SLOVENSKI STANDARD
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Machine tools safety - Machining centres, milling machines, transfer machines - Part 1: Safety requirements (ISO/DIS 16090-1:2020)

Werkzeugmaschinen-Sicherheit - Bearbeitungszentren, Fräsmaschinen, Transfermaschinen - Teil 1: Sicherheitsanforderungen (ISO/DIS 16090-1:2020)

Sécurité des machines-outils - Centres d'usinage, machines à fraiser, machines transfer - Partie 1: Exigences de sécurité (ISO/DIS 16090-1:2020)

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Machine tools safety — Machining centres, milling machines, transfer machines —

Part 1:
Safety requirements

Partie 1: Exigences de sécurité

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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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 10, *Safety*.

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 regards 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, e.g. 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 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.

Milling machines present a wide range of hazards. Protection of operators and other persons from contact with moving cutting tools, especially when being rapidly rotated in the spindle or being swung from a tool magazine to the spindle during power-operated tool changing, or from contact with fast–moving workpieces, is of great importance.

When power-operated mechanisms are provided for workpiece transfer, they can also create hazardous situations during loading/unloading and workpiece alignment, clamping or releasing of the workpiece.

The significant hazards covered by this document are those listed in Clause 4. The safety requirements and/or protective measures to prevent or minimize those hazards identified in Table 2 and procedures for verification of these requirements or measures are found in 5.17.

The figures in Annex D are examples only and are not intended to illustrate the only interpretation of the text.

Machine tools safety — Machining centres, milling machines, transfer machines —

Part 1: Safety requirements

1 Scope

This document specifies the technical safety requirements and protective measures for the design, construction and supply (including installation and dismantling, with arrangements for transport and maintenance) of milling machines (see 3.1.1), including machines capable of performing boring operations (see 3.1.2), machining centres and transfer machines designed for continuous production use, which are intended to cut cold metal, and other non-combustible cold materials except for wood or materials with physical characteristics similar to those of wood as defined in ISO 19085-1, and for glass, stone and engineered/agglomerated materials as defined in EN 14618.

This document covers the following machines:

a) manually, without numerical control, operated boring and milling machines (see 3.2.1, Group 1), e.g. knee and column type milling machines (see Figures C.1 and C.2);

b) manually, with limited numerical control, operated boring and milling machines (see 3.2.2, Group 2), e.g. profile and contouring milling machines (see Figures C.3 and C.4);

c) numerically controlled milling machines and machining centres (see 3.2.3, Group 3), e.g. automatic milling machines and milling centres, e.g. multi-spindle milling machines, gear-milling machines (see Figures C.5, C.6 and C.7);

d) transfer and special-purpose machines (see 3.2.4, Group 4), which are designed to process only pre-specified workpieces or limited range of similar workpieces by means of a predetermined sequence of machining operations and process parameters (see Figures C.8, C.9, C.10, C.11, C.12 and C.13).

This document also applies to machines fitted with the following devices/facilities whose hazards have been dealt with:

— tool magazine(s);

— tool changer(s);

— workpiece handling mechanism(s);

— powered workpiece clamping mechanism(s);

— swarf/chip conveyor(s);

— power-operated door(s);

— moveable operator cabin(s);

— additional equipment for turning;

— additional equipment for grinding.

When in this document the sole word “machine” or “machines” is being used, it is referred to all above-mentioned groups and types of machines.

This document deals with all significant hazards, hazardous situations and events relevant to this type of machinery which may occur during transportation, assembly and installation, setting, operation, cleaning and maintenance, troubleshooting, dismantling or disabling according to ISO 12100, when the machinery is used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This document presumes accessibility to the machine from all directions and specifies access conditions to operator positions. It also applies to workpiece transfer devices including transport devices for loading/unloading when they form an integral part of the machine.

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 230-5:2000, *Test code for machine tools — Part 5: Determination of the noise emission*

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

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

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

ISO 9355-1:1999, *Ergonomic requirements for the design of displays and control actuators — Part 1: Human interactions with displays and control actuators*

ISO 9355-2:1999, *Ergonomic requirements for the design of displays and control actuators — Part 2: Displays*

ISO 9355-3:2006, *Ergonomic requirements for the design of displays and control actuators — Part 3: Control actuators*

ISO 11161:2007, *Safety of machinery — Integrated manufacturing systems — Basic requirements*

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

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

ISO 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 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design*

ISO 13851:2019, *Safety of machinery — Two-hand control devices — Principles for design and selection*

ISO 13854:2017, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

ISO 13855:2010, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body*

ISO 13856-1:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors*

ISO 13856-2:2013, *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 14122-1:2016, *Safety of machinery — Permanent means of access to machinery — Part 1: Choice of fixed means and general requirements of access*

ISO 14122-2:2016, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 14122-3:2016, *Safety of machinery — Permanent means of access to machinery — Part 3: Stairs, stepladders and guard-rails*

ISO 14122-4:2016, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*

ISO 14738:2002, *Safety of machinery — Anthropometric requirements for the design of workstations at machinery*

ISO 15534-1:2000, *Ergonomic design for the safety of machinery — Part 1: Principles for determining the dimensions required for openings for whole-body access into machinery*

ISO 15534-2:2000, *Ergonomic design for the safety of machinery — Part 2: Principles for determining the dimensions required for access openings*

ISO 15641:2001, *Milling cutters for high speed machining — Safety requirements*

ISO 16156:2004, *Machine-tools safety — Safety requirements for the design and construction of work holding chucks*

ISO 19085-1:2017, *Woodworking machines — Safety — Part 1: Common requirements*

ISO 19353:2019, *Safety of machinery — Fire prevention and fire protection*

ISO 23125:2015, *Machine tools — Safety — Turning machines*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP code); Corrigendum 2*

IEC 60825-1:2014, *Safety of laser products — Part 1: Equipment classification and requirements*

IEC 61000-4-2:2008, *Electrostatic discharge immunity test*

IEC 61000-4-4:2012, *Electrical fast transient / burst immunity test*

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments*

IEC 61000-6-3:2006, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Emission standard for residential, commercial and light-industrial environments*

IEC 61000-6-4:2018, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Emission standard for industrial environments*

IEC 61800-5-2:2016, *Adjustable speed electrical power drive systems — Part 5-2: Safety requirements — Functional*

IEC 62061:2005, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

IEC/TS 62046:2008, *Safety of machinery — Application of protective equipment to detect the presence of persons*

EN 528:2008, *Rail dependent storage and retrieval equipment - Safety requirements*

EN 614-1+A1:2009, *Safety of machinery - Ergonomic design principles - Part 1: Terminology and general principles*

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

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

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

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

EN 1127-1:2019, *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 and ISO 13849-1 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms

3.1.1
milling machine
machine tool using geometrically defined rotary cutters to remove material in order to produce plane or formed surfaces on a workpiece while advancing (i.e. feeding) the tool or the workpiece in a certain direction (axis movement) or certain directions (axes movements)

3.1.2
boring machine
machine tool for boring holes in which the principal motion is a rotating cutter against a non-rotating workpiece along a feed axis and the diameter of the hole is adjusted by a different axis which is usually perpendicular to the feed axis

Note 1 to entry: This definition does not include machines exclusively for drilling.

3.1.3
transfer machine
special purpose machine
machine designed to process only a pre-specified workpiece or family of workpieces, by means of a predetermined sequence of machining operations and process parameters

3.1.4
boring operation
machining process of enlarging a hole that has already been produced (e.g. drilled or cast), by means of a single-point cutting tool or a boring head which contains several such tools

3.1.5
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]

3.1.6
computerized numerical control
CNC
realization of *NC* (3.1.5) using a computer to control the machine functions

[SOURCE: ISO 2806:1994, 2.1.2, modified — Manual data input]

3.1.7
manual data input
MDI
mode of operation of a CNC system in which the part program is generated by inputting data manually at the machine

3.1.8
electro-sensitive protective-equipment
ESPE
assembly of devices and/or components working together for protective tripping or presence-sensing purposes comprising a sensing device, controlling monitoring devices, output devices and all interconnecting wiring

[SOURCE: IEC 61496-1:2012, 3.5]

3.1.9
active opto-electronic protective device
AOPD
device whose sensing function is performed by opto-electronic emitting and receiving elements detecting the interruption of optical radiation, generated within the device, by an opaque object present in the specified detection zone

Note 1 to entry: IEC 61496-2 gives detailed provisions on AOPD. For applications, see IEC/TS 62046.

3.1.10
pressure sensitive protective device
PSPD
sensor(s) that responds to the application of pressure, a control unit and one or more output signal switching device(s) and equipment for detecting persons or parts of persons which generates an appropriate signal to the control system to reduce risk to the persons detected

Note 1 to entry: ISO 13856-1, ISO 13856-2 and ISO 13856-3 give detailed provisions.

Note 2 to entry: Safety-related control system associated with the PSPD or the PSPD itself can further include a secondary switching device, start interlock, re-start interlock, etc.

3.1.11
safe operating stop
SOS
function that prevents motor from deviating more than a defined amount from the stopped position by providing energy to the motor to enable it to resist external forces

Note 1 to entry: The SOS function prevents the motor from deviating from the stop position by more than a specified value. The power drive system supplies the motor with energy so that it can withstand external forces; see also IEC 61800-5-2.

Note 2 to entry: This safety function corresponds to a controlled stop category 2 of IEC 60201-1, where torque, speed or rotation positions are maintained and monitored.

3.1.12
safe stop 1
SS1
function which either

a) initiates and controls the motor deceleration rate within set limits to stop the motor and initiates the STO (see 3.1.14) function when the motor speed is below a specified limit, or

b) initiates and monitors the motor deceleration rate within set limits to stop the motor and initiates the STO function when the motor speed is below a specified limit, or

c) initiates the motor deceleration and initiates the STO function after an application specific time delay

Note 1 to entry: This safety function corresponds to a controlled stop in accordance with stop category 1 of IEC 60204-1.

3.1.13
safe stop 2
SS2
function which either

a) initiates and controls the motor deceleration rate within set limits to stop the motor and initiates the safe operating stop function when the motor speed is below a specified limit, or

b) initiates and monitors the motor deceleration rate within set limits to stop the motor and initiates the safe operating stop function when the motor speed is below a specified limit, or

c) initiates the motor deceleration and initiates the safe operating stop function after an application specific time delay

Note 1 to entry: This safety function corresponds to a controlled stop in accordance with stop category 2 of IEC 60204-1.

3.1.14
safe torque off
STO
function which ensures that no energy is applied to the motor that can cause rotation or motion (in the case of a linear motor)

Note 1 to entry: The Power Drive System (PSD) will not provide energy to the motor which can generate torque or force (in the case of a linear motor), see also IEC 61800-5-2:2016, 4.2.3.2.

Note 2 to entry: This safety function corresponds to an uncontrolled stop in accordance to stop category 0 of IEC 60204-1.

Note 3 to entry: This safety function may be used where power removal is required to prevent an unexpected start-up.

Note 4 to entry: In circumstances where external influences (e.g. falling of suspended loads) are present, additional measures (e.g. mechanical brakes) may be necessary to prevent any hazardous situation.

Note 5 to entry: Electronic means and electric contactors are not adequate for protection against electric shock and additional measures for isolation may be necessary.

3.1.15
direction control
positive actuation device to select and maintain a movement

Note 1 to entry: A direction control can be a soft key, touch key, push button control or a rotary type button, e.g. for opening or closing a door or for a movement for clockwise or counterclockwise.

3.1.16
non-combustible cold material
material, excluding wood, with PCS ≤ 3,0 MJ/kg (ISO 1716) or $\Delta T \le 50$ °C and $\Delta m \le 50$ % and $t_f \le 20$ s (ISO 1182), which withstand surface flame attacks and edge flame attacks with 30 s exposure time without flame spread in excess of 150 mm vertically from the point of application of the test flame within 60 s from the time of application (ISO 11925-2)

3.1.17
short presence
dwelling time of a person staying in the hazard zone less than an accumulated time of one hour, but never more than 10 min per single exposition, during an 8 h shift

3.1.18
minimum quantity lubrication
MQL
process of using a little quantity lubrication on cutting point by external spray or through-tool systems

Note 1 to entry: The amount to be used depends on the machining process and type of MQL delivery system.

3.1.19
manual reset/manual reset function
function within the SRP/CS used to restore manually one or more safety functions before restarting a machine

Note 1 to entry: Examples are to reset light curtains, open doors etc.

3.2 Groups of machines

With regard to the applications and the relevant hazards, machines are subdivided into four different groups. See the overview in Table 1.

