
Woodworking machines — Safety —
Part 3:
Numerically controlled (NC/CNC)
boring and routing machines

Machines à bois — Sécurité —

Partie 3: Perceuses et défonceuses à Commande Numérique (CN/CNC)

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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 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.

This document was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 4, *Woodworking machines*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 142, *Woodworking machines – 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 19085-3:2017), which has been technically revised.

The main changes are as follows:

- in the Scope, machines are “intended for continuous production use”, in line with ISO 19085-1:2021;
- the list of significant hazards has been moved to [Annex A](#);
- the structure has been simplified, in line with ISO 19085-1:2021, in particular in [5.6](#);
- the machines designs covered have been clarified, and the relevant requirements have been made more explicit for each design in new [5.6.3](#), with examples figures in the new [Annex H](#);
- the requirements against access to the rear through the un/loading zone in [5.6.4](#) have been improved and moved from old subclause 6.6.2.2.3.1 to [5.6.4](#);
- [Subclause 6.2](#) has been rewritten, and a new updated full Noise Test Code has been introduced in [Annex F](#);

This document is intended to be used in conjunction with ISO 19085-1:2021, which gives requirements common to different machine types.

A list of all parts in the ISO 19085 series can be found on the ISO website.

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.

Introduction

The ISO 19085 series provides technical safety requirements for the design and construction of woodworking machinery. It concerns designers, manufacturers, suppliers and importers of the machines specified in the Scope. It also includes a list of informative items to be provided to the user by the manufacturer.

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, 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 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.

The full set of requirements for a particular type of woodworking machine are those given in the part of ISO 19085 applicable to that type, together with the relevant requirements from ISO 19085-1, to the extent specified in the Scope of the applicable part of ISO 19085.

As far as possible, the safety requirements of parts of the ISO 19085 series refer to the relevant subclauses of ISO 19085-1. Each part contains replacements and additions to the common requirements given in ISO 19085-1.

[Clauses 1 to 3](#) are specific to each part and, therefore, replace ISO 19085-1:2021, Clauses 1 to 3.

For [Clauses 4 to 7](#) and the annexes, ISO 19085-1:2021, Clauses 4 to 7 and Annexes, each subclause can be:

- confirm as a whole;
- confirm with additions;
- exclude in total; or
- replace with specific text.

This is indicated by one of the following possible statements:

- “ISO 19085-1:2021, [subclause/Annex], applies”;

- “ISO 19085-1:2021, [subclause/Annex], applies with the following additions.” or “ISO 19085-1:2021, [subclause/Annex], applies with the following additions, subdivided into further specific subclauses.”;
- “ISO 19085-1:2021, [subclause/Annex], does not apply.”;
- “ISO 19085-1:2021, [subclause/Annex], is replaced by the following text.” or “ISO 19085-1:2021, [subclause/Annex], is replaced by the following text, subdivided into further specific subclauses.”.

Other subclauses and annexes specific to this document are indicated by the introductory sentence: “Subclause/Annex specific to this document.”.

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Woodworking machines — Safety —

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

1 Scope

This document gives the safety requirements and measures for numerically controlled (NC/CNC) boring machines, NC/CNC routing machines and NC/CNC boring and routing machines (as defined in [3.2](#), [3.3](#) and [3.4](#)), capable of continuous production use, hereinafter referred to as "machines".

This document deals with all significant hazards, hazardous situations and events, listed in [Annex A](#), relevant to the machines when they are operated, adjusted and maintained as intended and under the conditions foreseen by the manufacturer including reasonably foreseeable misuse. Also, transport, assembly, dismantling, disabling and scrapping phases have been taken into account.

This document is also applicable to machines fitted with one or more of the following devices/additional working units, whose hazards have been dealt with:

- additional working units for sawing, sanding, assembling or dowel inserting;
- fixed or movable workpiece support;
- mechanical, pneumatic, hydraulic or vacuum workpiece clamping;
- automatic tool change devices.

It is also applicable to machines fitted with edge-banding equipment, even if the relevant specific hazards have not been dealt with.

NOTE For the risk assessment needed for the edge-banding equipment, ISO 19085-17 can be useful.

Machines covered in this document are designed for workpieces consisting of:

- solid wood;
- material with similar physical characteristics to wood (see ISO 19085-1:2021, 3.2);
- gypsum boards, gypsum bounded fibreboards, cardboard;
- matrix engineered mineral boards, silicate boards;
- composite materials with core consisting of polyurethane or mineral material laminated with light alloy;
- polymer-matrix composite materials and reinforced thermoplastic/thermoset/elastomeric materials;
- aluminium light alloy profiles;
- aluminium light alloy plates with a maximum thickness of 10 mm;
- composite boards made from the materials listed above.

This document does not deal with specific hazards related to:

- use of grinding wheels;
- ejection through openings guarded by curtains on machines where the height of the opening in the enclosure above the workpiece support exceeds 700 mm;
- ejection due to failure of milling tools with a cutting circle diameter equal to or greater than 16 mm and sawing tools not conforming to EN 847-1:2017 and EN 847-2:2017;
- the combination of a single machine being used with other machines (as a part of a line);
- integrated workpiece loading/unloading systems (e.g. robots).

This document is not applicable to:

- single spindle hand fed or integrated fed routing machines;
- machines intended for use in potentially explosive atmosphere;
- machines manufactured prior to its publication.

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 2602:1980, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

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

ISO 19085-1:2021, *Woodworking machines — Safety — Part 1: Common requirements*

ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13856-3:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 3: General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices*

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

IEC 61496-2:2013, *Safety of machinery — Electro-sensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)*

IEC 61496-3:2018, *Safety of machinery — Electro-sensitive protective equipment — Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)*

EN 847-1:2017, *Tools for woodworking — Safety requirements — Part 1: Milling tools, circular saw blades*

EN 847-2:2017, *Tools for woodworking — Safety requirements — Part 2: Requirements for the shank of shank mounted milling tools /circular saw blades*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12100:2010, ISO 13849-1:2015, ISO 19085-1:2021 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

numerical control

NC

CNC

automatic control of a process by a device that makes use of numerical data

Note 1 to entry: In the CNC (“computerized numerical control”), the numerical data can be changed with a computer.

3.2

numerically controlled boring and routing machine

NC/CNC boring and routing machine

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

Note 1 to entry: Examples of different machine designs covered by this document are illustrated, without safeguarding devices, in [Figures 1](#) to [6](#).

3.3

numerically controlled boring machine

NC/CNC boring machine

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

3.4

numerically controlled routing machine

NC/CNC routing machine

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

3.5

loading/unloading zone

area close to the machine accessible to the operator for workpiece loading and/or unloading

3.6

machine setting mode

MODE 2

condition with safeguards disabled for setting, programming, fault finding, program verification, testing and manually controlled non-sequential operation of the machine

3.7

clamping device manual positioning mode

MODE 3

condition with safeguards disabled for manual positioning of clamping devices with laser indication

3.8
boring units positioning mode
MODE 4

condition with safeguards disabled for manual change of boring bits on boring machines only

3.9
jog control

control device for momentary activation of a function or a movement

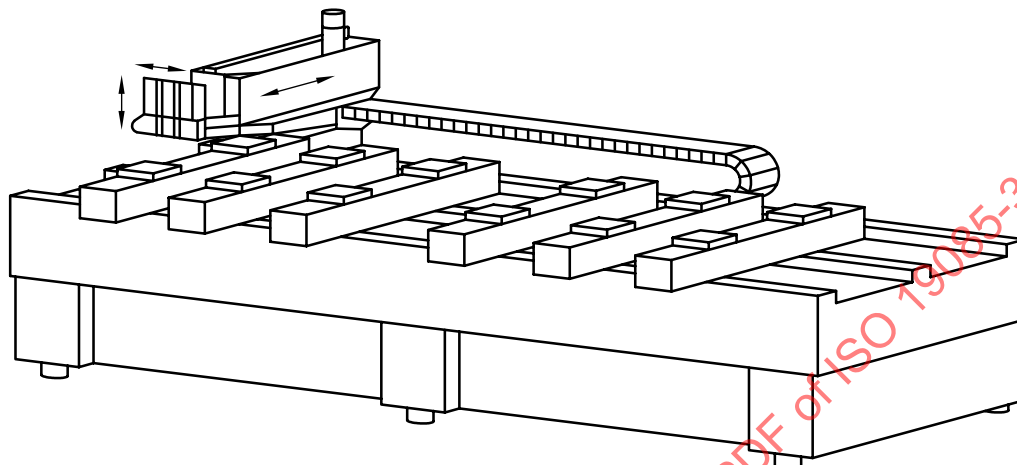


Figure 1 — Example of a C frame machine with fixed table and moving machining head

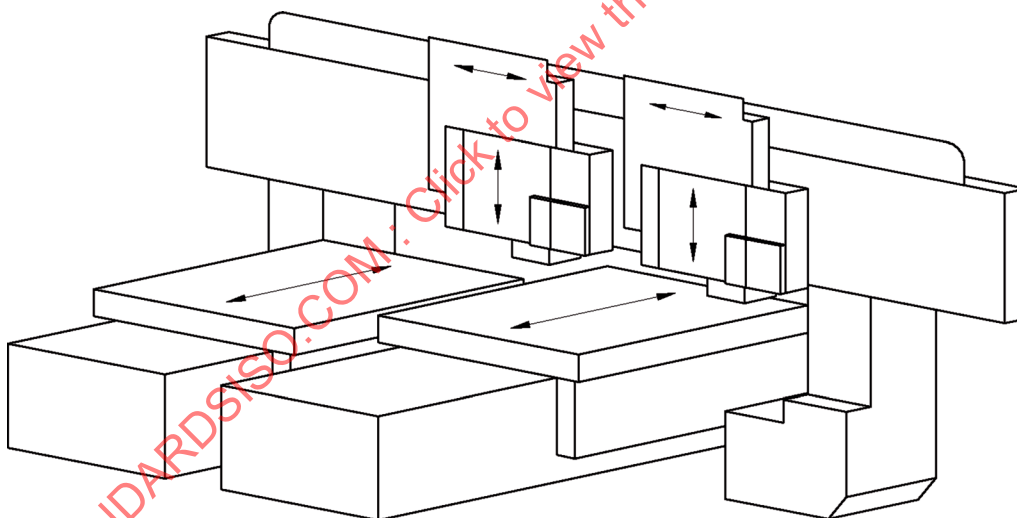


Figure 2 — Example of portal frame machine with moving tables, fixed portal, moving machining heads

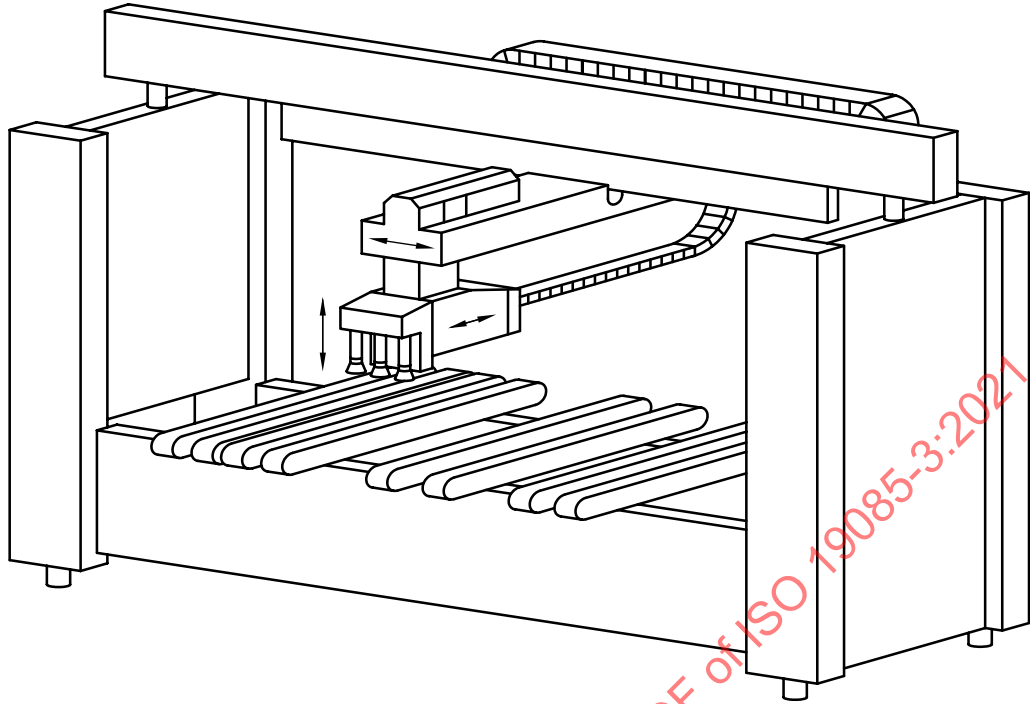


Figure 3 — Example of portal frame machine with fixed portal, feeding belts, moving machining head

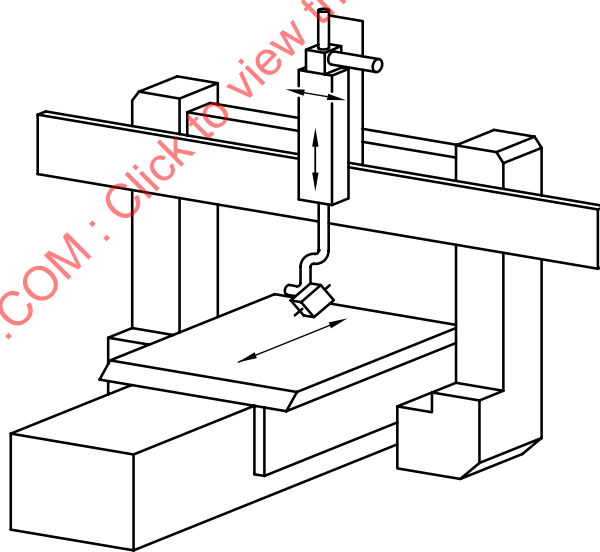


Figure 4 — Example of a machining centre with moving table, fixed portal, moving machining head

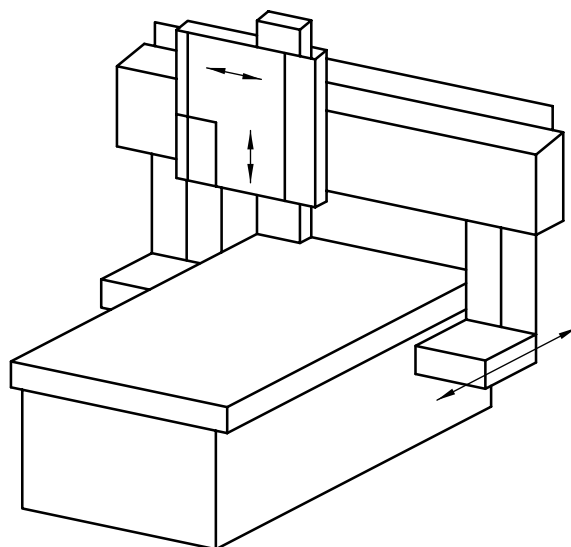


Figure 5 — Example of portal frame machine with fixed table, moving portal, moving machining head

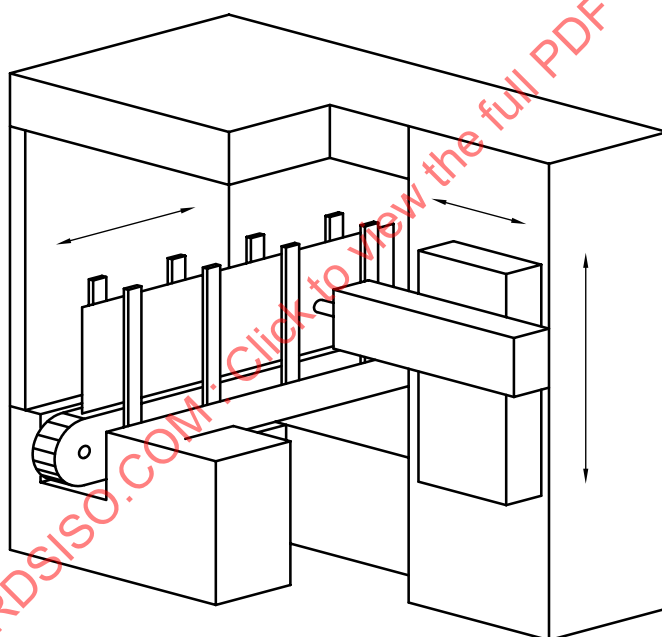


Figure 6 — Example of a through-feed vertical machine with moving workpiece, fixed frame, moving machining head

4 Safety requirements and measures for controls

4.1 Safety and reliability of control systems

ISO 19085-1:2021, 4.1, applies with the following additions.

Table B.1 replaces ISO 19085-1:2021, Table B.1.

4.2 Control devices

ISO 19085-1:2021, 4.2, applies with the following additions, subdivided into further specific subclauses.

4.2.1 General

The control devices for control power-on, operational and normal stop shall be located at the operator's position adjacent to the control display (at the main control panel).

Hold-to-run control devices and/or enabling control devices for tool or axes movements shall be located on the main control panel and/or on a hand-held set of controls connected to the machine by cable or wireless;

An emergency stop control device shall be provided at each working station and, in particular, at each of the following positions:

- a) at the main control panel;
- b) at the hand-held control set;
- c) adjacent to all hold-to-run control devices;
- d) adjacent to all cycle start control devices;
- e) at the workpiece loading and unloading station;
- f) inside any enclosure fitted with access door required in 5.6.2;
- g) close to or inside any tool magazine separated from the machining area and under power during loading and unloading of the tools.

If the distance between two of the positions above is less than 1 m, only one emergency stop control device is required instead of two.

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

4.2.2 Hand-held control sets

Additional control devices for cycle start not including reset function, for operational stop and for normal stop may be provided on hand-held control sets with or without cable connection, taking account of the requirements of 4.4.4 for emergency stop. Reset function control devices, control power-on control devices and mode selector shall not be fitted on hand-held control sets.

When a wireless control set loses its connection to the machine, an emergency stop shall be automatically activated. The SRP/CS for the emergency stop activation in case of wireless control disconnection shall achieve $PL_r = c$.

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

4.3 Start

4.3.1 Direct start

ISO 19085-1:2021, 4.3.1, does not apply.

4.3.2 Start via control power-on

ISO 19085-1:2021, 4.3.2, applies.

4.4 Safe stops

4.4.1 General

ISO 19085-1:2021, 4.4.1, applies with the following additions.

At the end of stopping sequence, powered workpiece clamping devices may be de-energized if no additional hazard occurs.

Stop initiated by opening of moveable guards or activation/triggering of the safety related control system of a protective device shall be either a normal stop or an operational stop or an emergency stop.

If the machine is divided into physically separated danger zones, actuators to be stopped may be only those of the relevant danger zone. In this case, a local manual reset control device is required.

4.4.2 Normal stop

ISO 19085-1:2021, 4.4.2, applies.

4.4.3 Operational stop

ISO 19085-1:2021, 4.4.3, applies.

4.4.4 Emergency stop

ISO 19085-1:2021, 4.4.4, applies.

4.5 Braking function of tools

ISO 19085-1:2021, 4.5, applies with the following additions.

Only electric braking systems are allowed.

4.6 Mode selection

ISO 19085-1:2021, 4.6, applies with the following additions, subdivided into further specific subclauses.

4.6.1 General

The mode selection switch shall be located outside the hazard zone, e.g. on the main control panel, and shall not be reachable from inside the hazard zone.

4.6.2 Machine setting mode [MODE 2]

In machine setting mode of operation, when moveable guards are opened or protective devices disabled, the following requirements apply:

- a) spindle rotation, if needed, shall be controlled by a jog control in combination with an enabling control. The control system for jog control is not safety related;
- b) only one powered (physical or virtual) linear or circular movement shall be possible at a time; no PL is required; any physical or virtual movement shall be controlled by a jog control in combination with an enabling control; the control system for jog control is not safety related. The movement speed of each physical axis shall be limited to $2 \text{ m} \cdot \text{min}^{-1}$ and 4.11 applies. In addition, the speed of virtual movements (i.e. vector or tangential speed) shall be limited to $2 \text{ m} \cdot \text{min}^{-1}$ without PL_r , e.g. by numerical control;

- c) spindle speed shall be limited, taking into account its braking ability, to a value that allows the spindle without tool to stop within 2 revolutions after the release of the enabling control device. The SRP/CS for monitoring the limited spindle speed shall achieve $PL_r = c$;

NOTE The number of 2 revolutions only refers to the deceleration procedure. Response time of the operator is not included, e.g. releasing the enabling device and control are not included.

- d) speed monitoring in accordance with 4.7.3 shall be provided for spindle rotation;
- e) movement of the automatic tool change mechanism shall be controlled by a jog control in combination with an enabling control; the control system for jog control is not safety related. When crushing or shearing hazards exist, two-hand control device shall be provided;
- f) initiation of any other dangerous movement shall be prevented. The SRP/CS for prevention of unexpected start shall achieve $PL_r = c$.

4.6.3 Clamping device manual positioning mode [MODE 3]

For machines without bumpers or sensitive edges, trip bars or trip plates, and with laser indication fitted to the moving machining head, when front side safeguards are disabled, any hazardous movement including spindle rotations shall not be possible except machine head enclosure movement. This movement shall be controlled by a jog control in combination with an enabling control. The movement speed shall be limited to $10 \text{ m} \cdot \text{min}^{-1}$ and 4.11 applies. The control system for jog control is not safety related.

4.6.4 Boring units positioning mode [MODE 4]

For boring machines, when safeguards are disabled, any hazardous movement including spindle rotation shall not be possible except boring units' movement. Only the movement of one axis of one boring unit at a time shall be possible. This movement shall be controlled by a jog control in combination with an enabling control. The movement speed shall be limited to $10 \text{ m} \cdot \text{min}^{-1}$ and 4.11 applies. The control system for jog control is not safety related.

4.7 Tool speed changing

4.7.1 Speed changing by shifting the belts on the pulleys

ISO 19085-1:2021, 4.7.1, applies with the following additions.

The requirement of ISO 19085-1:2021, 4.7.1, applies only to milling aggregates with pre-set spindle speed not controlled by inverter and to boring tools.

4.7.2 Speed changing by incremental speed change motor

ISO 19085-1:2021, 4.7.2, does not apply.

4.7.3 Infinitely variable speed by frequency inverter

ISO 19085-1:2021, 4.7.3, is replaced by the following text.

Machines equipped with an infinitely variable speed control (i.e. frequency inverter) for the tool drive shall have speed monitoring.

The control for speed monitoring shall ensure that, as soon as the real speed exceeds the selected speed or the programmed maximum tool speed by more than 10 %, the drive shall be stopped automatically in stop category 0 according to IEC 60204-1:2016, 9.2.2. The control system for speed monitoring is not safety related.

It shall not be possible to select a speed value higher than the maximum rotational speed of the tool stored in the memory of the control system (no PL required).

For boring tools, no speed monitoring is required.

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

4.8 Failure of any power supply

ISO 19085-1:2021, 4.8, applies with the following addition.

In the case of machines incorporating pneumatic or hydraulic clamping of the workpiece, in the event of a failure in the pneumatic or hydraulic power supply a safe stop of the machine shall be initiated. The SRP/CS for initiating a safe stop shall achieve $PL_r = b$.

4.9 Manual reset control

ISO 19085-1:2021, 4.9, applies.

4.10 Standstill detection and monitoring

ISO 19085-1:2021, 4.10, applies.

4.11 Machine moving parts speed monitoring

ISO 19085-1:2021, 4.11, applies.

4.12 Time delay

ISO 19085-1:2021, 4.12, applies.

4.13 Tele-service

ISO 19085-1:2021, 4.13, applies.

5 Safety requirements and measures for protection against mechanical hazards

5.1 Stability

ISO 19085-1:2021, 5.1 applies with the following additions.

Unintended dangerous movements of the machine or part of it caused by gravity, pressure, etc., shall be avoided, e.g. by mechanical blocking devices capable of withstanding the maximum expected forces.

The requirements on an integrated device for moving the machine do not apply.

5.2 Risk of break-up during operation

ISO 19085-1:2021, 5.2, is replaced by the following text.

To reduce the probability of break up during operation, the requirements of [5.3](#) apply. To reduce the effect of break up during operation, the requirements of [5.9](#), [5.5.1](#) and [5.5.2](#) apply.

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

5.3 Tool and tool fixing design

5.3.1 General

ISO 19085-1:2021, 5.3.1, applies with the following additions.

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

Tool release shall only be possible if the spindle is stopped and if its restart is prevented. This second requirement applies only when operator changes the tool manually.

The SRP/CS for interlocking between tool release and spindle rotation shall achieve $PL_r = c$ or consist of two independent systems both achieving $PL_r = b$.

As an exception, tool release function may achieve $PL_r = b$ if an additional mechanical system preventing tool release during rotation is provided.

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

5.3.2 Spindle locking

ISO 19085-1:2021, 5.3.2, applies.

5.3.3 Circular saw blade fixing device

ISO 19085-1:2021, 5.3.3, applies.

5.3.4 Flange dimension for circular saw blades

ISO 19085-1:2021, 5.3.4, applies with the following additions.

As an exception, for machines designed for a maximum saw blade diameter of 400 mm, the outer clamping diameter of the flanges shall be at least $D/5$, where D is the diameter of the largest circular saw blade for which the machine is designed.

5.4 Braking

5.4.1 Braking of tools

ISO 19085-1:2021, 5.4.1, applies.

5.4.2 Maximum run-down time

ISO 19085-1:2021, 5.4.2, applies.

5.4.3 Brake release

ISO 19085-1:2021, 5.4.3, does not apply.

5.5 Safeguards

5.5.1 Fixed guards

ISO 19085-1:2021, 5.5.1, applies.

5.5.2 Interlocking moveable guards

5.5.2.1 General

ISO 19085-1:2021, 5.5.2.1, applies.

5.5.2.2 Movable guards with interlocking

ISO 19085-1:2021, 5.5.2.2, applies.

5.5.2.3 Movable guards with interlocking and guard locking

ISO 19085-1:2021, 5.5.2.3, applies.

5.5.3 Hold-to-run control

ISO 19085-1:2021, 5.5.3, applies.

5.5.4 Two-hand control

ISO 19085-1:2021, 5.5.4, applies.

5.5.5 Electro-sensitive protective equipment (ESPE)

ISO 19085-1:2021, 5.5.5, applies with the following additions.

If light barriers (AOPD) are used, the following requirements apply.

a) If mounted horizontally:

- 1) the light beams shall be situated at a height between 100 mm and 400 mm above the floor level;
- 2) the pitch between the light beams shall be equal to or less than 100 mm;
- 3) it shall prevent standing between the AOPD and the machine frame, e.g. the distance between the active part of the light barriers and the machine frame at the light barrier level shall not exceed 100 mm.

b) If mounted inclined:

- 1) the pitch between the light beams shall be equal to or less than 200 mm, measured on the horizontal projection;
- 2) the lowest light beam shall be at a height of max. 400 mm above floor level;
- 3) the highest light beam shall be at a height of min. 800 mm above floor level;
- 4) the horizontal distance between top and bottom light beams shall be equal to or greater than 400 mm.

c) If mounted vertically, it shall have at least two light beams; the two light beams shall be situated at a height of 400 mm and 900 mm above the floor level.

If stationary laser scanners are used, the protected area of the scanner shall be situated at a height between 100 mm and 400 mm above the floor level.

AOPDs shall be mounted on the machine according to [5.6](#).

5.5.6 Pressure-sensitive protective equipment (PSPE)

ISO 19085-1:2021, 5.5.6, applies with the following additions, subdivided into further specific subclauses.

5.5.6.1 Pressure-sensitive mats

It shall not be possible to stand between the active part of the mats and the machine frame. This can be achieved, for example, by a distance between the active part of the mat and the machine (e.g. see l_6 in [Figure H.1](#)) not exceeding 100 mm.

The distance between the active part of the pressure sensitive mats and the lateral fixed guards (e.g. see l_7 in [Figure H.1](#)) shall not exceed 80 mm.

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

5.5.6.2 Other PSPE

Machines with PSPE other than pressure sensitive mats shall pass the dynamic test according to [Annex G](#).

Pressure-sensitive edges, trip bars, trip plates may be used only where the maximum axes speed does not exceed 25 m min⁻¹.

Verification: By checking the relevant drawings and/or circuit diagram, measurements, inspection of the machine, relevant functional testing of the machine and relevant tests described in [Annex G](#).

5.5.7 Enabling control

ISO 19085-1:2021, 5.5.7, applies.

5.6 Prevention of access to hazardous moving parts

ISO 19085-1:2021, 5.6, is replaced by the following text, subdivided into further specific subclauses.

5.6.1 General

Wherever a minimum distance from a tool is required in [Clause 5](#), this distance shall be measured from the periphery of the tool (not its axis) and with the tool in the worst-case position, i.e. leaving the smallest distance (see [Figure 7](#)).

All safeguards mentioned in [5.6](#) shall be according to their relevant subclause under [5.5](#).

The characteristics of the guards shall conform to [5.9](#) if they also need to prevent ejection of parts of tools and/or of workpieces.

5.6.2 Safeguarding of all machine sides except the loading/unloading zone

All machine sides except the loading and/or unloading zone shall be enclosed by fixed guards extending in height from a maximum of 180 mm up to at least 1 800 mm above the floor level, or to the top closure of the machine if any, whichever the less.

If it is necessary to enter the enclosure for setting, tool changing or cleaning, at least one door shall be provided and interlocked with guard locking to the drives, and the following requirements apply:

- a) each door shall be provided with its own manual reset control device to reset its interlocking;
- b) each door shall be equipped with an escape release of guard locking according to ISO 14119:2013, 5.7.5.2.

- c) audible warning at control power-on activation shall be given if the operator cannot have a complete view on the hazard area from the door manual reset control position (see 7.1); the warning shall last for maximum 3 s; the cycle start shall be prevented for minimum 6 s more after the warning (no PL required);
- d) an emergency stop device shall be placed inside the enclosure in the area where the operator cannot have a complete view at from the position of the door manual reset control;

As alternative to the fixed guards, the safeguarding solutions required in 5.6.3 may be applied to the machine sides not intended for loading/unloading too.

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

5.6.3 Safeguarding of the loading/unloading zones

5.6.3.1 General

Access to hazardous points due to moving parts (including rotating tools) through the loading/unloading zones shall be prevented by applying the requirements given in 5.6.2 or one of the safeguarding concepts described in 5.6.3.2 to 5.6.3.12.

These safeguarding concepts can be implemented on different machines designs and configurations, as indicated in Table 1; examples are given by figures in Annex H.

Table 1 — Correlation between machine designs, safeguarding concepts and example figures

Machine designs			Safeguarding concepts												
			Examples	A	B	C	D	E	F	G	H	I	J	K	Examples
Moving head enclosure	Fixed workpiece support	Figures 1 and 5	X												Figure H.1
				X									—		
					X								Figure H.12		
				X							Figures H.2 and H.13				
	Fixed solid tables	—					X							Figure H.14	
Moving workpiece support (sliding or shuttle tables)		Figures 2 and 4	X												Figures H.3, H.4 and H.5
				X	X									—	
Fixed workpiece support, horizontal	workpiece speed $\leq 25 \text{ m min}^{-1}$	—						X							Figure H.6
	workpiece speed $> 25 \text{ m min}^{-1}$	—										X			Figures H.10 and H.11
Vertical workpiece support	workpiece speed $\leq 25 \text{ m min}^{-1}$	Figure 6						X							—
	workpiece speed $40/25 \text{ m min}^{-1}$								X					Figure H.7	
	workpiece speed $> 40 \text{ m min}^{-1}$									X				Figure H.8	
workpiece machined on one side only, with limitations		—											X		Figure H.9
Through-feed boring machines with feeding belts		Figure 3												X	Figures H.15 and H.16

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

5.6.3.2 Safeguarding concept A

On machines with fixed workpiece support (see [Figure H.1](#)) and on machines with moving workpiece support (see [Figures H.3, H.4 and H.5](#)), where using stationary protective devices, like light barriers (including those with at least either the receiver or the emitter being stationary), stationary laser scanners or pressure-sensitive mats, to prevent access to the crushing, shearing or cutting area (protected zone), the following requirements apply:

- a) the protected zone (light barrier, stationary laser scanners) or sensing surface (pressure-sensitive mats) shall extend at least 850 mm from any cutting, crushing, shearing, drawing in and entanglement point, measured in horizontal direction; where only impact hazards exist, this distance may be reduced to 700 mm;
- b) where the protective device is divided into sections to allow the machine to work in one section while the other section is accessible for loading/unloading:
 - 1) the horizontal distance between the area accessible for loading/unloading and the protected zone where the machine is working shall be at least 850 mm from any cutting, crushing, shearing, drawing in and entanglement point (see [Figure H.1](#), key l_5); if this distance of 850 mm is violated, a safe stop shall be initiated. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$. Where only impact hazards exist, this distance may be reduced to 700 mm;
 - 2) the section of the protective device accessible for loading/unloading shall be manually reset by the operator before the machining head or sliding or shuttle tables are allowed to traverse into this area. Automatic reset shall not be possible;

NOTE The prevention of automatic traversing without manual reset is required since the operator can involuntarily release the protective safety device, e.g. by stepping or leaning onto the workpiece support.

- c) when a person is detected, a safe stop shall be initiated and the machining head shall stop within 700 mm. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$. No PL is required for ensuring the distances.

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

5.6.3.3 Safeguarding concept B

The following requirements apply on machines with fixed workpiece support and on machines with moving workpiece support, where using:

- pressure-sensitive mats for speed reduction of machining head enclosure or of sliding tables; in combination with
 - stopping devices, e.g. pressure-sensitive bumpers or edges or trip bars or trip plates mounted to the moving parts of the machine for stopping the machining head enclosure or for stopping sliding tables.
- a) The sensing surface of pressure-sensitive mats shall extend at least 850 mm from any cutting, crushing, shearing, drawing in and entanglement point, measured in horizontal direction. Where only impact hazards exist, this distance may be reduced to 700 mm;
 - b) where the protective device is divided into sections to allow the machine to work in one section while the other section is accessible for loading/unloading:
 - 1) the horizontal distance between the area accessible for loading/unloading and the protected zone where the machine is working shall be at least 850 mm from any cutting, crushing, shearing, drawing in and entanglement point. If this distance of 850 mm is violated, the speed reduction shall be initiated; the SRP/CS for the initiation of the speed reduction shall achieve $PL_r = c$. Where only impact hazards exist, this distance may be reduced to 700 mm;

- 2) the section of the protective device accessible for loading/unloading shall be manually reset by the operator before the machining head or sliding tables are allowed to traverse into this area. Automatic reset shall not be possible;

NOTE The prevention of automatic traversing without manual reset is required since the operator can involuntarily release the protective safety device, e.g. by stepping or leaning onto the workpiece support.

- c) when a person is detected by the pressure-sensitive mats, the speed of the machine moving part shall be reduced within 500 mm to a value that allows to fulfil the requirements stated in 5.6.3.5 b). After activation of the limited speed, a manual reset control device shall be activated to restore the full speed. No PL is required for ensuring the distances. The SRP/CS for the initiation of the speed reduction shall achieve $PL_r = c$;
- d) manual reset to restore the full speed is not required if another device is provided, e.g. ESPE, which shall detect an operator even having no contact with the floor, e.g. by stepping or leaning onto the workpiece support;
- e) when stopping devices are triggered, a safe stop shall be initiated. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$.

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

5.6.3.4 Safeguarding concept C

The following requirements apply on machines with fixed workpiece support (see Figure H.12) and on machines with moving workpiece support, where using:

- stationary protective devices like light barriers (including those with at least either the receiver or the emitter being stationary) or stationary laser scanners to prevent access to the crushing, shearing or cutting area (protected zone); in combination with
 - non-stationary protective devices mounted to the moving part of the machine (i.e. machining head enclosure or sliding tables), like pressure-sensitive bumpers, edges, trip bars, trip plates or laser scanner, to stop the machine; and
 - a control device, e.g. button, pedal or PSPE, for actuating the speed reduction of machine head or sliding tables.
- a) The protected zone (light barrier, stationary laser scanners) or sensing surface (pressure-sensitive mats) shall extend at least 850 mm from any cutting, crushing, shearing, drawing in and entanglement point, measured in horizontal direction. Where only impact hazards exist, this distance may be reduced to 700 mm;
- b) when a person is detected by the stationary protective devices, if the speed reduction has not been activated, a safe stop shall be initiated and the machining head shall stop within 700 mm. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$. No PL is required for ensuring the distances;
- c) activation of the speed reduction device shall reduce the speed of the machining head within 500 mm to a value that allows to fulfil the requirements of 5.6.3.5 b). After activation of the limited speed, a manual reset control device shall be activated to restore the full speed. No PL is required for ensuring the distances. The SRP/CS for the initiation of the speed reduction shall achieve $PL_r = c$.
- d) when the non-stationary protective devices are triggered, a safe stop shall be initiated. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$.

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

5.6.3.5 Safeguarding concept D

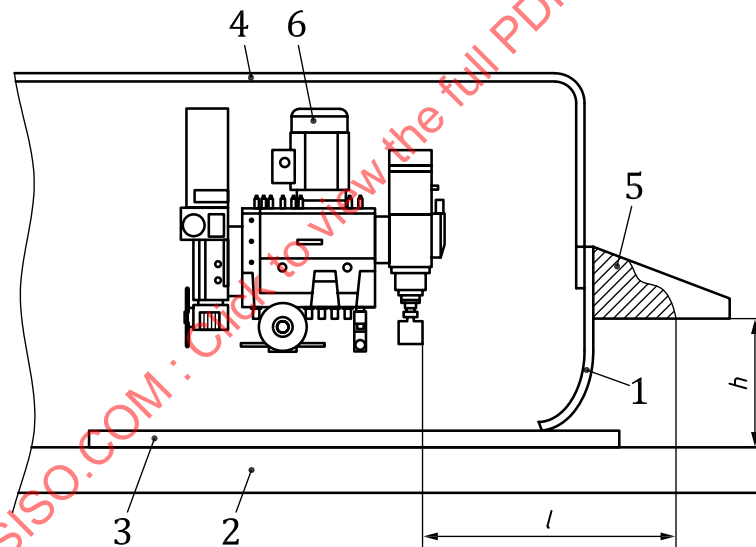
On machines with fixed workpiece support, where using only non-stationary protective devices mounted to the moving part of the machine, like pressure-sensitive bumpers (see [Figure H.2](#) and [Figure H.13](#)), edges, trip bars, trip plates, laser scanners, to prevent access to the crushing, shearing or cutting area (protected zone), the following requirements apply:

- a) for laser scanner, the distance from test probe according to IEC 61496-3:2018 to the machining head enclosure, when it has come to a safe stop from the maximum machine speed, shall be at least 850 mm. No PL is required for ensuring the distance. The SRP/CS for the initiation of the safe stop shall achieve $PL_r=c$. Laser scanners shall also be triggered by an operator, even having no contact with the floor, e.g. by stepping or leaning onto the workpiece support;
- b) for pressure-sensitive bumpers, edges, trip bars, trip plates, the distance between the test probe and any cutting, crushing, shearing, drawing in and entanglement point inside the machining head enclosure shall be at least l , measured after the machine has come to a safe stop from the maximum speed (no PL is required for ensuring the distance; see [Figure 7](#)):

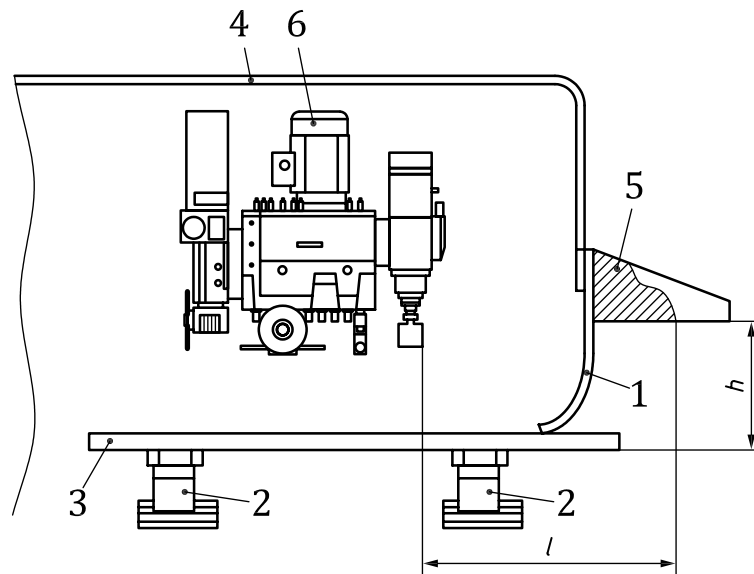
— $l = 550$ mm, if h is up to 200 mm;

— $l = 550 + 0,75 (h - 200)$ mm, if h is between 200 mm and 700 mm;

where h is the height of the opening in the enclosure above the workpiece support.



a) Machining head enclosure above a solid table



b) Machining head enclosure above supporting bars

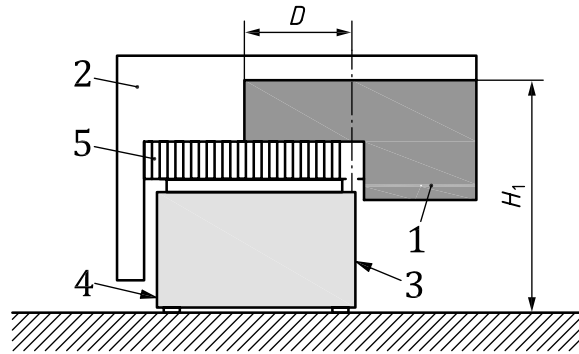
Key

h	height of opening for workpiece feeding	l	remaining distance
1	curtain	4	machining head enclosure
2	workpiece support	5	pressure-sensitive bumper/edge or trip bar
3	workpiece	6	machining head

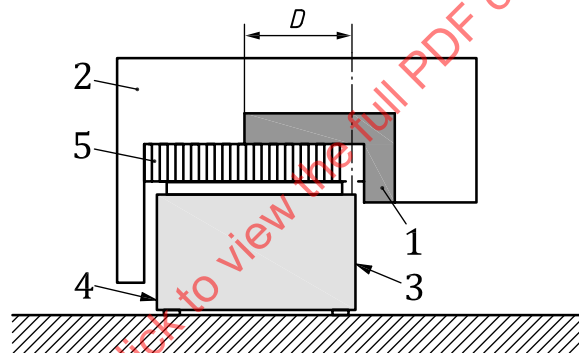
Figure 7 — Distance l for machining head enclosure

In addition:

- 1) On machines where entering the workpiece support of the machine, e. g. for loading and unloading, is not envisaged by its intended use (see [Figure H.2](#)):
 - i) pressure-sensitive bumpers suitable for maximum axes speed exceeding 25 m min^{-1} (see [Figure 8](#)) shall extend to the whole machining head enclosure that can cause impact, crushing, shearing hazards of head, hand, arm, leg, shoulder up to a height H_1 of 1 800 mm or the height of the machining head enclosure, whichever the less, and from the edge inward (distance D) up to at least 700 mm from the machine side accessible by the operator when machining. If it is necessary to position the clamping system at a distance of more than 700 mm, the bumper shall extend to this distance or up to 850 mm, whichever is less;
 - ii) pressure-sensitive edges, trip bars, trip plates and bumpers suitable for maximum axes speed of 25 m min^{-1} (see [Figure 9](#)) shall extend around all shearing, crushing edges and horizontally inwards up to at least 700 mm (distance D) from the machine side according to [Figure 10](#). If it is necessary to position the clamping system at a distance of more than 700 mm, the pressure-sensitive edge, trip bar, trip plate and bumpers shall extend to this distance or up to 850 mm whichever is less.
- 2) On machines where entering the workpiece support of the machine, e. g. for loading and unloading, is envisaged by its intended use (see [Figure H.13](#)), the bumpers required in 1) shall extend to the whole transversal dimension of the moving part of the machine.
- 3) when non-stationary protective device is triggered, a safe stop shall be initiated. The SRP/CS for the initiation of the safe stop shall achieve $PLr = c$.

**Key**

- | | |
|----------------------|--|
| 1 bumper surface | 4 rear machine side (not accessible during machining) |
| 2 head enclosure | 5 curtain |
| 3 front machine side | D dimension of the bumper from the edge of the machine frame inwards |
| | H_1 height of the upper edge of the bumper |

Figure 8 — Example of bumper arrangement for high speed**Key**

- | | |
|----------------------|--|
| 1 bumper surface | 4 rear machine side (not accessible during machining) |
| 2 head enclosure | 5 curtain |
| 3 front machine side | D dimension of the bumper from the edge of the machine frame inwards |

Figure 9 — Bumper arrangement for limited speed

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

5.6.3.6 Safeguarding concept E

On machines with fixed workpiece support in form of solid tables, where entering the working area for loading/unloading is envisaged by the intended use (see [Figure H.14](#)), to prevent access to the crushing, shearing or cutting area (protected zone), the following non-stationary protective devices shall be provided to both sides of the moving bridge supporting the machining head:

- a) a vertically mounted ESPE 1 (AOPD or laser scanner, [Figure H.14](#), key 3), fulfilling the following requirements:
 - 1) the protected zone shall extend at least 850 mm from any cutting, crushing, shearing, drawing in and entanglement point, measured in horizontal direction. Where only impact hazards exist, this distance may be reduced to 700 mm;

- 2) crushing hazard due to the ESPE 1 support shall be prevented by pressure-sensitive bumpers, edges, trip bars, trip plates, which shall extend up to a height of at least 1 800 mm above the floor level and shall cover the whole crushing surface of the ESPE 1 support;
 - 3) the ESPE 1 shall be mounted vertically and shall extend from at least 1 500 mm up to at least 1 800 mm above the floor level and shall extend to the whole transversal dimension of the moving bridge supporting the machining head;
- b) a vertically mounted ESPE 2 (AOPD or laser scanner, [Figure H.14](#), key 4), fulfilling the following requirements:
- 1) it shall be mounted in the same vertical plane as the ESPE 1;
 - 2) it shall be muted while it is passing in correspondence of the solid tables; the SRP/CS for muting shall achieve at least $PL_r=c$;
- c) a horizontally mounted laser scanner, mounted at each pillar of the moving bridge ([Figure H.14](#), key 5), fulfilling the following requirements:
- 1) it shall cover the area between the two ESPE 2 and between the tables and the pillars of the moving bridge;
 - 2) it may be muted while both ESPE2 are active (not triggered); the SRP/CS for muting shall achieve at least $PL_r=c$.

Triggering any of the above safeguards shall cause a safe stop of the machine. The SRP/CS for the initiation of the safe stop shall achieve $PL_r=c$.

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

5.6.3.7 Safeguarding concept F

On machines with fixed horizontal (see [Figure H.6](#)) or vertical workpiece support where the workpiece is moving in and out from the machining head enclosure during processing with a maximum speed of 25 m/min, where the opening's dimension perpendicular to the workpiece surface is 100 mm or lower, access to hazardous points through the loading/unloading zones shall be prevented by one of the following measures:

- a) by a tunnel providing a safety distance of at least 200 mm from any further internal shearing and crushing point and at least 400 mm from any tool;
- b) either a mechanically actuated trip device, sensing in both directions, with a tripping force less than or equal to 50 N, or an AOPD with one light beam, which shall meet the following requirements:
 - 1) when triggered, it shall initiate a safe stop. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$;
 - 2) shall extend along the longest dimension of the infeed opening;
 - 3) shall be at least 150 mm from any further internal shearing and crushing point and at least 400 mm from any tool;
 - 4) shall be positioned at a maximum distance of 100 mm from the workpiece support (the free edge of the trip device).

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

5.6.3.8 Safeguarding concept G

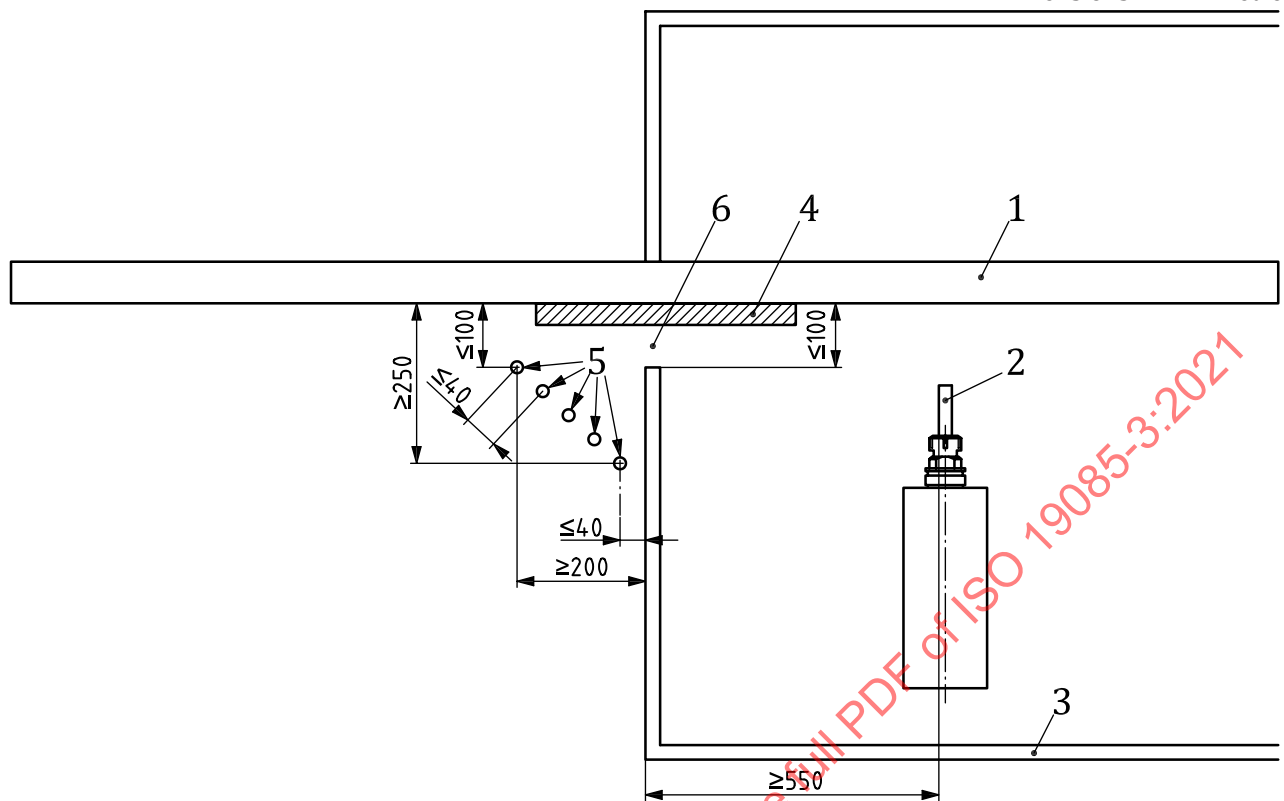
On machines with fixed vertical workpiece support where the workpiece is moving in and out from the machining head enclosure during processing with a maximum speed of 40 m/min (see [Figure H.7](#)), limited to 25 m/min when the workpiece protrudes from the workpiece support, where the opening's dimension perpendicular to the workpiece surface is 100 mm or lower, access to hazardous points through the loading/unloading zones shall be prevented by one of the following measures:

- a) by a tunnel providing a safety distance of at least 550 mm from any further internal shearing and crushing point including any tool;
- b) providing a light barrier (AOPD) installed over the workpiece support fulfilling the following requirements (see [Figure 10](#)):
 - 1) each beam shall be parallel to the workpiece support;
 - 2) the maximum pitch shall be 40 mm;
 - 3) the distance between the two extreme beams shall be at least 200 mm;
 - 4) the beam closest to the machine head shall be distant at least 250 mm from the workpiece support;
 - 5) the beam most distant from the machine head shall be maximum 100 mm away from the workpiece support;
 - 6) when it is triggered, the feed shall be stopped; the SRP/CS for the initiation of the feed stop shall achieve $PL_r = c$.

Access from above and below of the light barrier shall be prevented by fixed guards and the distance between the opening safeguarded by the AOPD and the tools shall be at least 550 mm.

In addition, when the workpiece protrudes from the workpiece support, it shall be detected. The SRP/CS for detection of workpiece's position shall achieve at least $PL_r = b$.

Dimensions in millimetres

**Key**

- | | | | |
|---|-------------------------------|---|--|
| 1 | workpiece support | 4 | workpiece |
| 2 | tool | 5 | beams of the light barrier |
| 3 | housing of the machining head | 6 | opening in the housing of machining head for workpiece feeding |

Figure 10 — Example of AOPD for vertical moving workpiece, top view

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

5.6.3.9 Safeguarding concept H

On machines with fixed vertical workpiece support where the workpiece is moving faster than 40 m/min in and out from the machining head enclosure during processing, where a stationary protective device like light barriers or stationary laser scanners or pressure-sensitive mats (Figure H.8, key 3) is used for stopping of moving parts and preventing access to the crushing, shearing or cutting area (protected zone), in combination with two sensors for speed reduction, (see Figure H.8, key 4) the following shall apply:

- when triggering a sensor for speed reduction, the speed of the workpiece shall be reduced to maximum 25 m min^{-1} within 500 mm (no PL is required for ensuring the distance). The SRP/CS for the initiation of the speed reduction shall achieve $PL_r = c$. After activation of the limited speed, a manual reset control device shall be activated to restore the full speed, unless the operator cannot involuntarily release the protective safety device, e.g. by stepping or leaning onto the workpiece support;
- the protective device for stopping of moving parts shall extend at least 850 mm from any crushing/shearing point. If the protective device is triggered, a safe stop shall be initiated. The SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$.

- c) the protective device for stopping of moving parts shall extend at least 700 mm externally beyond the position of the sensors for speed reduction.

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

5.6.3.10 Safeguarding concept I

On machines with fixed horizontal workpiece support where the workpiece is moving in and out from the machining head enclosure during processing with a speed that can be higher than 25 m/min (see [Figure H.10](#) and [Figure H.11](#)), access to any hazardous points of the loading zone and unloading zone shall be prevented by any of the following – different solutions may be installed on different sides or sections of the machine:

- a) fixed guards with a minimum height of 1 800 mm and a maximum distance from the floor of 180 mm, providing a distance of at least 850 mm from any hazardous point;
- b) fixed guards in combination with moveable guards with interlocking. The moveable guards shall be provided with guard locking if the stopping time of the moving parts is higher than 2 s;
- c) stationary protective devices as light barrier, stationary laser scanners or pressure-sensitive mats extending at least 850 mm from any cutting, crushing, shearing, drawing-in and entanglement point, measured in horizontal direction; alternatively, the distance may be reduced to 150 mm, if a vertical light barrier (AOPD) with a resolution not greater than 40 mm and the upper light beam at not less than 1 600 mm from floor level is provided; when a person is detected, a safe stop shall be initiated; the SRP/CS for the initiation of the safe stop shall achieve $PL_r = c$;
- d) a fixed guard positioned in front of the loading/unloading workpiece support ([Figure H.10](#), key 4), providing a distance of at least 850 mm from the hazardous points, extending to the lateral fence ([Figure H.10](#), key 5), extending vertically from a height of maximum 180 mm above floor level up to 150 mm below the level of the workpiece support and at least 800 mm from the floor level.

In addition, access to the gaps between two consecutive loading/unloading belts/chains or between the last belt/chain and the lateral fence, where these gaps are wider than 400 mm, shall be prevented, for example, by one of the following:

- 1) an AOPD with at least one beam positioned at 800 mm from the floor level and 300 mm from the fixed guard inwards;
- 2) a gap-filling device linked to the top edge of the vertical fixed guard required above and extending horizontally inwards for the whole width of the workpiece support or 850 mm, whichever is smaller, if the workpiece support level is at least at 950 mm from the floor;
- 3) stationary protective devices such as light barriers or stationary laser scanners or pressure-sensitive mats, extending horizontally inwards at least 1 m, if mounted horizontally.

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

5.6.3.11 Safeguarding concept J

On machines for boring, milling and sawing, where the workpiece is machined only on one side up to the first 100 mm from its edge, is fixed during machining and has a maximum thickness of 100 mm (see [Figure H.9](#)), access to hazardous points through the loading/unloading zones shall be prevented by providing clamping devices and a manually adjustable guard installed in front of the opening and adjustable in vertical direction down to the workpiece support. The adjustable guard shall be transparent and subdivided into at least as many sections as working areas are available.

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

5.6.3.12 Safeguarding concept K

Through feed boring machines with feeding belts (see [Figure H.15](#) and [Figure H.16](#)) shall be safeguarded by any of the following – different solutions may be installed on different sides or sections of the machine:

- a) fixed guards and/or moveable guards with interlocking without guard locking extending in height from maximum 180 mm up to at least 1 800 mm above the floor level.

The horizontal distance l from any opening to any tool and to any other hazardous point shall be at least:

- $l = 550$ mm, if h is up to 200 mm;
- $l = 550 + 0,75 (h - 200)$ mm, if h is between 200 mm and 700 mm;

where h is the height of the opening above the workpiece support.

Crushing and shearing hazards between the workpiece and the openings provided for workpiece loading/unloading, processing and/or feeding shall be prevented by:

- 1) lateral fixed guards extending in height from a maximum 180 mm up to at least 1 800 mm above the floor level in combination with a solid (without gaps) workpiece support, both protruding at least up to 850 mm outwards from the opening; or
- 2) by stopping the workpiece at 30 mm from the opening inwards. For workpiece unloading, a start control device shall be positioned outside the opening in combination with a safe stop control device. Unloading workpiece feed speed shall be limited to 25 m/min. As an exception, workpiece feed speed may reach 40m/min or 60m/min where additional requirements stated in [5.7](#) are fulfilled. The SRP/CS for automatic stop and for manual start of the workpiece feeding belts shall achieve $PL_r = b$. The SRP/CS for initiating the machine safe stop via the safe stop control device shall achieve $PL_r = c$.

This solution may be applied also where additional milling and/or sawing units are provided (see [Figure H.15](#)).

- b) ESPE according to [5.5.5](#) (e.g. light barrier) or pressure-sensitive mats according to [5.5.6.1](#) extending at least 850 mm from any hazardous point, tools included. This solution shall not be applied where additional milling and/or sawing units are provided (see [Figure H.16](#)).

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

5.6.4 Measures against access to the rear of the machine from un/loading zone

On machines with fixed workpiece support, fixed workpiece during machining and only one accessible side for loading and unloading and other sides protected by fixed guards (see, for example, [Figure H.1](#), key 2), access to the rear zone of the machine across the machine frame and the side areas between it and the lateral machine fences while the machine is running shall be prevented as follows:

- a) for machines without option for alternate loading, by stationary protective devices like light barriers or stationary laser-scanner or pressure safety mats positioned in front of the machines and extending up to the lateral machine fences;
- b) for machines with option for alternate loading, and for machines with non-stationary protecting devices like bumpers, pressure sensitive edges, trip bars, trip plates and laser scanners, by a

combination of protective devices and fixed guards or interlocked moveable guards, e.g. by all devices required in 1), 2) and 3), or by the devices required in 4):

- 1) an AOPD on the back of the workpiece support (see [Figure 11](#), key 4):
 - extending horizontally from the moving enclosure of the machining head towards both lateral sides,
 - positioned at a height of $400\text{ mm} \pm 100\text{ mm}$ above the workpiece support level,
 - positioned at a maximum horizontal distance of 300 mm from the rear edge of the workpiece support towards the rear;
- 2) vertical deterring/impeding devices consisting of guards positioned in line with the front surface of the machine frame, extending vertically from a height of maximum 180 mm above floor level up to at least 700 mm above floor level, and at such height extending horizontally inwards over a distance of at least 400 mm (see [Figure 11](#), key 5);
- 3) vertical deterring/impeding devices positioned in line with the AOPD on the back of the workpiece support, extending vertically from a height of maximum 180 mm above floor level up to at least 700 mm above floor level (see [Figure 11](#), key 7).

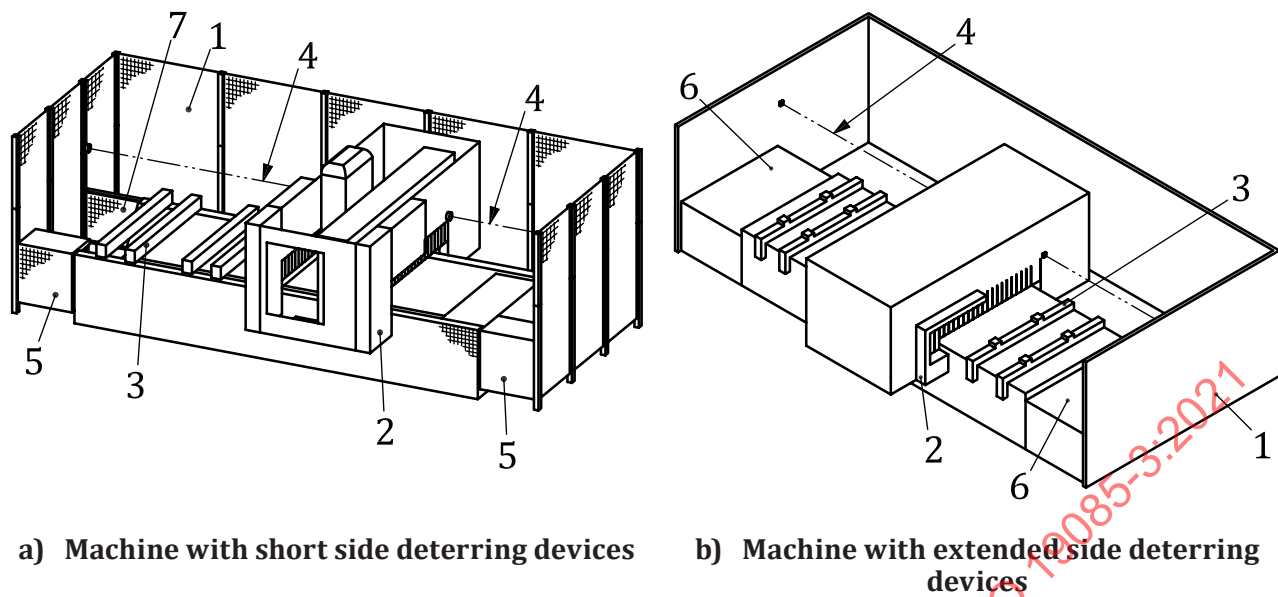
As alternative to the deterring impeding devices on the back, one of the following solutions may be adopted:

- i) the horizontal surface of the deterring devices on the front required in 2) shall extend to the AOPD on the back (see [Figure 11](#), key 6);
- ii) a horizontal ESPE at a height not higher than the workpiece support level, extending from the front deterring/impeding device inwards up to a distance of maximum 300 mm from the AOPD on the back of the workpiece support;
- iii) a vertical AOPD with at least two light beams, situated at a height of 400 mm and 900 mm above the floor level.

Where, as deterring/impeding devices, moveable interlocking guards are provided in order to give access to the rear zone of the machine, guard locking is not required.

- 4) pressure-sensitive mats or horizontal ESPE (see [Figure 12](#), key 1) detecting access to the crushing, shearing or cutting area (protected zone) in combination with lateral fixed guards with a minimum height of 1 800 mm and a maximum distance from the floor of 180 mm (see [Figure 12](#), key 2), and at least one light beam, positioned at an height between 200 and 900 mm from the floor level, in a vertical plane positioned at $\pm 100\text{ mm}$ from the external edge of the pressure-sensitive mats (see [Figure 12](#), key 3). Leaving the pressure-sensitive mats or horizontal ESPE without triggering, i.e. changing status from not interrupted to interrupted, this light beam within 2 s shall initiate a safe stop. The SRP/CS for initiation of safe stop shall achieve $PL_r = c$. The light beam shall be of Type 2 according to IEC 61496-2:2013.

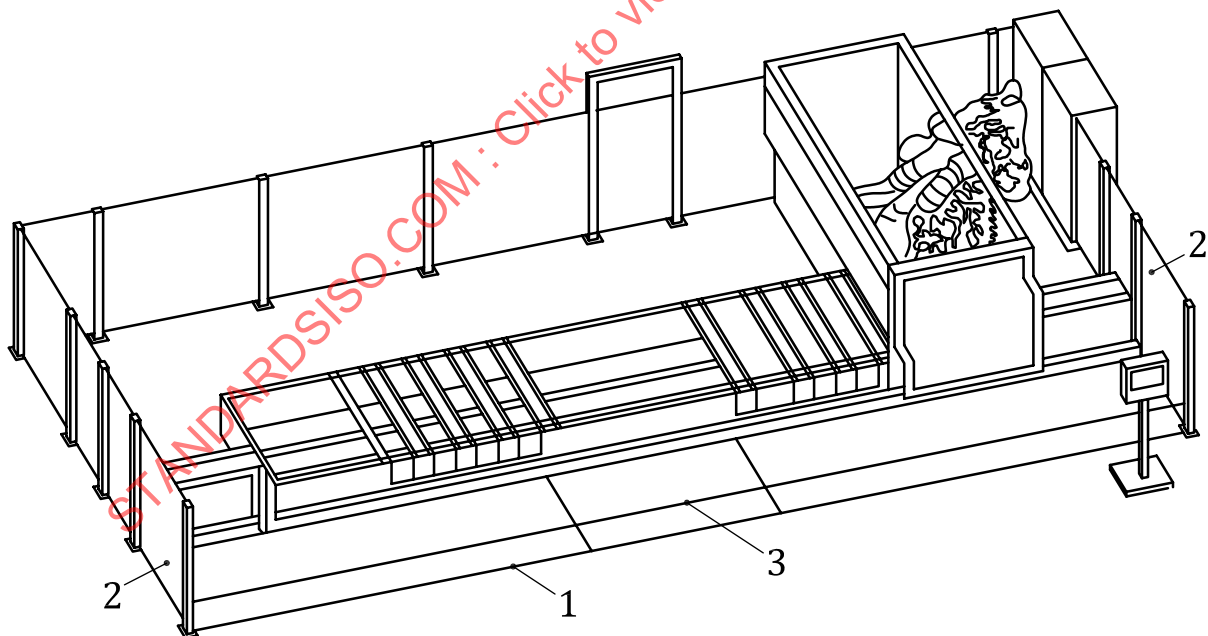
As an alternative to the front light beam ([Figure 12](#), key 3), confirmation shall be given by the operator that he or she has left the protected zone. Leaving the pressure-sensitive mats or horizontal ESPE without this confirmation within 2 s shall initiate a safe stop. The confirmation may be done by the same control device to reset the pressure-sensitive mats or horizontal ESPE.



Key

- | | |
|------------------------------------|---|
| 1 fixed guards | 5 front deterring/impeding devices |
| 2 bumpers | 6 front deterring/impeding devices with extended horizontal surface |
| 3 supporting bars (or solid table) | 7 rear deterring/impeding devices |
| 4 backside AOPD | |

Figure 11 — Examples of safeguarding with backside AOPD



Key

- | |
|---|
| 1 stationary protective device detecting access to the protected zone |
| 2 lateral fixed guards |
| 3 light beam at access side |

Figure 12 — Examples of safeguarding with front side AOPD

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

5.6.5 Minimum clearances at the loading/unloading zone

For machines where the loading/unloading zone is laterally delimited by fixed parts (i.e. fixed guards or walls of the building), crushing hazard between moving machining head enclosure and these fixed parts at the sides of the loading/unloading zone shall be avoided by dimensioning the machine such that a minimum clearance of 500 mm between the extreme positions of the moving machining head enclosure and the side fixed parts is ensured at the front side (see dimension l_4 in [Figure H.1](#)).

As an exception, this minimum clearance may be reduced to 300 mm where sensitive bumpers or edges are provided to prevent crushing hazard to the whole body, i.e. they pass the test in [Annex G](#) with the characteristics of the second to last column of [Table G.1](#).

The minimum clearance defined above shall be ensured by mechanical end-stops.

Verification: By checking the relevant drawings and/or circuit diagram, measurements, inspection of the machine, relevant functional testing of the machine and relevant tests described in [Annex G](#).

5.7 Impact hazard

ISO 19085-1:2021, 5.7, applies with the following additions.

As an exception, on machines where all following conditions are fulfilled:

- a) the workpiece moves on a solid (without gaps) workpiece support;
- b) the workpiece does not protrude from the workpiece support; and
- c) the maximum workpiece thickness (dimension perpendicular to the workpiece support) does not exceed 100 mm;

the maximum workpiece feed speed may reach:

- 40 m/min where the workpiece is clamped during feeding;
- 60 m/min where the workpiece is only supported by feeding belts during feeding.

The limited speeds stated above shall be monitored according to [4.11](#).

5.8 Clamping devices

ISO 19085-1:2021, 5.8, is replaced by the following text.

Where powered clamping is provided, crushing hazards shall be prevented by one of the following measures:

- a) a two-hand control to control the clamping stroke;
- b) two-stage clamping with a maximum clamping force at the clamping device of 150 N for the first stage, followed by full clamping force actuated by a manual control;
- c) reduction of the gap between clamp and workpiece to 6 mm or less by a manually adjustable device in combination with clamping stroke limitation to a maximum of 10 mm;
- d) guarding of the clamp by a guard fixed to the clamping device to reduce the gap between workpiece and guard to less than 6 mm; the maximum extension of the clamp outside the guard shall not exceed 6 mm;
- e) limitation of the clamp closing speed to 10 mm s^{-1} or less.

The SRP/CS for prevention of unexpected activation of second stage clamping force in b) shall achieve $PL_r = b$.

The SRP/CS for the limitation of the clamp closing speed in e) shall achieve $PL_r = b$.

Where pneumatic or hydraulic clamping is provided, the requirements of ISO 4413:2010 or ISO 4414:2010 shall be met.

When powered clamping is selected (vacuum, pneumatic or hydraulic), the following requirements apply:

- 1) feed and spindle rotation shall be interlocked so that axes and/or spindle movements cannot start and run until clamping pressure/vacuum supply for clamping is available (no PL is required for interlocking);
- 2) in the area where the workpiece is processed, the release of clamping during rotation of the spindle shall only be possible if the machining head is in the rest position and the integrated feed has stopped. (no PL is required for interlocking);
- 3) where twin sliding table or separate loading/unloading sections are provided, the requirements for release of clamping stated in 2) only apply for the part of the machine where machining is under progress. Release of clamping on the table where no machining is in progress shall only be possible when the corresponding table has come to rest. (no PL is required for interlocking);
- 4) for vacuum clamping:
 - i) the vacuum sensor shall be adjustable and shall be located as close as possible to the workpiece support;
 - ii) when vacuum loss is detected (i.e. the vacuum selected value is not warranted any more) a safe stop shall be initiated; the SRP/CS for initiating a safe stop when vacuum loss is detected shall achieve at least $PL_r = b$;

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

5.9 Measures against ejection

5.9.1 General

ISO 19085-1:2021, 5.9.1, applies with the following additions.

A device to minimize the risk of ejection specific to this machine is curtains according to [5.9.3](#).

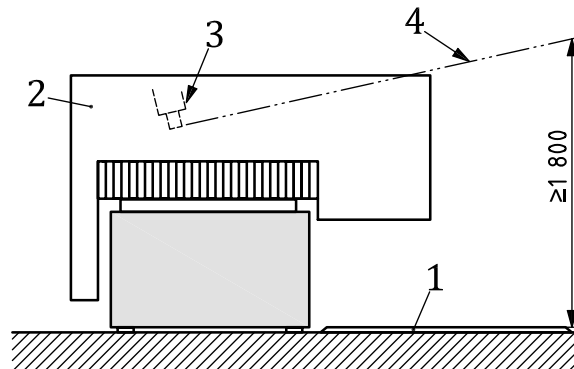
Direct ejection of parts of the tools and/or of the workpieces in any direction shall be prevented by fixed guards with a height from maximum 180 mm up to at least 1 800 mm above the floor level.

As an exception about ejection's directions, on machines with the machining head enclosure moving over fixed base with supporting bars (see [Figures H.1, H.2, H.12 and H.13](#)), direct ejection through the space between the supporting bars shall be prevented by fixed guards at least in the direction perpendicular to the feed movement of the machining head enclosure, while ejection in the direction of the feed movement of the machining head enclosure is considered an acceptable residual risk.

As an exception about fixed guards' height, on machines with sliding tables (see [Figure H.3, H.4](#)), direct ejection under the curtains shall be prevented by fixed guards or moveable guards with interlocking, mounted around the sliding tables area in front of the machine, extending from maximum 180 mm above the floor level up to the lower edge level of the curtains (for example, see [Figure H.3](#), key 3).

The top height of the fixed guards mounted to the moving machining head may be lower than 1 800 mm, where protective devices like light barriers, stationary laser scanners or pressure-sensitive mats are provided preventing operators from staying close to the machining head without stopping the machine.

In this case, the top height of the fixed guards shall be enough for all possible trajectories of ejected parts to pass above 1 800 mm at the position of these protective devices. See [Figure 13](#).



Key

- | | | | |
|---|--------------------------------------|---|---------------------|
| 1 | pressure sensitive mats (as example) | 3 | tool |
| 2 | machining head enclosure | 4 | ejection trajectory |

Figure 13 — Ejection trajectory over machining head enclosure

Where fixed guards need openings for workpiece loading/unloading, processing and/or feeding, these openings shall be guarded by curtains according to [5.9.3](#).

For machines where entering the working area for loading/unloading is envisaged by the intended use (see [Figures H.12, H.13](#)), curtains may extend to the whole sides of the machine head enclosure that are perpendicular to the feed movement of the machining head enclosure.

The height ([Figure 7](#), key *h*) of the opening guarded by curtains, measured from the work piece clamping surface to the lower edge of the enclosure, shall not exceed 700 mm.

The curtains may be raised during operation if:

- only boring units, edge-banding aggregates, assembly unit or dowel devices are used; and
- the rotation of any other spindle or unit is prevented once the curtains have left the guarding position.

The SRP/CS for the interlocking of any spindle or unit other than those listed in a) with the guarding position of the curtains shall achieve $PL_r = c$.

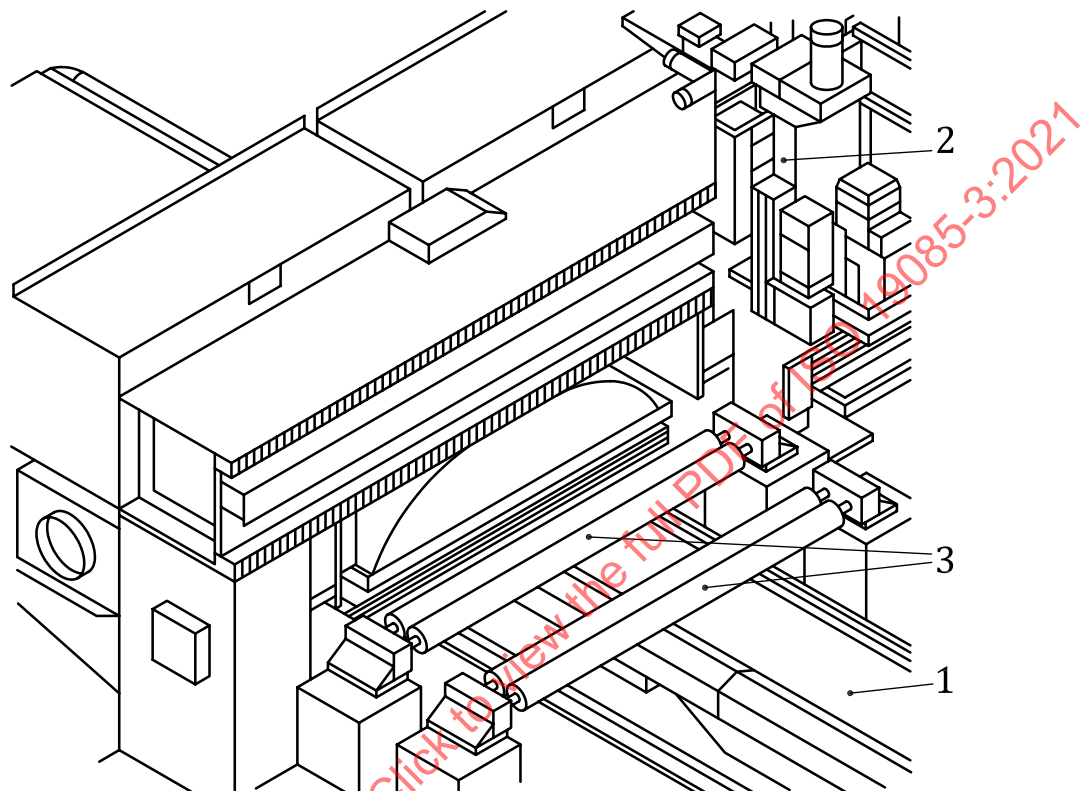
As an exception, curtains are not required:

- on boring machines designed to use only boring tools, even if incorporating edge-banding aggregates, assembly unit or dowel inserting units;
- where direct ejection of milling tools and saw blades or their parts through the opening for workpiece loading/unloading can be excluded, i.e. where the axis of rotation of these tools is perpendicular to the plane of the opening;
- on routing machines and on routing and boring machines where all following conditions are met:
 - complex milling tools according to EN 847-1:2017 are not allowed [see [7.3.2 a\) 4](#)];
 - the maximum allowed diameter of the milling tool does not exceed 60 mm, or 125 mm if the cutting width is not higher than 10 mm;
 - the width of the openings for workpiece loading/unloading at any point does not exceed 100 mm;

- the maximum allowed diameter of the saw blade does not exceed 125 mm.

As an exception, curtains and fixed guards to prevent ejection are not required on routing machines and routing and boring machines provided with a roller hold-down system for the workpiece where the maximum allowed diameter of the tool does not exceed 16 mm (see [Figure 14](#)).

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



Key

- 1 workpiece support
- 2 machining head
- 3 roller hold-down system

Figure 14 — Roller hold-down system for routing machines and routing/boring machines with tool diameter not exceeding 16 mm

5.9.2 Guards materials and characteristics

5.9.2.1 Choice of class of guards

ISO 19085-1:2021, 5.9.2.1, applies with the following additions.

For machines designed to use milling tools or saw blades, guards preventing ejection shall be of class A. As an exception, only for preventing ejection from saw blades alone, guards shall be of class B.

5.9.2.2 Guards of class A

ISO 19085-1:2021, 5.9.2.2, applies.

5.9.2.3 Guards of class B

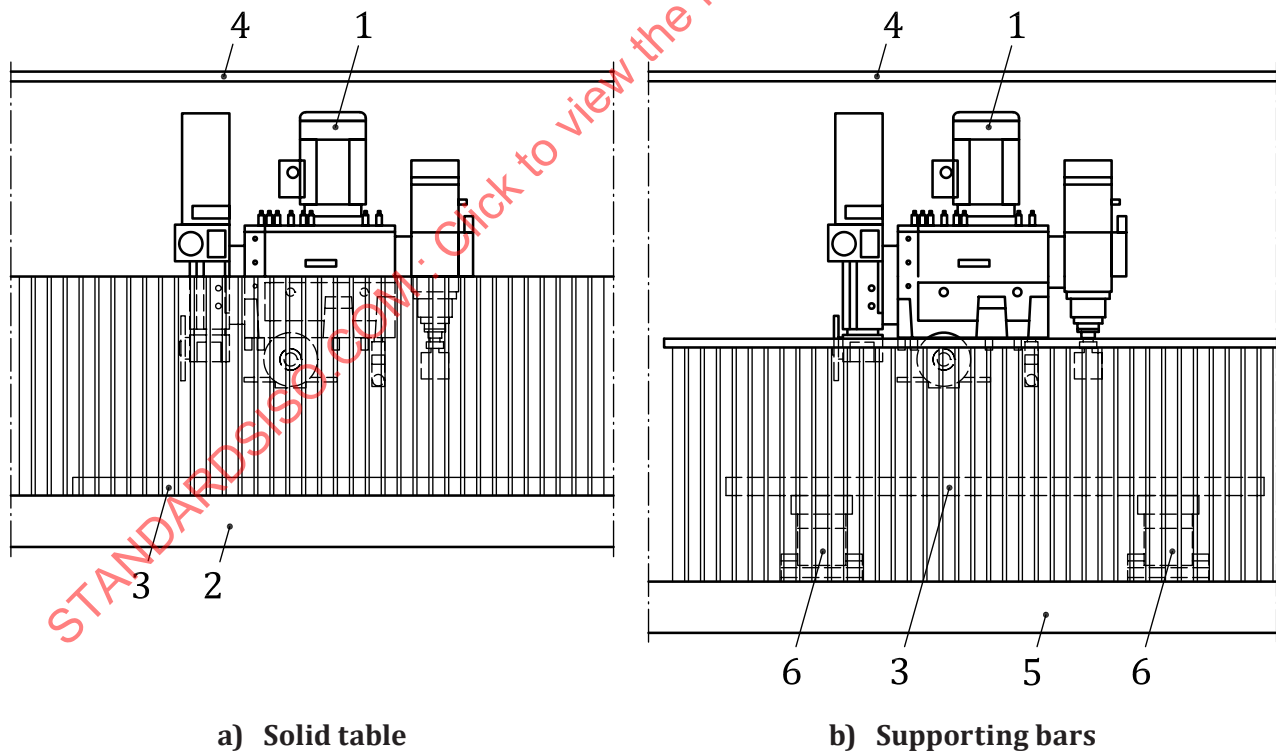
ISO 19085-1:2021, 5.9.2.3, applies.

5.9.3 Curtains

Subclause specific to this document.

The curtains shall be made according to the following requirements:

- a) the curtain's free end on its whole length shall extend to the lowest surface on which the workpiece can be clamped, or down to the upper surface of the supporting bars for machines with sliding table or twin-table (see, for example, [Figure 15](#)); in addition, on machines where entering the working area for loading/unloading is envisaged by the intended use (see [Figures H.12 and H.13](#)), the parts of the curtains to the sides of the workpiece support shall extend to the floor level, and their height shall not exceed 700 mm;
- b) the curtain shall be located so that it cannot come into contact with any tool that can be mounted into the machine when it is used as intended;
- c) the curtain shall be made of a minimum of six layers of strips: the strips shall have maximum width of 80 mm. The layers shall alternately overlap on one half of the strips' width;
- d) the curtain shall pass the impact test specified in [Annex I](#);
- e) the curtain shall pass the wear test specified in [Annex I](#).



Key

- | | | | | | |
|---|----------------|---|--------------------------|---|---------------------------------|
| 1 | machining head | 3 | workpiece | 5 | supporting bars |
| 2 | solid table | 4 | machining head enclosure | 6 | vacuum pods/clamps/suction cups |

Figure 15 — Examples of curtains on machines with sliding tables

Verification: By checking the relevant drawings, inspection of the machine, measurement, relevant tests described in [Annex I](#) and [Annex J](#) and relevant functional testing of the machine.

5.10 Workpiece support and guides

ISO 19085-1:2021, 5.10, applies with the following additions.

Examples of workpiece supports are:

- solid table [see [Figure 7](#) a), key 2];
- supporting bars [see [Figure 7](#) b), key 2];
- feeding rollers or roller tables;
- feeding belts.

6 Safety requirements and measures for protection against other hazards

6.1 Fire

ISO 19085-1:2021, 6.1, applies.

6.2 Noise

6.2.1 Noise reduction at the design stage

ISO 19085-1:2021, 6.2.1, applies with the following additions.

Other major noise sources are:

- a) axes' drives; and
- b) clamping, i.e. any of the following clamping system:
 - 1) vacuum system including vacuum pump;
 - 2) pneumatic system;
 - 3) hydraulic system.

6.2.2 Noise emission measurement and declaration

ISO 19085-1:2021, 6.2.2, applies with the following additions.

Annex F replaces ISO 19085-1:2021, Annex F.

6.3 Emission of chips and dust

ISO 19085-1:2021, 6.3, applies with the following additions.

A means shall be provided to improve the efficiency of guiding the chips and dust to the opening of the capture device, e.g. a deflector mounted to the tool or brushes mounted around the machining head.

6.4 Electricity

ISO 19085-1:2021, 6.4, applies.

6.5 Ergonomics and handling

ISO 19085-1:2021, 6.5, applies with the following addition.

The height of the workpiece support surface shall be designed according to ergonomic principles (see EN 1005-4) under consideration of the workpiece sizes to be expected during intended use.

Typical examples of height of the workpiece support surface are between 750 mm and 900 mm above the floor level, but deviations to such dimensions may apply due to the size of the workpieces.

6.6 Lighting

ISO 19085-1:2021, 6.6, applies.

6.7 Pneumatics

ISO 19085-1:2021, 6.7, applies.

6.8 Hydraulics

ISO 19085-1:2021, 6.8, applies.

6.9 Electromagnetic compatibility

ISO 19085-1:2021, 6.9, applies.

6.10 Laser

ISO 19085-1:2021, 6.10, applies.

6.11 Static electricity

ISO 19085-1:2021, 6.11, applies.

6.12 Errors of fitting

ISO 19085-1:2021, 6.12, applies.

6.13 Isolation

ISO 19085-1:2021, 6.13, applies.

6.14 Maintenance

ISO 19085-1:2021, 6.14, applies.

6.15 Relevant but not significant hazards

ISO 19085-1:2021, 6.15, applies.

7 Information for use

7.1 Warning devices

ISO 19085-1:2021, 7.1, applies with the following additions.

An audible warning of control power-on activation shall be provided on machines fitted with access door to the machine enclosure, if the operator cannot have a complete view of the machining area from the door manual reset control position [see [5.6.2 c\)](#)].

7.2 Marking

7.2.1 General

ISO 19085-1:2021, 7.2.1, applies.

7.2.2 Additional markings

ISO 19085-1:2021, 7.2.2, is replaced by the following text.

A label shall be fitted onto the machine, with graphical symbol ISO 7000-0419 as follows:



7.3 Instruction handbook

7.3.1 General

ISO 19085-1:2021, 7.3.1, applies.

7.3.2 Additional information

ISO 19085-1:2021, 7.3.2, is replaced by the following text.

The following additional information shall be provided in the instruction handbook:

- a) instructions for safe use shall also include:
 - 1) the correct selection of milling tools for each operation, which includes precautions during machining such as:
 - i) the range of milling tool diameters and lengths which are suitable for the machine; and
 - ii) that only milling tools with a cutting diameter below 16 mm shall be used or milling tools with a cutting diameter above 16 mm and/or saw blades both manufactured in accordance with EN 847-1:2017 and EN 847-2:2017 shall be used;
 - 2) information regarding the requirements for other tools, e.g. boring tools, sanding wheels, etc., that can be used on the machine;
 - 3) information that the pull-in force of spindles of HSK clamping systems shall be periodically checked by personnel authorized by the manufacturer, including the intervals;
 - 4) where applicable (see [5.9.1](#)), information not to use complex milling tools according to EN 847-1:2017;
- b) warnings regarding residual risks shall also include:
 - 1) recommendation that the off-cuts and parts of the workpiece are either clamped, e.g. by mechanical clamp, or completely chipped (by appropriate cutting program, including proper tools use) prior to their detachment, to avoid the risk of their ejection;
 - 2) reminder not to remove chips while the tool is running and the machining head is not in the rest position;
 - 3) reminder to take precautions to reduce the risk of production of ignition sources;

- 4) where applicable, reminder to be aware about the residual risk of parts being ejected to the sides through the space between the clamping bars;
- 5) on machines with fixed workpiece support where the workpiece is moving in and out from the housing of the machining head during processing (see [Figures H.6](#) and [H.7](#)) and not leaning completely against its support all-time, warning of shearing hazard with the front edge of the opening when processing workpieces with cut-outs, e.g. window frames, holes with diameter ≥ 8 mm, and/or not rectangular shape.
- 6) on machines where entering the working area for loading/unloading is envisaged by the intended use (see [Figures H.12](#), [H.13](#) and [H.14](#)) warnings regarding residual risks due to entering the working area, stepping or leaning onto the workpiece support, and falling down from the table;
- c) instructions about protective device tests, method and frequency shall also include curtain maintenance by checking the of absence of damage (at least each month);
- d) instructions for setting the machine and precautions during setting:
 - 1) instructions for clamping device mounting, setting and use;
 - 2) adjustment method for the pressure devices and the method for fixing auxiliaries;
 - 3) method for choosing the spindle speed, taking into account the work to be done and the tool used. The relationship between the tool diameter, the cutting length and the maximum rotational speed of the spindle is important. Examples may be given for the most common cutting lengths;
 - 4) instruction for adjustment and use of the safeguarding prescribed in [5.6.3.11](#);

Verification: By checking the information given in the instruction handbook and relevant drawings.

Annex A (informative)

List of significant hazards

ISO 19085-1:2021, Annex A, is replaced by the following text.

[Table A.1](#) lists all significant hazards, hazardous situations and events (see ISO 12100:2010), identified by risk assessment as significant for the machines as defined in the scope and which require action to eliminate or reduce the risk.

Table A.1 — List of significant hazards

No.	Hazards, hazardous situations and hazardous events	ISO 12100:2010	Relevant sub-clause in this document
1	Mechanical hazards related to machine parts or workpiece due to		
	a) shape	6.2.2.1	5.5 , 5.6 , 5.8 , 6.5
	b) relative location	6.2.2.2, 6.3	5.5 , 5.6
	c) mass and stability (potential energy of elements which may move under the effect of gravity)		5.1 , 5.3 , 6.5 , 6.14
	d) mass and velocity (kinetic energy of elements in controlled or uncontrolled motion)		4.7 , 5.5 , 5.6 , 5.8
	e) mechanical strength		5.9 , Annexes C, E, G, I and J
	— accumulation of energy inside the machinery		
	f) liquids or gases under pressure, or	6.2.10, 6.3.5.4	6.7 , 6.8
	g) vacuum		5.8
1.1	Crushing hazard	—	5.6 , 7.3
1.2	Shearing hazard		5.6 , 7.3
1.3	Cutting or severing hazard		5.6 , 7.3
1.4	Entanglement hazard		5.6
1.5	Drawing in or trapping hazard		5.6
1.6	Impact hazard		5.7
1.7	Stabbing or puncture hazard		5.6
1.8	Friction or abrasion hazard		5.6
1.9	High pressure fluid injection or ejection hazard	6.2.10	6.8
2	Electrical hazards		
2.1	Contact of persons with live parts (direct contact)	6.2.9, 6.3.5.4	6.4
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	6.2.9	6.4
4	Hazards generated by noise, resulting in		
4.1	Hearing loss (deafness), other physiological disorders (loss of balance, loss or awareness)	6.2.2.2, 6.3	6.2
4.2	Interference with speech communication, acoustic signals		6.2
6	Hazards generated by radiation		
6.1	Low frequency, radio frequency radiation, microwaves	—	6.9
6.5	Lasers	6.3.4.5	6.10

Table A.1 (continued)

No.	Hazards, hazardous situations and hazardous events	ISO 12100:2010	Relevant sub-clause in this document
7	Hazards generated by materials and substances (and their constituent elements) processed, or used by the machinery		
7.1	Hazards from contact with or inhalation of harmful fluids and dusts	6.2.3, 6.2.4	6.3
7.2	Fire hazard	6.2.4	6.1 , 6.11
8	Hazards generated by neglecting ergonomic principles in machine design		
8.1	Unhealthy postures or excessive efforts	6.2.7, 6.2.8, 6.2.11.12, 6.3.5.5, 6.3.5.6	4.2 , 6.5
8.2	Hand-arm or foot-leg anatomy	6.2.8	6.5
8.4	Local lighting	6.2.8.6	6.6 , 7.3
8.5	Mental overload and underload, stress	6.2.8.5	6.5
8.6	Human error	6.2.8.1, 6.2.11.8, 6.2.11.10, 6.3.5.2, 6.4	6.12 , 7.3
8.7	Design, location or identification of manual controls	6.2.8.7, 6.2.11.8	4.2 , 7.3
8.8	Design or location of visual display units	6.2.8, 6.4.2	4.2
9	Hazard combination	6.3.2.1	4.2
10	Unexpected start-up, unexpected overrun/overspeed (or any similar malfunction) from		
10.1	Failure/disorder of the control system	6.2.11, 6.3.5.4	4.1 , 4.8
10.2	Uncontrolled restoration of energy supply after an interruption	6.2.11.4	4.8
10.3	External influences on electrical equipment	6.2.11.11	4.1 , 6.9
10.5	Errors in the software	6.2.11.7	4.1
11	Impossibility of stopping the machine in the best possible conditions	6.2.11.1, 6.2.11.3, 6.3.5.2	4.1
12	Variations in the rotational speed of tools	6.2.2.2, 6.2.3	4.7
13	Failure of the power supply	6.2.11.1, 6.2.11.4	4.8
14	Failure of the control circuit	6.2.11, 6.3.5.4	4.1
15	Errors of fitting	6.2.7, 6.4.5	6.12
16	Break-up during operation	6.2.3	5.2
17	Falling or ejected objects or fluids	6.2.3, 6.2.10	5.2 , 5.3 , 5.9.2 , 5.5 , 5.6
18	Loss of stability/overturning of machinery	6.3.2.6	5.1 , 5.2
19	Slip, trip and fall of persons (related to machinery)	6.3.5.6	5.9.2

Annex B (informative)

Performance levels required

ISO 19085-1:2021, Annex B, is replaced by the following text.

[Table B.1](#) gives a quick-view summary of the performance level required (PL_r) for each safety function. However, refer to [Clauses 4](#) and [5](#) for full requirements.

Table B.1 — Safety functions and their PL_r

Area	No.	Safety functions	PL _r	Subclause in ISO 19085-1:2021	Subclause in this document
Start	1	Prevention of unexpected control power-on	c	4.3.2	
	2	Interlocking of control power-on with safeguards	c	4.3.2	
	3	Manual start of workpiece feeding belts	b		5.6.3.12
Stop	4	Normal stop (braking function excluded)	c	4.4.2	
	5	Monitoring of the standstill condition	c	4.4.3	
	6	Emergency stop (braking function excluded)	c	4.4.4	
	7	Emergency stop activation in case of wireless control disconnection	c		4.2.2
	8	Initiating safe stop in case of pneumatic or hydraulic power supplies failure	b		4.8
	9	Initiation of safe stop when a person is detected (protective device triggered)	c		5.6.3.2 , 5.6.3.3 , 5.6.3.4 , 5.6.3.5 , 5.6.3.6 , 5.6.3.7 , 5.6.3.9 , 5.6.3.10
	10	Initiation of safe stop via safe stop control device	c		5.6.3.12
	11	Automatic stop of the workpiece feeding belts	b		5.6.3.12
	12	Initiation of feed stop	c		5.6.3.8
	13	Initiation of safe stop when leaving the protected zone without triggering the light beam (or confirmation) within 2 s	c		5.6.4
	14	Initiation of safe stop when vacuum loss is detected	b		5.8
Tool Braking	15	Activation of the brakes	c	4.5	
	16	Electronic braking system (PDS/SR excluded)	b	4.5	
	17	SS1 of PDS(SR)	c	4.5	
Mode selection	18	Mode selection	c	4.6	
	19	Monitoring of the limited spindle speed for setting	c		4.6.2
	20	Prevention of start of any other dangerous movement	c		4.6.2
Spindle speed	21	Speed indication	b	4.7.1	

Table B.1 (continued)

Area	No.	Safety functions	PL _r	Subclause in ISO 19085-1:2021	Subclause in this document
Controls	22	Manual reset	c	4.9	
	23	Standstill detection and monitoring	c	4.10	
	24	Speed monitoring of moving parts (except tools)	b	4.11	
	25	Time delay	c	4.12	
	26	Detection of the workpiece position	b		5.6.3.8
Safeguards	27	Interlocking of moveable guards	c	5.5.2.2, 5.5.2.3	
	28	Guard locking of moveable guards	c	5.5.2.3	
	29	Hold-to-run	b/c	5.5.3	
	30	Two-hand control	c	5.5.4	
	31	Interlocking of dangerous movements with ESPE	c	5.5.5	
	32	Interlocking of dangerous movements with PSPE	c	5.5.6	
	33	Enabling control	c	5.5.7	
	34	Initiation of speed reduction when person is detected (protective device triggered)	c		5.6.3.3 , 5.6.3.9
	35	Initiation of speed reduction via control device or PSPE	c		5.6.3.4
	36	Muting ESPE 2 when passing in correspondence of solid tables	c		5.6.3.6
	37	Muting laser scanner when both ESPE 2 are active	c		5.6.3.6
	38	Interlocking of any spindle or unit other than those listed in a) with the guarding position of the curtain	c		5.9.1
Tool holder	39	Interlocking function of tool release with spindle rotation	c/b+b		5.3.1
Powered clamping	40	Limitation of clamping closing speed to 10 mm/s	b		5.8
	41	Prevention of unexpected activation of second stage clamping force	b		5.8

Annex C
(normative)

Stability test

ISO 19085-1:2021, Annex C, does not apply.

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Annex D
(normative)

Test for braking function

ISO 19085-1:2021, Annex D, applies.

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Annex E
(normative)

Impact test for guards

ISO 19085-1:2021, Annex E, applies.

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Annex F **(normative)**

Noise test code

F.1 General

ISO 19085-1:2021, F.1, applies.

F.2 Determination of the A-weighted emission sound pressure level at workstations

F.2.1 Basic standards and measurement procedure

ISO 19085-1:2021, F.2.1, applies.

F.2.2 Measurement time interval

ISO 19085-1:2021, F.2.2, is replaced by the following text.

The measurement time interval shall be 30 s, including three cuts.

F.2.3 Position of microphones at workstations

ISO 19085-1:2021, F.2.3, applies with the following additions.

The operator's positions are at 0,5 m from:

- the main control panel; and
- the middle of the loading and unloading areas for machines with option for alternate loading/unloading.

The microphone used to measure the emitted noise shall be placed at the designated operator's positions, 1,5 m above floor level.

F.2.4 Measurement uncertainty

ISO 19085-1:2021, F.2.4, applies.

F.3 Determination of the A-weighted sound power level

F.3.1 Basic standards and measurement procedure

ISO 19085-1:2021, F.3.1, applies.

F.3.2 Sound power level determination on very large machines

ISO 19085-1:2021, F.3.2, applies.

F.3.3 Measurement time interval

ISO 19085-1:2021, F.3.3, is replaced by the following text.

The measurement time interval shall be 30 s, including three cuts.

F.3.4 Measurement uncertainty

ISO 19085-1:2021, F.3.4, applies.

F.4 Mounting conditions

ISO 19085-1:2021, F.4, applies.

F.5 Operating conditions

F.5.1 Operation during measurements

ISO 19085-1:2021, F.5.1, applies with the following additions.

The operating conditions given in [Table E.1](#) shall be set up during the measurements, for NC/CNC routing machines, NC/CNC boring machines, NC/CNC boring and routing machines, of all designs. However, ISO 19085-1:2021, F.5.1, shall be applied instead to:

- machines for boring, milling and sawing where the workpiece is machined only on one side with limitations (see [Figure H.9](#));
- through-feed machines with feed speed higher than 25 m/min for timber beams/solid wood only (no wood-based panels) as per [Figure H.11](#);
- very large machines where entering the workpiece support for loading and unloading is envisaged by the intended use ([Figures H.12, H.13, H.14](#)).

For NC routing and boring machines, it is not required to test boring units.

F.5.2 Test material

F.5.2.1 Particle board

ISO 19085-1:2021, F.5.2.1, applies.

F.5.2.2 Coated particle board

ISO 19085-1:2021, F.5.2.2, does not apply.

F.5.2.3 Softwood

ISO 19085-1:2021, F.5.2.3, does not apply.

F.5.2.4 Hardwood

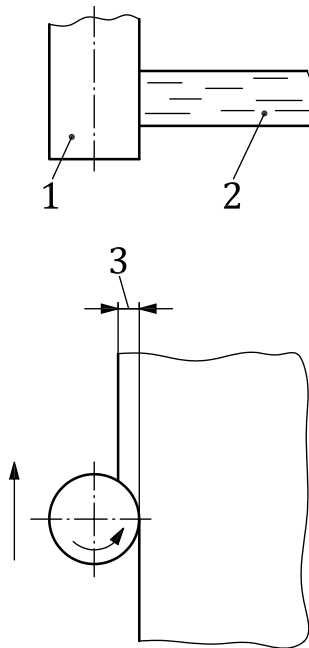
ISO 19085-1:2021, F.5.2.4, does not apply.

F.5.3 Standardized tools

ISO 19085-1:2021, F.5.3, does not apply.

Table F.1 — Operating conditions for most of the NC/CNC boring/routing machines

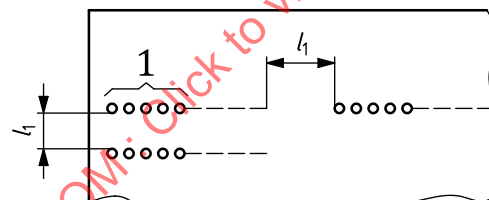
Parameter		Value		Fulfilled or deviation
		Routing machine/unit	Boring machine/unit	
Workpiece				
	Material	Particle board, according to F.5.2.1		
	Workpiece length	800 mm		
	Workpiece width	600 mm – 800 mm		
	Workpiece thickness	16 mm		
	Previous processing	none		
Position of the workpiece		In the middle of the table for machines with one table or two synchronized tables; against the right side of the left table for machines with two independent tables		
Tool				
	Type of tool	Router bit with shaft, carbide-tipped, straight not interrupted knife-edges	Multi-boring unit with bits, two flutes and centre point, left or right hand	
	Number of	knives: 2	bits: 10 or max. allowed	
	Diameter of	cutting circle: 25 mm	bit: 8 mm	
	Working length of	cutting knife: 40 mm–50 mm	bit: 50 mm	
Cutting data				
	Cutting principle	Cutting against the feed	—	
	Spindle speed	18 000 min ⁻¹ ^a	6 000 min ⁻¹ ^a	
	Feed rate	6 m min ⁻¹	1 m min ⁻¹	
	Pitch	—	32 mm ^b	
	Cutting depth	5 mm	(through-pass bores)	
Type of work		Routing the workpiece down to a final width of ~300 mm, along x-axis, on the front edge on the side facing the loading position. See Figure F.1 .	Through-pass bores. See Figure F.2 . Distance <i>l</i> ₁ between two series of 10 bores of at least 70 mm	
^a Or as close as possible.				
^b Or manufacturer's specification.				



Key

- 1 router bit
- 2 particle board
- 3 cutting depth

Figure F.1 — Routing operation during noise measurements



Key

- 1 10 bores
- l_1 distance between series of bores

Figure F.2 — Boring operation during noise measurements

F.6 Information to be recorded

ISO 19085-1:2021, F.6, applies.

F.7 Information to be reported

ISO 19085-1:2021, F.7, applies.

F.8 Declaration and verification of noise emission values

F.8.1 General and content

ISO 19085-1:2021, F.8.1, applies.

F.8.2 Example of format of noise emission declaration

ISO 19085-1:2021, F.8.2, applies.

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Annex G **(normative)**

Dynamic test for pressure-sensitive bumpers, edges, trip bars, trip plates

Annex specific to this document.

G.1 General

This annex describes how to measure forces of pressure-sensitive bumpers, edges, trip bars or trip plates applied on various test probes representing parts of a human body being in the path of movement. Forces limit values are also stated.

Any modification influencing the properties of the pressure-sensitive safety system requires a new test. Examples of such modifications are changes in the dynamic of the drive system, safety relevant control system or safety relevant evaluation software.

G.2 Test procedure and conditions

A dynamic test shall be made to get information on the characteristics of the system at the maximum speed.

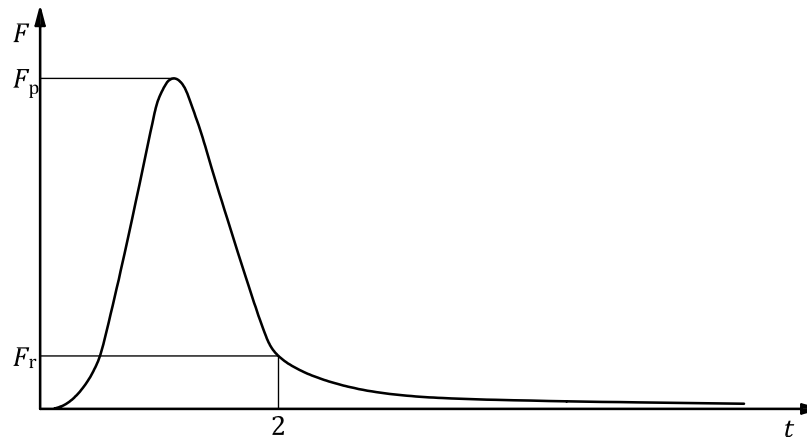
To perform the test, the part of the body involved and the kind of PSPE shall be first taken into account to define the proper test probe suitable for the specific machine-system configuration.

Position the test probe on the machine as indicated in [G.3](#), [G.4](#), [G.5](#) and [G.6](#) and move the machine part at maximum speed against the test probe.

The forces for the dynamic test shall be measured at the maximum speed of the machine head.

The force shall be measured three times at each measuring point, with a pause of at least 1 min in between the measurements.

[Figure G.1](#) shows a typical force-time diagram for bumpers and sensitive edges.

**Key**

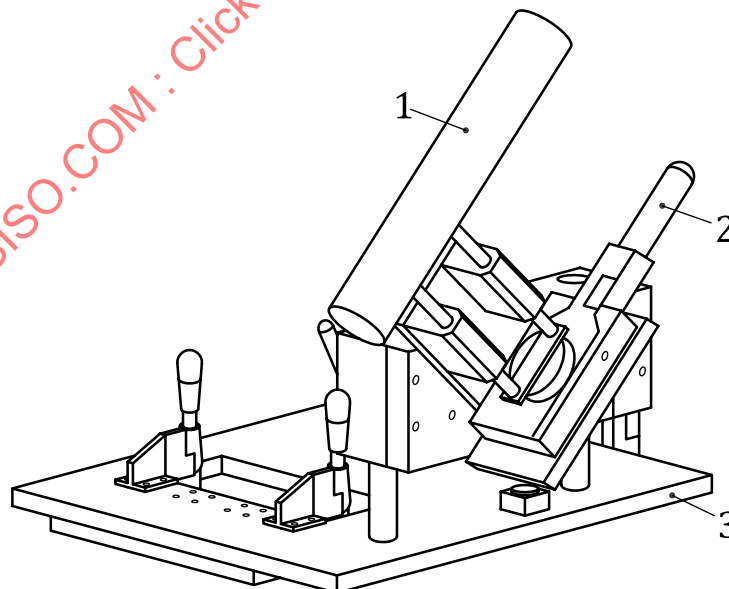
- t time, in s
 F force
 F_p peak force
 F_r remaining force

Figure G.1 — Example of force-time diagram for bumpers or sensitive edges

G.3 Test equipment and installation

The ramp up and down time of the amplifier of the measuring instrument for the force shall be less than 5 ms and the spring rigidity shall be 500 N/mm.

[Figure G.2](#) shows an example of test equipment to measure force at shearing point.

**Key**

- 1 test probe
 2 measuring instrument
 3 supporting structure

Figure G.2 — Example of test equipment to measure force at shearing point

G.4 Maximum forces

Maximum forces are dependent on the kind of hazard and the part of the body affected, as stated in [Table G.1](#), which also provides the test probe to be used when measuring forces (see [G.5](#) and [G.6](#)).

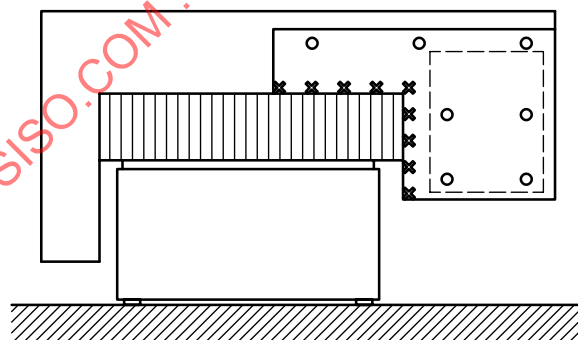
Table G.1 — Maximum forces and test probe selection

Type of hazard:	Impact hazard	Shearing hazard 45°	Crushing hazard ^a	
Body part:	Head/hand/arm/ shoulder/leg/ whole body	Head/fingers/ hand/arm	Whole body	Head/hand/ arm/leg/ shoulder
Peak force, F_p ^b	600 N	250 N	800 N	250 N
Remaining force, F_r ^c	—	150 N	250 N	150 N
ISO 13856-3:2013, Table 2, test probe for bumpers/ edges testing	Test probe 1	Test probe 5	Test probe 6	Test probe 1
ISO 13856-3:2013, Table 2, test probe for trip bars/ plates testing	Test probe 1	Test probe 5	Test probe 1 for trip plates only	Test probe 1
^a Crushing hazard occurs when minimum gap gets lower than stated in ISO 13854:2017.				
^b F_p is the peak force measured at the maximum speed of the machining head.				
^c F_r is the remaining force 2 s after triggering the device.				

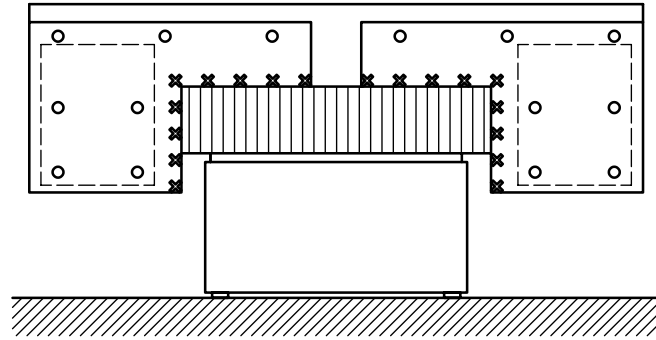
G.5 Test direction and test locations

G.5.1 General

The measuring points shall be located at the surface of the moving part, in the areas where impact or crushing hazard occurs, and at the edges of the opening, in the areas where shearing hazard occurs, as shown in [Figure G.3](#).



a) Example for machine with rear machine side not accessible during machining



b) Example for machine with all sides accessible during machining

Key

- area where impact and/or crushing hazard can occur
- ✕ area where shearing hazard can occur
- area where whole body crushing can occur

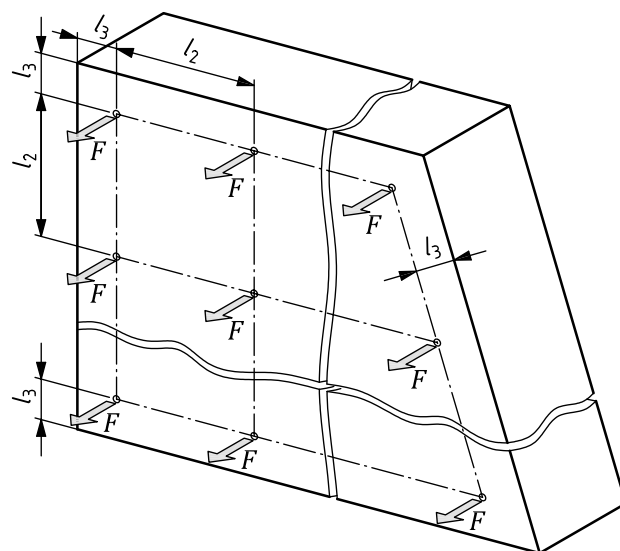
Figure G.3 — Examples of test location and direction of the force at the surface of a bumper with both dimensions exceeding 150 mm for two different machines designs as per [Figure 1](#)

When testing pressure-sensitive bumpers, pressure-sensitive edges and trip bars, the contact point of the force shall be in the centre of the test probe.

G.5.2 Measurements with test probe 1

The probe shall be oriented in the direction indicated by key 1 in [Figure G.7](#).

Pressure-sensitive bumpers, where both dimensions of the contact surface exceed 150 mm, shall be tested at the crossing points of an orthogonal grid with perimeter lines 100 mm offset inwards (see [Figure G.4](#), key l_3) and intermediate lines at 350 mm maximum step (see [Figure G.4](#), key l_2).

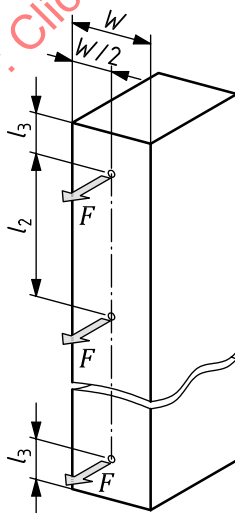


Key

- F forces
- l_2 distance between two measuring points
- l_3 distance from the edge of the device to the centre of the test probe

Figure G.4 — Test location and forces direction at the surface of a bumper with both dimensions exceeding 150 mm

Pressure-sensitive edges and pressure-sensitive bumpers with one dimension not exceeding 150 mm (see [Figure G.5](#), key W) shall be tested at the points along the median longitudinal axis at maximum 350 mm step (see [Figure G.5](#), key l_2) starting from 100 mm from the short edges (see [Figure G.5](#), key l_3). The minimum number of measuring points shall be three. The distance between them shall be equal.



Key

- F forces
- l_2 distance between two measuring points
- l_3 distance from the edge of the device to the centre of the test probe
- W width of the device

Figure G.5 — Test location and force direction at pressure-sensitive edges and bumpers with one dimension not exceeding 150 mm

Trip bars shall be tested at 100 mm from their end sides and in the middle of their length.

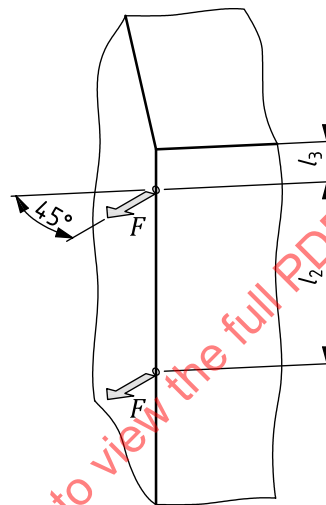
Trip plates shall be tested along their free longitudinal edge at 100 mm from their end sides and in the middle. The test probe shall overlap 10 mm trip plate free longitudinal edge.

G.5.3 Measurements with test probe 5

The probe shall be oriented in the direction indicated by key 1 in [Figure G.8](#).

Forces shall be measured at an angle of 45° referred to the direction of the movement (see [Figure G.6](#)). The tolerance of the angle shall be $\pm 5^\circ$.

Pressure-sensitive bumpers and pressure-sensitive edges shall be tested along the edge at 50 mm from its end sides and in intermediate points with maximum 350 mm step. The minimum number of measuring points shall be three. The distance between them shall be equal.



Key

- F forces
- l_2 distance between two measuring points
- l_3 distance from the edge of the device to the centre of the test probe

Figure G.6 — Test location and direction of the force at edges with 45° angled direction

Trip bars shall be tested at 50 mm from their end sides and in the middle of their length.

Trip plates shall be tested along their free longitudinal edge at 50 mm from their end sides and in the middle. The test probe shall overlap 10 mm trip plate free longitudinal edge.

G.5.4 Measurements with test probe 6

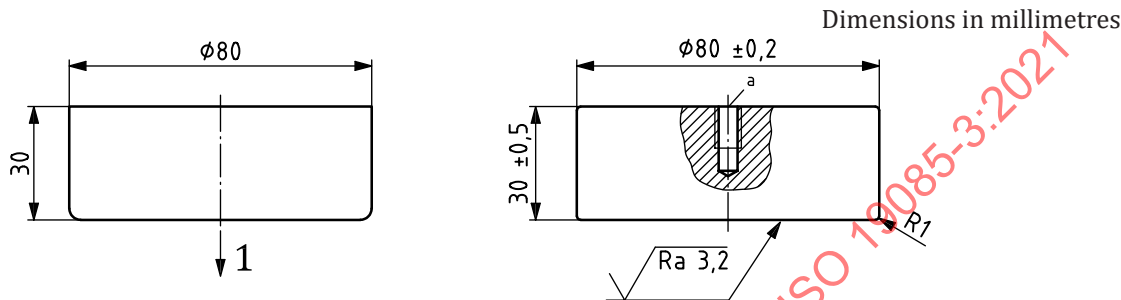
The probe shall be vertically oriented in the direction indicated by key 1 in [Figure G.9](#).

Pressure-sensitive bumpers and edges shall be tested positioning the test probe with its longitudinal axis along a vertical line at 200 mm offset inwards from lateral sides and intermediate lines at 500 mm maximum step.

G.6 Test probes and direction of force

Test probe 1 defined in ISO 13856-3:2013 shall be selected according to Table G.1 for testing:

- pressure-sensitive bumpers and pressure-sensitive edges along the moving part of the machine in the movement direction, if there is hazard of crushing of parts of body (whole body excluded) and/or any impact;
- trip bars and trip plates, if there is hazard of impact and/or crushing (whole body crushing applies only to trip plates).

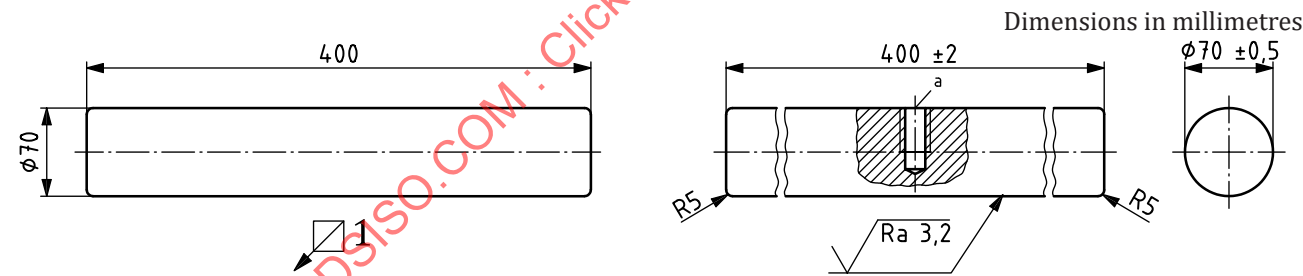


Key

- 1 orientation of the probe parallel to the direction of the movement of the machine part
R rounding radius of edge in mm Ra surface roughness in μm

Figure G.7 — Test probe 1

Test probe 5 defined in ISO 13856-3:2013 shall be selected according to Table G.1 for testing pressure-sensitive bumpers, pressure-sensitive edges, trip bars and trip plates at 45° of the moving part of the machine in the movement direction, if there is hazard of shearing.

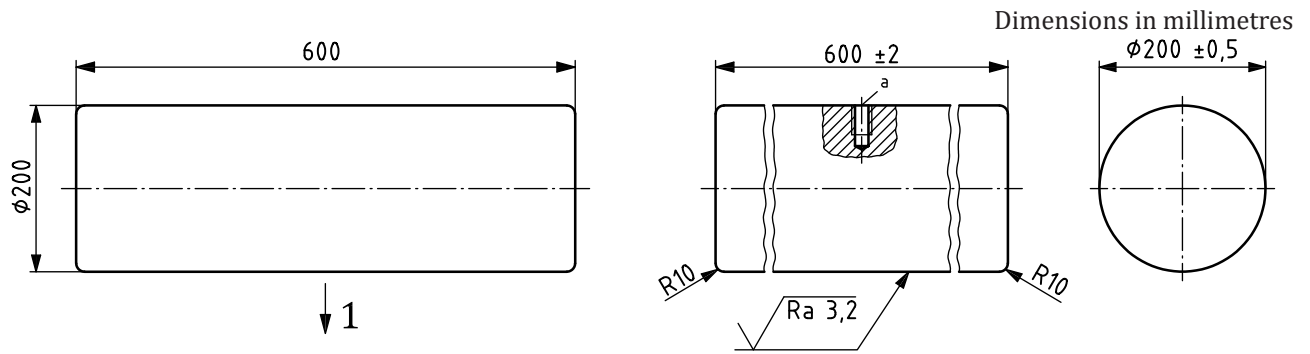


Key

- 1 orientation of the probe parallel to the direction of the movement of the machine part
R rounding radius of edge in mm Ra surface roughness in μm

Figure G.8 — Test probe 5

Test probe 6 defined in ISO 13856-3:2013 shall be selected according to Table G.1 for testing pressure-sensitive bumpers and pressure-sensitive edges along the machine moving part in movement direction, if there is hazard of crushing of the whole body.



Key

- 1 orientation of the probe parallel to the direction of the movement of the machine part
 R rounding radius of edge in mm
 Ra surface roughness in μm

Figure G.9 — Test probe 6

G.7 Test results and evaluation

The three force measurements performed at each measuring point shall be used to calculate the corresponding statistically evaluated value as the mean value plus one-sided confidence interval at the confidence level of 95 %, according to ISO 2602:1980.

The dynamic test is passed if all statistically evaluated values of the forces (F_d , F_r) for the measure points are lower than the maximum admissible forces (F_d , F_r), according to [Table G.1](#).

G.8 Test report

The test report shall contain at least the following information:

- the date and place of the test and the name of the test institute;
- a reference to this document, i.e. ISO 19085-3:2021 (method given in [G.5](#));
- information on the test procedure and conditions according to [G.2](#);
- information on the test equipment and installation according to [G.3](#);
- information on the test probe (the sample) according to [G.6](#);
- the test results and evaluation according to [G.7](#);
- any deviation from the procedure;
- any unusual features observed.

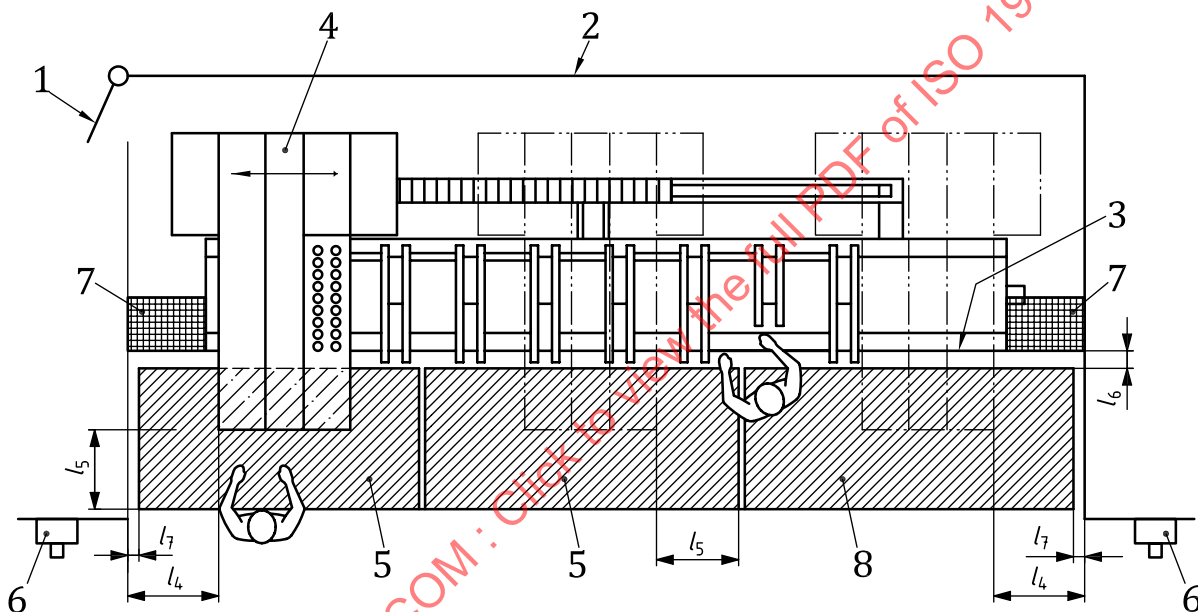
Annex H (informative)

Examples of safeguarding concepts for different machine designs

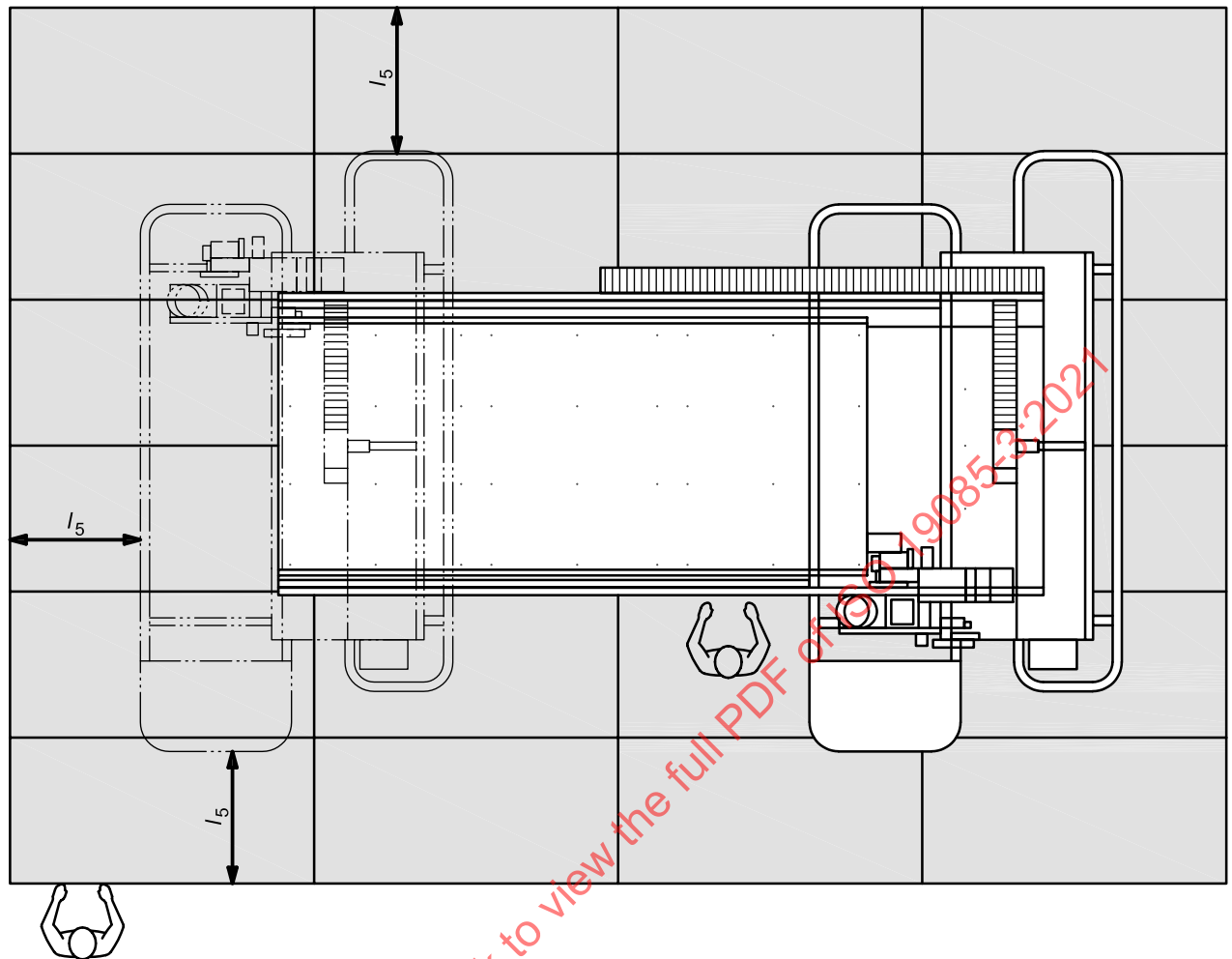
Annex specific to this document.

This annex gives examples of the safeguarding concepts described in 5.6.3 for different designs of machines.

Figure H.1 shows the safeguarding concepts required in 5.6.2, 5.6.3.2, 5.6.5 and 5.9.1 applied to machines with a moving enclosure of the machining head over a fixed base equipped with a solid table or moveable bars as of workpiece support.



a) Machine with one side accessible



b) Machine with all sides accessible

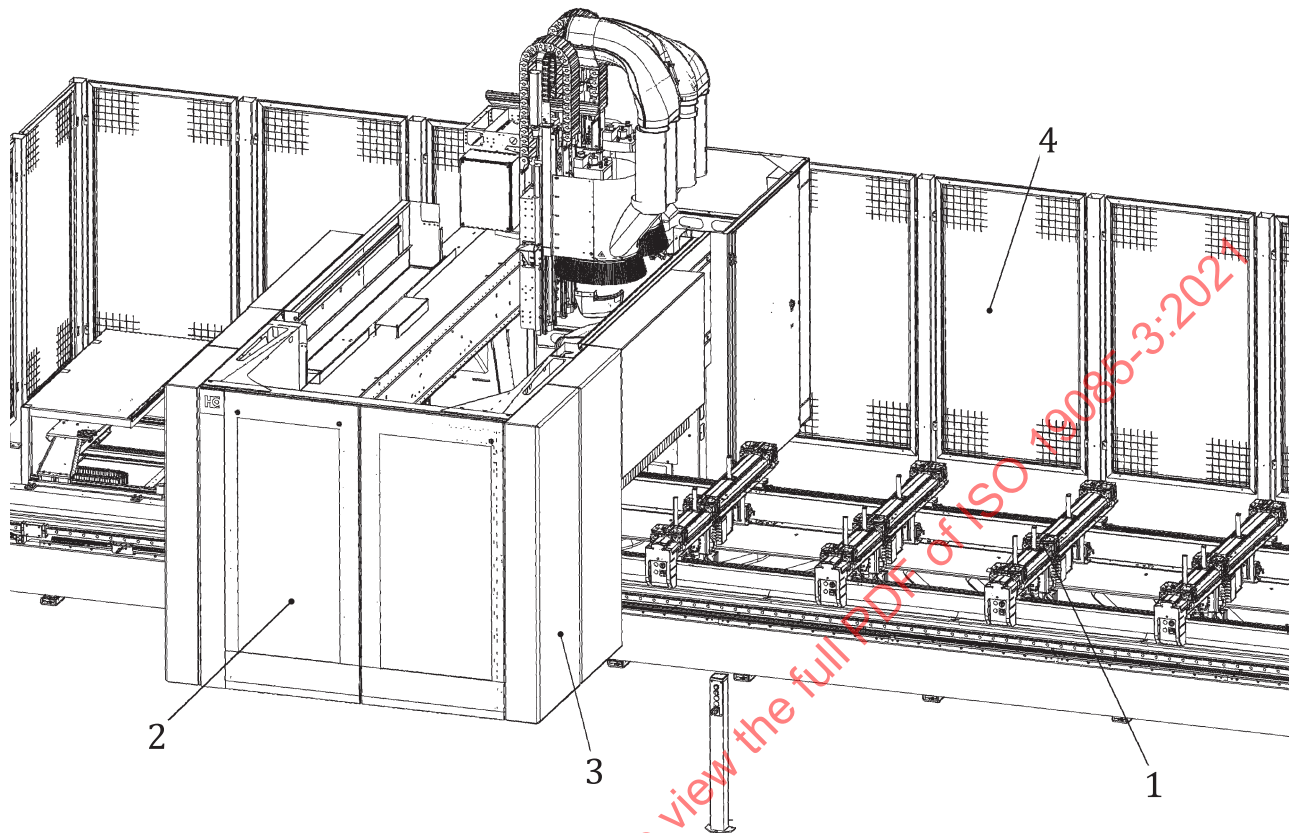
Key

- 1 door with interlocking and guard locking
- 2 fixed guard
- 3 front edge of the table
- 4 machining head enclosure in its limit position
- 5 active pressure-sensitive mats
- 6 reset control device
- 7 deterring/impeding device (i.e. fixed guard or movable guard with interlocking)
- 8 pressure-sensitive mat inactive for loading and unloading
- l_4 minimum distance between machine and side fixed guards on front side when no bumpers are provided
- l_5 minimum extension of protective devices from the moving parts
- l_6 maximum gap between machine and pressure-sensitive mat/light barrier
- l_7 maximum gap between pressure-sensitive mat/light barrier and fixed guards

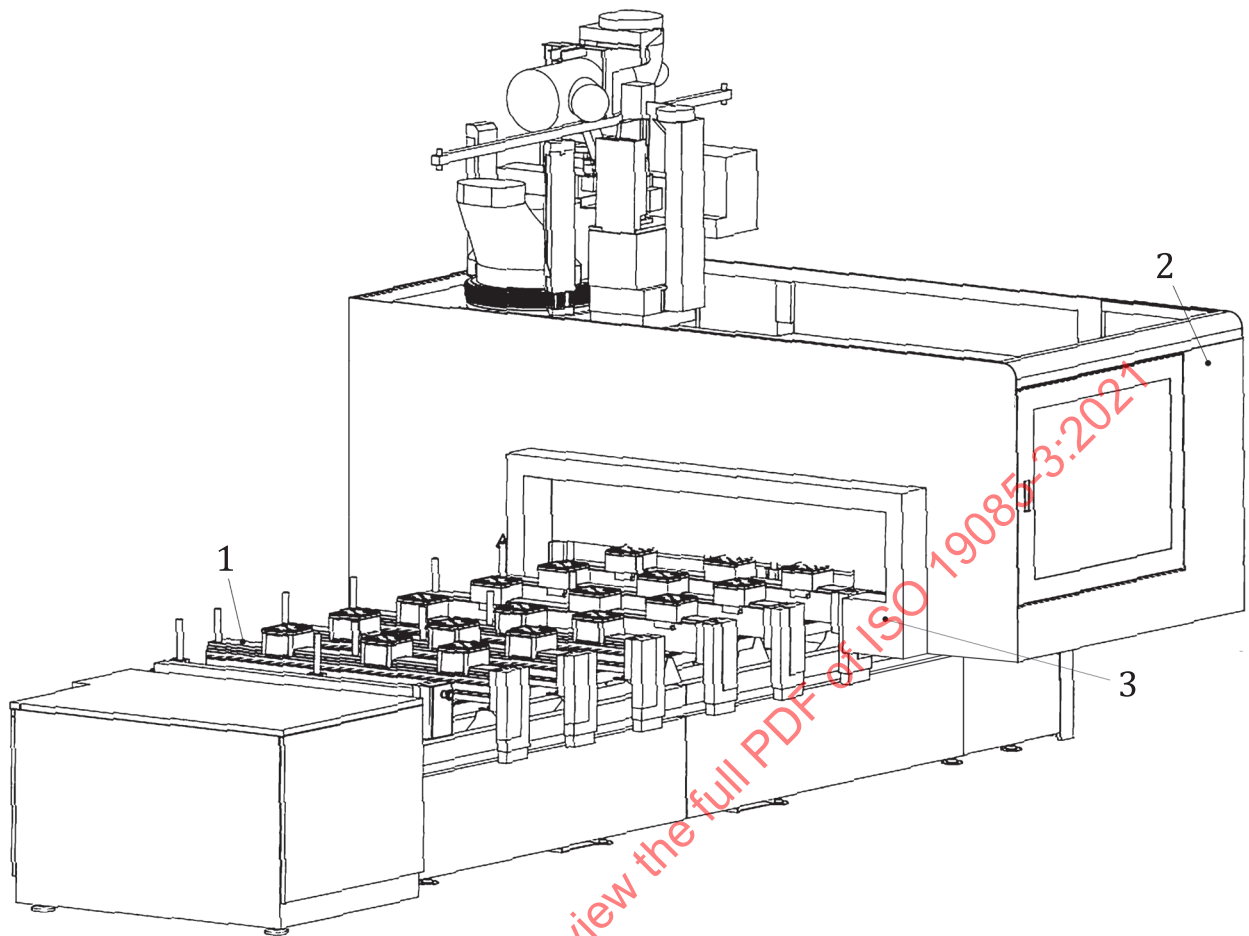
NOTE 5 and 8 together are the loading/unloading zone with alternating active and inactive sections.

Figure H.1 — Safeguards on machines with moving enclosure of the machining head over fixed base with solid table or bars

Figure H.2 shows the safeguarding concepts required in 5.6.2, 5.6.3.5 and 5.9.1 applied to machines with a moving enclosure of the machining head over a fixed base equipped with a solid table or movable bars as of workpiece support, accessible from one side [e.g. Figure H.2.a)] or from all sides [e.g. Figure H.2b)].



a) With bumpers suitable for axes speed exceeding 25 m/min



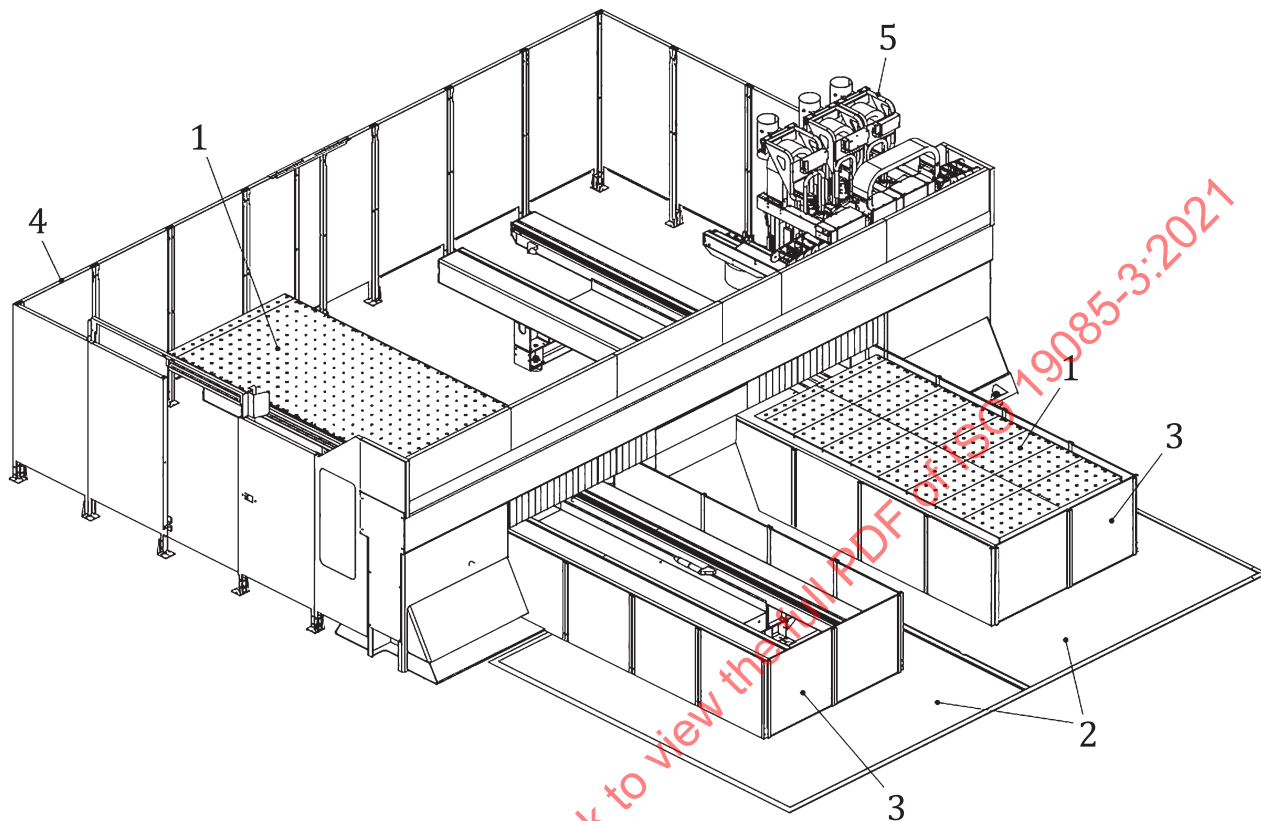
b) With bumpers suitable for maximum axes speed of 25 m/min

Key

- | | | | |
|---|-------------------------------------|---|--------------|
| 1 | workpiece support (supporting bars) | 3 | bumpers |
| 2 | housing of the machining head | 4 | fixed guards |

Figure H.2 — Safeguards on machines with moving enclosure of the machining head over fixed base with bars

Figure H.3 shows the safeguarding concepts required in 5.6.2, 5.6.3.2 and 5.9.1 applied to machines with twin sliding tables partially out of the enclosure during processing. The same applies to machines with one moving table.

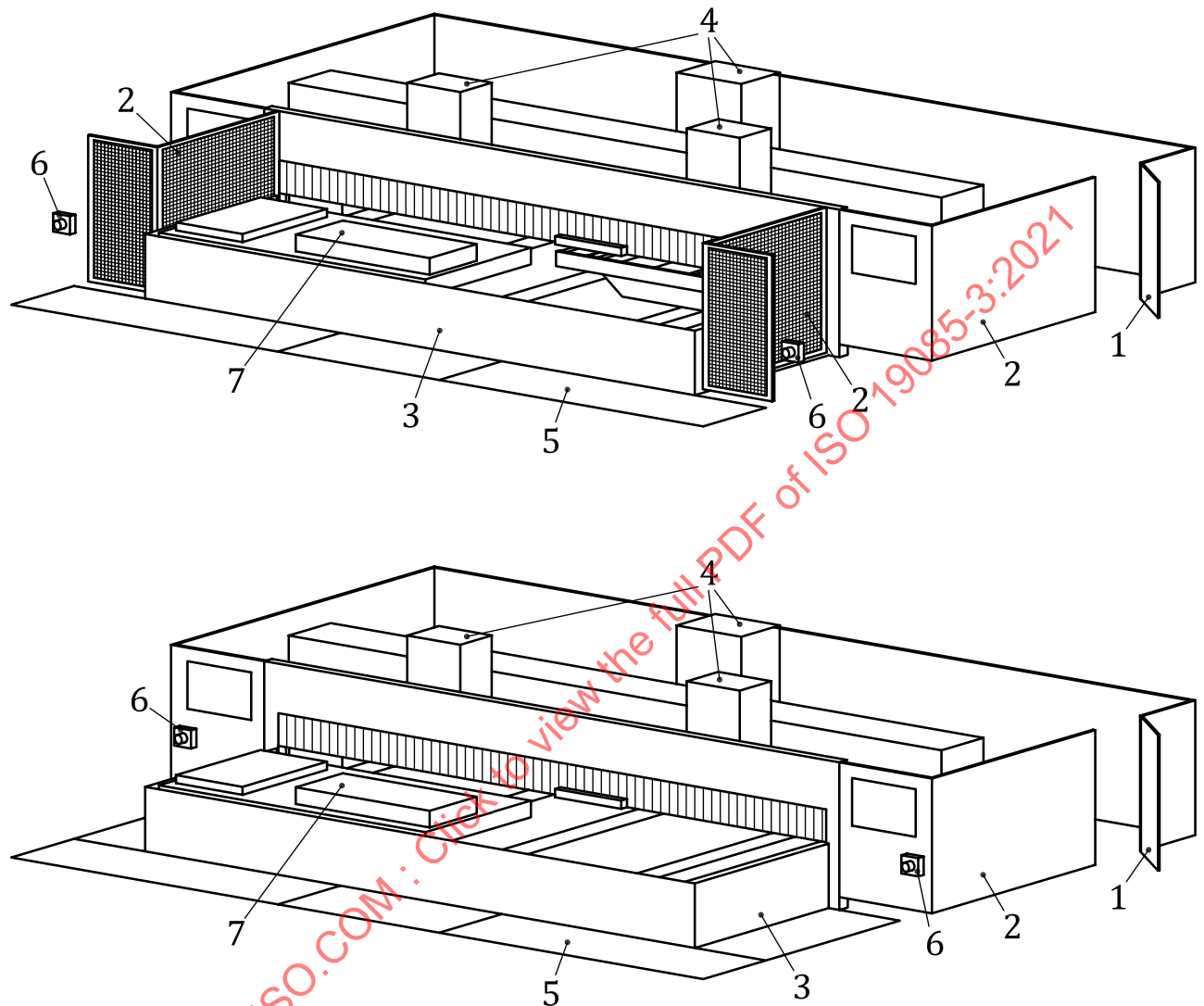


Key

- | | |
|---|---|
| 1 workpiece support (sliding table) | 4 fixed guards at the rear of the machine |
| 2 safety mats | 5 machining head |
| 3 fixed guards around the sliding table at the loading/unloading side | |

Figure H.3 — Safeguards on machines with twin sliding tables, partially out during processing

Figure H.4 shows the safeguarding concepts required in 5.6.2, 5.6.3.2 and 5.9.1 applied to machines with twin sliding tables, which can be synchronized, partially out of the enclosure during processing.

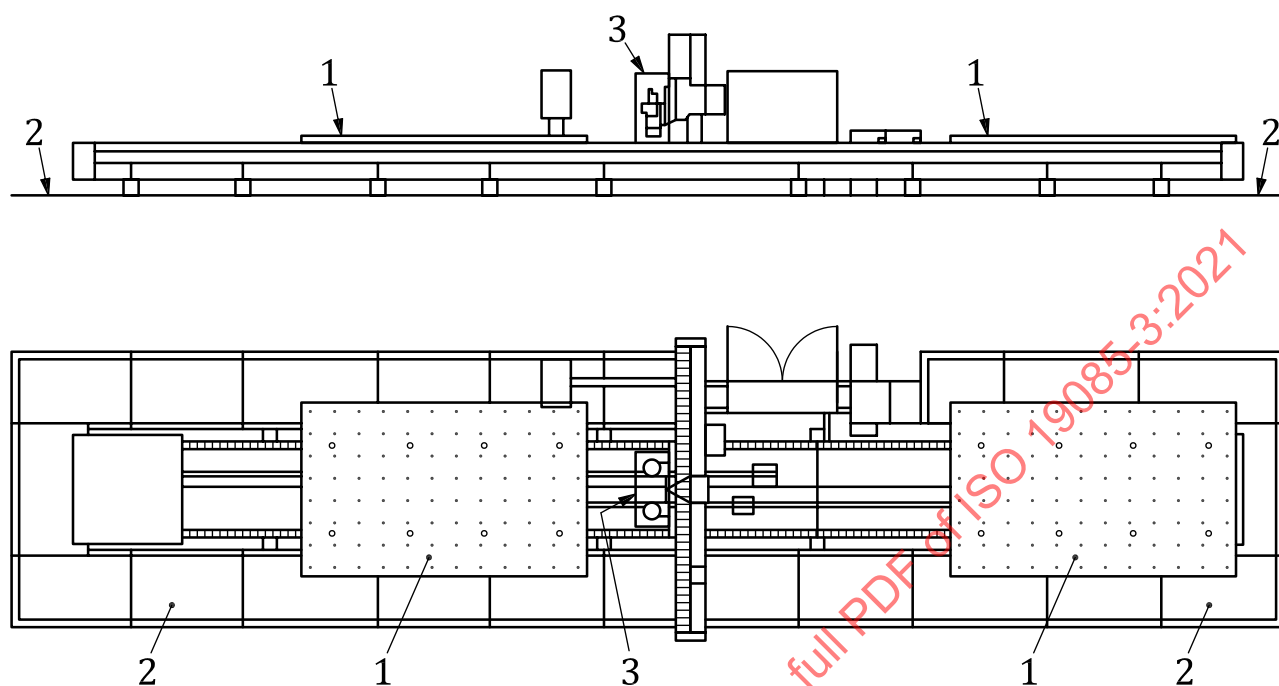


Key

- | | |
|---------------------|------------------------|
| 1 access door | 4 machining head |
| 2 high fixed guards | 5 safety mats |
| 3 low fixed guards | 6 reset control device |

Figure H.4 — Safeguards on machines with twin sliding tables, partially out during processing

Figure H.5 shows the safeguarding concepts required in 5.6.3.2 and 5.9.1 applied to machines with shuttle tables, with 3 stations in a line.

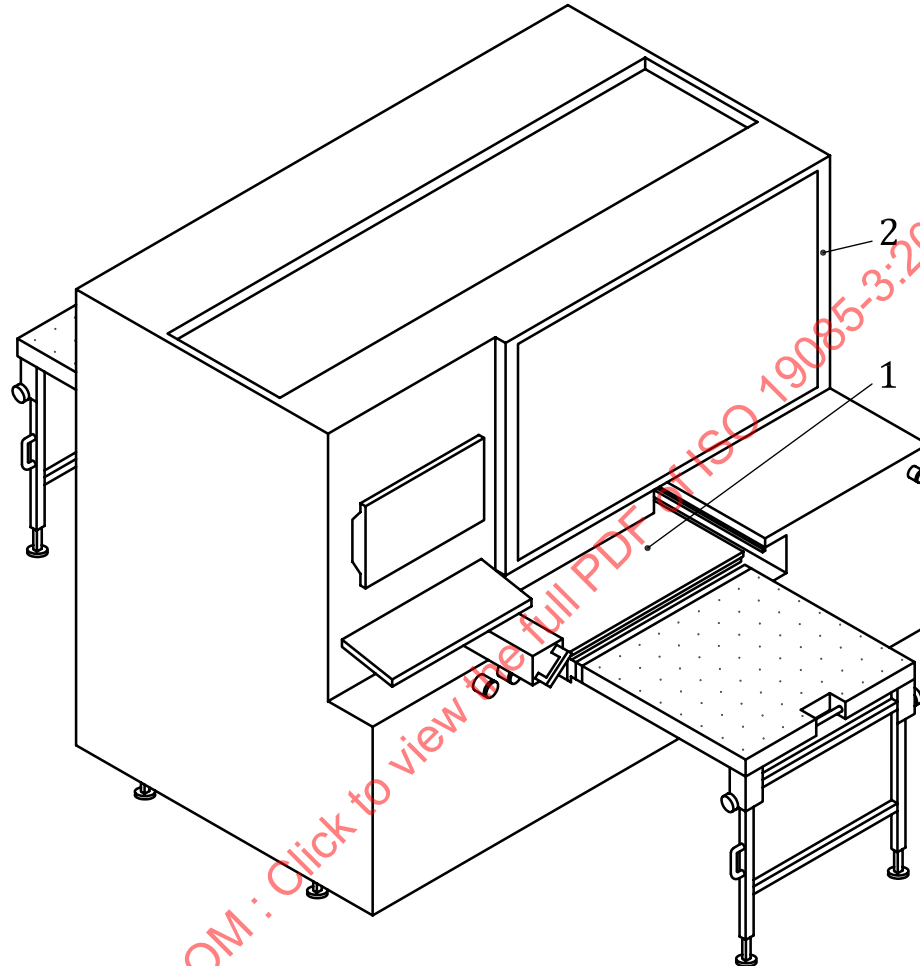


Key

- 1 shuttle tables
- 2 safety mats
- 3 housing of the machining head

Figure H.5 — Safeguards on machines with shuttle tables

Figure H.6 shows the safeguarding concepts required in 5.6.2, 5.6.3.7, 5.9.1 and 7.3.2 b) 5) applied to machines with fixed workpiece support where the workpiece is moving in and out from the housing of machining head during processing with a maximum speed of 25 m/min.

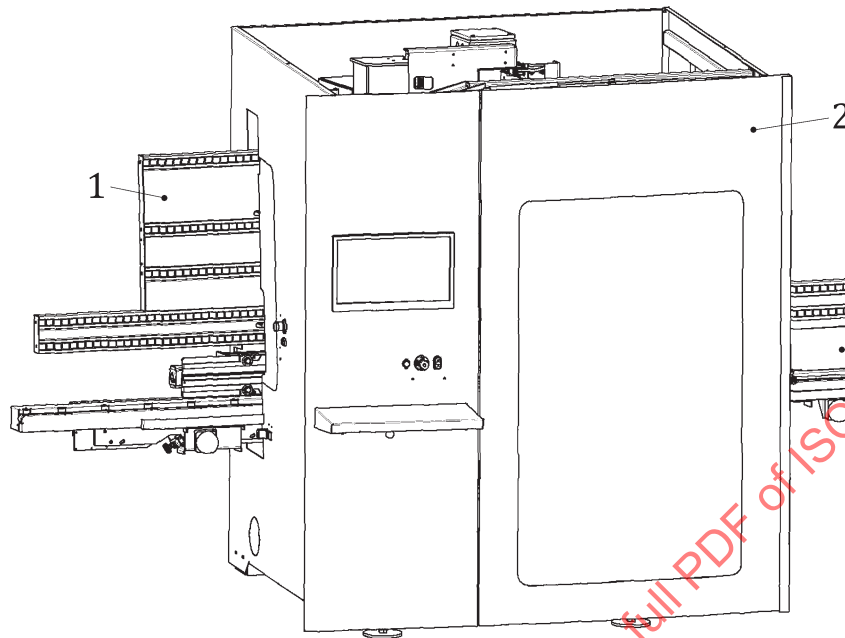


Key

- | | |
|---------------------|---------------------------------|
| 1 workpiece support | 2 housing of the machining head |
|---------------------|---------------------------------|

Figure H.6 — Machines with fixed workpiece support where the workpiece is moving in and out from the housing of machining head during processing with a maximum speed of 25m/min

Figure H.7 shows the safeguarding concepts required in 5.6.2, 5.6.3.8, 5.9.1 and 7.3.2 b) 5) applied to machines with fixed workpiece support where the workpiece is moving in and out from the housing of machining head during processing with a maximum speed of 40 m/min or 25 m/min.

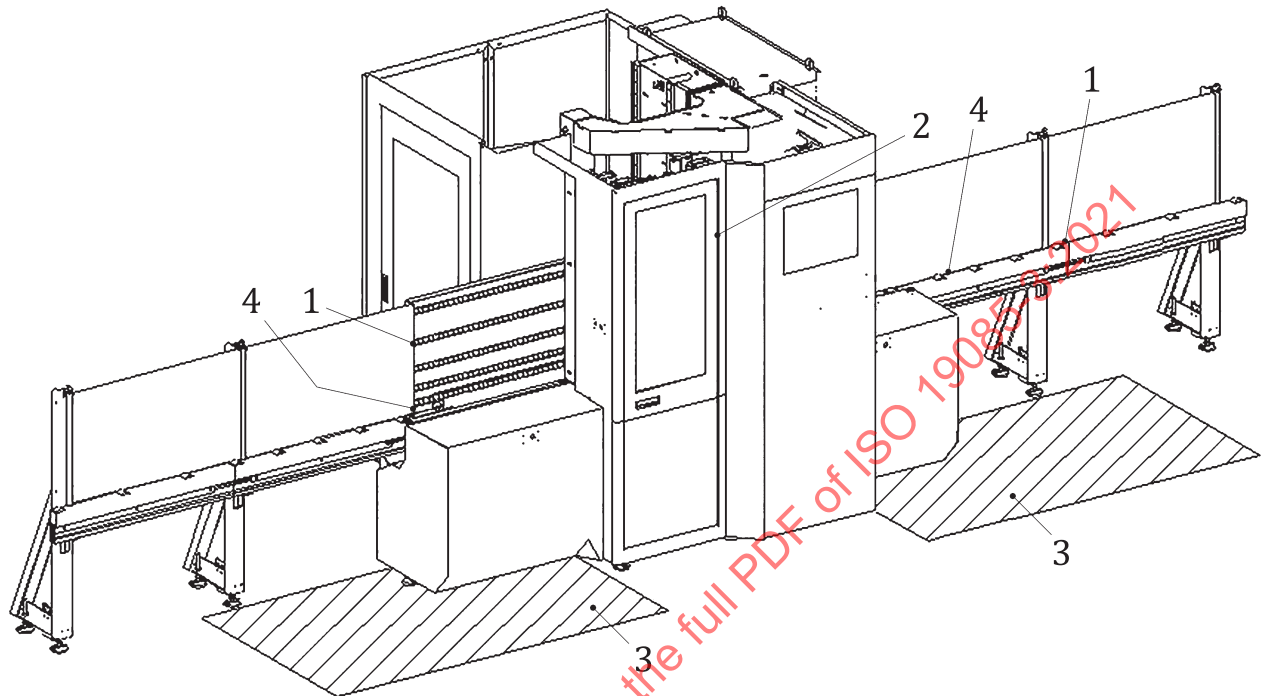


Key

- | | |
|---------------------|---------------------------------|
| 1 workpiece support | 2 housing of the machining head |
|---------------------|---------------------------------|

Figure H.7 — Machines with fixed workpiece support where the workpiece is moving in and out from the housing of machining head during processing with a maximum speed of 40 m/min or 25 m/min

Figure H.8 shows the safeguarding concepts required in 5.6.2, 5.6.3.9 and 5.9.1 applied to machines with fixed workpiece support where the workpiece is moving in and out from the housing of machining head during processing with a speed higher than 25 m/min.



Key

- | | | | |
|---|-------------------------------|---|--------------------------------------|
| 1 | workpiece support | 3 | safety mats |
| 2 | housing of the machining head | 4 | device for workpiece speed reduction |

Figure H.8 — Machines with almost vertical workpiece, feed speed >25m/min, two sets of safeguarding devices