



# FINAL DRAFT International Standard

## ISO/FDIS 16089

### Machine tools — Safety — Stationary grinding machines

*Machines-outils — Sécurité — Machines à meuler fixes*

ISO/TC 39/SC 10

Secretariat: **SNV**

Voting begins on:  
**2024-07-22**

Voting terminates on:  
**2024-10-14**

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

[ISO/FDIS 16089](https://standards.iteh.ai/catalog/standards/iso/73bc5c88-f7a3-4536-862e-d9c37cae7bfe/iso-fdis-16089)

<https://standards.iteh.ai/catalog/standards/iso/73bc5c88-f7a3-4536-862e-d9c37cae7bfe/iso-fdis-16089>

**ISO/CEN PARALLEL PROCESSING**

RECIPIENTS OF THIS DRAFT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

iTeh Standards  
(<https://standards.iteh.ai>)  
Document Preview

ISO/FDIS 16089

<https://standards.iteh.ai/catalog/standards/iso/73bc5c88-f7a3-4536-862e-d9c37cae7bfe/iso-fdis-16089>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2024

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
<b>Foreword</b> .....	<b>v</b>
<b>Introduction</b> .....	<b>vi</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions, types of grinding machines, and symbols</b> .....	<b>3</b>
3.1 Terms and definitions .....	3
3.1.1 General terms.....	3
3.1.2 Terms related to parts of grinding machines.....	5
3.1.3 Terms related to modes of safe operation (MSO).....	6
3.1.4 Terms related to speeds and axes speed .....	7
3.2 Types and groups of grinding machines described in this document.....	7
3.2.1 General.....	7
3.2.2 Group 1: Manually controlled grinding machine without power operated axes and without numerical control (see <a href="#">Figure 2</a> ).....	9
3.2.3 Group 2: Manually controlled grinding machine with power operated axes and, if applicable, with limited numerically controlled capability (see <a href="#">Figure 3</a> ).....	10
3.2.4 Group 3: Numerically controlled grinding machine (see <a href="#">Figures 4</a> and <a href="#">5</a> ).....	11
3.3 Symbols.....	13
<b>4 List of significant hazards</b> .....	<b>14</b>
4.1 General.....	14
4.2 Main hazard zones.....	15
4.3 Significant hazards and hazardous situations covered by this document.....	15
<b>5 Safety requirements and/or measures</b> .....	<b>18</b>
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 <a href="#">Table 2</a> , Nos 1.1 to 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 .....	21
5.2.3 Group 3 machines, numerically controlled grinding machines.....	22
5.2.4 Tool holding device.....	23
5.2.5 Workpiece holding.....	24
5.2.6 Vertical or slant axes under gravity.....	24
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.....	31
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.....	32
5.7.1 General.....	32
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.....	35
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.....	38
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 .....	39
5.13 Specific requirements resulting from ejected fluids or objects hazards .....	42

# ISO/FDIS 16089:2024(en)

5.13.1	General requirements	42
5.13.2	Guards to prevent ejection in the event of abrasive product breakage	42
5.13.3	Devices protecting against ejection of workpieces and workpiece parts	43
5.14	Specific requirements resulting from loss of stability hazards	44
5.15	Specific requirements resulting from slips, trips and fall of persons hazards	44
<b>6</b>	<b>Verification of the safety requirements and/or protective measures</b>	<b>44</b>
<b>7</b>	<b>Information for use</b>	<b>46</b>
7.1	Marking	46
7.2	Instruction for use	46
7.2.1	General	46
7.2.2	Tooling	49
7.2.3	Workpiece holding	49
7.2.4	Machine functions accessible from the NC panel	49
7.2.5	Restart	49
7.2.6	Noise	50
7.2.7	Vibration	50
7.2.8	Ancillary handling devices	51
7.2.9	Residual risks to be addressed by the machinery user	51
7.2.10	Installation instructions for the grinding machine	52
7.2.11	Cleaning instruction for the machine	52
<b>Annex A</b>	<b>(normative) Abrasive product guards, work zone enclosures and their combinations</b>	<b>53</b>
<b>Annex B</b>	<b>(informative) Impact test for guards — Bursting test</b>	<b>89</b>
<b>Annex C</b>	<b>(informative) Impact test for guards — Projectile impact</b>	<b>92</b>
<b>Annex D</b>	<b>(normative) Clamping methods for abrasive products and safety requirements for tool holding devices</b>	<b>96</b>
<b>Annex E</b>	<b>(informative) Noise reduction</b>	<b>106</b>
<b>Annex F</b>	<b>(normative) Noise test code</b>	<b>107</b>
<b>Annex G</b>	<b>(normative) Requirements for grinding machines for the machining of materials generating flammable and explosive dusts</b>	<b>112</b>
<b>Annex H</b>	<b>(informative) Measures for the use of flammable metalworking fluids</b>	<b>115</b>
<b>Annex I</b>	<b>(informative) Examples for the integration of extraction and fire extinguishing systems when using flammable metalworking fluids</b>	<b>118</b>
<b>Annex J</b>	<b>(informative) Functional safety — Example for rotational speed limit monitoring of the wheel spindle</b>	<b>120</b>
<b>Annex K</b>	<b>(informative) MSO 3 optional special mode for manual intervention under restricted operating conditions — Examples</b>	<b>123</b>
<b>Annex ZA</b>	<b>(informative) Relationship between this European Standard and the essential requirements of EU Directive 2006/42/EC aimed to be covered</b>	<b>128</b>
<b>Bibliography</b>		<b>133</b>

## 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 document 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](http://www.iso.org/directives)).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at [www.iso.org/patents](http://www.iso.org/patents). ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 10, *Safety*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 143, *Machine tools — Safety*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16089:2015), which has been technically revised.

The main changes are as follows:

- contradictory requirements for the reliability of the control function have been corrected in [Table 3](#);
- requirements for guards in [Annex A](#) have been revised: for example, wall thicknesses have been changed for abrasive product guards ([Tables A.1](#) to [A.6](#)) and a new [Table A.7](#) has been added, and for enclosures, a new calculation method for wall thicknesses has been introduced;
- editorial corrections have been made.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## Introduction

This document is a type-C standard as stated in ISO 12100.

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organisations, market surveillance etc.)
- Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:
- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, for example, for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

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

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

Document Preview

[ISO/FDIS 16089](https://standards.iteh.ai/catalog/standards/iso/73bc5c88-f7a3-4536-862e-d9c37cae7bfe/iso-fdis-16089)

<https://standards.iteh.ai/catalog/standards/iso/73bc5c88-f7a3-4536-862e-d9c37cae7bfe/iso-fdis-16089>

# Machine tools — Safety — Stationary grinding machines

## 1 Scope

This document 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 [3.1](#) and 3.4.

NOTE 2 Requirements in this document 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 document covers the significant hazards listed in [Clause 4](#) and applies to ancillary devices (e.g. for workpieces, tools, workpiece holding devices and handling devices), which are integral to the machine.

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

This document 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 document can be taken as a basis for safety requirements. Specific information on hazards arising from other metalworking processes are covered by other International Standards.

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

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

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 1083, *Spheroidal graphite cast irons — Classification*

ISO 2553, *Welding and allied processes — Symbolic representation on drawings — Welded joints*

## ISO/FDIS 16089:2024(en)

- ISO 3522, *Aluminium and aluminium alloys — Castings — Chemical composition and mechanical properties*
- ISO 3574, *Cold-reduced carbon steel sheet of commercial and drawing qualities*
- ISO 3746, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane*
- ISO 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, *Hydraulic fluid power — General rules and safety requirements for systems and their components*
- ISO 4414, *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 4997, *Cold-reduced carbon steel sheet of structural quality*
- ISO 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*
- ISO 6316, *Hot-rolled steel strip of structural quality*
- ISO 6361-2, *Wrought aluminium and aluminium alloys — Sheets, strips and plates — Part 2: Mechanical properties*
- 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 9444-1, *Continuously hot-rolled stainless steel — Tolerances on dimensions and form — Part 1: Narrow strip and cut lengths*
- ISO 9444-2, *Continuously hot-rolled stainless steel — Tolerances on dimensions and form — Part 2: Wide strip and sheet/plate*
- ISO 10218-1:2011, *Robots for industrial environments — Safety requirements — Part 1: Robots*
- ISO 11161, *Safety of machinery — Integrated manufacturing systems — Basic requirements*
- ISO 11202, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections*
- ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*
- ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*
- ISO 13850, *Safety of machinery — Emergency stop function — 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 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*
- ISO 14118:2017, *Safety of machinery — Prevention of unexpected start-up*
- ISO 14119:2013, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*
- ISO 14120:2015, *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 and general requirements of access*

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 14737, *Carbon and low alloy cast steels for general applications*

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

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 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, types of grinding machines, and symbols

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

#### 3.1 Terms and definitions

##### 3.1.1 General terms

###### 3.1.1.1

###### **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, for example, external cylindrical grinding and internal cylindrical grinding.

###### 3.1.1.1.1

###### **stationary grinding machine**

*grinding machine* (3.1.1.1) fixed in position during operation

Note 1 to entry: For types and groups of stationary grinding machines, see 3.1.4.

Note 2 to entry: In this document, the term “grinding machines” stands for “stationary grinding machines”.

**3.1.1.2**

**manual control**

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

**3.1.1.3**

**manually controlled grinding machine**

*grinding machine* (3.1.1.1) for which all process steps for the machining are controlled or started by an operator without support by an NC-machining program

**3.1.1.4**

**numerical control**

**NC**

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

[SOURCE: ISO 2806:1994, 2.1.1]

**3.1.1.5**

**computerized numerical control**

**CNC**

realization of *NC* (3.1.1.4) using a computer to control the machine functions

[SOURCE: ISO 2806:1994, 2.1.2]

**3.1.1.6**

**numerically controlled grinding machine**

**NC grinding machine**

*grinding machine* (3.1.1.1) that operates under *numerical control* (3.1.1.4) or *computerized numerical control* (3.1.1.5)

**3.1.1.7**

**power operated axis**

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

**3.1.1.8**

**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<sup>[47]</sup> and EN 13236<sup>[48]</sup>).

**3.1.1.9**

**dressing tool**

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

**3.1.1.10**

**work zone**

space where cutting takes place

**3.1.1.11**

**access to the hazard zone**

means to enter the hazard zone either with individual parts of the body or with the whole body

**3.1.1.12**

**operational stop**

cessation of the movements of the machine in the production process

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

**3.1.1.13**

**safe operational stop**

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

**3.1.1.14**

**safe stop**

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

**3.1.1.15**

**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 13849-1:2015, 3.1.23, modified — Note 1 to entry has been deleted.]

**3.1.1.16**

**required performance level**

**PL<sub>r</sub>**  
performance level (PL) applied in order to achieve the required risk reduction for each safety function

[SOURCE: ISO 13849-1:2015, 3.1.24, modified — Note 1 to entry has been deleted.]

**3.1.2 Terms related to parts of grinding machines**

**3.1.2.1**

**vision panel**

window provided in a guard through which the operator can view the *work zone* (3.1.1.10) or other areas of the machine

**3.1.2.2**

**transparent screen**

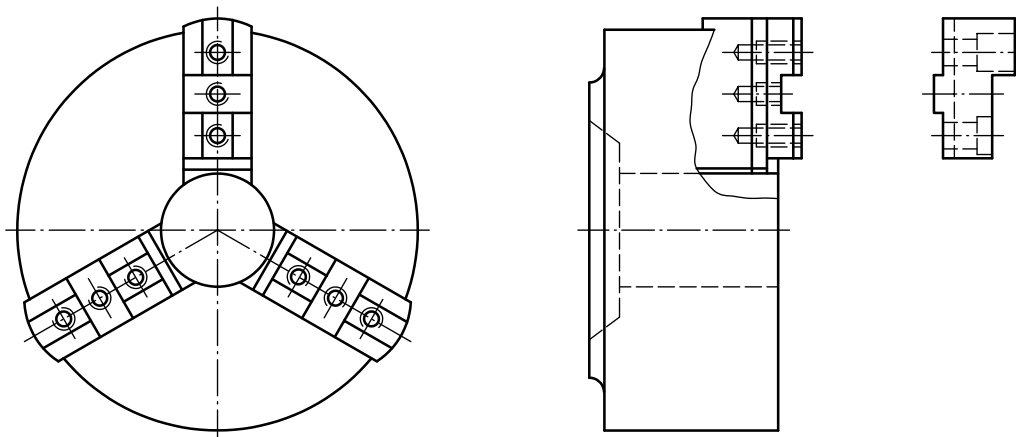
screen used on the machines for the protection of the face and the eyes of the operator from small pieces of debris and grinding sparks

**3.1.2.3**

**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.

**3.1.2.4**

**collet**

**chuck with multiple clamping**

elements for the internal or external clamping of workpieces

[SOURCE: ISO 19719:2010, 1.5]

**3.1.2.5**

**electronic handwheel**

manually operated control device which initiates and maintains an axis movement by pulse generation input to the *numerical control* (3.1.1.4) during its rotation

**3.1.2.6**

**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

**3.1.2.7**

**work zone enclosure**

guard for *grinding machines* (3.1.1.1), 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

**3.1.2.8**

**tool holding device**

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

**3.1.3 Terms related to modes of safe operation (MSO)**

**3.1.3.1**

**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.

**3.1.3.2**

**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

**3.1.3.3**

**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.

**3.1.3.4**

**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, for example, by a program or the operator with movable guards open to access the work area.

**3.1.3.5**

**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, for example, laser, ballbar testing, and/or spindle error analysis.

**3.1.4 Terms related to speeds and axes speed**

**3.1.4.1**

**maximum operating speed**

maximum permissible speed specified by the manufacturer of the abrasive product

**3.1.4.2**

**maximum permissible speed**

highest speed that is permitted by the machine manufacturer, set as a machine parameter

**3.1.4.3**

**reduced speed**

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

**3.1.4.4**

**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

**3.1.4.5**

**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;

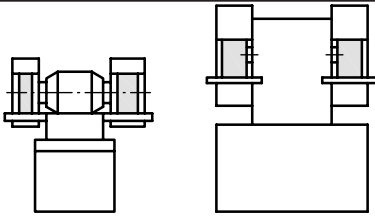
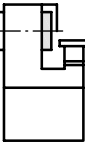
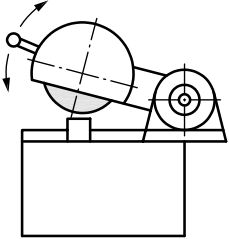
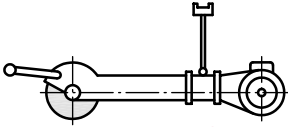
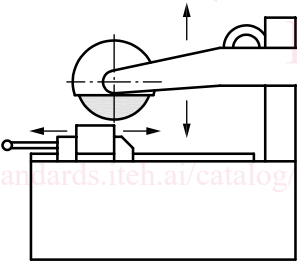
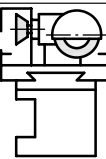
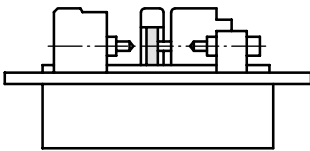
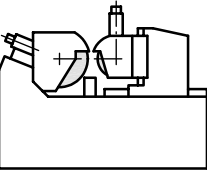
$D$  is the outside diameter of the abrasive product in millimetres

**3.2 Types and groups of grinding machines described in this document**

**3.2.1 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 of different types of grinding machines, see [Table 1](#).

Table 1 — Types of grinding machines

No.	Schema of machine type	Designation	Grinding method
1.1		en: Bench or pedestal grinding machine fr: Touret pour établi ou sur socle de: Tisch- oder Ständerschleifmaschine	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.
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.