

B.2.3 General data sheet (continued)

Testing operation Operating arrangement	Routing particle board edges  Key 1 router bit 2 particle board 3 cutting depth Direction of work: x-axis : i.e. on the front edge on the side facing the loading position. Position of the workpiece: in the middle of the table for machines with one table or two synchronised tables or against the right side of the left table for machines with two independent tables.	Standard condition(s)	Condition chosen within permitted range or conditions deviating from standard
Tool and cutting data	Type of tool: Router bit with shaft, carbide-tipped, straight not interrupted knife-edges. Spindle speed ^b min⁻¹ 18 000 Cutting circle diameter mm 25 Cutting speed m s⁻¹ Number of knives 2 Cutting knife length mm 40 to 50 Cutting depth mm 5 Feed rate m min⁻¹ 6 Cutting principle: cutter rotation against the feed		

^b The spindle speed should be chosen as near as possible to 18 000 min⁻¹

(to be continued)

B.2.3 General data sheet (*concluded*)

Testing material	Material : Particle board, three-layer construction
	Moisture content : 6 % to 10 %
	Board thickness : 16 mm
	Board length : 800 mm
	Board width : 800 mm to 600 mm, processed down to a final width of approximately 300 mm
	Previous processing : none

Photo or detailed illustration of the machine tested	
--	--

Testing laboratory	Firm/Institution :
	Address :
	Telephone : Date :
	Signature :
	Test carried out :
	Place :
	Date :

B.3 Operating conditions for boring units of NC boring machines and NC combined boring/routing machines

B.3.1 General

This subclause contains a series of standard operating conditions to be applied in connection with measurement of noise from NC boring machines and NC combined boring/routing machines. Microphone positions are specified to allow measurement of sound pressure level at operator's position and for determining the sound power level of a machine of this type.

These standard conditions shall be complied with as closely as possible. If, in a specific situation, it is necessary to deviate from standard conditions, the actual condition applied for the test shall be recorded where a blank space in the column "Condition chosen within permitted range or conditions deviating from standard" allows for such a situation.

All mandatory and standard safety attachments shall be mounted and in use during the tests.

This clause may also serve as a data sheet on which information on operating conditions is recorded.

The present subclause shall be used in connection with measurement of noise from machines as shown in Table B.2.

Table B.2 — Machine classification

Machine type	Machine classification number (as shown in ISO 7984:1988)
NC boring machines and NC combined boring/routing machines	12.49

This subclause may also be applied for measurement of noise from special kinds of machines having a similar construction and function.

B.3.2 Noise measurements

B.3.2.1 Test conditions

The machine shall be tested under the following conditions:

- a) testing under no load in accordance with specifications in this subclause;
- b) testing under load as specified in this annex. The measurement result is the average of a series of at least three operations, in accordance with 5.4.2. During the first and last part of the work cycle, when the tool enters or leaves the work piece, a higher level of noise may be emitted. These parts of the operating cycle shall not be included in the measurement;
- c) integrating sound level meters shall be used.

B.3.2.2 Microphone positions

B.3.2.2.1 Operator position

The microphone used to measure the emitted noise at the position of the operator shall be situated as follows:

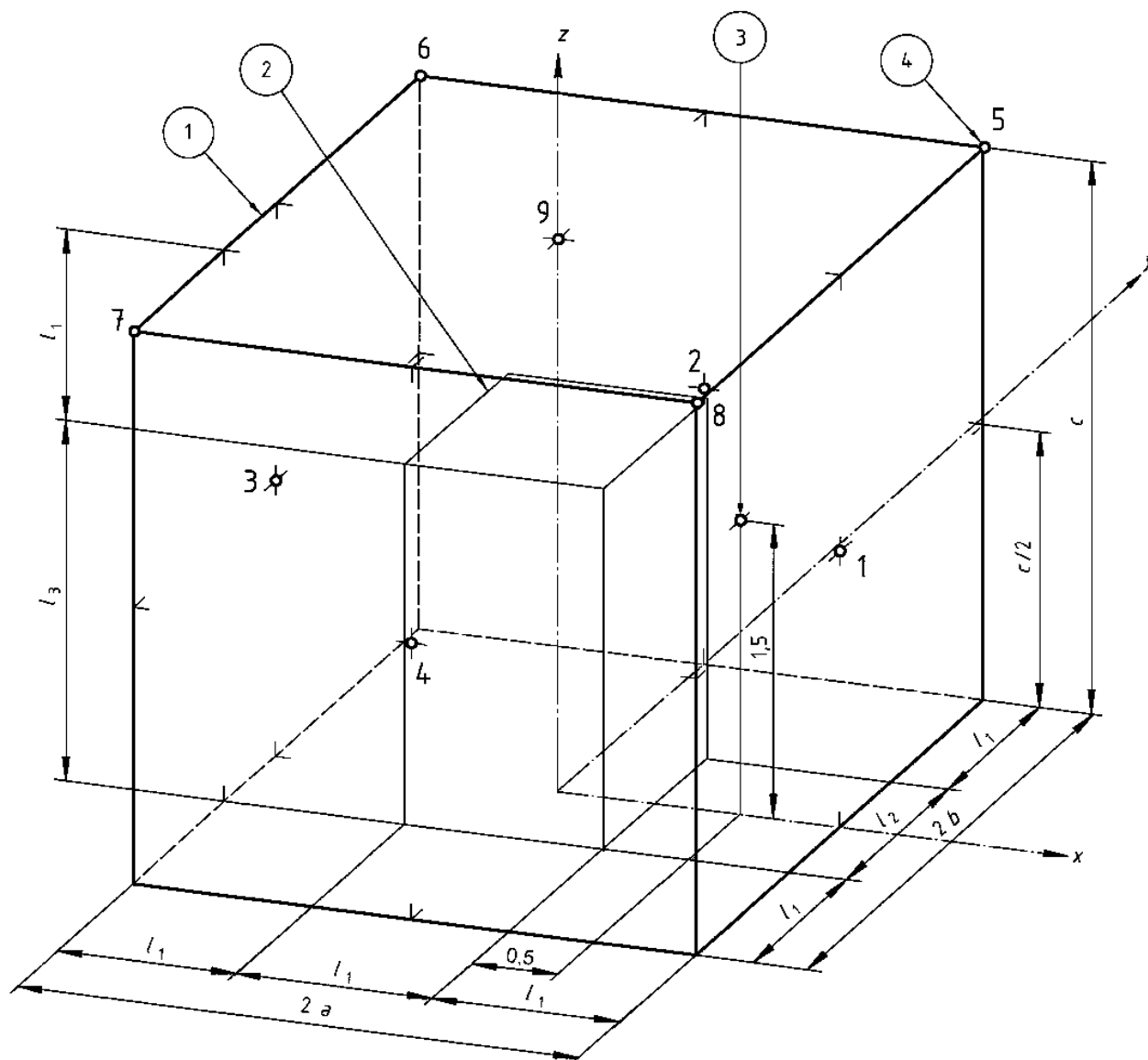
- a) 1,5 m above floor level and
- b) 0,5 m in front of the middle of the reference box (machine or enclosure surface) for machines with change loading in front of the middle of the machining station, or
- c) 0,5 m in front of the front line of pressure sensitive mat or light barrier in front of the machining station.



B.3.2.2.2 Other microphone positions

The microphones used for the measurement of the sound power level emitted by the machine shall be situated as shown in Figure B.2.

Dimensions in meter



Key

- 1 measurement surface
- 2 reference box
- 3 operator position microphone location
- 4 measuring microphone positions

Figure B.2 — Microphone positions for noise measurement of boring units of NC-Boring machines and NC combined boring/routing machines

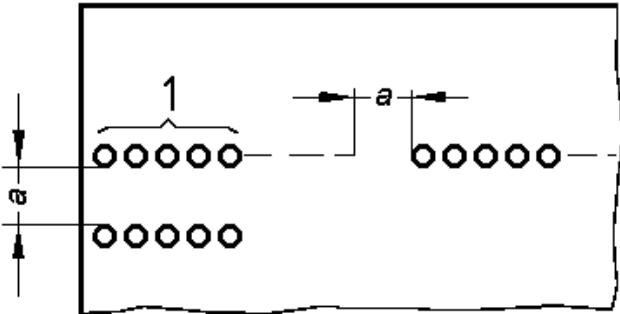
B.3.3 General data sheet

Machine data	Make : Model : Year of manufacture : Serial n° : Overall dimensions of machine ^a Length l₁ : mm Width l₂ : mm Height l₃ : mm <table border="1" data-bbox="478 696 1343 1055"> <thead> <tr> <th>Nominal spindle speed min⁻¹</th><th>Spindle speed min⁻¹</th><th>Head assembly</th></tr> </thead> <tbody> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td></tr> </tbody> </table> ☐ Attached frequency converter ☐ Separate frequency converter ☐ Attached static converter ☐ Change loading	Nominal spindle speed min ⁻¹	Spindle speed min ⁻¹	Head assembly												
Nominal spindle speed min ⁻¹	Spindle speed min ⁻¹	Head assembly														
Machine installation	Remarks/description Machine installed according to manufacturer's recommendations yes ☐ no ☐ Machine installed with dust extraction according to manufacturer's specifications yes ☐ no ☐ Machine mounted on vibration damping/isolation material yes ☐ no ☐ Machine fitted in separate noise enclosure yes ☐ no ☐ Machine equipped with integral noise enclosure yes ☐ no ☐ Machine equipped with noise reducing hood yes ☐ no ☐ Other noise control measures yes ☐ no ☐															
^a Those elements which protrude from the machine and which are not likely to contribute to the noise emission (e.g. hand-wheels, levers) may be disregarded.																

(to be continued)

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B.3.3 General data sheet (continued)

Testing operation Operating arrangement	 Key 1 10 bores Position of the work piece: In the middle of the table (one table or two synchronised tables) or against the right side of the left table (two independent tables).	Standard condition(s)	Condition chosen within permitted range or conditions deviating from standard
Tool and cutting data	Type of tool: Multiboring unit with bits, two flutes and centre point, left or right hand Spindle speed ^b min⁻¹ Number of bits n Bit diameter mm Bit working length mm Pitch mm Minimum distance <i>a</i> between a series of 10 bores mm Feed rate for boring m min⁻¹	18 000 10 or max. permissible 8 2 32 or producers specification 70 1	
Testing material	Material : Particle board, three-layer construction Moisture content : 6 % to 10 % Board thickness : 16 mm Board length : 800 mm Board width : 800 mm to 600 mm Previous processing : none		

^b The spindle speed should be chosen as near as possible to 18 000 min⁻¹.

(to be continued)

B.3.3 General data sheet (*concluded*)

Photo or detailed illustration of the machine tested	
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Testing laboratory	Firm/Institution : Address : Telephone : Date : Signature : Test carried out : Place : Date :
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Annex C (normative)

Curtains on NC routing and NC combined boring and routing machines – Impact test method

C.1 General

This annex defines tests for curtains used on NC routing machines and combined boring and routing machines in order to minimise risks of ejection of parts of tools out of the working zone.

This annex applies to curtains as well as on samples of materials.

C.2 Test method

C.2.1 Preliminary remarks

This test method reproduces the hazard of the ejection of tools parts. The test allows estimating the retention capacity of curtains against penetration and dislodgement from the machine by ejected parts from machine.

C.2.2 Testing equipment

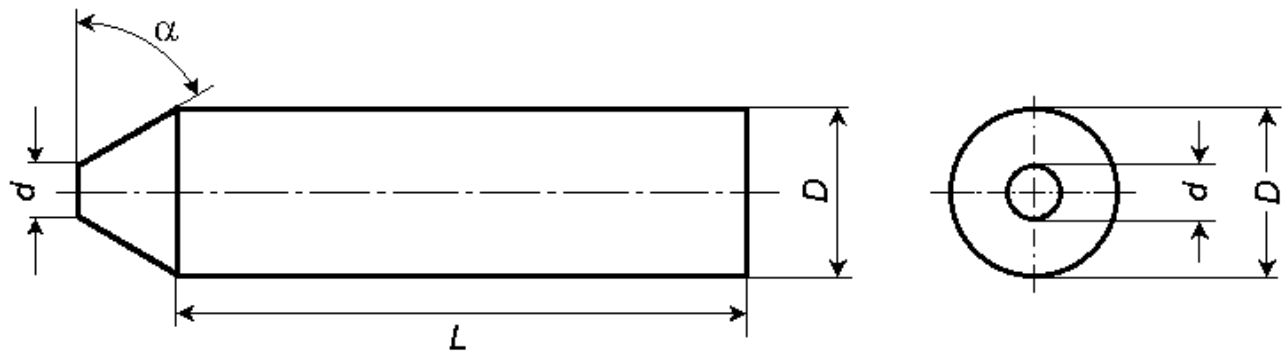
C.2.2.1 General

The testing equipment comprises a propulsion device, a projectile, a support for the test object and a system that allows measuring or recording the impact speed with an accuracy of $\pm 5\%$.

C.2.2.2 Projectiles

The shape, mass and dimensions of projectiles shall be as follows:

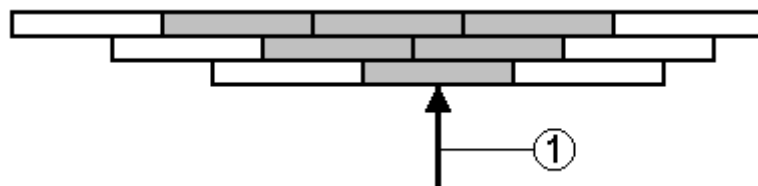
- a) shape: truncated cone with geometrical specification indicated in Figure C.1;
- b) mass: 20 g;
- c) material: steel;
- d) tensile strength: $R_m = 560 \text{ N mm}^{-2}$ to 690 N mm^{-2} ;
- e) yield strength: $R_{0,2} \geq 330 \text{ N mm}^{-2}$
- f) elongation at rupture: $A \geq 20\%$;
- g) hardened to 56_0^{+4} HRC over depth of at least 0,5 mm.

**Key** D 12 mm d 3 mm α 60°**Figure C.1 — Projectile for curtain test****C.2.2.3 Sampling and supporting the curtain under test**

The curtain support shall be able to maintain the fixed part of the curtain in position during the test.

The test sample shall have such dimension (width) that its behaviour is representative of the behaviour of a complete curtain: In practice it needs to consider a curtain assembly wide enough to contain all the stripes involved by the impact of the projectile.

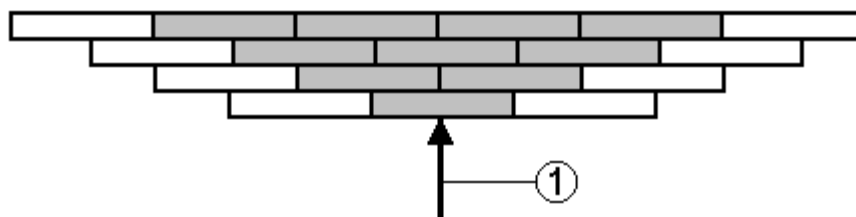
For example for a three layer assembly the test sample shall have the minimum width indicated in Figure C.2 where the stripes involved in the impact are indicated in grey.

**Key**

1 target point

Figure C.2 — Sample for curtain with 3 layers

For a four-layer assembly the test sample shall have the minimum width indicated in Figure C.3 where the stripes involved in the impact are indicated in grey.



Key

1 target point

Figure C.3 — Sample for curtain with 4 layers

C.2.3 Test procedure

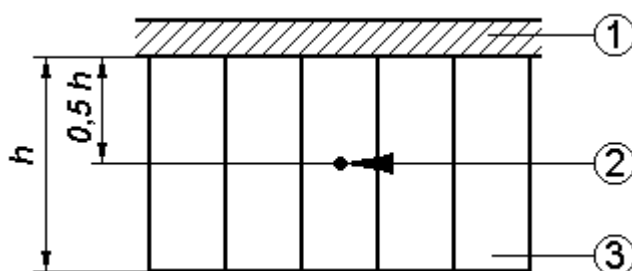
The impact test shall be performed with the projectile indicated in C.2.2.2 and with an impact speed of 70 m s^{-1} . Impact shall be as square as possible to the curtain surface.

The target point is indicated in Figure C.4.

The centre of the projectile tip shall hit the stripes in an area having a diameter of 3 mm around the target point.

The distance between the target and the exit of the projectile from the propulsion device shall be $250 \text{ mm} \pm 10 \text{ mm}$ (see Figure C.5).

Five tests shall be carried out and the projectile tip shall hit a different stripe at each test.



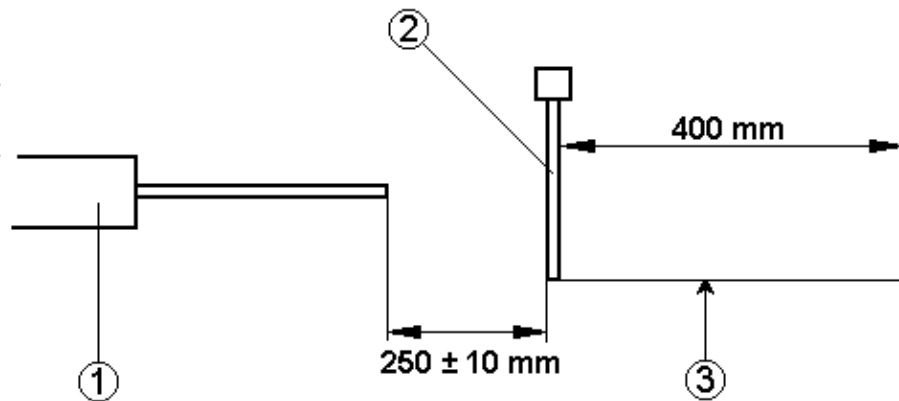
Key

1 support

2 target point

3 curtain stripes

Figure C.4 — Target point for curtains



Key

- 1 propulsion device
- 2 curtain
- 3 horizontal plane

Figure C.5 — Test arrangement for curtains

C.3 Results

The projectile shall not cross the vertical plane located at a distance of 400 mm from the curtain over the horizontal plane passing through the bottom edge of the test sample (see Figure C.5).

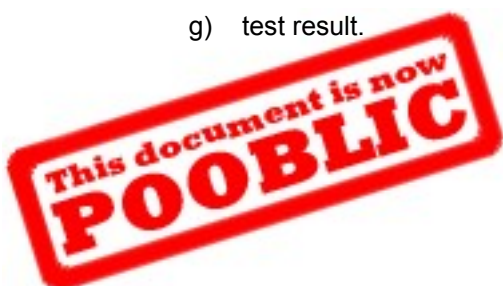
C.4 Assessment

The test is passed if all five tests out of the five tests are positive.

C.5 Test report

The test report shall give the following minimum information:

- a) date, place of the test and name of the testing institute;
- b) projectile mass, dimensions, speed;
- c) applicant identification;
- d) design, material and dimensions of the test object;
- e) clamping or fixing of the test object;
- f) direction of shock, point of impact of the projectile;
- g) test result.



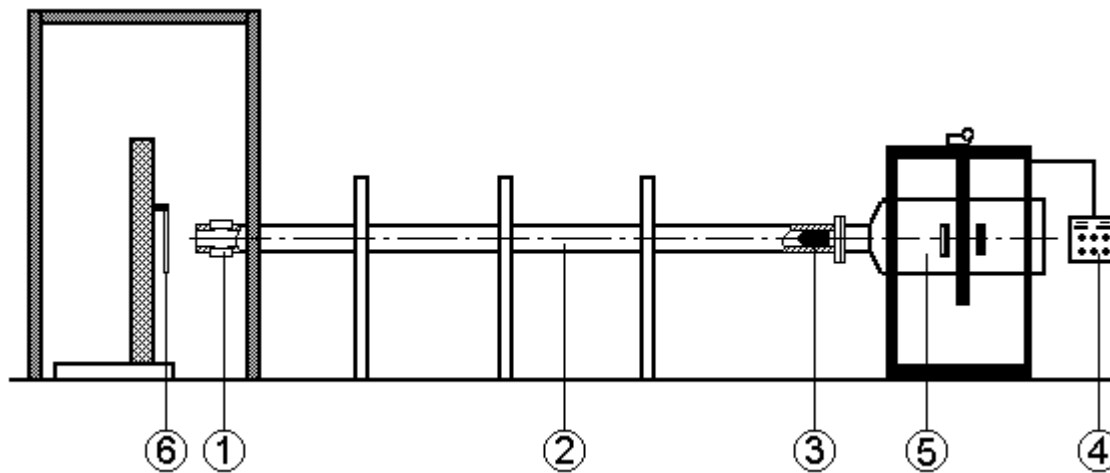
Annex D (informative)

Test equipment for impact test

The propulsion device consists of a compressed air vessel with flanged gun barrel (see Figure D.1). The compressed air may be released by a valve to accelerate the projectile toward the test object.

The air gun is fed by an air compressor. The speed of the projectile may be controlled by the pressure of the air.

The projectile speed is measured near the nozzle of the gun barrel by a suitable speedometer e.g. by proximity sensor or photocell.



Key

- 1 speedometer
- 2 gun barrel
- 3 projectile
- 4 control panel
- 5 compressed-air vessel
- 6 test object

Figure D.1 — Example of equipment for impact test

Annex E (normative)

Braking tests

E.1 Conditions for brake tests

- a) The spindle unit shall be set in accordance with the intended use of the machine (e.g. for belt tension) (see 6.3 b));
- b) when selecting the speed and the tools, conditions shall be chosen which create the greatest kinetic energy for which the machine is designed (the selection to take into account tool sizes, types, spindle speed etc.);
- c) before beginning the test the spindle unit shall be running for at least 15 min at no load (idle speed);
- d) verify that the actual spindle speed is within 10 % of the intended speed;
- e) the speed measuring equipment shall have an accuracy $\leq 1\%$ of full scale;
- f) the time measuring equipment shall have an accuracy $\leq 0,1$ s.

E.2 Tests

E.2.1 Un-braked run-down time

The un-braked run-down time shall be measured as follows:

- a) initiate spindle stop and measure the un-braked run-down time;
- b) restart the spindle drive motor and allow it to reach the intended speed;
- c) repeat steps a) and b) twice more.

The un-braked run-down time is the average of the three measurements taken.

E.2.2 Braked run-down time

The braked run-down time shall be measured as follows:

- a) initiate braking and measure the braked run-down time;
- b) allow the spindle to remain stationary for $\left(\frac{P}{7,5}\right)^2$ min where P is the motor power in kW;
- c) restart the spindle drive motor and run at no load for $\left(\frac{P}{7,5}\right)^2$ min;



d) repeat steps a) to c) nine times.

The braked run-down time is the average of the ten measurements taken.



Annex F (normative)

Use of electronic components

F.1 General

For the implementation of any safety related function with electronic equipment the appropriate requirements of EN ISO 13849-1:2006 shall apply.

The design of SRECS shall be such as to achieve the machine safety functions required in this document on base of the categories. Depending on the safety specifications the safety functions shall be achieved in category 2, 3 or 4 in accordance with the requirements of EN ISO 13849-1:2006.

SRECS shall be designed to be capable to fulfil the highest category required for the corresponding machine safety function in accordance with the requirements of EN ISO 13849-1:2006. On machines designed for different modes of operation the control system shall meet the safety requirements for the machine safety functions for each mode of operation.

Unless SRECS being part of a component for which a special standard exists they shall fulfil the environmental requirements in accordance with the requirements of 6.1 and 6.2 of EN 50178:1997.

Unless SRECS to category 2 being part of a component for which a special standard exists they shall fulfil the EMC requirements for type 2 in accordance with the requirements of EN 61496-1:2004. Unless SRECS to category 3 or 4 being part of a component for which a special standard exists they shall fulfil the EMC requirements for type 4 according to EN 61496-1:2004.

NOTE 1 Also see 5.4.10 for the EMC requirements of the complete machine.

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

NOTE 2 For the components characteristics a confirmation from the components' manufacturers may be used.

F.2 SRECS

F.2.1 Components, hardware

SRECS hardware components (including sensors, actuators, PLC's, CNC systems, logic solvers etc.) shall be designed and constructed in accordance with the requirements of the relevant standards and EN ISO 13849-1:2006.

SRECS hardware components (including sensors, actuators, PLC's, CNC systems, logic solvers etc.) shall be selected, assembled, combined and installed in accordance with the requirements of the technical instruction (including application and installation instructions) of the component's manufacturer.

A PLC fulfilling category 3 or 4 in accordance with the requirements of EN ISO 13849-1:2006 may be used in control systems for the implementation of the safety functions listed in 5.2.1.



NOTE 1 If a PLC is used, it should be noted that the overall response time could change in a defined range. The reaction time caused by the PLC depends mainly on the cycle time of the program. To consider the worst case it can be necessary to calculate with the double cycle time if no alarms or interrupts are used for faster switch off.

A PLC not fulfilling category 3 or 4 in accordance with the requirements of EN ISO 13849-1:2006 may only be a part of a SRP/CS up to category 3 e.g. as one channel of a dual channel system.

Verification: Verification shall be carried out against the specification(s) by checking relevant drawings and/or circuit diagrams, calculation and inspection of the machine.

NOTE For the components characteristics a confirmation from the components' manufacturers can be useful.

F.2.2 Safety related software

F.2.2.1 Embedded software

SRECS embedded software shall be in accordance with Clause 6 and Clause 7 of EN 61508-3:2001.

NOTE 1 Access to the embedded software of standard components is not possible by the end user.

Verification: Verification has to be carried out against the specification(s) by checking relevant drawings and/or circuit diagrams, calculation and inspection of the machine.

NOTE 2 For the embedded software a confirmation from the components' manufacturers can be useful.

F.2.2.2 Application software

Programming of the SRECS shall fulfil the instructions (technical manual) of the component's manufacturer.

The safety related software shall be clearly separated from the functional software to avoid inadvertent alteration of the safety related software.

It shall only be possible for authorised persons to modify the software of the SRECS. Where access to programmable functions at the numerical control or SRECS is provided during production and/or setting mode (e.g. for workpiece support, speed setting), unauthorised access to programmed data or programmable functions shall be prevented. In particular it shall not be possible for the user to suspend the operation of safety functions (e.g. ESPE using AOPD) by means of sequences inserted in or called up by the application programme. This may be achieved in the form of a password.

Clauses 6 and 7 of EN 61508-3:2001 shall be taken into account for the application software development.

NOTE 1 These requirements for application software can be achieved by use of techniques such as defensive programming, structured programming, modularity (i.e. logic/function blocks, sequence diagrams etc.), re-use of software modules that satisfy the above requirements, depending of the programming tool available with the SRECS.

NOTE 2 It is recommended to apply pre-certified software modules (e.g. two-hand controls, emergency stop) if available.

Verification: Verification has to be carried out against the specification(s) by checking relevant drawings and/or circuit diagrams, calculation and inspection of the machine.

F.2.3 Validation

A SRECS shall be validated to ensure that the specified machine safety function performance is achieved. This validation shall show that all parts interact correct to perform the safety function and that unintended functions do not occur.



Validation of the SRECS shall be in accordance with the requirements of EN ISO 13849-2:2003, i.e. by checking the relevant drawings and/or diagrams, flow charts, simulation of faults, inspection, measurement and relevant functional testing on the machine.

NOTE Validation includes the use of testing and analysis techniques (e.g. static, dynamic or failure analysis). These analysis techniques may be used to reduce the number of test cases.



Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide one means of conforming to Essential Requirements of the New Approach Machinery Directive 98/37/EC, amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard (except Annex F) confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

Table ZA — Correspondence between this European Standard and Directive 98/37/EC

Clause(s)/subclause(s) of this EN	Essential Requirements (ERs) of Directive 98/37/EC	Qualifying remarks/Notes
	1.1.2 Principle of safety integration	
5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.2.7, 5.2.8, 5.3.6, 5.3.8, 5.4.14, 6.3	a) fitted for its function	
Clauses 5 and 6	b) eliminate the risks, give measures, inform	
Clauses 5 and 6	c) use	
5.4.5	d) ergonomics	
5.4.5, 6.3	e) constraint in use	
5.3.1, 5.4.9, 6.3	f) equipment	
5.3.2, 5.3.5, 5.3.6, 5.3.7, 5.4.3	1.1.3 Materials and products	
5.4.6, 6.3	1.1.4 Lighting	
5.2.2, 5.3.7, 5.4.5	1.1.5 Design of machinery to facilitate its handling	
5.2.1, 5.2.7, 5.2.8, 5.2.11, 5.4.13	1.2.1 Safety and reliability of control systems	
5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.7, 6.3	1.2.2 Control devices	

5.2.2, 5.2.3, 5.2.7	1.2.3 Starting	
5.2.2, 5.2.4, 5.2.5, 5.2.6	1.2.4 Stopping device (normal stopping – emergency stop – complex installations)	
5.2.7, 5.2.8, 6.3	1.2.5 Mode selection	
5.2.10, 5.4.7, 5.4.13, 5.4.14	1.2.6 Failure of power supply	
5.2.1, 5.2.11, 5.4.13, 5.4.14	1.2.7 Failure of control circuit	
Annex F	1.2.8 Software	
5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.2.7, 5.2.8, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.6, 5.3.7, 5.3.8, 6.1, 6.2, 6.3	1.3 Protection against mechanical hazards	
5.3.1	1.3.1 Stability	
5.3.2, 6.3	1.3.2 Risk of break-up during operation	
5.3.2, 5.3.3, 5.3.5, 5.3.7	1.3.3 Risks due to falling or ejected objects	
5.1	1.3.4 Risk due to surfaces, edges or angles	
5.2.8	1.3.6 Risk relating in variations in the rotational speed of tools	
5.2.7, 5.3.7	1.3.7 Prevention of risks related to moving parts	
5.3.7	1.3.8 Choice of protection against risks related to moving parts (A moving transmission parts – B moving parts directly involved in the process)	
5.2.1.2, 5.3.7	1.4.1 Required characteristics of guards and protective devices	
5.3.2, 5.3.7	1.4.2 Special requirements for guards	
5.2.1.2, 5.3.7	1.4.3 Special requirements for protection devices	
5.2.10, 5.4.4, 5.4.13	1.5.1 Electricity supply	



5.4.9	1.5.2 Static electricity	
5.2.10, 5.4.6, 5.4.7	1.5.3 Energy supply other than electricity	
5.4.1	1.5.6 Fire	
5.4.2	1.5.8 Noise	
5.4.8, Annex F	1.5.11 External radiation	
5.4.11	1.5.12 Laser equipment	
5.4.3	1.5.13 Emission of dust, gases etc.	
5.4.14	1.6.1 Machinery maintenance	
5.2.2, 5.3.7, 5.4.14	1.6.2 Access to operating position and servicing	
5.4.13	1.6.3 Isolation of energy sources	
5.2.2, 5.2.6, 5.2.7, 5.2.8, 5.2.10, 5.3.7, 5.4.5, 5.4.14, 6.3	1.6.4 Operator intervention	
5.4.3, 6.3	1.6.5 Cleaning of internal parts	
5.2.1, 5.3.3, 5.4.5, 6.3	1.7.0 Information devices	
6.1	1.7.1 Warning devices	
6.2	1.7.3 Marking	
6.3	1.7.4 instructions	
5.3.6, 5.3.7 5.3.5 5.3.4	2.3 Machinery for working wood and analogous materials a) guiding b) ejection c) brake	

WARNING: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

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- [16] ISO 7984:1988, *Woodworking machines — Technical classification of woodworking machines and auxiliary machines for woodworking*

