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Machine tools — Safety — Stationary grinding machines (ISO 16089:2015)



National foreword

This British Standard is the UK implementation of EN ISO 16089:2015. It supersedes BS EN 13218:2002+A1:2008 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee MTE/1, Machine tools, to Subcommittee, Committee MTE/1/1, Machine tools - Safety.

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

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Machines-outils - Sécurité - Machines à meuler fixes
(ISO 16089:2015)

Werkzeugmaschinen - Sicherheit - Ortsfeste
Schleifmaschinen (ISO 16089:2015)

This European Standard was approved by CEN on 3 October 2015.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

This document (EN ISO 16089:2015) has been prepared by Technical Committee ISO/TC 39 "Machine tools" in collaboration with Technical Committee CEN/TC 143 "Machine tools - Safety" the secretariat of which is held by SNV.

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of an identical text or by endorsement, at the latest by June 2016, and conflicting national standards shall be withdrawn at the latest by June 2016.

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

This document supersedes EN 13218:2002+A1:2008.

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 EU Directive.

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

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, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 16089:2015 has been approved by CEN as EN ISO 16089:2015 without any modification.

Annex ZA
(informative)
**Relationship between this European Standard and the Essential
Requirements of EU Directive 2006/42/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 a means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC on machinery.

Once this standard is cited in the Official Journal of the European Union 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 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.

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

Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	3
3.1 General terms	3
3.2 Parts of grinding machines	5
3.3 Modes of safe operation (MSO)	6
3.4 Types and groups of grinding machines defined in this International Standard	7
3.4.1 General	7
3.4.2 Group 1: manually controlled grinding machine without power operated axes and without numerical control	9
3.4.3 Group 2: manually controlled grinding machine with power operated axes and, if applicable, with limited numerically controlled capability	10
3.4.4 Group 3: numerically controlled grinding machine	11
3.5 Speeds and axes speed	12
4 List of significant hazards	13
4.1 General	13
4.2 Main hazard zones	14
4.3 Significant hazards and hazardous situations covered by this International Standard	14
5 Safety requirements and/or measures	18
5.1 General requirements	18
5.1.1 General	18
5.1.2 Requirements for guards for all groups of grinding machines	19
5.2 Specific requirements resulting from mechanical hazards identified in Table 2, Nos. 1.1 - 1.4, 1.6 and 1.7	19
5.2.1 Group 1 machines, manually controlled grinding machines without power operated axes and without numerical control	19
5.2.2 Group 2 machines, manually controlled grinding machines with power operated axes and, if applicable, with limited numerically controlled capability	22
5.2.3 Group 3 machines, numerically controlled grinding machines	22
5.2.4 Tool holding device	24
5.2.5 Workpiece holding	24
5.2.6 Vertical or slant axes under gravity	25
5.2.7 Modes of machine operation	25
5.2.8 Optional or additional equipment for grinding machines	29
5.3 Specific requirements resulting from electrical hazards	31
5.4 Specific requirements resulting from noise hazards	32
5.5 Specific requirements resulting from vibration hazards	32
5.6 Specific requirements resulting from radiation hazards	32
5.7 Specific requirements resulting from materials or substance hazards	33
5.7.1 General	33
5.7.2 Devices for the use of metalworking fluids	33
5.7.3 Measures against fire and explosion hazards	34
5.8 Specific requirements resulting from neglect of ergonomic principles hazards	36
5.9 Specific requirements resulting from unexpected start-up, over-run, or over-speed hazards	37
5.10 Specific requirements resulting from variation in the rotational speed hazards	39
5.11 Specific requirements resulting from failure of the power supply hazards	39
5.12 Specific requirements resulting from failure of the control circuit hazards	40
5.13 Specific requirements resulting from ejected fluids or objects hazards	43
5.13.1 General requirements	43

5.13.2	Guards to prevent ejection in the event of abrasive product breakage	43
5.13.3	Devices protecting against ejection of workpieces and workpiece parts	44
5.14	Specific requirements resulting from loss of stability hazards	45
5.15	Specific requirements resulting from slips, trips and fall of persons hazards	45
6	Verification of the safety requirements and/or protective measures	45
7	Information for use	48
7.1	Marking	48
7.2	Instruction for use	48
7.2.1	General	48
7.2.2	Tooling	51
7.2.3	Workpiece holding	51
7.2.4	Machine functions accessible from the NC panel	51
7.2.5	Restart	52
7.2.6	Noise	52
7.2.7	Vibration	53
7.2.8	Ancillary handling devices	53
7.2.9	Residual risks to be addressed by the machinery user	53
7.2.10	Installation instructions for the grinding machine	54
7.2.11	Cleaning instruction for the machine	54
Annex A (normative)	Abrasive product guards, work zone enclosures, and their combinations	55
Annex B (informative)	Impact test for guards — Bursting test	94
Annex C (informative)	Impact test for guards — Projectile impact	97
Annex D (normative)	Clamping methods for abrasive products and safety requirements for tool holding devices	101
Annex E (informative)	Noise reduction	112
Annex F (informative)	Noise emission determination	113
Annex G (normative)	Requirements for grinding machines for the machining of materials generating flammable and explosive dusts	114
Annex H (informative)	Measures for the use of flammable metalworking fluids	117
Annex I (informative)	Examples for the integration of extraction and fire extinguishing systems when using flammable metalworking fluids	120
Annex J (informative)	Functional safety — Example for rotational speed limit monitoring of the wheel spindle	122
Annex K (informative)	MSO 3 (Optional special mode for manual intervention under restricted operating conditions) – Examples	125
Bibliography		130

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 10, *Safety*.

This first edition of ISO 16089 is an adaptation of European Standard EN 13218:2002+A1/AC:2010-04. Significant differences between the European Standard and ISO 16089 are as follows.

- a) Introduction of a subdivision of grinding machines into three groups, based on the degree of automation. Specific safety measures for safe design for each group of grinding machines.
- b) Introduction of the Mode of safe operation 3 (*optional special mode for manual intervention under restricted operating conditions*) with a separate selection device and specific safety measures, and a new informative Annex providing examples.
- c) Instead of the categories of EN 954-1, the required performance level according to ISO 13849-1 is defined for relevant safety functions.
- d) The decrease in the impact resistance of unprotected polycarbonate depending on the duration of use is shown in the form of an aging curve in Annex A.
- e) Measures for the use of flammable metalworking fluids are given in the new Annex H.
- f) Examples for the integration of extraction and fire extinguishing systems when using flammable metalworking fluids are given in the new Annex I.
- g) Example for rotational speed limit monitoring of the wheel spindle given in the new Annex K.

Introduction

In order to take technological progress into account, it was decided to revise EN 13218 for this purpose. Due to the worldwide use of these machines, an agreement was made by CEN/TC 143 and ISO/TC 39/SC 10. According to the Vienna Agreement, this revision was carried out as ISO 16089.

A decisive aspect for the preparation of this standard was the consideration of foreseeable misuse, e.g. by means of manipulation of protective devices.

Safety measures for grinding machines are, in particular, characterized by guards with interlocking and guard locking, to effectively counteract risks of fracture of ceramic tools. In some special cases of grinding operations, guards can be regarded as disturbing by the operator because they obstruct process monitoring. Then, by means of manipulation of the interlocking devices, automatic mode without guard can occur with dramatically increased hazards for the operator. To reduce the incentive for manipulation, the possibility of using a special mode (MSO 3) was provided in the operating mode concept for grinding machines such as in the preceding standard EN 13218. This implies the same strong safety measures as for the operating mode setting. These restrictions offer a significant motivation for switching back into automatic mode where higher speeds and feed rates are available for a more profitable production. Comparisons of risks show that the provision of a special mode presents a much lower risk than a manipulated automatic mode.

At the time this International Standard was developed, it was already foreseen that the information given in [A.3.2](#) on the wall thickness of abrasive product guards and in [A.3.5](#) on the work zone enclosure will probably be modified by an Amendment to this International Standard, depending on the result of further scientific research.

Machine tools — Safety — Stationary grinding machines

1 Scope

This International Standard specifies the requirements and/or measures to eliminate the hazards or reduce the risks in the following groups of stationary grinding machines which are designed primarily to shape metal by grinding:

Group 1: Manually controlled grinding machines without power operated axes and without numerical control.

Group 2: Manually controlled grinding machines with power operated axes and limited numerically controlled capability, if applicable.

Group 3: Numerically controlled grinding machines.

NOTE 1 For detailed information on the groups of grinding machines, see the definitions in [3.1](#) and [3.4](#).

NOTE 2 Requirements in this International Standard are, in general, applicable to all groups of grinding machines. If requirements are applicable to some special group(s) of grinding machines only, then the special group(s) of grinding machine(s) is/are specified.

This International Standard covers the significant hazards listed in [Clause 4](#) and applies to ancillary devices (e.g. for workpieces, tools, and workpiece holding devices, handling devices), which are integral to the machine.

This International Standard also applies to machines which are integrated into an automatic production line or grinding cell inasmuch as the hazards and risks arising are comparable to those of machines working separately.

This International Standard also includes in [Clause 7](#) a minimum list of safety-relevant information which the manufacturer has to provide to the user. See also ISO 12100:2010, Figure 2, which illustrates the interaction of manufacturer's and user's responsibility for the operational safety.

The user's responsibility to identify specific hazards (e.g. fire and explosion) and reduce the associated risks can be critical (e.g. whether the central extraction system is working correctly).

Where additional metalworking processes (e.g. milling, turning, laser processing) are involved, this International Standard can be taken as a basis for safety requirements. For specific information on hazards arising from other metalworking processes, which are covered by other International Standards, see the Bibliography.

This International Standard applies to machines that are manufactured after the date of issue of this International Standard.

This International Standard does not apply to stationary honing, polishing, and belt grinding machines and not to transportable motor-operated electric tools in accordance with IEC 61029-2-4 and IEC 61029-2-10.

2 Normative references

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

ISO 447, *Machine tools — Direction of operation of controls*

- ISO 2553, *Welding and allied processes — Symbolic representation on drawings — Welded joints*
- ISO 3834-1, *Quality requirements for fusion welding of metallic materials — Part 1: Criteria for the selection of the appropriate level of quality requirements*
- ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components*
- ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components*
- ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*
- ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*
- ISO 9355-1, *Ergonomic requirements for the design of displays and control actuators — Part 1: Human interactions with displays and control actuators*
- ISO 9355-2, *Ergonomic requirements for the design of displays and control actuators — Part 2: Displays*
- ISO 9355-3, *Ergonomic requirements for the design of displays and control actuators — Part 3: Control actuators*
- ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*
- ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*
- ISO 10218-1:2006, *Robots for industrial environments — Safety requirements — Part 1: Robots*
- ISO 11161, *Safety of machinery — Integrated manufacturing systems — Basic requirements*
- ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- ISO 13849-1:2006, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*
- ISO 13850, *Safety of machinery — Emergency stop — Principles for design*
- ISO 13856-2, *Safety of machinery — Pressure-sensitive protective devices — Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*
- ISO 13857:2008, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*
- ISO 14118:2000, *Safety of machinery — Prevention of unexpected start-up*
- ISO 14119:1998, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*
- ISO 14120:2002, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*
- ISO 14122-1, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means of access between two levels*
- ISO 14122-2, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*
- ISO 14122-3, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*
- ISO 14122-4, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 19719, *Machine tools — Work holding chucks — Vocabulary*

IEC 60204-1:2009, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

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

IEC 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments*

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

IEC 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

EN 1127-1, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100, ISO 13849-1, and the following apply.

3.1 General terms

3.1.1

grinding machine

machine tool intended to machine workpieces by means of rotating grinding tools

Note 1 to entry: The machine can combine different types of grinding methods, e.g. external cylindrical grinding and internal cylindrical grinding.

3.1.1.1

stationary grinding machine

grinding machine (3.1.1) fixed in position during operation

Note 1 to entry: For types and groups of stationary grinding machines, see 3.4.

Note 2 to entry: In the following text of this International Standard, the term “grinding machines” will stand for “stationary grinding machines”.

3.1.2

manual control

control where each movement of the machine is individually initiated and controlled by the operator

3.1.3

manually controlled grinding machine

grinding machine (3.1.1) for which all process steps for the machining are controlled or started by an operator without support by an NC-machining program

3.1.4

numerical control

NC

automatic control of a process performed by a device that makes use of numeric data introduced while operation is in progress

[SOURCE: ISO 2806:1994, 2.1.1]

3.1.5

computerized numerical control CNC

realization of *NC* ([3.1.4](#)) using a computer to control the machine functions

[SOURCE: ISO 2806:1994, 2.1.2]

3.1.6

numerically controlled grinding machine NC grinding machine

grinding machine that operates under *numerical control* ([3.1.4](#)) or *computerized numerical control* ([3.1.5](#))

3.1.7

power operated axis

axis which is operated by a force other than muscular or gravity force

3.1.8

abrasive product grinding tool

rotary cutting tool of varied shapes with geometrically unspecified cutting edges made from abrasive grains and bond

Note 1 to entry: There is a distinction between bonded abrasive products and superabrasive products (see EN 12413 and EN 13236).

3.1.9

dressing tool

fixed or rotary tool for the generation or reproduction of the grinding capacity (sharpening) and/or the geometry (truing) of abrasive products

3.1.10

work zone

space where cutting is to take place

3.1.11

access to the hazard zone

entering or reaching the hazard zone either with individual parts of the body or with the whole body (whole body access)

3.1.12

operational stop

stop of the machine movements in the production process

Note 1 to entry: Control functions between control system and machine drives are maintained (torque, speed of rotation, position).

3.1.13

safe operational stop

operational stop with additional control system measures preventing dangerous machine movements due to control system faults

3.1.14

safe stop

stop by removal of the power to the machine actuators, preventing dangerous machine movements due to control system faults

3.1.15 performance level PL

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

[SOURCE: ISO 13849-1:2006, 3.1.23, modified]

3.1.16 required performance level PL_r

performance level (PL) applied in order to reach the required risk reduction for each safety function

[SOURCE: ISO 13489-1:2006, 3.1.24, modified]

3.2 Parts of grinding machines

3.2.1 vision panel

window provided in a guard through which the operator can view the *work zone* ([3.1.10](#)) or other areas of the machine

3.2.2 transparent screen

screen used on the machines for the protection of the face and the eyes of the operator from small pieces of debris and grinding sparks

3.2.3 chuck

clamping device in which workpieces are clamped either by manual force or with the aid of pneumatic, hydraulic, electric energy, or mechanically stored energy (e.g. preloaded springs)

Note 1 to entry: See [Figure 1](#).

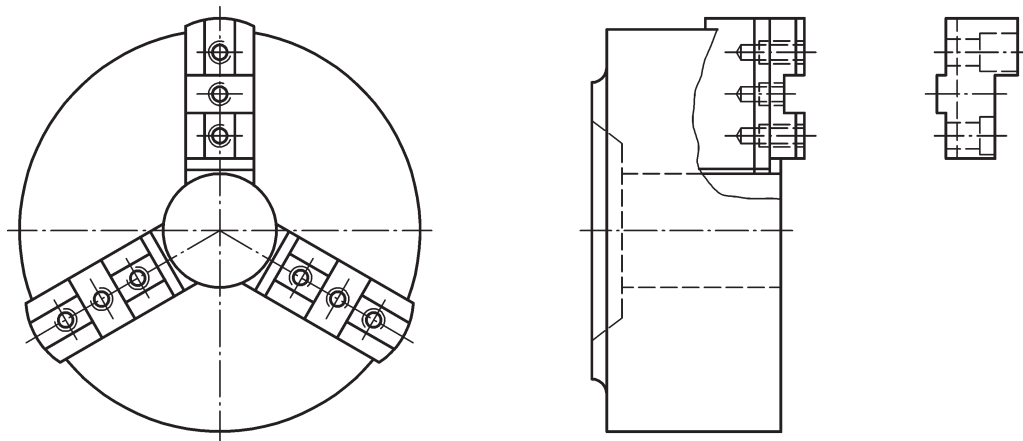


Figure 1 — Chuck

Note 2 to entry: The chuck with 3 jaws is only an example; a chuck can have 2, 3, 4, 6, etc. jaws.

[SOURCE: ISO 16156:2004, 3.1, 3.2, and 3.3, modified]

3.2.4

collet

chuck with multiple clamping

elements for the internal or external clamping of workpieces

[SOURCE: ISO 19719:2010, 1.5]

3.2.5

electronic handwheel

manually operated control device which initiates and maintains an axis movement by pulse generation input to the *numerical control* ([3.1.4](#)) during its rotation

3.2.6

abrasive product guard

guard which encloses the abrasive product exposing only the part necessary for grinding and which is designed and constructed in such a way that it retains fragments in the guarded area in the event of breakage of the abrasive product

3.2.7

work zone enclosure

guard for grinding machines, which is so designed that any ejected object (e.g. fragments abrasive product, part of machine, material, working fluid) are retained in the work zone (enclosed) and that access to the dangerous movement is prevented

3.2.8

tool holding device

device intended to secure and position the abrasive product on the wheel spindle

3.3 Modes of safe operation (MSO)

3.3.1

MSO 0

manual mode

mode with no automatic machine operation, where the operator has control over the machining process without the use of pre-programmed operations

Note 1 to entry: This can be controlled by the use of push buttons, mechanical or electronic hand wheels, or joysticks.

3.3.2

MSO 1

automatic mode

operation mode for the automatic, programmed, sequential operation of the machine, with the facility for manual or automatic loading/unloading of workpiece and tools, until stopped by program or operator

3.3.3

MSO 2

setting mode

operation mode in which adjustments for the subsequent machining process are performed by the operator

Note 1 to entry: Checking of grinding tool or workpiece position (e.g. by touching the workpiece with a probe or the grinding tool) are procedures of the setting mode. Adjustment includes machine setup operations.

3.3.4

MSO 3

optional special mode for manual intervention under restricted operating conditions mode

operation mode in which the possibility for manual intervention into the machining process, as well as for a limited automatic mode started by the operator, is given

EXAMPLE Programmed movements can be continued automatically, e.g. by a program or the operator with movable guards open to access the work area.

3.3.5

MSO service

mode for service and maintenance tasks

Note 1 to entry: In MSO service, the machining of a workpiece is not allowed.

EXAMPLE Axis calibration by e.g. laser, ballbar testing, and/or spindle error analysis.

3.4 Types and groups of grinding machines defined in this International Standard

3.4.1 General

Grinding machines are subdivided into different groups with regard to the relevant hazards and into different types with regard to the grinding process. For examples for different types of grinding machines, see [Table 1](#).

Table 1 — Types of grinding machines

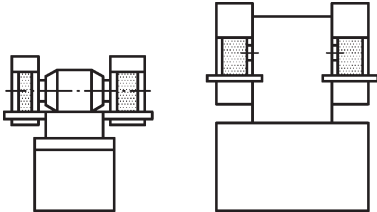
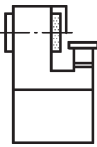
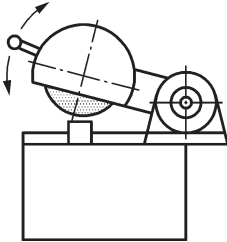
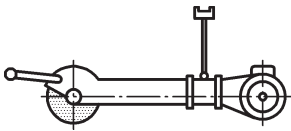
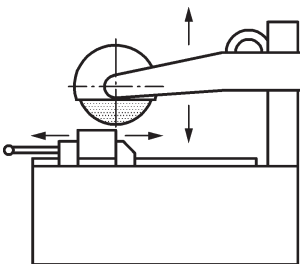
No.	Type of machine (scheme)	Designation	Grinding method
1.1		en: Bench or pedestal grinding machine fr: Touret pour établi ou sur socle de: Tisch- oder Ständer-schleifmaschine	Peripheral grinding Grinding at the periphery of the abrasive products. The workpiece is guided by hand.
1.2		en: Pedestal grinding machine fr: Lapidaire de: Ständerschleifmaschine	Side grinding Grinding at the side of the abrasive products. The workpiece is guided by hand.
1.3		en: Cutting-off machine fr: Tronçonneuse de: Trennschleifmaschine	Cutting-off Grinding for the generation of cuts. The workpiece is fixed, the cutting-off wheel is mechanically guided (manual feed).
1.4		en: Swing frame grinding machine fr: Meulage et tronçonnage avec machine suspendue de: Pendelschleifmaschine	Peripheral grinding, cutting-off High pressure grinding at the periphery of the abrasive products. The workpiece is firmly attached or stabilized by its own weight. The grinding machine is suspended and guided by hand.
1.5		en: Cutting-off machine fr: Tronçonneuse de: Trennschleifmaschine	Cutting-off Grinding for the generation of slots or cuts. The workpiece is guided by hand. The cutting-off wheel is mechanically guided.

Table 1 (continued)

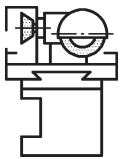
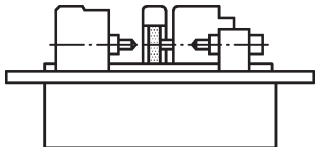
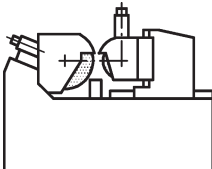
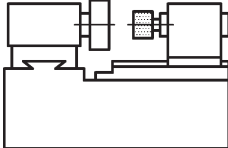
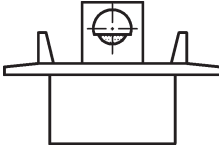
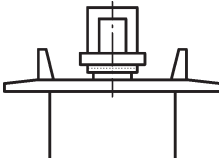
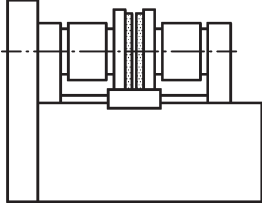
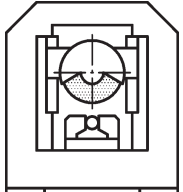
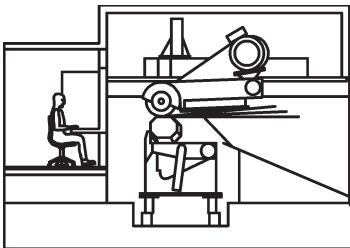
No.	Type of machine (scheme)	Designation	Grinding method
1.6		en: Tool grinding machine fr: Affûteuse de: Werkzeugschleifmaschine	Peripheral and side grinding Grinding for the generation or reproduction of cutting faces. Workpiece and abrasive product are mechanically guided.
1.7		en: External cylindrical grinding machine fr: Rectifieuse cylindrique extérieure de: Außenrundscheifmaschine	External cylindrical grinding Grinding for the generation of external surfaces at a rotating workpiece. Workpiece and abrasive product are mechanically guided
1.8		en: Centreless external cylindrical grinding machine fr: Rectifieuse cylindrique sans centre de: Spitzenlose Außenrundscheifmaschine	Centreless external cylindrical grinding Grinding for the generation of external faces at a rotating workpiece. The workpiece is mechanically guided in its position to the abrasive product by a control wheel and rests on a guiderail between the two wheels
1.9		en: Internal cylindrical grinding machine fr: Rectifieuse cylindrique intérieure de: Innenrundscheifmaschine	Internal cylindrical grinding Grinding for the generation of internal faces at a rotating workpiece. Workpiece and abrasive product are mechanically guided.
1.10		en: Surface grinding machine, reciprocating or rotary table, horizontal spindle fr: Rectifieuse plane à table à déplacement rectiligne ou rotative – broche horizontale de: Planschleifmaschine, Rechteck- oder Rundtisch, waagerechte Spindel	Surface grinding — Peripheral grinding Grinding for the generation of plane surfaces, where the workpiece is attached to a table. Workpiece and abrasive product are mechanically guided.
1.11		en: Surface grinding machine, reciprocating or rotary table, vertical spindle fr: Rectifieuse plane à table à déplacement rectiligne ou rotative – broche verticale de: Planschleifmaschine, Rechteck- oder Rundtisch, senkrechte Spindel	Surface grinding — Side grinding Grinding for the generation of plane surfaces where the workpiece is attached to a table. Workpiece and abrasive product are mechanically guided.

Table 1 (continued)

No.	Type of machine (scheme)	Designation	Grinding method
1.12		en: Surface grinding machine, double spindle, horizontal or vertical fr: Rectifieuse plane à deux broches horizontales ou verticales de: Doppelspindel-Planschleifmaschine, waagerechte oder senkrechte Spindel	Surface grinding — side grinding Grinding of plane parallel opposite faces. Workpiece and abrasive product are mechanically guided.
1.13		en: Cutting-off machine fr: Tronçonneuse de: Trennschleifmaschine	Cutting-off Grinding for the generation of slots or cuts. Workpiece and abrasive product are mechanically guided.
1.14		en: High pressure grinding machine fr: Machine pour meulage à haute pression de: Hochdruckschleifmaschine	Surface grinding High pressure grinding for the generation of plane surfaces where the workpiece is attached to a table. Workpiece and abrasive product are mechanically guided.

3.4.2 Group 1: manually controlled grinding machine without power operated axes and without numerical control

Grinding machine without power operated axes with the exception of the wheel spindle and individual axes for rough positioning. All movements are initiated and controlled by the operator, one at a time.

This group of grinding machines can be equipped with the following features:

- mechanical facilities for mechanical feed;
- manual workpiece or tool guiding for processing;
- electronic facilities for constant surface speed (CSS);
- copying attachments (e.g. radius grinder, template);
- measuring equipment for workpiece outline (e.g. microscope);
- indexing equipment (partial device);
- power controlled rough positioning of individual axes.

Grinding machines of this group have no limited nor fully numeric control system (NC).

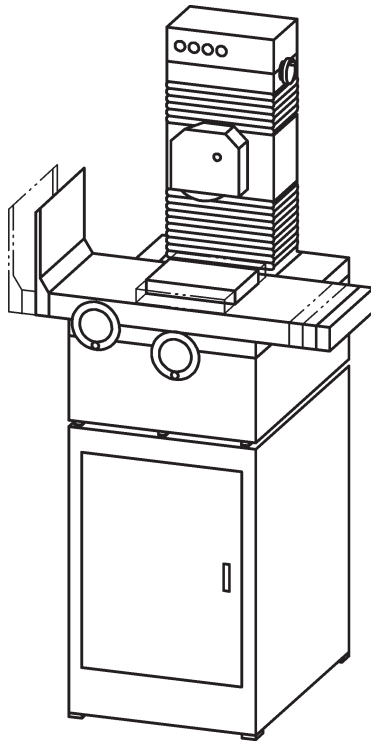


Figure 2 — Example of a group 1 grinding machine

3.4.3 Group 2: manually controlled grinding machine with power operated axes and, if applicable, with limited numerically controlled capability

Grinding machine with power operated axes that can be operated by the use of electronic handwheels or as a machine with limited NC control by operating controls on NC panel.

The feed movement between grinding tool and workpiece is carried out manually by physical force or power operated.

This group of grinding machines can be equipped with the following features:

- a) all of the features of group 1;
- b) a limited numeric control system (NC) providing:
 - 1) MSO 0 exclusively;
 - 2) axis interpolation (i.e. copying/predefined profiling).

However, the following features are not provided:

- automatic program start;
- automatically initiated tool change system;
- automatic workpiece change system.

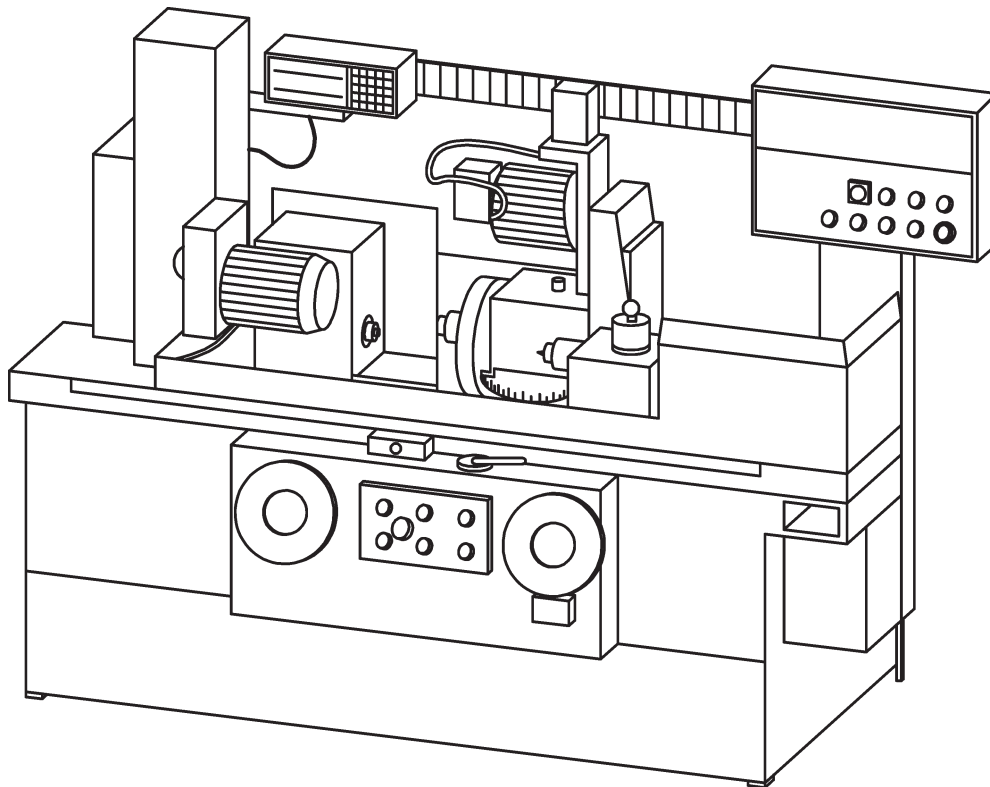


Figure 3 — Example of a group 2 grinding machine

3.4.4 Group 3: numerically controlled grinding machine

Grinding machine with numerical control (NC) providing automatic function.

This group of grinding machines can be equipped with the following features:

- a) a numeric control system with different modes of safe operation;
- b) automatic workpiece change systems;
- c) automatic tool magazine, tool transfer, and tool changing systems;
- d) automatic tailstock quill advance or retreat;
- e) automatic truing devices;
- f) secondary machining operations (e.g. milling, turning, drilling);
- g) additional ancillary handling devices.

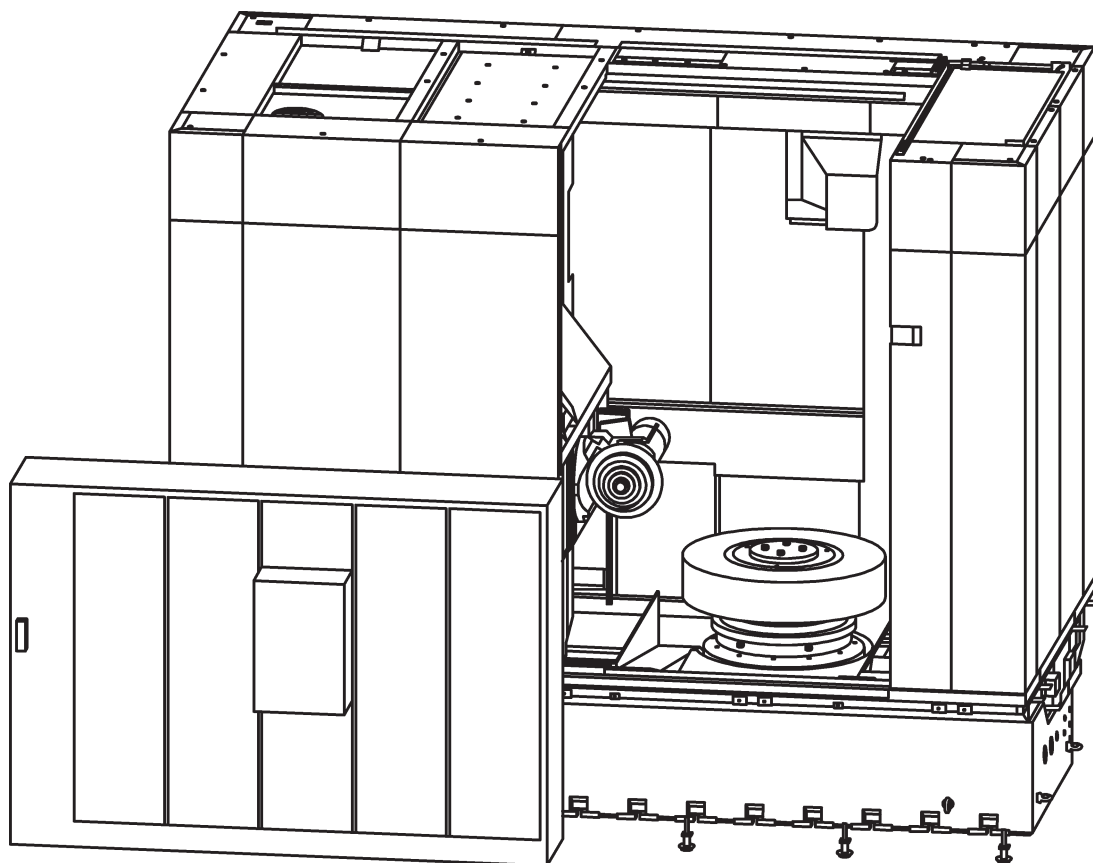


Figure 4 — Example 1 of a group 3 grinding machine

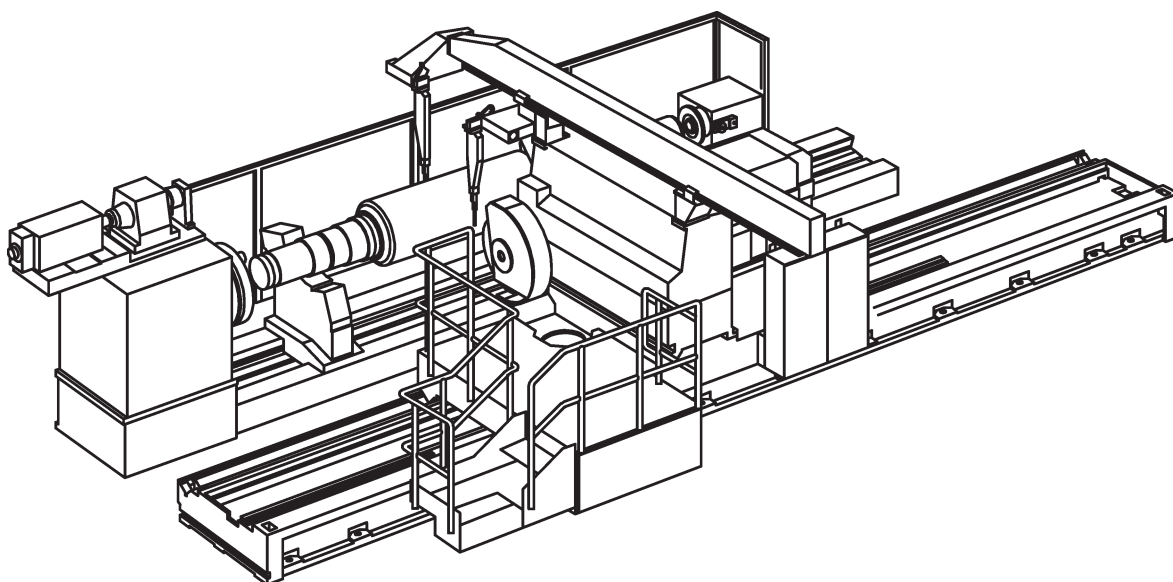


Figure 5 — Example 2 of a group 3 grinding machine

3.5 Speeds and axes speed

3.5.1

maximum operating speed

maximum permissible speed specified by the manufacturer of the abrasive product

3.5.2

maximum permissible speed

maximum permissible speed set as a machine parameter by the machine manufacturer

3.5.3

maximum possible speed

highest possible speed which occurs in case of failure

3.5.4

reduced speed

speed which is limited for safety related purposes by the machine manufacturer to a maximum permissible value

3.5.5

rotational speed

speed of an abrasive product calculated by the formula

$$n = \frac{v \times 1\,000 \times 60}{D \times \pi}$$

where

n is the rotational speed in rotations per minute;

v is the peripheral speed in metres per second;

D is the outside diameter of the abrasive product in millimetres.

3.5.6

peripheral speed

speed of an abrasive product calculated by the formula

$$v = \frac{D \times \pi \times n}{60 \times 1\,000}$$

where

n is the rotational speed in rotations per minute;

v is the peripheral speed in metres per second;

D is the outside diameter of the abrasive product in millimetres.

4 List of significant hazards

4.1 General

The manufacturer of the grinding machine shall conduct a risk assessment in accordance with ISO 12100. The list of hazards and hazardous situations in [Table 2](#) is the result of task and hazard identification determined by risk assessment carried out in accordance with ISO 12100:2010, Clauses 4 and 5.4, for grinding machines covered by the Scope of this International Standard. The safety requirements and/or protective measures in [Clauses 5](#) and [6](#) are based on the risk assessment and deal with the identified hazards by either eliminating them or reducing the risks they generate.

The risk assessment assumes foreseeable access from all directions, as well as unexpected start-up. Risks to both the operator(s) and other person(s) who can have access to the hazard zones are identified, taking into account hazards which can occur under various conditions (e.g. commissioning, set-up, production, maintenance, repair, and decommissioning) during the life of the machine. The assessment includes an analysis of the effect of failure in the control system.

In addition, the user of this International Standard (i.e. the designer, manufacturer and supplier) shall confirm through a risk assessment that the risk assessment is complete for the machine under consideration with particular attention to

- a) the intended use of the machine including maintenance, setting and cleaning and its reasonably foreseeable misuse (see ISO 12100:2010, 3.23 and 3.24), and
- b) the identification of the significant hazards associated with the machine.

4.2 Main hazard zones

The main hazard zones are the following:

- a) work zones with moving axis(es) and wheel spindle(s) including truing spindle(s), workpiece holding device, work holding spindle(s), rest(s), tailstock, workpiece(s);
- b) handling devices for workpiece loading/unloading;
- c) internal and external tool magazines and tool changers;
- d) gear box;
- e) cam mechanisms.

4.3 Significant hazards and hazardous situations covered by this International Standard

The significant hazards covered by this International Standard are listed in [Table 2](#). The numbering of the (sub)clauses in the table refers to the numbering in ISO 12100:2010, Table B.1.

Table 2 — List of significant hazards and hazardous situations

No. ^a	Causes for hazards and hazardous situations	Examples for hazardous situations and hazard zones at grinding machines	Possible consequences	Relevant (sub)clause in this International Standard
1	Mechanical hazards			
1.1	Approximation of a moving part to a fixed part	Manual activities in the area between abrasive product and parts of the grinding machine, particularly the work rest or between abrasive product and workpiece	Crushing Shearing Drawing-in Trapping	5.1.2 5.2 5.1.2
		Feed movement of the abrasive product to the workpiece	Crushing Shearing Ejected parts	5.1.2 5.2
		Manual activity in the vicinity of the abrasive product or the spindle	Entanglement	5.1.2 5.2
		Clamping of tools and workpieces	Crushing Shearing	
1.2	Moving parts	Activity in the area of travelling axes, moving machine parts, and in the area of automatic loading devices during machining, setting, maintenance, and repair. Reciprocating movement of the workpiece table. Activities in the area of working platforms	Impact Entanglement Drawing-in Trapping	5.1.2 5.2 5.9 5.1.2

Table 2 (continued)

No. ^a	Causes for hazards and hazardous situations	Examples for hazardous situations and hazard zones at grinding machines	Possible consequences	Relevant (sub)clause in this International Standard
1.3	Rotating parts	Unintended contact with the rotating abrasive product during loading and unloading and/or measuring	Friction Abrasion Drawing-in Trapping	5.1.2 5.2 5.9 5.10 5.12
1.4	Pointed and cutting parts Sharp edges	Unintended contact with sharp workpiece edges during loading and unloading and/or measuring	Cutting Puncture Friction Abrasion	5.1.2 5.2
1.5	Falling or ejected objects	Ejection or falling down of material parts and chips during start-up, setting, grinding operation, change of abrasive product, maintenance, or decommissioning Workpiece falling down; Rupture of abrasive product; Machine parts ejected after rupture at or in the vicinity of the machine	Crushing Shearing Impact Penetration Puncture	5.1.2 5.2 5.9 5.10 5.12 5.13 7.2.2 7.2.3 7.2.5
1.6	Gravity	Falling movable machine elements during setting, e.g. during abrasive product or workpiece change due to gravity. Activities in the area of working platforms or at pits	Crushing Shearing Impact	5.1.2 5.2 5.12
1.7	High pressure	At hydraulic components when staying at or in the vicinity of the machine, particularly during installation and commissioning of the machine	Penetration or impact of media under pressure into the skin/eyes	5.1.2 5.2
1.8	Stability	Falling or tipping of a non-fixed machine or of machine parts when staying at or in the vicinity of the machine	Impact Crushing	5.14 7.2.10
1.9	Rough, slippery surface	Activities in the floor and step area at and around the machine and work in a height due to — ejection or spillage of metalworking fluid, lubricants, or hydraulic fluid; — residues contained in ejected fluids; — insufficient railing or other containing devices, particularly at points, where there is a risk of falling.	Slipping Tipping Falling	5.1.2 5.2 5.15
2	Electrical hazards			
2.1	Live parts	Contact with live parts	Electric shock	5.3
2.2	Parts which have become live under fault conditions	Contact with parts which have become live under fault conditions	Electric contact	5.3

Table 2 (continued)

No. ^a	Causes for hazards and hazardous situations	Examples for hazardous situations and hazard zones at grinding machines	Possible consequences	Relevant (sub)clause in this International Standard
3	Thermal hazards			
	Objects or materials with high temperature	Ejection of hot grinding sparks during grinding when staying at or in the vicinity of the machine	Burns	5.1.2 5.2
4	Noise hazards			
	Manufacturing process and moving parts	Aerodynamic noise due to — the rotating abrasive product; — vibration of abrasive product and/or workpiece during grinding; — drive and transmission elements; — air blast for cleaning; when staying at or in the vicinity of the machine.	Permanent hearing loss Other (e.g. mechanical, electrical) hazards as a consequence of a disturbed voice communication or an interference of acoustic signals	5.4 7.2.6 Annex F Annex G
5	Vibration hazards			
	Vibrating parts	Transmissions of vibrations from the grinding process on the operator at machines for manually guided grinding	Discomfort Neurological disease Joint damages	5.5 7.2.7
6	Radiation hazards			
6.1	Low and high frequency electro-magnetic radiation	During activities at electric equipment, particularly during setting or maintenance	Influence on active implants e.g. pacemakers, defibrillators	5.6
6.2	Optical radiation (infrared, visible and ultraviolet), including laser radiation	During activities at measuring devices and measuring lasers, particularly during setting or maintenance	Burning Eye damage	5.6
7	Material/substances hazards			
7.1	Biological and microbiological (viral or bacterial) agent	Contact with metalworking fluids contaminated with bacteria when staying at or in the vicinity of the machine	Infection	5.7.1
7.2	Liquid	Skin contact with metalworking fluids when staying at or in the vicinity of the machine	Skin damage	5.7.1 5.7.2
7.3	Vapours	Inhalation and intake of substances used or generated during machining, e.g. by metalworking fluids when staying at or in the vicinity of the machine	Breathing difficulties Poisoning	5.7.1 5.7.2
7.4	Fire hazardous material	Fire and explosion hazards a) during machining of flammable material, e.g. aluminium, magnesium b) during use of flammable material, e.g. oil containing metalworking fluid	Burns due to fire and explosion	5.7 5.7.3 Annex H Annex I Annex J
8	Ergonomic hazards			

Table 2 (continued)

No. ^a	Causes for hazards and hazardous situations	Examples for hazardous situations and hazard zones at grinding machines	Possible consequences	Relevant (sub)clause in this International Standard
8.1	Design or location of indicators and optical displays	Misjudgment of the indicated information at operator's position	Other (e.g. mechanical, electrical) hazards as a consequence of human error	5.8
8.2	Design, location or identification of control devices	Faulty operation of the machine at operator's position		5.8
8.3	Effort	At control devices and during handling	Fatigue	5.8
8.4	Body posture	Inadequate consideration of hand/arm or foot/leg anatomy during workpiece or tool change	Disturbance of the musculoskeletal system	5.8
8.5	Repeated activities		Fatigue	5.8
8.6	Visibility, local lighting	Affection of the accuracy and the judgment ability of/for manual activities during handling and alignment of the workpiece and the abrasive product during loading/unloading, setting, abrasive product change, and maintenance at loading/unloading and changing points of the abrasive products	Fatigue Other (e.g. mechanical, electrical) hazards as a consequence of human error	5.8
9	Hazards related to the environment in which the machine is used			
	Human error	Reasonably foreseeable misuse, Incorrect operation of the machine (manipulations) Inappropriate handling and setting of the workpiece and the abrasive product Insufficient design of the workplace and/or machining process Inadequate consideration of hand/arm or foot/leg anatomy Incorrect installation	All hazards listed above	5.2.6 7.2.4 7.2.11
10	Combination of hazards			

Table 2 (continued)

No. ^a	Causes for hazards and hazardous situations	Examples for hazardous situations and hazard zones at grinding machines	Possible consequences	Relevant (sub)clause in this International Standard
10.1	Failure of power supply	Fall or ejection of moving machine parts or a mounted workpiece or tool or their fragments Failure of stop control for moving parts	Crushing Shearing	5.9 5.11
10.2	Restoration of energy supply after an interruption	Uncontrolled movements (including speed variation) Unintended/unexpected start-up	Impact Cutting	5.9 5.10
10.3	Failure of control system	Falling or ejection of moving machine parts or a mounted workpiece or tool Failure of stop control for moving parts Uncontrolled movements (including speed variation) Unintended/unexpected start-up Other hazardous events due to failure or poor design of the control system Variation of speed of tools (during setting)	Cutting-off Drawing-in Trapping Penetration Puncture Friction Abrasion	5.9 5.10 5.12

^a [Table 2](#) contains the hazards specific to grinding machines from Table B.1 in ISO 12100:2010, Annex B. The numbers of the clauses in this column also refer to that table.

5 Safety requirements and/or measures

5.1 General requirements

5.1.1 General

Grinding machines shall comply with the safety requirements and/or measures of [Clause 5](#). For hazards which are not dealt with in this International Standard, the machines shall be designed in accordance with the principles of ISO 12100:2010, Clause 4 and 6.1.

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

The designer shall take into account hazards which can occur during the life of the machine to both operator and other persons who have access to the hazard zone(s) for conditions of intended use, including reasonably foreseeable misuse of the machine (see ISO 12100:2010, 3.23 and 3.24). The hazards for both machining operation and/or operations requiring intervention by the operator and/or other persons (e.g. setting, cleaning, maintenance and repair) shall be considered. An analysis of the failure of machine components, including failure in the control system(s), is part of the risk assessment and guidance on this subject is given in ISO 13849-1. Therefore, reliability requirements for safety functions are defined as performance level (PL), in accordance with ISO 13849-1 (see [5.12 b](#))).

All requirements and/or protective measures given in [Clause 5](#) apply to all groups of grinding machines, unless specifically referenced.

5.1.2 Requirements for guards for all groups of grinding machines

5.1.2.1 General

Guards shall be in accordance with ISO 14120. The fixing systems of fixed guards shall remain attached to the guards or to the machinery when the guards are removed. The requirement does not necessarily apply to fixed guards, which, for instance, have only to be removed, when the machine is completely renewed, when more extensive repairs are necessary or when it is demounted to be transferred to another site.

5.1.2.2 Position and safety

The requirements are the following:

- a) Height and position: where guards are floor-mounted (e.g. perimeter fencing), they shall be fixed securely and have a minimum height of 1,4 m. The distance from the hazard zone shall be in accordance with ISO 13857:2008, Table 2. Any opening between the bottom of the guard and the floor shall not exceed 180 mm.
- b) For the guarding of drives, access to mechanical power transmission drives (e.g. chains and sprockets, gears, leadscrews, feedscrews and ballscrews etc.) shall be prevented, e.g. by fixed guards or by design, so that the hazardous zone is not accessible.

If access to these parts is required during normal operation of the machine, interlocked movable guards shall be provided (see c)).

NOTE Interlocked movable guards are not always necessary for group 1 and group 2 machines.

- c) Interlocking of guards
 - 1) movable guards shall be interlocked with or without guard locking in accordance with ISO 14119 in order to prevent access to hazardous machine movements. The selection of interlocking devices shall be in accordance with ISO 14119:1998, Clause 7;
 - 2) a failure in the interlocking device, i.e. function and/or arrangements, shall result in a category 1 stop of the machine in accordance with IEC 60204-1:2009, 9.2.2;
 - 3) for requirements concerning safety functions of interlocking devices associated with movable guards, see [5.12 b\) 1\)](#).

5.2 Specific requirements resulting from mechanical hazards identified in Table 2, Nos. 1.1 - 1.4, 1.6 and 1.7

5.2.1 Group 1 machines, manually controlled grinding machines without power operated axes and without numerical control

Requirements are the following:

- a) The machines shall be provided with means of preventing unintended contact with the abrasive product. The complete abrasive product shall be guarded except that part necessarily exposed for the work.

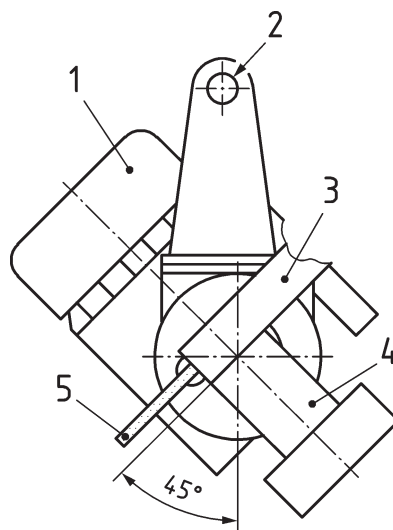
This requirement is usually met by the abrasive product guard in accordance with [5.13.2.1](#).

- b) In case of power controlled rough positioning, the speed of axes shall be 2 m/min. at maximum. Control of the movements shall be effected by means of a hold-to run device (see [5.12 b\) 2\)](#)) or an electronic hand wheel (see [5.12 b\) 3\)](#)).

- c) For loading and unloading or measuring, additional equipment or precautions shall be provided or taken to prevent contact with the rotating abrasive product, except for machines, where the workpiece is guided by hand. These may include one or more of the following:
- 1) stopping the rotation of the abrasive product;
 - 2) providing safeguards;
 - 3) positioning the abrasive product so that it cannot be reached by the operator (respect of safety distances, at least 200 mm between abrasive product and workpiece).

NOTE Deviation from ISO 13857 due to small work zone.

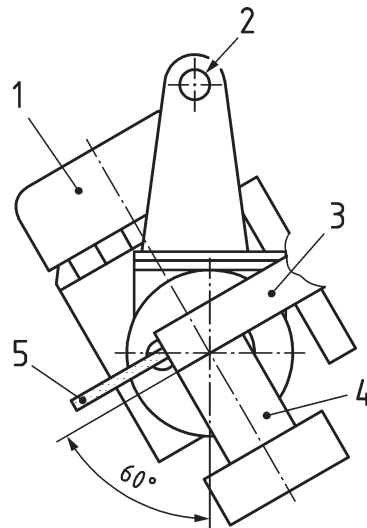
- d) Cutting-off machines for mechanically guided cutting-off in accordance with [Table 1](#), No. 1.3 shall be provided with measures to ensure that the cutting-off wheel moves automatically back to its initial position after use. It shall remain in that position and be automatically guarded against contact until the cutting-off wheel has stopped.
- e) Swing frame grinding and swing frame cutting-off machines in accordance with [Table 1](#), No. 1.4 shall be equipped with an adjustable counterbalance weight so that the grinding head moves away from the workpiece after release of the handles.
- f) At swing frame grinding machines for manually guided grinding, the grinding head can only be swivelled by up to 45° from the vertical axis on either side (see [Figure 6](#)).
- g) At swing frame cutting-off grinding machines for manually guided cutting-off, the grinding head can only be swivelled by up to 60° from the vertical axis on either side (see [Figure 7](#)).



Key

- 1 motor
- 2 suspension
- 3 guard
- 4 swivelling axis
- 5 grinding wheel

Figure 6 — Swing frame grinding machine



Key

- 1 motor
- 2 suspension
- 3 guard
- 4 swivelling axis
- 5 cutting-off wheel

Figure 7 — Swing frame cutting-off machine

- h) Bench and pedestal grinding machines in accordance with [Table 1](#), Nos. 1.1 and 1.2 shall be provided with a transparent screen for the protection of the face and especially the eyes of the operator against small grinding particles and grinding sparks.

The screens shall have sufficient resistance to impact and abrasion so that they do not break or crack in the case of impact load, e.g. during handling of workpieces, and that the surface abrasion caused by ejected abrasive grit and grinding sparks is minimised. Polycarbonate is an example for a suitable screen material.

The screen shall be adjustable and of sufficient size so that the operator in normal working positions can only view the grinding operation through the screen. The screen shall not impede guiding and holding of the workpieces.

The minimum dimensions of screens are given in [A.3.4](#).

- i) At Group 1 grinding machines, unintended start-up of the wheel spindle and, if applicable, the axis for rough positioning shall be prevented in accordance with ISO 14118:2000, Clause 6.
- j) The wheel spindle may be operated if an abrasive product guard in accordance with [5.13.2.1](#) is provided and the peripheral speed of the abrasive product is limited to values $v \leq 50\text{m/s}$. For monitoring of the reduced spindle speed of the wheel spindle, see [5.12 b\) 5](#)). Rotation of the spindle shall only be initiated manually by a control device (e.g. a start button) provided for that purpose (see [5.12 b\) 14](#))).

5.2.2 Group 2 machines, manually controlled grinding machines with power operated axes and, if applicable, with limited numerically controlled capability

Requirements are the following:

a) Protection against contact with abrasive products

The machines shall be provided with means of preventing unintended contact with the abrasive product. The complete abrasive product should be guarded except that part necessarily exposed for the work.

This requirement is usually met by the abrasive product guard in accordance with [5.13.2.1](#).

b) Access into the work zone

Group 2 grinding machines - except for machine tools with workpiece dimensions ≤ 300 mm - shall be equipped with fixed and/or movable guards at the rear and the sides of the work zone preventing access to hazards zones, including the machining point, and the ejection of metalworking fluid from the work zone. The minimum distances specified in ISO 13857 shall be complied with.

c) Reaching of trapping and entanglement points at rotating parts in the work zone, e.g. at chucks, workpieces, shall be prevented by fixed and/or movable guards.

d) Shearing and crushing points outside the work zone, e.g. between reciprocating table and stationary machine parts (including electrical cabinets) and at reciprocating switches (e.g. on surface grinding machines) shall be prevented by design or safeguarded.

e) For manual interventions, such as loading and unloading or measuring, additional equipment or precautions shall be provided or taken preventing contact with the rotating abrasive product. These may include one or more of the following:

- 1) stopping the rotation of the abrasive product;
- 2) providing an automatic safeguard;
- 3) positioning the abrasive product so that it cannot be reached by the operator (respect of safety distances, at least 200 mm between abrasive product and workpiece).

NOTE Deviation from ISO 13857 due to small work zone.

f) Mode of safe operation

Only MSO 0 in accordance with [5.2.7.2](#) is permitted. Deviating from [5.2.7.2](#) c), the reduced axis speed of the reciprocating movement longitudinal to the table may be 25 m/min at maximum at surface grinding machines, if only a striking hazard exists.

g) Hazard of entrapment, trapping, and impact resulting from power rotation of handwheels shall be prevented, e.g. by automatic disengagement or by using plain solid (no spokes) handwheels with either no pegs or sprung to safe position pegs.

5.2.3 Group 3 machines, numerically controlled grinding machines

5.2.3.1 Access to the work zone

Guards shall be provided to mitigate the risks listed in [Table 2](#) (entanglement, crushing, shearing, etc.) by preventing access to dangerous parts of the machines. General guidance for the selection of safeguards, where the hazards from moving parts cannot be avoided by design is given in ISO 12100:2010, 6.3.2, 6.3.3. For the features of guards to minimize the hazard of ejection, see [5.13](#).

5.2.3.2 Specific requirements for guards

The specific requirements for guards for Group 3 machines are the following:

a) Interlocking of guards

- 1) All guards through which frequent access to hazardous movement is required during operation shall be designed as interlocked movable guards (see as well [5.1.2.2 c\)](#)). Opening of a movable guard or actuation of a protective device shall cause hazardous movements to stop and further movement to be inhibited (see ISO 14118). If the movable guards provide access to the work zone and hazards by follow-up movements arise, they shall be additionally equipped with guard locking. Measures to minimize the possible defeat of interlocking device(s) shall be taken (see ISO 14119:1998, Clause 5 and Clause 7).
- 2) When persons can have whole body access or can remain in the hazardous zone(s) without being visible to the operator, a means to inhibit restart shall be provided, e.g. presence-sensing protective equipment or door closure inhibition by captive keys.

NOTE Captive key is an interlocking device allowing the door unlock after initiation of stopping function for dangerous movements by its key.

b) Power operated guards

- 1) The requirements of [5.2.3.2 a\)](#) shall also apply.
- 2) If power operated guards for operator access are provided, they shall be in accordance with ISO 12100:2010, 6.3.3.2.6 and shall be equipped with a protective device to avoid shearing and crushing hazards at the front edge. If pressure-sensitive edges are provided, they shall be fitted on the total length of the front edge or up to a height of 2,50 m above the floor or platform, if the height of the guard is more than 2,50 m. The pressure-sensitive edge shall be in accordance with ISO 13856-2. The safety function of the guard shall comply with [5.12 b\) 9\)](#).
- 3) The force to prevent the door from closing shall not exceed 75 N and the kinetic energy of the guard shall not exceed 4 J. When the guard is fitted with a protective device which automatically initiates reopening of the guard on actuation, this may be a maximum of 150 N and the kinetic energy a maximum of 10 J (see ISO 14120:2002, 5.2.5.2). These requirements only apply under the assumption that the front edges have a minimum width of 8 mm and that no shearing movement occurs. At the side edge between movable guard and housing, a gap width of 4 mm shall not be exceeded.
- 4) If the requirements of b) 2 and b) 3) cannot be met, another fixed position protective device, e.g. a two-hand control device, shall be provided.
- 5) It shall not be possible to start the movement of the machine until the guard is fully closed. Closing of the guard can be used as a start command for the machine, when the guard system meets the requirements of ISO 12100:2010, 6.3.3.2.5.
- 6) These requirements shall only apply for guards as defined in ISO 12100:2010, 3.27.

5.2.3.3 Additional specific requirements

Additional specific requirements for Group 3 machines are the following:

- a) Access into the work zone is allowed according to the requirements in [5.2.7](#) on modes of machine operation.
- b) Guards shall also be designed to contain and/or prevent exposure to grinding debris, fluids and parts that can be ejected (see also [5.13](#) and [5.15 b\)](#)).

c) Contact protection

For manual interventions in MSO 1 such as loading and unloading or measuring, additional equipment or precautions shall be provided or taken preventing contact with the rotating abrasive product. These can include the following:

- 1) stopping the rotation of the abrasive product
- 2) providing an automatic safeguard;
- 3) positioning the abrasive product so that it cannot be reached by the operator (respect of safety distances in ISO 13857).

d) Mode of safe operation

MSO 1 and MSO 2 are mandatory for this machine group. MSO 0, MSO 3, and MSO service are optional.

e) For MSO 0, the requirements for Group 2 machines shall apply (see [5.2.2](#)).

5.2.4 Tool holding device

Tool holding devices shall be designed so that there is no clamping loss during operation including acceleration and deceleration.

For clamping methods for abrasive products and safety requirements for tool holding devices, see Annexe D and Annex E.

5.2.5 Workpiece holding

5.2.5.1 General

Grinding machines shall be provided with clamping devices, holding or guiding the workpieces to prevent them from inadvertent movement. Opening and closing of the workpiece holding devices for manual workpiece change can be possible in all modes of safe operation.

5.2.5.2 Workpiece rests

- a) Grinding machines without workpiece holding device (compare [Table 1](#) No. 1.1 and 1.2) shall be provided with workpiece rests capable of accommodating safely the forces generated.
- b) The workpiece rests shall be adjustable with respect to the wear of the abrasive product so that the distance between the abrasive product and the workpiece rest will not exceed 2 mm. It shall be of at least the same width as the abrasive product for which the grinding machine was designed and it shall be of substantial construction and securely attached to the grinding machine.

5.2.5.3 Power operated workpiece holding devices

- a) Grinding machines with power operated clamping devices shall be equipped so that in the case of clamping energy losses or if the actuating force of the clamping device falls below a pre-set minimum value, the machining process is prevented or a machine stop category 1 in accordance with IEC 60204-1 shall be initiated. For rotating workpiece holding devices, a rotation of the power operated work holding spindle without or with reduced actuating force is permitted for positioning of the workpiece in exceptional cases, if there is no hazard caused by ejection of the workpiece. The reduced spindle speed of the work holding spindle for the relevant mode of safe operation shall not be exceeded.
- b) Efficiency of the actuating function shall be monitored, e.g. monitoring of the clamping pressure and/or the clamping travel (see [5.12 b\) 7](#))).
- c) At rotating workpiece holding devices, opening of the clamping device shall not be possible with rotating work holding spindle (see [5.12 b\) 7](#))).

- d) For manual loading, injuries of the fingers during operation of the clamping device shall be avoided[pre-setting of a maximum jaw stroke < 4 mm (see ISO 13857)].
- e) Rotating workpiece holding devices shall be clearly marked with their maximum permissible speed.
- f) The status of the clamping device shall be signalled to the operator.

In the event of a failure or interruption of the clamping energy, the clamping function shall be kept or the design of the grinding machine or the guard shall ensure that no parts can be ejected.

5.2.6 Vertical or slant axes under gravity

Means shall be provided to prevent hazardous movement of vertical or slant axes under gravity (e.g. brake system). For requirements concerning the safety function control for the prevention of unintended descent of vertical or slant axes, see [5.12 b\) 13](#)).

5.2.7 Modes of machine operation

5.2.7.1 Mode selection

- a) The modes of safe operation which are mandatory or optional for the specific grinding machine are given in [5.2.2. f\)](#) and [5.2.3.3 d\)](#).
- b) To select a mode
 - 1) The selection of a mode of safe operation shall be either by key switch, access code or other equally secure means and shall only be permitted from outside the work zone. The selected mode shall be easily visible (e.g. by display or by position of the selector switch). Selection of a mode shall not initiate a hazardous situation. If a lockable mode selection switch is used, it shall be in accordance with ISO 12100:2010, 6.2.11.10 and IEC 60204-1:2009, 9.2.3.
 - 2) The mode selection device and the associated control system arrangements shall ensure that only one mode is selected and enabled at any one time. For requirements concerning safety function for mode selection, see [5.12 b\) 10](#)).
 - 3) For the selection of MSO 3 (see [5.2.7.5](#)), a separate device is necessary, which shall meet the requirements under 1) and 2).

5.2.7.2 MSO 0: Manual mode

When MSO 0 is selected and the movable guards are open or when machines do not require guards against mechanical hazards as specified in [5.2](#), the following requirements apply:

- a) The wheel spindle may be operated if an abrasive product guard in accordance with [5.13.2.1](#) is provided and the peripheral speed of the abrasive product is limited to values $v \leq 50$ m/s. For monitoring of the reduced speed of the wheel spindle, see [5.12 b\) 5](#)). Rotation of the spindle shall only be initiated manually by a control device (e.g. a start button) provided for that purpose (see [5.12 b\) 14](#)));
- b) The feed movement between abrasive product and workpiece shall be effected manually. At maximum, 2 axis movements, which may also be numerically controlled, may be initiated simultaneously by a start button (see [5.12. b\) 14](#))) while the wheel spindle is rotating. The infeed movements of all other axes may be effected manually by hand wheels, power operated by electronic hand wheels (see [5.12 b\) 3](#))) or by hold-to-run devices (see [5.12 b\) 2](#)));
- c) Axes shall move at a reduced speed as follows (see [5.12 b\) 6](#))):
 - 1) 2 m/min at maximum,
 - 2) 5 m/min at maximum for a travel of more than 1 m up to 5 m, and

- 3) 10 m/min at maximum for a travel of more than 5 m in combination with a protective device (e.g. a two hand control device or a pressure-sensitive mat) ensuring the operator is standing in a safe position;
- d) The peripheral speed of the work holding spindle(s) shall be limited to 0,7 m/s at maximum for clamping devices or workpieces up to a diameter of 500 mm. For larger diameters, limitation to 1,3 m/s at maximum peripheral speed shall be applied, but not more than 50 min⁻¹ at the reduced speed. For monitoring of the reduced speed of the work holding spindle, see [5.12 b\) 5](#)).

NOTE The values for the reduced speed of the feed, rotational, and periphery given in a), c), and d) are maximum values. In the framework of the risk assessment, they are reduced in accordance with the machine-specific hazardous situation, if applicable.

5.2.7.3 MSO 1: Automatic mode

When MSO 1 is selected and the movable guards are open, the following requirements apply:

- a) No movement of machine elements shall be possible, and all axes and spindles shall be in safe stop (see [5.12 b\) 12](#)) or safe operational stop (see [5.12 b\) 11](#)). Exceptions are the following movements:
 - 1) For manual workpiece holding, see [5.2.5](#).
 - 2) Workpiece spindle(s) rotation shall be controlled by hold-to-run control [see [5.12 b\) 2](#)] and shall not exceed 5 min⁻¹ and the peripheral speed shall not exceed 5 m/min for the largest standard work holding device described in the instruction for use. The reduced speed shall be monitored [see [5.12 b\) 5](#)].
 - 3) The wheel spindle may be operated, providing
 - the peripheral speed of the abrasive products shall be limited to $v \leq 50$ m/s, where the requirements of [5.2.3.3 c\)](#) (contact protection) and [5.13.2.1](#) (abrasive product guard) are met, or
 - the peripheral speed of the abrasive product shall be limited to $v \leq 16$ m/s, where the abrasive product guard according to [5.13.2.1](#) is not provided and the requirements of [5.2.3.3 c\)](#) are not met.

For monitoring of the reduced speed of the wheel spindle, see [5.12 b\) 5](#)).

NOTE For manual clearing of the chip spaces of the abrasive product by means of a dressing stone, the requirement for contact protection can be met by means of personal protective equipment subject to the result of a risk assessment, if applicable (see [Clause 7](#)).

When MSO 1 is selected and the movable guards are closed, all programmed movements of machine elements are possible and the machine shall only be started or restarted by actuation of the start device. The monitoring of the maximum permissible speed of the wheel spindle shall be active (see [5.12 b\) 5](#)); (exception: mains operated asynchronous motor).

5.2.7.4 MSO 2: Setting mode

This operating mode is not intended for machining.

When MSO 2 is selected and the movable guards are open, the following requirements apply:

- a) The wheel spindle may be operated using a starting device, providing
 - the peripheral speed of the abrasive products shall be limited to $v \leq 50$ m/s, where the requirements of [5.2.3.3 c\)](#) (contact protection) and [5.13.2.1](#) (abrasive product guard) are met, or
 - the peripheral speed of the abrasive product shall be limited to $v \leq 16$ m/s, where the abrasive product guard according to [5.13.2.1](#) is not provided and the requirements of [5.2.3.3 c\)](#) are not met.

For monitoring the reduced speed of the wheel spindle see 5.12 b) 5).

b) Axes shall move at a reduced speed as follows (see 5.12 b) 6)):

- 1) 2 m/min at maximum;
- 2) 5 m/min at maximum for a travel of more than 1 m up to 5 m;
- 3) 10 m/min at maximum for a travel of more than 5 m in combination with a protective device (e.g. a two hand control device or a pressure-sensitive mat) ensuring the operator is standing in a safe position.

Control of the movements shall be effected by means of a hold-to run device (see 5.12. b) 2)) or an electronic hand wheel (see 5.12 b) 3)).

For the hold-to-run device or the electronic hand wheel, a PL_r lower than specified in 5.12. b) is sufficient, if there is a realistic chance to avoid the hazard. This can be assumed, if the reduced speed of the axes is limited to a value below 0,5 m/min (see 5.12 b) 6)).

c) Limitation of the speed of power operated work holding spindle(s) to $n \leq 50 \text{ min}^{-1}$ but not more than 1,3 m/s, measured at the diameter of the clamping device or, if the workpiece diameter is larger, at the largest workpiece diameter. For monitoring of the reduced speed of the work holding spindle, see 5.12 b) 5). Control of the movement shall be effected by means of a hold-to-run device (see 5.12 b) 2)) or an electronic hand wheel (see 5.12 b) 3)) or by means of a start button in combination with an enabling device (see 5.12 b) 4)).

The hold-to-run device may also be designed as a two-step foot switch for ergonomic reasons (see 5.12 b) 2)).

For the hold-to-run device or the electronic hand wheel, a PL_r lower than specified in 5.12 b) is sufficient, if there is a realistic chance that the severity of the injury to be expected is low. This can be assumed, if no trapping, entanglement, drawing-in hazards, etc. are present.

NOTE The values for the reduced speeds of the feed, rotation, and periphery given in a) to c) are maximum values. In the framework of the risk assessment, they are reduced in accordance with the machine-specific hazardous situation, if applicable.

d) When access is given to a hazard zone from more than one position through movable guard(s) and part of the hazard zone is not visible from the operator's position, no movement shall be possible unless the remaining guards at these hazard zones are closed

e) If the machine is equipped with handling devices for workpiece and tool loading/unloading:

- 1) For handling device setting, the requirements specified under b) or the requirements in ISO 10218-1:2006, 5.7.3 and 5.7.4 apply, even if the handling device is only programmable in less than three axes;
- 2) If the axes speed cannot exceed the limits (e.g. on pneumatic axes), monitoring of the reduced speed according to 5.12 b) 6) with guard open is not required. Power operated motion shall only be initiated under control of an enabling device together with a hold-to-run device to permit step-by-step movement. When continuous movement is required, the enabling device and the hold-to-run device shall be at a safe distance from the hazardous situation to keep both hands outside the hazardous zone (see ISO 13855). For requirements concerning the safety functions, e.g. hold-to run control and enabling device, see 5.12 b) 2) and 4). No hazardous movement shall arise from the actuation of any sensor or feedback device;
- 3) If a robot is used for workpiece loading/unloading, the requirements of ISO 10218-1 shall apply.

When MSO 2 is selected and the movable guards are closed, all movements of machine elements are possible. Monitoring of the maximum permissible speed of the wheel spindle shall be active (see 5.12 b) 5); (exception: mains operated asynchronous motor).

5.2.7.5 MSO 3: optional special mode for manual intervention under restricted operating conditions

This operating mode is only intended, where access for the operator to the danger zone is absolutely necessary, and provided that all safety measures applicable under technological aspects and feasible in accordance with the state of the art are carried out. Access for the operator can be absolutely necessary in the case of production of single items and small production series with high precision and complexity. Furthermore, automatic program runs with guards opened are required for first program testing with complex workpiece and tool arrangements.

If MSO 3 is selected and the guards are open, the requirements according to [5.2.7.4](#) (MSO 2: setting mode) apply to manual operation, and the following requirements apply to execute programmed cycles:

- a) The wheel spindle may be operated, providing
- the peripheral speed of the abrasive products shall be limited to $v \leq 50$ m/s, where the requirements of [5.2.3.3 c\)](#) (contact protection) and [5.13.2.1](#) (abrasive product guard) are met, or
 - the peripheral speed of the abrasive product shall be limited to $v \leq 16$ m/s, where the abrasive product guard according to [5.13.2.1](#) is not provided and the requirements of [5.2.3.3 c\)](#) are not met.

For monitoring of the reduced speed of the wheel spindle, see [5.12 b\) 5\)](#).

- b) Axes shall move at a reduced speed as follows (see [5.12 b\) 6\)](#)):
- 1) 2 m/min at maximum;
 - 2) 5 m/min at maximum for a travel of more than 1 m.
- c) The peripheral speed of the work holding spindle(s) shall be limited to 0,7 m/s at maximum for clamping devices or workpieces up to a diameter of 500 mm. For larger diameters, limitation to 1,3 m/s at maximum peripheral speed shall be applied, but not more than 50 min⁻¹ at the reduced speed. For monitoring of the reduced speed of the work holding spindle, see [5.12 b\) 5\)](#).

NOTE The values for the reduced speeds of the feed, rotation, and periphery given in a) to c) are maximum values. In the framework of the risk assessment, they are reduced in accordance with the machine-specific hazardous situation, if applicable.

- d) Control of the programmed movements under b) and c) can be effected by a hold-to-run device (see [5.12 b\) 2\)](#)) or with an electronic hand wheel (see [5.12 b\) 3\)](#)) or with start button, each in combination with an enabling device.
- e) Access to the danger zone created by moving clamping devices, e.g. rotating protruding jaws on chucks, shall be prevented by guards.
- f) A started program cycle shall be displayed throughout the whole cycle. The next step prior to execution shall also be displayed.

Requirements of [5.3](#) to [5.15](#) shall additionally be met. Examples for applications where MSO 3 is required are given in Annex K.

When MSO 3 is selected and the movable guards are closed, all movements of machine elements are possible without enabling device. Monitoring of the reduced speed of the wheel spindle shall be active (see [5.12 b\) 5\)](#)).

5.2.7.6 MSO service

MSO service shall only be provided for service staff, trained and authorized by the machine manufacturer, and for staff qualified by the client in accordance with the instructions of the machine manufacturer (see as well [7.2.9](#)).

a) General

- 1) For the selection of MSO service, a lockable switch mounted on a cable connected, detachable service device shall be provided. The connection of the service device shall be accessible at the machine, e.g. at the outside of an electric enclosure. Warning signs at the service device shall inform that the use of the service device is restricted to service staff, trained and authorized by the machine manufacturer. As long as the service device is connected to the machine, no other mode of safe operation shall be selectable. The instructions for use shall require removing the device after completing service activities

The service device may be replaced by other selection devices limiting application of MSO service to the persons mentioned above.

- 2) Manual operation shall be possible under the conditions in [5.2.7.4](#).
- 3) According to the risk assessment, additional safety measures can be necessary, such as secondary guards, barriers, or screens, in connection with warning signs.

b) This mode will enable restricted automatic functionality of the machine with the movable guards open. The restrictions are the following:

- 1) machining shall not be possible in MSO service;
- 2) axes speed shall be reduced and monitored (see [5.12 b\) 6\)](#)) with the exception of cases according to [5.2.7.6 b\) 5\)](#). These reduced axes speed shall not exceed 2 m/min, or 5 m/min for axes with traverse of more than 1 m;
- 3) Continued moving cycles can be possible (e.g. repeatability test);
- 4) Rotation of the wheel and work holding spindles shall be possible under the conditions in [5.2.7.5 a\)](#) and c);
- 5) Control of the programmed movements may be effected by a hold-to-run device (see [5.12 b\) 2\)](#)) or with an electronic hand wheel (see [5.12 b\) 3\)](#)) or with start button, each in combination with an enabling device. This enabling device shall be placed outside the hazard zone, if the reduced speed is exceeded according to [5.2.7.6 b\) 2\)](#).

5.2.8 Optional or additional equipment for grinding machines

5.2.8.1 Handling devices for workpiece loading/unloading

If the machine is equipped with handling devices for workpiece loading/unloading, the following requirements shall be fulfilled.

- a) Load/unload positions for operators at workpiece transfer devices shall be located outside the work zone and away from the other hazardous mechanism (e.g. the tool changer).
- b) Access to the hazardous movements of handling devices shall be prevented by means of fixed and/or interlocked movable guards (see [5.12 b\) 1\) iv\)](#)) or hazardous movement(s) shall be either stopped or inhibited by the actuation of protective devices (e.g. interlocked guard or light curtain).
- c) For requirements concerning setting mode of handling devices for workpiece loading/unloading, see [5.2.7.4 e\)](#).

- d) Actuation of a machine's emergency stop device (see 5.12 c)) shall also initiate the emergency stop function of the handling device and vice versa, if the loader is in the machine area. If the machine and the loader form one integrated manufacturing system, ISO 11161 shall be applied.
- e) If access to the handling device hazard zone is possible, access from that area to the machine work zone
 - is either impossible, or
 - the machine shall be in stopped condition and unexpected start-up shall be prevented.
- f) If access to the work zone of the machine is possible, access to the handling device
 - is either impossible, or
 - the handling device shall be in stopped condition and unexpected start-up shall be prevented (for prevention of unexpected start-up, see ISO 14118).

5.2.8.2 Machines equipped with a tailstock and/or quill

If the machine is equipped with a tailstock and/or quill, means shall be provided to prevent the tailstock being unintentionally pulled off the end of the bed during manual adjustment of its position (e.g. mechanical stop). For machines with power operated tailstock and/or quill:

- a) Power operated movements of the quill when the guard is open, with the exception of spring-actuated quills, shall not exceed 1,2 m/min when the stroke is >10 mm and shall only be possible by using one of the following devices:
 - 1) a control device requiring both hands outside the work zone (e.g. by two-hand control in accordance with ISO 13851; see 5.12 b) 2)),
 - 2) a hold-to-run control, (see 5.12 b) 2)), or
 - 3) a 2-position or 3-position-foot switch; see 5.12. b) 2).
- b) Means to adjust the clamping force are recommended. If the clamping system is not activated or not closed, a process start shall be inhibited. The process shall be stopped (e.g. controlled stop) if the clamping system opens unintended (e.g. initiation of the opening mechanism or a minimum clamping force level predefined by the operator is not reached) (see 5.12 b) 7)).
- c) Opening and closing of the tailstock quill for manual workpiece change may be possible in all modes of safe operation.
- d) Manual initiation of power operated tailstock and power operated quill movements shall not be possible when the work holding spindle is rotating (see 5.12 b) 7)), if the holding force of chuck or steady rest is not sufficient.
- e) The clamping limit shall be
 - 1) indicated on the tailstock quill and the end position of the quill shall be durably indicated (e.g. by a coloured ring), or
 - 2) monitored by a limit switch which is interlocked with the spindle rotation (see 5.12 b) 7)).
- f) Power operated movement of the tailstock body towards to the workpiece when the guard is open in all modes of safe operation shall only be possible by using a hold-to-run control (see 5.12 b) 2)). The tailstock body can retract to the defined position by one operation considering ISO 13854 for the necessary gaps to avoid crushing. The maximum traverse rate of the tailstock body shall not exceed 2 m/min.

5.2.8.3 Externally accessible tool magazine, tool-transfer, and tool-changing mechanism

If the machine is equipped with an externally accessible tool magazine, tool transfer, or tool changing mechanism, the following requirements shall apply.

- a) Access to an externally accessible tool magazine and tool transfer and tool changing mechanism shall be safeguarded by a combination of fixed and movable guards (see 5.2.3.2 a)) in accordance with ISO 14119:1998, 7.1. For requirements concerning safety functions for interlocking devices associated with tool changer, tool magazine, see 5.12 b) 1) iii).
- b) When the movable guard(s) for access to the tool magazine is (are) open, the tool magazine drive shall be stopped in safe stop or safe operational stop according to 5.12 b) 11) and 5.12 b) 12). In MSO 2, MSO 3, and in MSO service with the movable guard(s) open, power operated movement of the tool magazine (e.g. for tool replenishment, maintenance, or adjustment purposes) shall only be possible by means of hold-to-run control allowing a single tool station index movement or by two-hand control device (see ISO 13851) for continuous movement. This movement shall be at a reduced speed of 2 m/min or initiated from control devices located outside the reach of hazardous movements in accordance with ISO 13857.
- c) In order to prevent falling or ejection of tools, they shall be held within the tool holder of the magazine. The design data for tool holding (e.g. limits for maximum mass, moments of inertia, and spatial envelope of tools) shall be provided to the user (see 7.2.2).
- d) Fixed or movable guards shall prevent access to movable parts of the tool changer. When movable guards providing access to the tool changer from any hazard zone are open, the movement of the tool changer shall be inhibited. No hazardous machine movements shall arise from the actuation of any sensor or feed-back device. To prevent falling or ejection of tools, they shall be held in the tool changer under all operating conditions including loss of power.

5.3 Specific requirements resulting from electrical hazards

- a) Direct contact with electrical equipment
 - 1) Electrical equipment shall be in accordance with IEC 60204-1, unless otherwise specified in this International Standard.
 - 2) See IEC 60204-1:2009, Clause 6, for the prevention of electric shock and IEC 60204-1:2009, Clause 7, for protection against short circuits and for protection against overloading. In particular, the following requirements in the relevant clauses of IEC 60204-1:2009 shall be fulfilled:
 - i) Clause 7 for protection of equipment;
 - ii) Clause 8 for equi-potential bonding;
 - iii) Clause 12 for conductors and cables;
 - iv) Clause 13 for wiring practices;
 - v) Clause 14 for electrical motors and associated equipment.
 - 3) Electrical enclosures shall not be exposed to the risk of damage from the ejection of tools and/or workpieces. Live parts shall not be accessible (see IEC 60204-1:2009, 6.2.2). The risk of fire caused by faults in the electrical equipment is not considered significant on the machine where power circuits are protected against over current (see IEC 60204-1:2009, 7.2.2).
- b) For indirect contact with electrical equipment, the requirements of IEC 60204-1:2009, 6.3 shall be fulfilled.

NOTE See IEC 60204-1:2009, 3.27 for the definition of “indirect contact”.

- c) For the protection of control gear, enclosures of control gear shall provide a degree of protection of at least IP2X, in accordance with IEC 60204-1:2009, 6.2.2, except for control gear enclosures within the work zone that shall be protected to IP55.

5.4 Specific requirements resulting from noise hazards

When designing the machine, the available information and technical measures to control noise at its source shall be taken into account (see, for example, ISO/TR 11688-1).

NOTE The main noise sources at grinding machines depend on the grinding method and the components and equipment used on the grinding machine. Sources of airborne noise include the following:

- abrasive products and workpieces;
- wheel spindles;
- work holding spindles;
- axis drives;
- ball screws;
- dressing and truing devices;
- loading, unloading, ejection, and transfer operations;
- hydraulic systems;
- extraction systems;
- pneumatic systems;
- metalworking fluid systems.

If means for the noise reduction at source are insufficient, secondary noise reduction measures shall be taken wherever possible. For measures for noise reduction, see Annex E.

For determination of noise emission, see Annex F.

The declaration of the noise emission values shall be in accordance with [7.2.6](#).

5.5 Specific requirements resulting from vibration hazards

On grinding machines with manually guided tool feed using a handle, for examples, see [Table 1](#), Nos. 1.3 and 1.4, where operators can be subject to vibrations of more than 2,5 m/s², measures for preventing vibrations shall be taken. Measures for the reduction of vibrations can be achieved by construction and design, damping, and/or insulation (see CR 1030-1). For measurement of mechanical vibrations, see ISO 20643.

5.6 Specific requirements resulting from radiation hazards

- a) For low-frequency radiation, radio frequency radiation, all microwaves, see [5.9 k](#)). See also EN 12198-1, EN 12198-2 and EN 12198-3 for more information.
- b) Built-in laser feedback systems shall be designed to prevent exposure to beam paths or specular reflections in accordance with IEC 60825-1.

5.7 Specific requirements resulting from materials or substance hazards

5.7.1 General

Materials or substances used for the construction and operation of grinding machines shall be chosen in such a way that no health hazardous effects occur over the life of the grinding machines, e.g. asbestos shall not be used for brake and clutch lining.

Where material hazardous to health is machined or used or where dusts, fumes, and mists are likely to be generated, the safeguards shall be designed to minimize operator exposure. An integral extraction system and/or means of fitting an extraction system shall be provided.

Grinding machines with an integral extraction system shall be designed so that the extraction is activated as soon as functions likely to generate dusts, fumes, and mists are switched on. After switching off these functions, the extraction system shall continue to run until hazards caused by dusts, fumes, and mists no longer exist. For totally enclosed machines, the after-run period depends on the volume of the workroom and on the extraction capacity, e.g. it should only be possible to open the guards after the air in the workroom has been exchanged at least twice. The integral extraction system shall be designed such that no exposure on hazardous substance on a dangerous level is possible, when the guards will be opened.

Measures shall be provided to prevent the escape of harmful mist, e.g. resulting from the use of compressed air.

As the actual requirements for the extraction system will depend on a variety of different parameters, e.g. the nature of the materials being used, it is not possible to give more detailed technical requirements in this International Standard.

5.7.2 Devices for the use of metalworking fluids

5.7.2.1 General

Where metalworking fluids for cooling and lubrication are used during grinding which can cause hazards to health, the grinding machine shall be provided with devices for the prevention or minimization of these hazards.

5.7.2.2 Measures for the protection against contact or inhalation

- a) The system shall be designed to prevent splash, overflow, and leakage of the metalworking fluid.
- b) Fluid reservoirs and other system components shall be made of materials to ensure the continued integrity of the system.
- c) The delivery nozzles shall be designed so that unwanted spray is minimized.
- d) Where the generation of mists and vapours in the work zone is foreseen, guards and an extraction system shall be provided or means for attachment of such a system (see [5.7.1](#)).
- e) The metalworking fluid shall have a capacity for the correct function of the grinding machine to avoid excessive heating and subsequent evaporation of the fluid. Alternatively, cooling systems shall be provided.
- f) Where it is foreseen to be necessary for operators to place their hands into the work zone (e.g. during load/unload operations, setting, etc.), the metalworking fluid flow into the work zone shall be automatically stopped (see [5.12](#), b) 19)), when the guards are opened. Adjustment of metalworking fluid flow for the cooling of components or for bed flushing may be possible, e.g. for adjustment of nozzles. All other machines without automatic fluid control shall be provided with devices for manual control or diversion of the metalworking fluid supply.

- g) Fluid reservoirs shall be fitted with clearly readable fluid level indicators marked with minimum/maximum filling levels.
- h) The metalworking fluid system shall be capable of delivering metalworking fluid in a quantity to prevent the generation of hazardous vapours or aerosols during all foreseeable operating/grinding conditions.
- i) The metalworking fluid system shall be designed to facilitate maintenance including sampling and to reduce as far as possible the exposure of personnel to the metalworking fluid during maintenance.
- j) The grinding machine shall be designed so that grinding residues can be removed without requiring drainage of the whole system.

5.7.2.3 Biological and microbiological hazards (viral or bacterial)

- a) The total content of the metalworking fluid systems shall be circulated in normal use so that no stationary volume within the tank exists except where settlement is required by design.
- b) To avoid stagnant areas remaining within the machine, metalworking fluid shall drain from the machine towards the tank under gravity.
- c) Discharge pipework shall have sufficient diameter and slope to minimize sludge settlement.
- d) The metalworking fluid system shall be provided with filtration.
- e) When sediment build-up occurs, cleaning shall be taken into account (e.g. rounded corners in containers). Cleaning shall not require drainage of the whole system (see ISO 14159).
- f) The inside of tanks shall not contribute to the growth of bacteria (e.g. smooth surfaces).
- g) Metalworking fluid containers shall have covers designed to prevent the ingress of foreign matter.
- h) Contamination of the metalworking fluid by oil or grease from external sources such as lost machine lubrication shall be avoided or means shall be provided for their systematic removal. It should be possible to add a separation or removal system for oil or grease, if necessary.
- i) Where a grinding machine is provided with enclosed guards used with metalworking fluid, the enclosure shall be designed to provide an interface between the guard enclosure and an extraction system. The positioning of the interface should take into consideration the internal airflows generated by the machine when in normal operation to enable effective operation of the extraction system.

5.7.3 Measures against fire and explosion hazards

5.7.3.1 Flammable metalworking fluids

5.7.3.1.1 Requirements on metalworking fluids systems

Grinding machines designed for the use of flammable metalworking fluids shall be provided with the following devices minimizing the risk of generation of flammable mixtures and ignition sources.

- a) Metalworking fluid circuit shall be designed in such a way (pipe cross-section, storage container, pumps, nozzle types and positioning options etc.) to ensure sufficient quantities of metalworking fluid at the machining point at any time and for any tool.
- b) If the metalworking fluid supply is not functioning, start-up of the machine shall be prevented. For monitoring of the metalworking fluid supply, see [5.12 b\) 18](#)).
- c) In case of malfunction of the metalworking fluid supply, the process shall be stopped automatically in an appropriate manner, e.g. separation of tool and workpiece and disconnection of wheel spindle and extraction system.

d) Suitable extraction systems shall be provided.

5.7.3.1.2 Requirements on extraction systems

The extraction efficiency shall at least ensure maintenance of negative pressure in the workroom in order to safely prevent egress of metalworking fluid vapours and aerosols from the machine.

If the extraction system is not properly functioning, starting of the operating cycle of the machine shall be prevented (see 5.12 b) 18)) or a machining process under way shall automatically be stopped by appropriate means, e.g. separation of tool and workpiece and disconnection of wheel spindle and tool drives.

All metal bodies in the workroom, including the extraction system pipework, shall be continuously connected to the protective conductor system.

If fire and explosion hazards cannot be prevented by these means, additional measures to limit the effects of fire and explosion events shall be taken.

Such measures include the following:

- 1) Pressure-resistant workroom enclosure including vision panels and pressure relief, where required, in a direction presenting no hazard to persons. The pressure-resistant workroom enclosure shall also fulfil the requirements for guards specified in 5.1.2 and, if applicable, in 5.2.3.2. For information on the dimensioning of pressure relief surfaces, see Annex H.
- 2) Prevention of the escaping of flames and hot gases into the operating area and the environment of the machine, e.g. by flame-proof labyrinth seals at movable parts of the guards (circumferential). For examples, see Annex H.
- 3) Fire extinguishing devices (for technical control requirements for fire alarm and automatic fire extinguishing systems, see 5.12 b) 16) and 17)).
- 4) The machine, including the control system, shall be so designed that connection to devices for fire detection, fire extinguishing systems, fire alarm, pressure relief devices, etc. according to the manufacturer's recommendations is possible.

For machines intended for being connected to a central extraction system, measures or systems shall be provided, preventing, in case of a fire,

- fire propagation into the central extraction system,
- further air supply into the machining room, and
- extraction of extinguishing medium.

NOTE 1 E.g. use of flame arresters (for an example see Annex H), exhaust air shut-off valves.

Integral extraction systems shall automatically shut-off in case of a fire or explosion.

For examples for the integration of extraction and fire extinguishing systems when using flammable metalworking fluids, see Annex I.

NOTE 2 Further measures for risk reduction depend on the actual conditions of use of the machine and shall be considered for the individual case.

5.7.3.2 Flammable and explosive dusts

Where grinding machines are designed for the machining of materials which can generate flammable and explosive dusts (e.g. aluminium, magnesium, and their alloys), devices for the safe removal of these dusts and any flammable gas (e.g. hydrogen) shall be provided in order to prevent hazards caused by fire or explosion. Explosion protection measures from EN 1127-1 shall be taken where applicable.