Tööpingid. Ohutus. Töötluskeskused KONSOLIDEERITUD TEKST

Machine tools - Safety - Machining centres
CONSOLIDATED TEXT

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EESTI STANDARDIKESKUS
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EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

Käesolev Eesti standard EVS-EN 12417:2001+A2:2009 sisaldab Euroopa standardi EN 12417:2001+A2:2009 ingliskeelset teksti.	This Estonian standard EVS-EN 12417:2001+A2:2009 consists of the English text of the European standard EN 12417:2001+A2:2009.
Standard on kinnitatud Eesti Standardikeskuse 27.03.2009 käskkirjaga ja jõustub sellekohase teate avaldamisel EVS Teatajas.	This standard is ratified with the order of Estonian Centre for Standardisation dated 27.03.2009 and is endorsed with the notification published in the official bulletin of the Estonian national standardisation organisation.
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Standard on kättesaadav Eesti standardiorganisatsioonist.	The standard is available from Estonian standardisation organisation.

ICS 25.040.10

Võtmesõnad: installa, machine tools, machining centers, maintenance, noise measurements, occupational safety, operating stations, protection against danger, protection devices, safety, safety requirements, set up, transport, working places, workplace safety

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

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English Version

Machine tools - Safety - Machining centres

Machines-outils - Sécurité - Centres d'usinage

Werkzeugmaschinen - Sicherheit - Bearbeitungszentren

This European Standard was approved by CEN on 9 June 2001 and includes Amendment 1 approved by CEN on 3 February 2006 and Amendment 2 approved by CEN on 29 December 2008.

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Contents

Page

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Foreword

This document (EN 12417:2001+A2:2009) has been prepared by Technical Committee CEN/TC 143 "Machine tools - Safety", the secretariat of which is held by SNV.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2006-02-03 and Amendment 2, approved by CEN on 2008-12-29.

This document supersedes EN 12417:2001.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟩A1⟨ ⟨A1⟩ and ⟩A2⟨ ⟨A2⟩.

Annex A is normative. Annexes B to D and ZA ⟩A2⟨ and ZB ⟨A2⟩ are informative.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EC Directive(s).

⟩A2⟨ For relationship with EC Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document. ⟨A2⟩

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Introduction

This European Standard is a type C standard as stated in EN 292–1.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence.

Machining centres present a wide range of hazards, not least from their wide application as rotating tool, 'stationary' workpiece machine tools, for general purpose cutting of cold metal work material.

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

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

Total enclosure of the work zone using guards during cutting is practicable for smaller machines. The requirements for access to the work zone of large machines used for the processing of a wide range of workpiece configurations can require that operators are safeguarded by other means (e.g. perimeter fencing, protective devices at the operating position).

Pendant controls enable operators to move around the machine, especially large machines, and to view the work zone, the load/aligning, clamping, cutting, or unloading operations, maneuvering the pendant control as they move.

The significant hazards covered by this standard are those listed in clause 4. The safety requirements and/or protective measures to prevent or minimize those hazards identified in Table 1 and procedures for verification of these requirements or measures are found in clause 5.

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

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1 Scope

1.1 This standard specifies the technical safety requirements and protective measures to be adopted by persons undertaking the design, construction and supply (including installation and dismantling, with arrangements for transport and maintenance) of machining centres (see 3.1).

1.2 This standard takes account of intended use including reasonably foreseeable misuse, maintenance, cleaning, and setting operations. It presumes access to the machine from all directions. It describes means to reduce risks to operators and other exposed persons.

1.3 This standard also applies to the workpiece transfer devices when they form an integral part of the machine.

1.4 This standard deals with significant hazards relevant to machining centres when they are used as intended and under the conditions foreseen by the manufacturer (see clause 4).

1.5 Hazards arising from other metal working processes (e.g. grinding, turning, forming, EDM, laser processing) are covered by other standards (see Bibliography).

1.6 This standard applies to machines which are manufactured after (its date of publication).

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 292-1:1991, *Safety of machinery - Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

EN 292-2:1991 and EN 292-2/A1:1995, *Safety of machinery - Basic concepts, general principles for design – Part 2: Technical principles and specifications*

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

EN 349:1993, *Safety of machinery – Minimum gaps to avoid crushing of parts of the human body*

EN 547:1996, *Safety of machinery – Human body measurements –*
Part 1: Principles for determining the dimensions required for openings for whole body access into machinery
Part 2: Principles for determining the dimensions required for access openings
Part 3: Anthropometric data

EN 574:1996, *Safety of machinery - Two hand control devices – Functional aspects – Principles for design*

EN 614, *Safety of machinery - Ergonomic design principles –*
Part 1: Terminology and general principles
Part 2: Interaction between machinery design and work tasks

EN 626-1:1994, *Safety of machinery – Reduction of risks to health from hazardous substances emitted by machinery – Part 1: Principles and specifications for machinery manufacturers*

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EN 894:1997, *Safety of machinery – Ergonomics requirements and data for the design of displays and control actuators –*
Part 1: Human interactions
Part 2: Displays

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

EN 953:1997, *Safety of machinery – Guards – General requirements for the design and construction of fixed and movable guards*

EN 954-1:1996, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design*

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

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

EN 999:1998, *Safety of machinery – The positioning of protective equipment in respect of approach speeds of parts of the human body*

prEN 1005:1998, *Safety of machinery – Human physical performance –*
Part 1: Terms and definitions
Part 2: Manual handling of machinery and component parts of machinery
Part 3: Recommended force limits for machinery operation

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

EN 1050:1996, *Safety of machinery - Principles for risk assessment*

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

EN 1127–1:1997, *Explosive atmospheres - Explosion prevention and protection – Part 1: Basic concepts and methodology*

EN 1760–1:1997, *Safety of machinery - Pressure sensitive protective devices – Part 1: General principles for the design and testing of pressure sensitive mats and pressure sensitive floors*

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

EN 60529:1991, *Specification for degrees of protection provided by enclosures (IP code)*

EN 60825-1:1994, *Safety of laser products – Equipment classification, requirements and user's guide*

EN ISO 3744:1995, *Acoustics – Determination of sound power level of noise sources using sound pressure – Engineering method in an essentially free field over a reflecting plane*

EN ISO 3746:1995, *Acoustics – Determination of sound power level of noise sources using sound pressure – Survey method using an enveloping measurement surface over a reflecting plane*

EN ISO 4871:1997, *Acoustics – Declaration and verification of noise emission values of machinery and equipment*

EN ISO 9614-1:1995, *Acoustics – Determination of sound power level of noise sources using sound intensity – Part 1: Measurement at discrete points*

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EN ISO 11202:1995, *Acoustics – Noise emitted by machinery and equipment – Measurement method of emission sound power levels at the work station and at other specified positions – Survey method in situ*

EN ISO 11204:1996, *Acoustics - Noise emitted by machinery and equipment – Method requiring environmental corrections*

prEN ISO 14122:1999, *Permanent means of access to machines and industrial plants -*
Part 2: Working platforms and gangways
Part 3: Stairways, stepladders and guard-rails

prEN 13478:1999, *Safety of machinery – Fire prevention and protection*

EN ISO 11688-1:1998, *Acoustics – Recommended practice for the design of low–noise machinery and equipment – Part 1: Planning*

ISO/TR 11688-2:1998, *Acoustics – Recommended practice for the design of low–noise machinery and equipment – Part 2: Introduction to the physics of low-noise design*

〚A1〛 EN ISO 15641, *Milling cutters for high speed machining — Safety requirements (ISO 15641:2001)* 〈A1〉

EN 50081–2:1993, *Electromagnetic compatibility – Generic emission standard – Part 2: Industrial environment*

EN 60204-1:1997, *Safety of machinery - Electrical equipment of machines – Part 1: General requirements (IEC 60204-1:1997)*

EN 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards - Immunity for industrial environments (IEC 61000-6-2:1999)*

EN 61496-1: 1997, *Safety of machinery - Electrosensitive protective equipment – Part 1 - General requirements and tests (IEC 61496-1:1997)*

IEC 61496-2:1997, *Safety of machinery - Electro-sensitive protective equipment – Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)*

ISO 2806:1994, *Industrial automation systems – Numerical control of machines – Vocabulary*

3 Terms and definitions

For the purposes of this standard, the following definitions apply. For other terms and definitions, see EN 292-1, EN 292-2+A1.

3.1
machining centre
a numerically controlled machine tool, where the spindle orientation is usually either horizontal or vertical, capable of carrying out two or more machining processes (e.g. milling, drilling, boring) and having facilities to enable tools to be changed automatically from a magazine or similar storage unit in accordance with the machining program. Such machines may incorporate facilities for manual control in varying degrees

3.2
numerical control (computer numerical control) (NC, CNC)
automatic control of a process performed by a device that makes use of numeric data introduced while the operation is in progress (ISO 2806:1994, 2.1.1)

3.3
work zone
the space where the metal cutting process can take place

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3.4
workpiece transfer device
a mechanism integrated with the machine as a means of supplying a previously loaded workpiece to a machine in exchange for a finished workpiece (e.g. pallet changing device – see annex C, Figures C.1, C.2, C.3, C.4)

3.5
electronic handwheel
a manually operated control device which initiates and maintains an axis movement by pulse generation input to the numerical control during its rotation

4 List of significant hazards

4.1 The list of hazards contained in Table 1 is the result of a hazard identification and risk assessment carried out as described by EN 1050 for machining centres covered by the scope of this standard. The safety requirements and/or protective measures and information for use contained in clauses 5 and 7 are based on the risk assessment and deal with the identified hazards by either eliminating them or reducing the effects of the risks they generate.

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

4.3 In addition, the user of this standard (i.e. the designer, manufacturer, supplier) shall validate that the risk assessment is complete for the machine under consideration with particular attention to:

— the intended use of the machine including maintenance, setting and cleaning, and its reasonably foreseeable misuse;

— the identification of the significant hazards associated with the machine.

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Table 1 — List of significant hazards and major sources of these hazards associated with machining centres

•	Description	Example(s) of related hazardous situation(s)	Associated activity	Related danger zone	Clause 5 Reference (Table 2)
1.	**Mechanical hazards**				
1.1	Crushing	workpiece clamping	loading/reorienting/ unloading	between clamps and workpiece	1.4
		movements associated with automatic tool changing	power–operated tool change	envelope of tool-changer motion between spindle and tool store	1.3
		moving axes	maintenance	within pits	1.7
		movement of operating platforms	normal operation, maintenance	at or near machine	1.8
1.2	Shearing	moving axes	manual operation/ tool change	between tool/ spindle and table/ workpiece	1.1.6.3 1.1.6.4 1.2.1.3
1.3	Cutting or severing	spindle or tool running or cutting	spindle running	at spindle or tool	1.1 to 1.1.6.4
1.4	Entanglement	movements associated with automatic tool changing	power–operated tool-change	envelope of tool-changer motion between spindle and tool store	1.3
		removal of swarf/chips	power–operated swarf/chip removal	swarf/chip collection and discharge zones	1.5
1.5	Drawing–in or trapping	rapid travel of table or spindle head	power–operated motion of workpiece on table or tool in spindle	envelope of movement of workpiece on table axes; envelope of movement of tool in spindle head	1.1
		rotating power transmission mechanisms	maintenance	in or around machine	1.6
1.6	Impact	moving/rotating tool	spindle running	at spindle or tool	1.1 to 1.1.6.4
		automatic tool changing	power–operated tool change	envelope of tool change motion	1.3
		automatic workpiece transfer (e.g. pallet loading system)	power-operated workpiece transfer	envelope of motion of workpiece and workpiece transfer mechanisms	1.4
1.7	Stabbing or puncture	moving/rotating tool (especially eccentric tools)	process control	at tool in spindle	1.1 to 1.1.6.4
		movements associated with automatic tool changing	power–operated tool change	envelope of tool changer motion (especially tool grippers)	1.3
		handling tools	during manual tool change or replenishing tool magazine	at sharp cutter faces	(see clause 7)
		handling swarf/chips	during loading/ unloading and cleaning	at workpiece, table, and swarf /chip collecting and discharge zones	(see clause 7)

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Table 1 (continued)

•	Description	Example(s) of related hazardous situation(s)	Associated activity	Related danger zone	Clause 5 Reference (Table 2)
2	**Electrical hazards**				
2.1	Contact of persons with live parts (direct contact)	contact with live parts or connections	during commissioning, maintenance, trouble shooting	electrical cabinet, terminal boxes, control panels at machine	2.1
2.2	Contact of persons with parts which have become live under faulty conditions (indirect contact)	contact with live parts or connections	during operation, inspection and maintenance of machine	at machine or faulty part	2.2
4	**Hazards generated by noise**				
4.1	Hearing loss (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	motion of power transmission elements, cutting processes and fluid power systems	during operating cycle of machine	near machine	4
4.2	Interference with speech communication, acoustical signals	air blast used for cleaning of tool or pallet locations	during operating cycle of machine	near machine	4
6	**Hazards generated by radiation**				
6.5	Lasers	direct or reflected visual exposure to laser radiation	maintenance of laser positional feedback system	within machine	6.5
7	**Hazards generated by materials and substances**				
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes, and dusts	conditions near machine caused by ejection of particles of work material, fluid droplets or mist from metal working fluids	during operating cycle of the machine	at or near machine	7.1
7.2	Fire or explosion	flammable work material, flammable (low flash point) metal working fluids	during operating cycle of the machine	at or near machine	7.2
7.3	Biological or micro–biological (viral or bacterial) hazards	contact with hydraulic or metal working fluid as liquid or mist containing detritus and bacteria	during operation, process control, and maintenance	at or near machine	7.3
8	**Hazards generated by neglecting ergonomic principles in the design process**				
8.1	Unhealthy postures or excessive effort (repetitive strain)	lifting and reaching while handling workpiece, tools, and machine parts	during loading/ unloading, process control, and maintenance	at load/unload and tool mounting positions, maintenance action points	8.1
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	inappropriate location of controls	during loading/ unloading, process control, and maintenance	at load/unload and tool mounting positions, maintenance action points	8.2
8.4	Inadequate local lighting	judgement and accuracy of manual actions impaired during handling/ positioning of work materials and cutters	during loading /unloading, process control, tool handling	at load/unload, tool mounting positions	8.4

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Table 1 (continued)

•	Description	Example(s) of related hazardous situation(s)	Associated activity	Related danger zone	Clause 5 Reference (Table 2)
8.6	Human errors, human behaviour	reasonably foreseeable misuse, inadvertent operation of controls, incorrect work material and cutter handling and setting	during loading/ unloading, process control, tool handling	at load/unload, tool mounting positions	8.6
8.7	Inadequate design, location or identification of manual controls	inadvertent operation of controls	during setting, operating cycle	at or near machine	8.7
8.8	Inadequate design or location of visual display units	misinterpretation of displayed information	during setting, operating cycle	at or near machine	8.8
10	**Unexpected start-up, unexpected overrun/ overspeed**				
10.1	Failure/disorder of the control system	mechanical hazards associated with selected machine movement	during setting, cleaning	at machine	10.1
10.2	Restoration of energy supply after an interruption	unexpected movements of machine	during setting, cleaning or maintenance	at or near machine	10.2
10.3	External influences on the electrical equipment	unpredictable behaviour of electronic controls due to electromagnetic interference	during setting or operating cycle of the machine	at or near machine	10.3
13	**Failure of the power supply**	malfunctions of the control with consequent misapplication of stored energy or power. Power workholding fails, motor overspeed. Part breakage causes machine elements to move under residual forces (inertia, gravity, spring/ energy storage means) causing external elements to move unexpectedly	during operation, process control, maintenance	at machine where machine elements retained in a safe condition by the application of power or fluid pressure.	13
14	**Failure of the control circuit**	Unexpected movements of machine	during setting, cleaning or maintenance	at or near machine	14
15	**Errors of fitting**	machine elements fail or swing unexpectedly	during process control, tool mounting, maintenance	at machine	15
17	**Falling or ejected objects or fluids**	ejection of machine parts, workpiece or tools caused by clamping device, control system failures or collision due to data errors	during the operating cycle of the machine	at or near machine	1.2.6 17
18	**Loss of stability, overturning of machinery**	unrestrained machine or machine part (maintained in position by gravity), falls or overturns	during loading/ unloading and process control, at heavy/unwieldy workpieces during maintenance (disassembly/ relocation)	at machine	18

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Table 1 (concluded)

19	**Slip , trip, and fall of persons** (related to machinery)	ejection or spillage of metal working fluids and lubricants (also hydraulic fluid if used); work at heights	during workpiece load/unload, setting, process control and maintenance work at heights work to replenish fluids (e.g. lubricants)	machine table, floor area around machine and workpiece permanent means of access to the machine	19
• This list is derived from annex A of EN 1050: 1996.					

5 Safety requirements and/or protective measures

5.1 General requirements

Machining centres shall comply with the safety requirements and/or protective measures of this clause.

In addition, the machining centre shall be designed according to the principles of EN 292 for hazards relevant but not significant which are not dealt with by this standard.

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5.2 Specific requirements

Table 2 — List of safety requirements and/or protective measures and their verification procedures

NOTE The numbering of various provisions in this table is in accordance with Table 1 and hence missing numbers correspond to hazards which are not significant

Hazards	Safety requirement and/or protective measure	Verification
1 Mechanical	**1.1 Work zone**	
	1.1.1 Primary safeguards The work zones of machining centres shall be safeguarded. The guarding arrangements shall be designed to prevent access to hazardous situations. NOTE General guidance for the design selection of safeguards, where the hazards from moving parts cannot be avoided by design is given in 4.1, 4.2 and Table 1 of EN 292-2:1991. For the purposes of this clause, 1) all protective equipment shall be in accordance with the following: in accordance with EN 61496-1:1997 (ESPE), in accordance with IEC 61496-2:1997, category 4 (AOPD), in accordance with EN 1760-1:1997 (PSPD). 2) Guards shall be in accordance with EN 953:1997, and interlocking devices shall be in accordance with EN1088:1995.	Visual inspection
	1.1.2 Guarding strategies	
	1.1.2.1 General The work zone shall be enclosed where possible by fixed and/or interlocked movable guards during machining operations. Where enclosure is not reasonably practicable (e.g. due to the size of the workpiece, its geometry, other special characteristics of the machine or its application), operators and other exposed persons shall be safeguarded by a combination of other means (e.g. protected operator position (cabin), perimeter guarding, other protective devices).	Visual inspection, assessment
	1.1.2.2 Enclosure Where reasonably practicable, work zone guarding shall be fixed to the structure of the machine (see 3.2.1 of EN 953:1997) (see also guard characteristics below and Figures C.1 – C.4, C.6).	Visual inspection Examination of drawings
	1.1.2.3 Alternatives to enclosures Access to the work zone, by the operator, from the normal (fixed) operating position shall be prevented by local guarding (typically forming a cabin - see Figures C.5 and C.7). Access to the cabin shall not require entry into the hazard zone enclosed by perimeter fencing or other protective devices. Where this is not possible because of the machine configuration or other operating constraints, the access route to the operating position shall not require approach to hazardous situations.	Visual inspection

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Table 2 (continued)

1 Mechanical	Where the machine operator requires access to the work zone from the protected (fixed) operating position (cabin) e.g. for setting purposes or process control, the cabin shall be designed so that access is via an interlocked movable guard from within the cabin. Alternatively the movement of a pendant control from the cabin position shall have the same effect as the interlocked guard above. Operation of the machine in mode 1 (automatic cycle) shall only be possible when the pendant control (above) is relocated in the cabin. Any other powered movement of machine elements shall only be achieved by selection of the appropriate operating mode (see operating modes below). Access to the work zone by persons other than the machine operator shall be prevented by perimeter fencing and/or other means (e.g. electrosensitive protective equipment (ESPE), active-opto electronic protective devices (AOPDs), pressure sensitive protective devices (PSPDs). Where access points (e.g. gates), are provided they shall be interlocked. Where interlocking is not possible because of the particular machine configuration and application, any non interlocked access points shall be within the visual field of the operator(s) from the normal working position. Where it is foreseen that the machine will be operated unattended, for some or all of the operating cycle, other means of access control (e.g. key pad operated locks), shall be provided to prevent unauthorised access.	Visual inspection, conformance to drawings/ specifications
	1.1.3 Multiple work zones Where more than one work zone is provided on a single machine, safeguards (e.g. fixed or movable interlocked guards, AOPD, ESPE) shall protect the operator(s) from adjacent active work zone hazards (e.g. when loading or unloading workpieces in a non-active work zone, cleaning). Unauthorised movement of the machine into an adjacent non-active work zone shall be prevented using a limiting device, (e.g. mechanical stops, range limit switches, light beams, AOPDs).	Visual inspection, functional test to ensure compliance, conformance to drawings/ specifications
	1.1.4 Guard Characteristics	
	1.1.4.1 Height and Position Where guards are floor mounted (e.g. perimeter fencing), they shall be securely fixed and have a minimum height of 1.4 m at a distance in accordance with Table 2 of EN 294:1992 from the hazard zone. Any opening between the bottom of the guard and the floor shall not exceed 300 mm.	Measurements to ensure compliance with EN 294
	1.1.4.2 Containment Guards shall be designed to contain and/or prevent exposure to swarf/chips, fluids and parts that can be discharged or ejected (see also 7.1.4 mist and vapour, 17.1 fluids mists and 17.2 ejection, 19.2 contamination of floors etc., in this table).	Practical check

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	1.1.4.3 Observation Where routine observation of the machine operation is required, means (e.g. windows) shall be provided so that this can be achieved without the need to open, remove or suspend any work zone guard or other protective device(s) (see also 8.4 lighting, in this table).	Visual inspection
	1.1.5 Interlocking	
	1.1.5.1 All movable guards through which frequent access to the work zone is required (i.e. more than once per shift) shall be interlocked. Opening of a guard or actuation of a protective device in mode 1 (automatic cycle - see below) shall cause hazardous movements to stop and further movement to be inhibited (see EN 1037). Measures to minimise the possible defeat of interlocking device(s) shall be taken (see clauses 5 and 7 of EN 1088:1995).	Visual inspection, practical check
	1.1.5.2 If opening of an interlocking movable guard exposes operators to hazards listed 1.1 -1.7 of Table 1, guard locking shall be provided (see EN 1088 and also 7.2.m, of clause 7).	Practical check
	1.1.6 Modes of operation	
	1.1.6.1 General Each machine shall have at least two modes of operation (i.e. modes 1 and 2) with the option of a third mode (i.e. mode 3). The selection of a mode of operation shall be either by key switch, access code or equally secure means and shall only be permitted from outside the work zone. Selection of a mode shall not initiate hazardous situations.	Visual inspection, practical check
	1.1.6.2 Mode 1 - Automatic cycle [automatic production] The guards shall be closed and/or the protective devices be active to permit execution of programmed sequential machine operation under numerical control.	Practical check
	1.1.6.3 Mode 2 - Setting Setting mode is a mode of operation in which adjustments for the subsequent machining process are performed by the operator. NOTE Assessment of tool or workpiece position, e.g. by touching the workpiece with a probe or tool, and programme sequence checking, belong to the setting mode. When any interlocked movable guard is open or a protective device is suspended, powered machine movements shall only be permitted under the following conditions:	
	a) Axis movements at a maximum rate of 2 m/min. or a maximum increment of 10 mm.	Measurement
	These movements shall be selected one axis at a time and may be initiated and maintained by one of the following means: – a hold-to-run control device; – an electronic handwheel; – manual data input (MDI) followed by cycle start together with an enabling device.	Practical check
	b) Spindle speed shall be limited by its stopping performance which shall not exceed 2 revolutions.	Measurement

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	Spindle rotation shall only be initiated and maintained by one of the following means: – a hold-to-run control device – a spindle start control device together with an enabling device. Release of an enabling device shall initiate a category 1 stop in accordance with 9.2.2 of EN 60204-1:1997.	Practical check
	c) The limits of speed or incremental distance [defined in a) and b) above] shall be monitored and if exceeded, the power to the drives shall be removed by a controlled stop (Category 1 - see 9.2.2 of EN 60204–1:1997).	Examination of circuit diagrams, practical check
	d) Means shall be provided to prevent hazardous movement of vertical or slant axes under gravity.	Practical check
	e) Automatic tool and workpiece changing mechanisms shall remain inhibited. Initiation of their automatic movement shall only be possible by reselection of mode 1.	Practical check
	Exception: For maintenance in mode 2 only, the provisions contained in 1.2, 1.3, 1.4 and 1.5 of this table are permitted.	Practical check
	f) Unguarded swarf/chip conveyor movements shall only be initiated and maintained by a hold-to-run control device.	Visual inspection, examination of circuit diagrams
	g) Where multiple hold-to-run control device locations are provided (e.g. main control station, hand-held pendant), only one shall be functional at a time.	Practical check
	〈A1〉 1.1.6.4 Mode 3 - Optional mode for manual intervention under restricted operating conditions When provided, this mode permits use of the machine under manual or numerical control with work zone guards open and/or protective devices suspended under the following conditions:	
	a) This mode shall only be provided when details of the intended application are known and the required skill level of operators shall be defined in the instruction handbook (see 7.2 g) of this European Standard).	Visual inspection (of Instruction handbook)
	b) Single axis and multiple axis vector speeds shall be limited to 5m/min.	Measurement
	c) Spindle speed shall be limited by its stopping performance which shall not exceed 5 revolutions. NOTE 1 In order to achieve this stopping requirement it may be necessary to provide tool diameter identification or measurement systems to limit the permitted speed of the spindle for each tool used. NOTE 2 Alternative solutions to this clause have been considered during the development of this standard but no firm conclusions have been reached. This particular problem will be re-visited in a future revision of this European Standard.	Measurement
	d) Execution of a program shall be initiated by a cycle start control device in conjunction with an enabling device and maintained by the enabling device;	Practical check
	e) Non-programmed movements shall be achieved as follows:	
	1) Spindle rotation shall be initiated by a spindle start control device together with an enabling device and maintained by the enabling device. Release of the enabling device shall initiate a category 1 stop in accordance with 9.2.2 of EN 60204-1:1997.	Examination of circuit diagrams, practical test

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	2) Axis movements may be initiated and maintained by one of the following means: – a hold-to-run control device – an electronic hand wheel – manual data input (MDI) followed by cycle start together with an enabling device.	Practical check
	f) The limits of speed or incremental distance [defined in b) and c) above] shall be monitored and if exceeded, the power to the drives shall be removed by a controlled stop (category 1 – see 9.2.2 of EN 60204-1:1997).	Practical check
	g) The requirements d), e), f) and g) of mode 2 in 1.1.6.3 shall also apply.	See 1.1.6.3 d, e, f and g.
	Where ergonomic considerations in the application of Mode 3 make the use of an enabling device impractical (e.g. because the duration of necessary process observation/intervention exceeds an acceptable fatigue time for the machine operator to actuate the enabling device or the manipulation of multiple parameter control devices prevents the sustained operation of an enabling device) then a combination of alternative engineering control measures, to reduce entanglement and crushing risks, shall be substituted for the enabling device. Two examples of accepted alternative engineering control measure combinations are: h) A safe standing position for the operator that is monitored by an active optical protection device (AOPD) or other approved safety monitoring device, (e.g. a scanning device or light curtain), but excluding the use of a pressure sensitive mat or similar easily defeated device, together with: - a readily accessible emergency stop control device shall be provided plus, - safe edge emergency stop arrangements shall be applied to all moving machine elements that pose a crushing risk plus, - the monitoring for reduced spindle and axes speeds shall satisfy the requirements of EN 954-1:1996, Category 3, and - identification of appropriate personal protective equipment (PPE) shall be provided in the instructions for use (see 7.2 n) and 7.2 o) of this European Standard). i) Protection against entanglement risk by means of a fixed guard enclosing the rotating spindle and cutter or an AOPD (light curtain) around (or in front of) the rotating spindle and cutter (the position of AOPD shall fulfil the requirements of EN999) together with: - a readily accessible emergency stop control device shall be provided plus, - safe edge emergency stop arrangements shall be applied to all moving machine elements that pose a crushing risk plus, - the monitoring for reduced spindle and axes speeds shall satisfy the requirements of EN 954-1: 1996, Category 3, and - identification of appropriate personnel protective equipment (PPE) shall be provided in the instructions for use (see 7.2 n) and 7.2 o) of this European Standard). NOTE 3 Other engineering control measures that provide the equivalent level of risk reduction, to those identified in h) and i) above, may be used. To reduce ejection risks, the cutting speed employed in any Mode 3 application shall be held below the scope of EN ISO 15641:2000. NOTE 4 The intended tool should preferably be a solid or one-piece milling cutter.	Evaluation of the need for Mode 3 operation without an enabling device plus examination of the machine and its circuit diagrams A1

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	1.1.7 Release of trapped persons Means shall be provided for the movement of machine axes for emergency purposes (e.g. release of trapped persons). These means are for example: a) With power off: - manually operated relief valves to depressurise systems under pressure; - manual release of power-actuated brakes provided that weight-balancing exists; b) With power on: - manual control facilities of power-piloted valves/ drives; - control facilities to start counter motions. (see also 7.2 m, of clause 7).	Visual inspection, verification against circuit diagrams, practical check
	1.2 Tool magazine	
	1.2.1 Access to hazardous movements of the tool magazine shall be prevented by fixed and/or interlocked movable guards (see EN 1088:1995, clause 7 and annexes).	Visual inspection
	1.2.2 When the interlocked movable guard is open, the tool magazine drive shall be stopped and further movements shall be inhibited (see also 1.1.5 of this table).	Examination of circuit diagrams, practical check
	1.2.3 Access openings shall be in accordance with EN 547-1:1996, EN 547-2:1996, EN 547-3:1996.	Measurement
	1.2.4 Where whole body access into the tool magazine guard enclosure is foreseen, a presence sensing device (e.g. ESPE, AOPD, PSPD) shall be provided to detect persons in the tool magazine area. When this device is actuated, the control system shall prevent any movement of the tool magazine or other accessible hazardous machine movements.	Examination of circuit diagrams, practical check
	1.2.5 Where powered movements with the interlocked guard open are required for tool replenishment, maintenance, or adjustment purposes, this shall be achieved by means of a hold-to-run control to permit a single tool station index movement or a two-hand control devicefor continuous movement. This device shall be in accordance with 9.2.5.7 Type 3 of EN 60204-1:1997 (see also EN 574:1996). Such movement shall either be at a reduced speed (i.e. 15 m/min. where only an impact hazard exists; 2 m/min. where a crushing, shearing or trapping hazard exists) or be initiated from control devices positioned at a safe distance from the hazardous machine parts. (see EN 294, EN 999:1998) No hazardous machine movements shall arise from the actuation of any magazine sensor or feedback device (see 10.1.4 of EN 60204-1:1997 and 7.2 f, of clause 7 in this standard).	Examination of circuit diagrams, measurement, practical check

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	1.2.6 In order to prevent falls or ejections, tools shall be securely held within the holders of the magazine. The design data for tool holding (e.g. limits for maximum mass, moments of inertia, tilting moment, spatial envelope of tools) shall be made available to the user (see 'information for use').	A test shall be carried out to verify that the anticipated heaviest tool will be securely held in the holders
	1.3 Tool changer	
	1.3.1 Access to hazardous movements from any direction shall be prevented by fixed and/or interlocked movable guards or hazardous movements shall be stopped or inhibited by the actuation of protective devices (see EN 1088:1995, clause 7 and annexes)	Visual inspection
	1.3.2 Where access is required to the tool changer with the guards open or protective devices suspended, powered motion shall only be initiated under the control of an enabling device together with a hold-to-run control device to permit step-by-step movement. When continuous movement is required, a two-hand control (see EN 574) at a safe distance from the hazardous situation (see EN 999) shall be provided. No hazardous machine movement shall arise from the actuation of any sensor or feedback device (see 10.1.4 of EN 60204-1:1997 and 7.2 f, of clause 7 in this standard). In order to prevent falls or ejections, tools shall be securely held in the tool changer under all operating conditions and/or loss of power.	Examination of circuit diagrams, measurement, practical check
	1.4 Workpiece transfer devices (e.g. pallet changing devices, automatic workpiece changing devices)	
	1.4.1 Load/unload positions for operators at workpiece transfer devices shall be located outside the work zone and away from other hazardous mechanisms (e.g. the tool changer).	Visual inspection
	1.4.2 Access to hazardous movement(s) shall be prevented by means of fixed and/or interlocked movable guards or hazardous movement(s) shall be either stopped or inhibited by the actuation of protective devices (e.g. ESPE, AOPD).	Visual inspection, practical check
	1.4.3 Where access is required with the guards open or the protective devices suspended, powered motion shall only be initiated under the control of an enabling device together with a hold-to-run device to permit step-by-step movement. When continuous movement is required, a two-hand control device shall be provided. This device shall be in accordance with 9.2.5.7 Type 3 of EN 60204-1:1997 and shall be at a safe distance from the hazardous situation (see EN 574 and EN 999). No hazardous movement shall arise from the actuation of any sensor or feedback device (see 10.1.4 of EN 60204-1:1997 and 7.2 f, of clause 7 in this standard).	Examination of circuit diagrams, measurement, practical check
	1.5 Swarf /chip collection and removal	
	1.5.1 Access to hazardous moving parts of swarf/chip collection and removal systems shall be prevented by means of fixed guards. Where operators have a need to access more frequently than once per shift, interlocked movable guards shall be provided. Guards shall be in accordance with EN 953.	Visual inspection, practical check
	1.5.2 Opening an interlocked movable guard, which provides access to the hazardous moving parts of a swarf/chip system shall cause the movement to cease and remain inhibited (see also 1.1.5 and 14.1.1 of this table).	Examination of circuit diagrams, practical check

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	1.5.3 If movement of a swarf/chip system with an interlocked guard open is essential (e.g. for cleaning purposes) the movement shall only be permitted under the control of a hold–to–run device with an adjacent emergency stop device. A warning sign shall indicate the hazardous area of the swarf/chip system discharge (see also 7.2 f, of clause 7).	Examination of circuit diagrams, practical check
	1.6 Power transmission mechanisms (e.g. driveshafts, belts, pulleys, gears)	
	1.6.1 Access to hazardous power transmission parts (e g belts, chains, gears. pulleys, shafts) shall be prevented by means of fixed guards but interlocked movable guards shall be provided where operators have a need to access more frequently than once per shift. Guard shall be in accordance with EN 953.	Visual inspection
	1.6.2 Opening an interlocked movable guard, which exposes moving power transmission parts, shall cause their movement to cease and remain inhibited. Interlocking provisions shall conform to EN 1088 and as a minimum to category 1 of EN 954-1:1996.	Visual inspection
	1.6.3 Where the hazardous moving parts can be reached before they come to rest. guard locking shall be applied to prevent opening of the guard until the hazardous movement has ceased. Delayed unlocking shall be achieved by means of a motion detector or timer control. (see 7.2 and 7.3 of EN 1088 and EN 999).	Visual inspection
	1.7 Pits	
	1.7.1 Pits in or around a machine shall be covered (e.g. floor grids) or secured against persons falling into them by e.g. – railings; – cables with roll up device; – chains (red/white, black/yellow) with a warning sign 1 m in front of the fall down position.	Visual inspection
	1.7.2 Where access to pits is necessary for observation, maintenance, or adjustment purposes, entry into the pit shall be via interlocked access gates which prevent machine movement in mode 1. Where powered machine movements are necessary, machine elements may be moved under the conditions set out in 1.1.6.3, 1.2,1.3, 1.4, and 1.5 of this table.	Visual inspection
	1.7.3 Safety distances between moving machine elements and pit walls or other fixed parts shall be in accordance with EN 349:1993. Where these safety distances cannot be achieved, additional protective measures shall be provided to minimise the risk of crushing or trapping.	Measurement of distance, visual inspection, practical check
	1.8 Operating platforms (prEN ISO 14122)	
	1.8.1 Operating platforms shall: – prevent persons or objects falling from them. Guard-rails and toe plates shall be provided if the height of the platform is more than 500 mm; – provide sufficient space for the operator(s), i.e. the minimum headroom over platforms (and gangways) shall be 2100 mm and the clear width between guardrails shall be minimum 600 mm, preferably 800 mm;	Visual inspection, practical check
	1.8.1 Operating platforms shall (continued): – have lighting and ventilation for the operating position(s); – provide safe means of access and egress for the operator. independent of power, to and from the platform in any position; – the design shall be such that the danger zone cannot be reached, e.g. by safe distances or by virtue of fixed or interlocked movable guards with guard locking; – give protection against swarf/chips and metal working fluid.	Visual inspection, practical check

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	1.8.2 Powered machine movements shall only be possible when an operating platform guard is opened if the requirements of mode 2 or mode 3 are met.	Visual inspection, practical check
	1.8.3 It shall be possible to control the flow of metal working fluid from the operating platform.	Practical check
	1.8.4 For telescoping (horizontally or vertically) operating platforms, linked to a machine moving element, protective measures to prevent crushing and collision shall be provided (e.g. expansion bellows, metal roller shutters. pressure sensitive devices).	Visual inspection
	1.8.5 Powered movements of platforms shall only be permitted (e.g. for observation) by the use of hold-to-run control in mode 2 or mode 3, and an emergency stop shall be provided.	Visual inspection, practical check
2 Electrical	**2.1 Direct contact** To minimise the hazards of malfunction, shock or burn, all electrical equipment shall be designed and applied in accordance with EN 60 204-1. Means shall be provided to isolate the machine from sources of electrical energy (see 5.3 of EN 60204-1:1997). In particular in reference to EN 60204-1: Means of isolation shall be located at the main electrical enclosure in accordance with 6.2.2 (b). All other enclosures shall be in accordance with 6.2.2(a). All live parts shall be protected against direct contact to at least IP2X in accordance with 6.2.2 (c).	Verify compliance with the requirements in EN 60204-1:1997 and in particular clause 19.
	2.2 Indirect contact (See 3.27 of EN 60204-1:1997 for definition) The requirements of 6.3 of EN 60204-1:1997 shall be followed.	Verify compliance with the require–ments in EN 60204–1: 1997 and in particular clause 19.
	2.3 Protection of control gear Enclosures of control gear shall provide a degree of protection of at least IP22 (see EN 60529:1991), except IP55 shall be provided for control gear enclosures within the work zone.	Visual inspection
4 Noise generated	**4.1 Noise reduction methods**	
	4.1.1 Control of noise at source When designing machining centres, the information and technical measures to control noise at source given in EN ISO 11688-1:1998 and ISO/TR 11688-2:1998 shall be followed. The design shall take into account noise from each source. Appropriate technical measures for reducing noise at the main sound sources of the machining centres are listed below: a) transmission noise — gearbox damping b) pneumatic exhaust — silencers c) power generation source — damping or absorber d) noise under cutting process e) cutting tool change f) workpiece change } damping or absorber inside the work zone enclosing guard	By examination of noise declaration.

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	4.1.2 Control of transmission paths Where noise levels must be reduced beyond those achievable by design at source the machine shall be provided with protective measures (e.g. noise enclosures, screens fitted to the machinery, silencers). The above list is not exhaustive alternative technical measures for noise reduction with identical or greater efficiency can be used.	By examination of noise declaration
6 Radiation	**6.5 Lasers** Built-in laser feedback systems shall be designed to prevent exposure to beam paths or specular reflections (see EN 60825-1:1994).	Examination of mechanical drawings practical check
7 Generated by materials or substances processed	**7.1 Fluids, mists, fumes, and dust** Because the materials which may be processed depend on specific applications, it is not possible to provide detailed recommendations for the reduction of the risks in this standard. However for metalworking fluids the following requirements apply:	Visual inspection, examination of mechanical drawings, practical check
	7.1.1 The system design shall prevent splash, leakage and overflow of the metalworking fluid.	
	7.1.2. Fluid reservoirs and other system components (e.g. pipes and hoses) shall be made of materials to ensure the integrity of the system and information on metalworking fluids to be used shall be given.	
	7.1.3. The metalworking fluid distribution system and delivery nozzles shall be designed to minimise spray.	
	7.1.4. Where the generation of harmful fine mists and vapour or smoke is foreseen in the work zone, means for containment shall be provided to prevent their escape and for the addition of integral or external extraction equipment. (see EN 626-1:1994)	
	7.1.5. The metalworking fluid capacity shall match the correct function of the machine and be sufficient to avoid excessive heating and subsequent evaporation of the fluid or alternatively coolers shall be provided.	
	7.1.6 The metalworking fluid system shall be capable of delivering sufficient amounts of fluids to prevent the generation of hazardous vapours at the cutting site.	
	7.1.7. Where it is foreseen to be necessary for operators to place their hands into the work zone (e.g. during load/unload operations, during setting), metalworking fluid shall be automatically stopped or diverted. NOTE Means may be provided to manually turn on the metalworking fluid for adjustment purposes with the guard open.	
	7.1.8. Tanks shall be fitted with metalworking fluid visual level indication and filling point which are easily accessible	
	7.1.9 All system components shall be designed to reduce exposure of personnel to metalworking fluids during maintenance.	
	7.1.10. Means such as filters shall be provided to prevent the accumulation of swarf/chips and other material from metal cutting operations within the machine and the metalworking fluid tank in order to prevent the dissolving of hard metals into fluids	

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	7.2 Fire or explosion Because of the diverse nature of workpiece materials which may be processed, and metalworking fluids which may be used, it is not possible to provide detailed requirements in this standard for the reduction of fire and explosion risks. Guidance may be found in prEN 13478:1999, Fire Prevention and Protection, and EN 1127-1:1997.	
	7.3 Minimising biological and microbiological hazards in metalworking fluids	Visual inspection, practical check
	7.3.1 The total content of the metalworking fluid systems shall be circulated in normal use so that no stationary volume within the tank exists except where settlement is required by design.	
	7.3.2 To avoid stagnant areas remaining within the machine metalworking fluid shall drain from the machine towards the tank under gravity.	
	7.3.3 Discharge pipework shall have sufficient diameter and slope to minimise sludge settlement. **7.3.4** The metalworking fluid system shall be provided with filtration for the removal of sediment (see 7.1.9 of this table). **7.3.5** When sediment build-up occurs, cleaning shall be made easy by design (e.g. rounded corners in containers). Cleaning shall not require drainage of the whole system. **7.3.6** The inside of tanks shall not contribute to the growth of bacteria (e.g. smooth, unpainted surfaces). **7.3.7** Provision shall be made to empty metalworking fluid containers completely. **7.3.8** Metalworking fluid containers shall have covers designed to prevent the ingress of foreign matter. **7.3.9** Contamination of the metalworking fluid by oil or grease from external sources such as lost machine lubrication shall be avoided or means shall be provided for their systematic removal.	
	7.3.10 Means shall be provided to enable: a) fluid samples to be taken, b) sumps and pipework to be cleaned and c) filters to be changed which minimise operators' exposure to fluid.	Visual inspection, practical check

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
8 Neglect of ergonomic principles in machinery design	**8.1 Unhealthy posture or excessive efforts (repetitive strain)** Machines shall be designed in accordance with ergonomic principles so as to avoid excessive effort, unhealthy posture or fatigue during use and in particular: – Workpieces, tooling and accessories shall be easily moved. Lifting equipment may be required for parts over 10 kg in weight. (see prEN 1005-1:1998, prEN 1005-2:1998, prEN 1005-3:1998). – Where work handling equipment. hoists, or lifting devices are required, provision shall be made for their installation and operation (e.g. by making work zone access possible through the top of the machine when guards are open). – Where parts are manually loaded. their fixtures. tool pockets or tool holder shall be positioned to prevent excessive reaching into the machine (see prEN 1005-1:1998, prEN 1005-2:1998, prEN 1005-3:1998). – Control devices to operate clamping or gripping devices (e.g. drawbars, chucks) shall be positioned to avoid excessive reaching whilst supporting the weight of the tool or workpiece. (e.g. application of foot controls). (See clause 4 of EN 894-3:2000.) – Movable guards shall be power operated where use of them will lead to repeated excessive effort (see also 4.2.2.6 of EN 292-2: 1991).	Practical test to check that weights, distances, and posture requirements are not excessive and are in accordance with the referenced standards.
	8.2 Inadequate consideration of hand-arm or foot-leg anatomy The positioning, labelling and illumination of control devices and points for observation or service such as those for filling and draining of tanks shall be chosen to satisfy ergonomic principles (see EN 614-1, -2; EN 894-1:1997, EN 894-2:1997, EN 894-3:2000; prEN 1005-1:1998, prEN 1005-2:1998, prEN 1005-3:1998; EN 999).	Measurement, check that distances involved in normal operation are in accordance with the referenced standards.
	8.4 Inadequate local lighting Lighting within the work zone shall be provided in accordance with EN 1837:1999 and be a minimum of 500 lux as measured at the tool tip with the interlocked movable guard open.	Measurement, visual inspection.
	8.6 Human error, human behaviour	
	8.6.1 Identification of pockets in tool magazines shall be clear and unambiguous.	Visual inspection
	8.6.2 Equipment and accessories indicated in the Instruction handbook and not readily available, for adjusting and maintaining the machine, shall be provided (see also 7.2 d, of clause 7).	Practical check
	8.7 Inadequate design location or identification of manual controls Input devices (e.g. key boards, key pads, push buttons) shall be in accordance with EN 894-1:1997, EN 894-3:2000.	Visual inspection
	8.8 Inadequate design or location of visual display units Screen displayed information shall be clear and unambiguous. Reflections and glare shall be minimised (see EN 894-1:1997, EN 894-2:1997)	Visual inspection and measurement

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
10 Unexpected startup unexpected overrun / over-speed	**10.1 Failure / disorder of the control system** Control systems shall be designed in accordance with EN 60204-1, EN 982, and EN 983. Unexpected machine movements (e.g. spindle rotation, axis movement, tool release from the spindle) shall be prevented (see EN 1037).	Practical Tests
	10.2 Restoration of energy supply after an interruption Control system design shall ensure that automatic restart is prevented and re-actuation of the start control is always required to initiate powered movement following for example any change of mode, selection of optional function, system re-set, guard interlock interruption, restoration of adequate pressure or voltage, or correction of a system failure (see EN 1037).	Examination of circuit diagrams, practical check
	10.3 External influences on the electrical equipment Electromagnetic compatibility Immunity: Electronic control systems shall be designed and installed so as to be protected from electromagnetic interference and stable when exposed to electrical system operation or failure in accordance with EN 61000-6-2. Emission: Electrical/electronic design shall apply technical information and physical measures to limit electromagnetic emissions in accordance with EN 50081-2:1993.	Use the verification methods described in EN 50081-2:1993 and EN 61000-6-2.
13 Failure of the power supply	**13.1 Energy supply failures**	
	13.1.1 Systems shall be designed such that a line rupture in any circuit (e.g. broken wire, pipe or hose) will not result in the loss of a safety function (see EN 60204–1, EN 982, EN 983).	Examination of circuit diagrams, practical check
	13.1.2 Interruption or failure of any energy supply shall not result in a hazard. Inadequate pressure or voltage shall be detected and the machine cycle shall be interrupted or inhibited.	
	13.1.3 Means shall be provided for the isolation of power supplies (see 5.1.6 of EN 982: 1996, 5.1.6 of EN 983:1996 and 5.3 of EN 60204-1:1997) and dissipation of stored energy (see 5.3 of EN 1037:1995).	
14 Failure of the control circuit	**14.1 Safety functions of control systems**	
	14.1.1 Safety functions of control systems shall be implemented using safety-related parts designed, constructed and applied in accordance with EN 954-1. In general, when activated, the input device to the safety function shall initiate a Category 1 stop, according to 9.2.2 of EN 60204-1:1997, of the hazardous movements and preclude unexpected start-up. Safety functions shall meet the requirements for the categories of EN 954-1 as listed below.	Conformance with diagrams, specifications

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
14 Failure of the control circuit	14.1.1 (continued) Safety function initiated or maintained by: a) interlocking device associated with a movable guard applied to: – work zone 3 – transmissions, drive mechanisms 3‡ – tool changer, tool magazine 3 – work loading/unloading device 3 – pallet changer 3 – swarf/chip conveyor 3‡ – access to pits, gates in perimeter fencing 3‡ b) Hold-to run control including 2-hand control 3* c) Enabling device 3 d) Speed limit control, including tool identification (see 17.2) 3* e) Control of tool clamping 1 f) Electrosensitive protective equipment (ESPE) 3 The ESPE device shall meet the requirements of a type 4 (see EN 61496-1:1997) g) Emergency stop 3 h) Pressure sensitive protective devices (PSPD) 3 The PSPD by itself shall meet the requirements of 4.15 of EN 1760-1:1997 ‡ If frequency of access is less than once per hour, then a Category 1 may be used * If this category cannot be achieved, then this function shall be combined with an enabling device	Conformance with diagrams, specifications
	Monitoring shall be achieved by one of the following methods: – separate channels; – continuous automatic monitoring (see 3.14 of EN 292-1:1991); – other appropriate means (e.g. current, velocity and position loops in servo drives).	Examination of circuit diagrams
	14.1.2 **a)** Each machine shall be fitted with one or more Emergency Stop control devices in accordance with 10.7 of EN 60204–1:1997.	Visual inspection, Examination of circuit diagrams,
	b) The Emergency Stop function shall be category 0 in accordance with 9.2.5.4.2 of EN 60204-1:1997, except for mechanisms requiring a sequenced shut down where a category 1 stop shall be implemented.	Examination of circuit diagrams, Practical check
15 Errors of fitting	**15.1** Means shall be embodied in the design of machine parts to prevent errors of fitting (e.g. use of male/female connections, asymmetrical location features) and/or the machine parts shall be marked with instructions for fitting.	Practical checks
17 Falling or ejected objects or fluids	**17.1 Containment of processed materials and fluids** Guards shall be provided to retain or contain the foreseeable ejection of processed material and metalworking fluid. Such guards shall be designed in accordance with clause 8 of EN 953:1997. These may take the form of a deflecting adjustable guard fixed to the spindle head to direct processed material/metalworking fluid towards their collecting area or by a fixed guard covering the whole area of ejection (see 7.2 f, of clause 7).	Visual examination, practical check

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
17 Falling or ejected objects or fluids	**17.2 Ejection of parts - guard strength** Guards shall be provided to contain the energies of, or protect persons from, the machine parts and/or components which can reasonably foreseeable be ejected (see annex A and 5.5 and 5.6 of EN 953:1997). Thicknesses of guard materials calculated from annex A may be reduced, where maximum ejection energies are limited by incorporation of systems which identify the tool to the NC system, enabling limitation of spindle speed applied. Where guards are fitted with viewing panels which are also intended to contain ejected parts, special consideration shall be given to the selection of materials and methods of fixing (Clause 5.5.2 EN 953:1997). Materials such as polycarbonate, which are liable to a reduction in impact resistance over time (aging), due to contamination (eg by lubricants, metalworking fluids, cleaning agents, solvents) and abrasion, shall be provided with additional protection (e.g. sealed multi-layer or laminated constructions) or additional thickness to counter this harmful effect during the anticipated service life of the machine. NOTE Annex A outlines a test procedure for the strength of materials in relation to maximum spindle speeds, cutting tool diameters, insert masses, and distances between cutting tools and guards.	Calculation of the appropriate material strength derived from the criteria outlined in annex A or equivalent means.
17 Falling or ejected objects or fluids	**17.3 Tool retention** For power operated spindle drawbars, the drawbar shall be designed to avoid risks from tool ejection if the power supply fails. The drawbar mechanism shall be monitored so that a failure to achieve correct registration or clamping of the retention knob on the tool shall inhibit the spindle start control in all operating modes. Unclamping of the tool by releasing of the drawbar shall be inhibited during spindle rotation.	Practical test, examination of the circuit diagrams
18 Loss of stability/ overturning of machinery	**18.1** Machines shall be designed and constructed so that they are stable under foreseeable operating conditions, and without risks of overturning, falling or unexpected movement. When the use of foundation bolting is one of the measures used to help prevent overturning, manufacturers shall specify the bolts and foundation requirements necessary (see also 7.2 b, of clause 7).	By observation and, where necessary, measurement during normal operation.
19 Slip, trip and fall of persons	**19.1 General requirements** Places of work and means of access on machines (such as stairs, integral ladders, platforms and walkways) shall be designed to minimise the likelihood of slips, trips, and falls by the provision of hand holds, foot holds, and where necessary slip resistant surfaces. Warnings about hazards and precautions shall be given in clause 7–Information for Use.	Visual examination
	19.2 Contamination of floors Where a fluid application system is provided, it shall be designed to prevent splash, spray and mist outside the machine enclosure. Information for Use shall draw attention to the importance of preventing fluid spillage onto the surrounding area and thus creating a slipping hazard (see 7.2 f, of clause 7)	Visual examination and practical test involving the use of fluid.

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Table 2 (continued)

Hazards	Safety requirement and/or protective measure	Verification
	19.3 High parts of the machine which must be accessible for maintenance or trouble shooting Where frequent access is required (i.e. at least once per shift), means of access shall be provided (see group A for examples). If only occasional access is required, one or both of the examples in B shall be provided. A – permanent means of access (e.g. stairways, ladders see prEN ISO14122-3:1999); – fixed working platforms with fixed railings and toe boards against falling hazards (see prEN ISO 14122-2:1999); B – supports for safety belt; – means to attach movable ladders.	Visual inspection

6 Verification of safety requirements and/or protective measures

Safety requirements and/or protective measures implemented per clause 5 shall be verified using the recommended procedures found in Table 2, column 3.

7 Information for use

7.1 General

Machine warning devices (e.g. audible and visual signals), markings (e.g. signs, symbols), and instructional material (e.g. manuals for operation, maintenance) shall be in accordance with EN 292-2: 1991, clause 5.

7.2 Instruction handbook

In addition to the requirements of 7.1, each machine shall be accompanied by an instruction handbook containing:

a) the name and address of the manufacturer/supplier;

b) any necessary information for safe installation of the machine and its guarding system (e.g. floor conditions, services, anti-vibration mountings, guarding fitting);

c) instructions for how the initial test and examination of the machine and its guarding system are to be carried out before first use and being placed into production;

d) instructions for periodic maintenance, test and examination of the machine, guards, protective devices and other safety critical parts (e.g. spindle braking elements);

e) instructions for any test or examination necessary after change of component parts or addition of optional equipment (both hardware and software) to the machine which can affect the safety functions;

f) instructions for safe operation, setting and maintenance including safe working practices and the training necessary to achieve the required skill level of operators;

g) the intended application of the machine when mode 3 (see Table 2, 1.1.6.4) is provided;

h) instructions on control systems including circuit diagrams for electrical, hydraulic, and pneumatic systems;

i) the noise levels determined by methods specified in 7.3;

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j) descriptions of possible failure modes and advice on detection and prevention by periodic maintenance and correction;

k) the specification for any fluid to be used in lubrication, braking, or transmission system:

l) guidance on correct selection, preparation, application, and maintenance of metal working fluids and/or lubricants;

m) provide guidance on the means for the release of persons trapped in the machine;

n) [A2] information describing residual risks (e.g. conditions where noise levels are likely to exceed 80 dB (A), hazards arising from sharp or hot tools/components); [A2]

o) recommendations on additional protective measures (e.g. personal protective equipment);

p) information defining the limits for the maximum mass, moment of inertia, tilting moment, and spatial envelope of tools for machines supplied with automatic tool magazine systems;

q) information defining the limits for the spatial envelope, maximum mass, position of the centre of gravity of the workpiece and work holding fixture;

r) procedures to avoid errors of fitting during maintenance of the machine.

A check list should be provided for the points d), e), and f) and include drawings and diagrams.

7.3 Noise declaration

Noise measurement shall be made according to EN ISO 3746 or EN ISO 11202 as appropriate. Guidance for noise emission measurement is given in annex D.

The declaration shall be made concerning the airborne noise emission (see annex A 1.7.4 f) of EN 292-2:1991/A1:1995). The declaration and verification of noise emission values shall be according to EN ISO 4871:1997, using the dual-number form of declaration. The declaration shall be accompanied by a statement of the measuring method used and the conditions applied during the test and values for the uncertainty K (see EN ISO 4871) as follows:

4 dB when using EN ISO 3746:1995,

2 dB when using EN ISO 3744:1995.

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

Uncertainty K = 4 dB for measurements made in accordance with EN ISO 3746:1995

If the accuracy of the declared emission values is to be verified, measurements shall be made using the same method and the same operating conditions as those employed for the declaration.

The noise declaration shall be accompanied by the following statement:

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

[A2] NOTE Information on noise emission should also be provided in the sales literature. [A2]

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7.4 Marking

Each machine shall be marked in a distinct and permanent manner with:

a) [A2] name and address of the manufacturer and, where applicable, business name and full address of the authorised representative; [A2]

b) mass of machine;

c) supply data for electrical and where applicable. hydraulic, and pneumatic systems (e.g. minimum pneumatic pressure);

d) lifting points for transportation and installation purposes where applicable;

e) speed range where applicable;

f) [A2] the designation of machinery and the designation of series or type. [A2]

Guards, protective devices and other parts that are part of the machine but not fitted shall be marked with identification data. Any other information needed for fitting shall be provided (see 7.2 b, of clause 7).

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Annex A
(normative)

Guards on machining centres - Impact test method

A.1 General

This annex defines tests for guards and guard materials used on machining centres in order to minimize risks of ejection of parts from the work zone.

A.2 Test method

A.2.1 Primary remarks

This test method is based upon machines equipped with milling cutters driven up to the maximum velocity given by following equation:

$v_c = B \pi n$ (m/s)

B = maximum tool diameter which can be mounted in the tool storage magazine [m]

n = maximum spindle speed (s^{-1})

This test method may be used for horizontal and vertical machining centres.

The aim of this test is to simulate the hazard that occurs when broken tool parts are ejected. It shows the resistance/strength of guards and/or guard materials to penetration by ejected parts and against parts of guard assemblies being broken loose from the machine.

A.2.2 Test equipment

The test equipment is comprised of a projectile, a means to bring the projectile to the required impact speed (e.g. a propulsion device, drop test rig) and a support for the test object.

A.2.2.1 Projectile

Shape, mass and dimensions of the projectile are given in Figure A.1.

Projectiles are made from steel with the following mechanical characteristics:

Ultimate tensile strength: R_m = 560 to 690 N/mm^2

Yield strength: $R_{0,2}$ = 330 N/mm^2

Elongation at rupture: A = 20 %

Mass: m = 0,1 kg

NOTE Mass may be added to the rear of the projectile and the impact speed reduced accordingly to maintain the impact energy for a drop test.

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Dimensions in millimetres

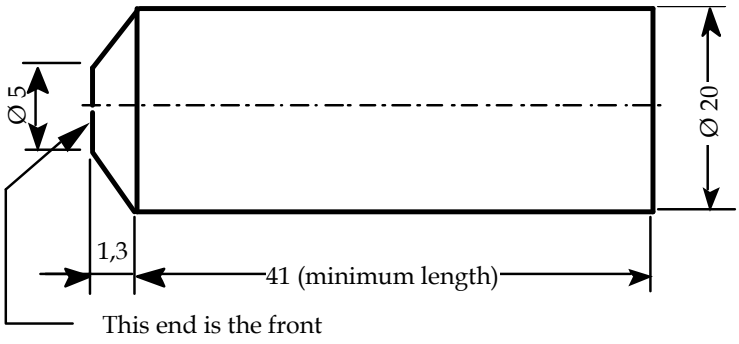

Figure A.1 — Test projectile

A.2.2.2 Speed measurement

The speed of the projectile shall be measured at a point as close to the point of impact as practicable.

A.2.2.3 Support of the test object

When testing the guard (or a sample of the guard material), the support shall be equivalent to the mounting on the machine. For testing of guard materials, samples which are fixed on a frame with an inner opening of 450 mm x 450 mm shall be used. The frame shall be sufficiently rigid. The mounting of the sample shall be by minimum friction clamping sufficient only to retain its position.

A.2.3 Test procedure

The projectile speed and other values shall be calculated as follows:

v_c – maximum cutting speed [m/s] (see A.2.1). Theoretical impact energy: $J_c = \frac{m v_c^2}{2}$ [J]

v_m – measured impact speed [m/s]. Measured impact energy: $J_m = \frac{m v_m^2}{2}$ [J]

The theoretical energy and the measured energy should be at the same value.

The direction of impact of the projectile shall, as far as possible, be perpendicular to the surface of the test object. The front end of the projectile shall be the surface to impact the test object. Targets for the projectile shall be the weakest and most unfavourable areas on the material sample or on the guard, in particular for vision panels, the centre of the panel.

A.3 Results

After the test, the damage found on the test piece is to be judged as follows:

A.3.1 Material damage

a) Buckling/bulging (permanent deformation without crack);

b) Incipient crack (visible only on the surface);

c) Through crack (crack visible from one surface to the other);

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d) Penetration (projectile penetration of the material);

A.3.2 Additional damage

a) Window that comes loose from its attachment;

b) Flying away of outer parts of the guards;

c) Guard door that comes loose from its mounting.

A.3.3 Judgment

The test is passed if there is no through crack or penetration of the test object and for guard doors if there is no additional damage according to A.3.2.

A.4 Test report

The test report shall give following minimum information.

— Date and place of the test and name of the test body;

— Projectile mass, dimension, speed and impact energy;

— Machining centres manufacturer, type, maximum tool diameter mounted in tool chain, spindle taper, power, maximum spindle speed;

— Design, material and dimensions of the test object;

— Clamping or fixing of the test object;

— Direction of shot, point of impact of the projectile;

— Test result.

A.5 Impact test results for sample materials tested (m = 0,1 kg)

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Material type	thickness d (mm)	Tensile strength R_m[N/mm^2]	Fracture elongation ε_B [%]	speed Vc [m/s]	Withstand energy E [J]
St 12.03	1,5	369	28	80	320
	3,0	405	28	115	661
	1,5+3,0*	369/405	28	150	1125
	3,0+1,5*	405/369	28	140	980
$AlMg^3$	5,0	242	18	120	720
Polycarbonate†	4,0	68	80	85	361
	6,0			100	500
	8,0			120	720
	12,0			150	1125
	2x6,0			170	1445
	2x12,0			230	2645
Polymethyl–metacrylate	12,0	74	4	25	31

* On the workzone side

† Test results are for new material with no allowance for aging

Information source – BIA, St. Augustin, GERMANY

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Annex B
(informative)

Equipment for impact test

B.1 Gun device

The gun device consists of a compressed air vessel with flanged gun barrel (see Figure B.1). The compressed air can be released as an impulse by a special valve to accelerate the projectile towards the test object.

B.2 Running the equipment

The air is fed by an air compressor. The speed of the projectile is controlled by the pressure of the air and the volume.

The projectile speed is measured near the muzzle of the gun barrel by a suitable velocimeter (e.g. by proximity sensors or photocells).

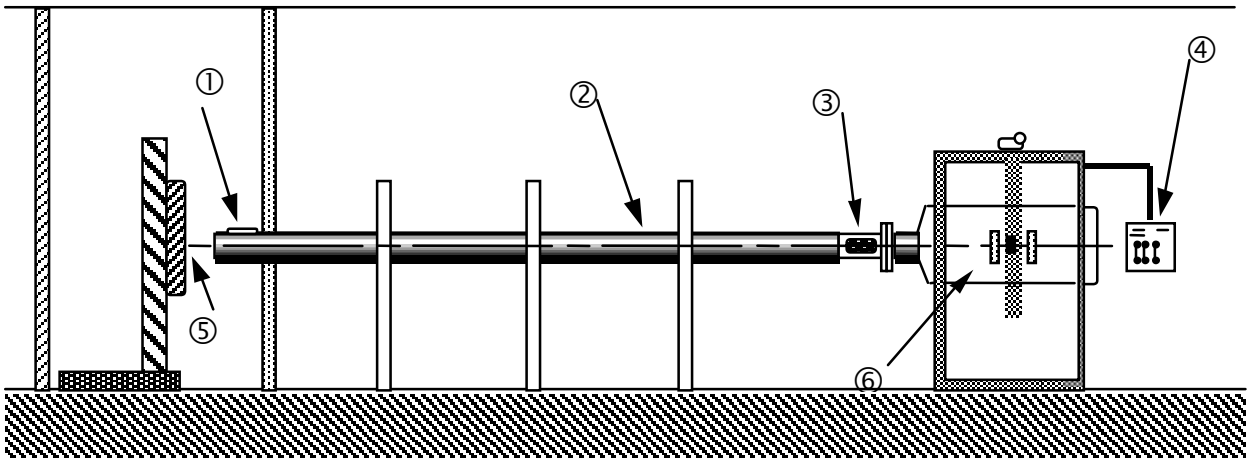

Figure B.1 — Equipment for impact test

Key
1 Velocimeter
2 Gun-barrel
3 Projectile
4 Control panel
5 Test object
6 Compressed air-vessel

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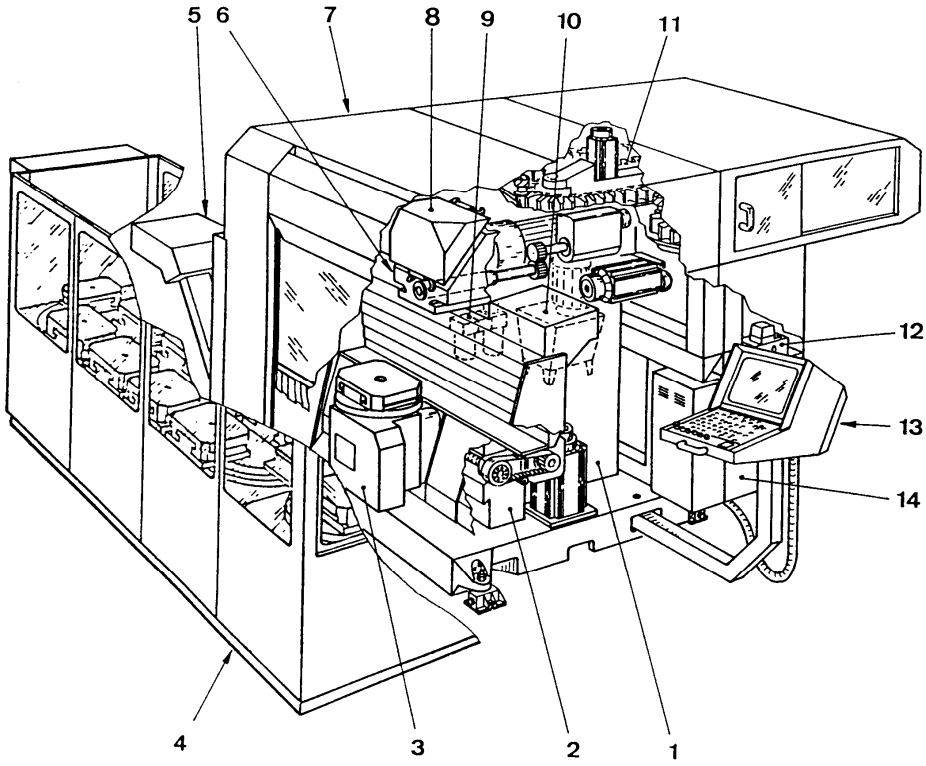
Annex C
(informative)

Illustrative figures used as examples



1 Column with feed drive, Y – axis
2 Cross slide with feed drive, X–axis
3 Work table
4 Pallet pool
5 Chip conveyer
6 Spindle head with main drive and feed drive, Z–axis
7 Guard
8 Tool changer
9 Pneumatic unit
10 Hydraulic unit
11 Tool magazine
12 Central lubricating unit
13 Control panel
14 Electrical cabinet

Figure C.1 — Machining centre with horizontal spindle and pallet pool

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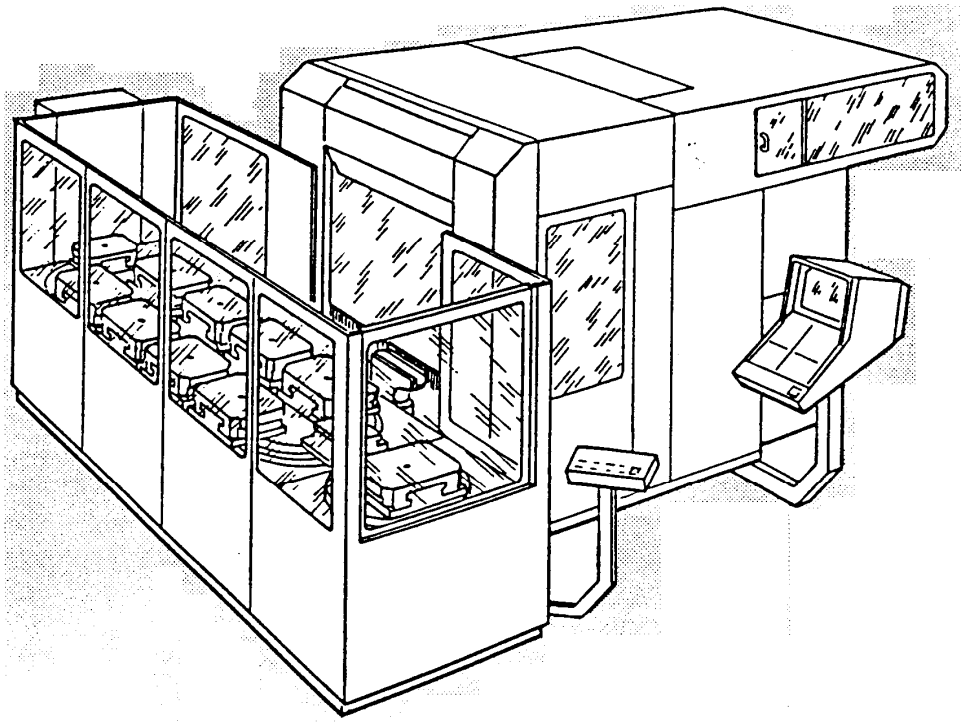
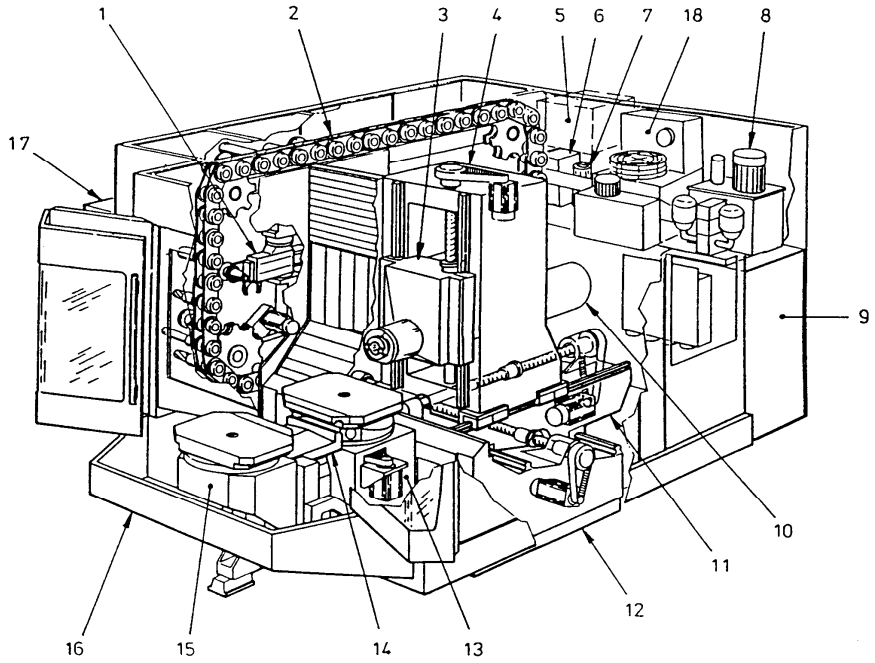


Figure C.2 — Total view of the machining centre shown in Figure C.1



Key

1 Tool changer	7 Pneumatic unit	13 NC–rotary table
2 Tool magazine	8 Hydraulic unit	14 Pallet changer
3 Spindle head with horizontal spindle	9 Electric cabinet	15 Setting station
4 Column with feed drive, Y–axis	10 Main drive	16 Guard
5 Mist separator	11 Cross slide with feed drive, Z–axis	17 Chip conveyor
6 Central lubricating unit	12 Bed with feed drive, X–axis	18 Cooler for the motor spindle

Figure C.3 — Machining centre with horizontal spindle and shuttle type tool changer

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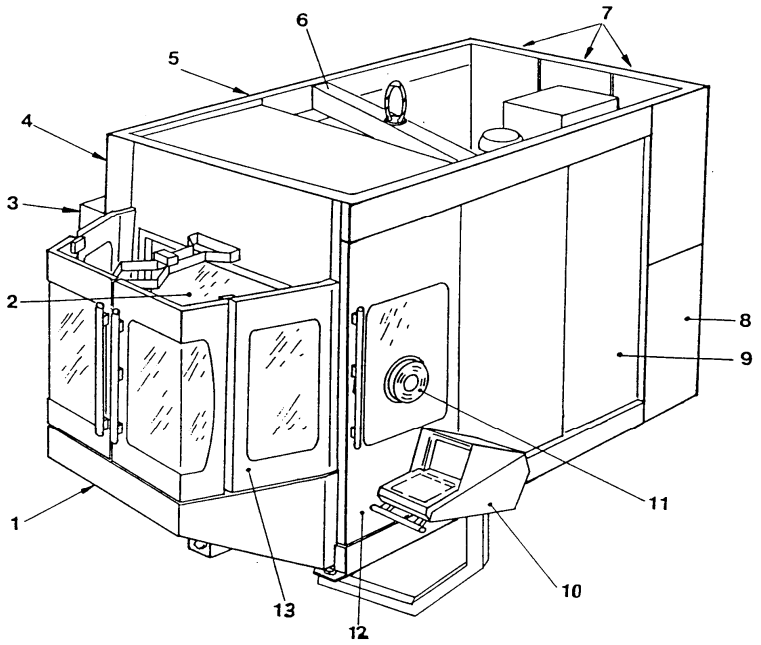

Key

1 Setting station
2 Rotating window of pallet changer
3 Chip conveyer
4 Vision panel of tool changer
5 Vision panel of tool magazine
6 Crosshead for transportation of the machine
7 Rear maintenance door (hydraulic, pneumatic, central lubricating unit, motor cooler)
8 Cabinet door
9 Maintenance door
10 Control panel
11 Rotating view panel
12 Sliding gate to work area
13 Front folding door

Figure C.4 — Total view of the machining centre shown in Figure C.3

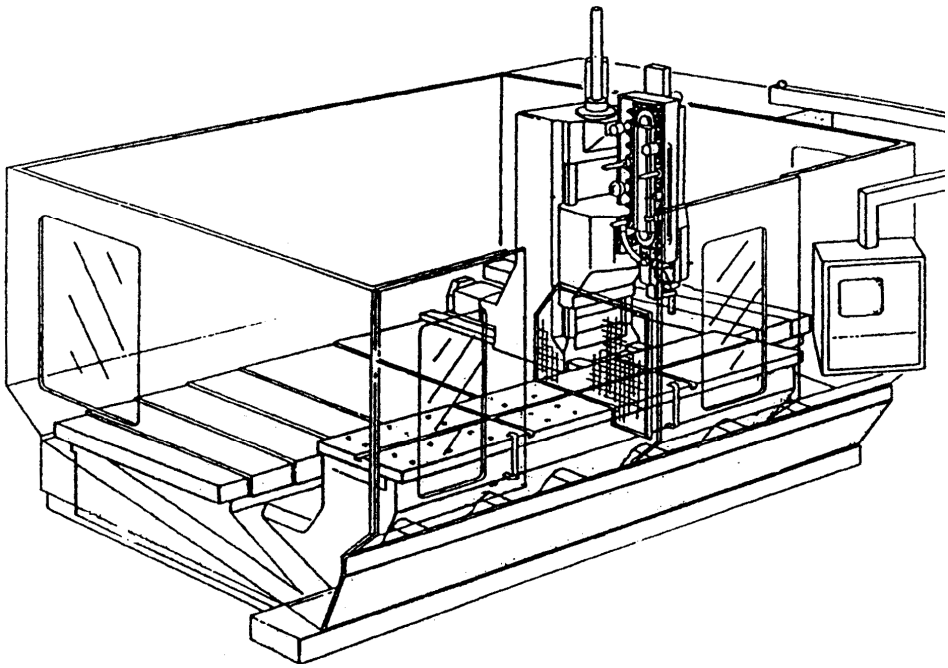

Figure C.5 — Machining centre with two separate work zones

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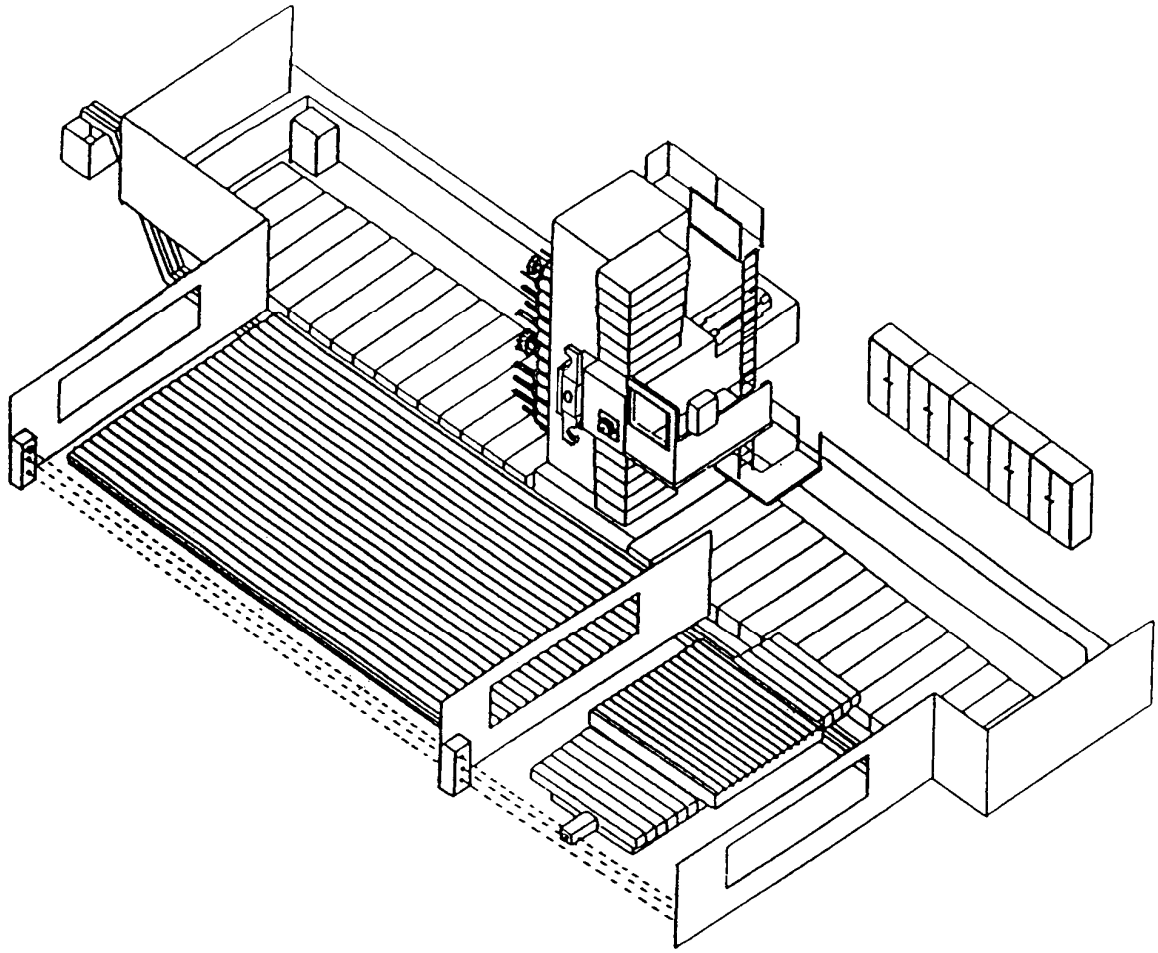

Figure C.6 — Large machining centre with perimeter safeguarding and two separate work zones

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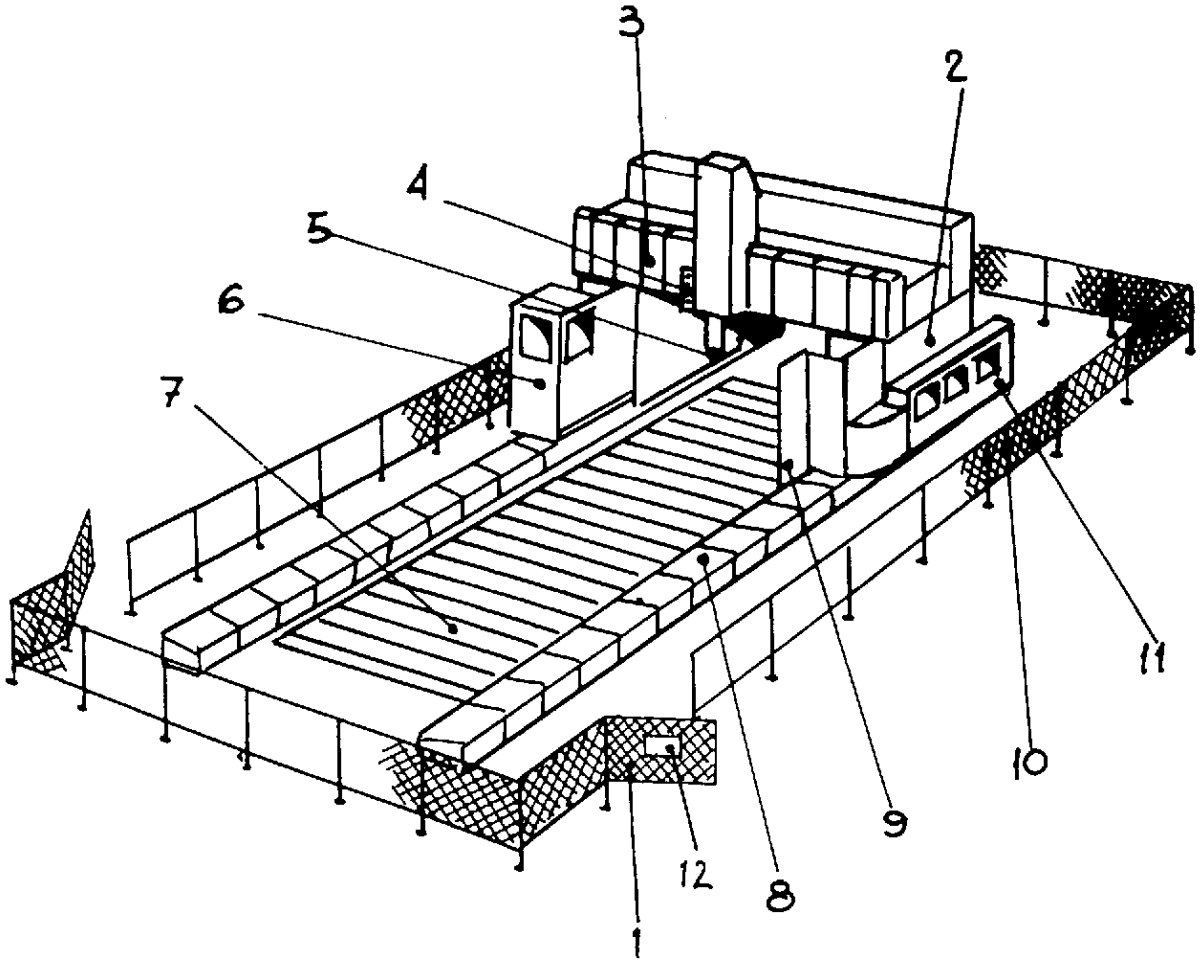

Key

1 Access gates
2 Travelling gantry
3 Telescopic steel covers
4 Auxiliary pendant (mode 2 only)
5 Cutter
6 Operating station enclosed on three sides, travels with gantry
7 Machine table
8 Covers over slideway
9 Swarf/chip deflector
10 Perimeter fence
11 Auto tool changer
12 Warning signs

Figure C.7 — Example of large gantry type machining centre with perimeter safeguarding and operator protection (see Table 2)

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Annex D
(normative)

Noise emission measurement

Operating conditions for noise measurement shall be:

— idle running at 80% of spindle maximum rotational speed;

— workpiece transfer operating (where applicable);

— tool changing and axes operating;

— swarf/chip conveyor running (if provided).

Mounting and operating conditions of the machine shall conform to the manufacturer's instructions and be identical for the determination of emission sound pressure level at the work station and the sound power levels.

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

— The environmental indicator, K_{2A}, or the local environmental factor, K_{3A}, shall be equal to or less than 4 dB;

— The difference between the background emission sound pressure level and the workstation sound pressure level shall be equal to or greater than 6 dB;

— The correction of the local environmental factor, K_{3A}, shall be calculated in accordance with A.2 of EN ISO 11204:1996 with the reference restricted to EN ISO 3746:1995 instead of the method given in annex A of EN ISO 11202:1995, or in accordance with EN ISO 3744:1995 where one of these standards has been used as the measuring method.

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

— The environmental indicator, K_{2A}, shall be equal to or less than 4 dB;

— The difference between the background sound pressure level and the machine sound pressure level at each measuring point shall be equal to or greater than 6 dB. The correction formula for this difference (see 8.2 of EN ISO 3746:1995) shall apply up to a difference of 10 dB;

— Only the parallelepiped measurement surface shall be used at 1,0 m from the reference surface;

— Where the distance from the machine to an auxiliary unit is less than 2,0 m, the auxiliary unit shall be included in the reference box;

— The measuring time required in 7.5.3 of EN ISO 3746:1995 referring to 30 s shall be excluded;

— The accuracy of the test shall be greater than 3 dB;

The number of microphone positions shall conform to EN ISO 3746:1995.

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Alternatively, where the facilities exist and the measuring method applies to the machine type, emission sound power levels may also be measured according to a method with higher precision (i.e. EN ISO 3744:1995 without the preceding modifications.

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

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Annex ZA
(informative)

A2 Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC, amended by Directive 98/79/EC

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

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

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A2

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Annex ZB
(informative)

A2 Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC on machinery.

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

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard. A2

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Bibliography

Other metalworking process and relevant additional information are covered by the following standards:

[1] ISO 513:1991, *Application of hard cutting materials for machining by chip removal – Designation of the main groups of chip removal and groups of application*

[2] ISO 683–1:1987, *Heat–treatable steels, alloy steels and free–cutting steels – Part 1: Direct–hardening unalloyed and low–alloyed wrought steel in the form of different black products*

[3] ISO 11161:1994, *Industrial automation systems — Safety of integrated manufacturing systems - Basic requirements*

[4] EN 692:1996, *Machine tools – Safety –Mechanical power presses (CEN/TC 143/WG 1)*

[5] prEN 693:1999, *Machine tools – Safety – Hydraulic power presses (CEN/TC 143/WG 1)*

[6] EN ISO 7250:1997, *Basic human body measurements for technological design (ISO 7250:1996)*

[7] prEN 12622, *Machine tools – Safety Press brakes (CEN/TC 143/WG 1)*

[8] prEN 13736, *Machine tools – Safety Pneumatic presses (CEN/TC 143/WG 1)*

[9] prEN 13985, *Machine tools – Safety Guillotine shears (CEN/TC 143/WG 1)*

[10] prEN 13218, *Machine tools – Safety – Stationary grinding machines (CEN/TC 143/WG 2)*

[11] EN 12413, *Safety requirements for bonded abrasive products (CEN/TC 143/WG 2)*

[12] prEN 13236, *Safety requirements for super abrasives (CEN/TC 143/WG 2)*

[13] EN 12415, *Safety of machine tools – Small numerically controlled turning machines and turning centres (CEN/TC 143/WG 3)*

[14] EN 418:1992, *Safety of machinery - Emergency stop equipment. functional aspects - Principles for design*

[15] EN 457:1992, *Safety of machinery - Auditory danger signals - General requirements, design and testing (ISO 7731:1986 modified)*

[16] EN 12626:1997, *Safety of machinery - Laser processing machines - Safety requirements (ISO 11553:1996 modified)*

[17] EN 1550:1997, *Machine tools – Safety – Requirements for the design and construction of work–holding chucks (CEN/TC 143/WG 3)*

[18] prEN 13128, *Machine tools – Safety – Milling machines (including boring machines (CEN/TC 143/WG 4)*

[19] prEN 12717, *Machine tools – Safety – Drilling machines (CEN/TC 143/WG 4)*

[20] prEN 14070:2000, *Machine tools – Safety – Transfer machines (CEN/TC 143/WG 4)*

[21] prEN 12957, *Machine tools – Safety – Electro–discharge machines (CEN/TC 143/WG 5)*

[22] prEN 13898, *Machine tools – Safety – Metal sawing machines (CEN/TC 143/WG 6)*

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