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Stroji za gradnjo predorov - Varnostne zahteve

Tunnelling machinery - Safety requirements

Tunnelbaumaschinen - Sicherheitstechnische Anforderungen

Machines pour la construction de tunnels - Exigences de sécurité

[SIST EN 16191:2014](#)

Ta slovenski standard je istoveten z: **EN 16191:2014**

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EUROPEAN STANDARD

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Tunnelling machinery - Safety requirements

Tunneliers - Prescriptions de sécurité

Tunnelbaumaschinen - Sicherheitstechnische
Anforderungen

This European Standard was approved by CEN on 10 April 2014.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

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Foreword

This document (EN 16191:2014) has been prepared by Technical Committee CEN/TC 151 “Construction equipment and building material machines - Safety”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by November 2014 and conflicting national standards shall be withdrawn at the latest by November 2014.

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

This document supersedes EN 12336:2005+A1:2008 and EN 815:1996+A2:2008.

The main technical changes compared to EN 12336:2005+A1:2008 and EN 815:1996+A2:2008 are the following:

- update of the scope;
- update of normative references;
- improvement of requirements on access systems, especially on minimum dimensions on walkways and access openings;
- requirements on control systems improved;
- improvement of fire prevention and protection;
- improvement of noise test code.

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

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

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

EN 16191:2014 (E)**Introduction**

This European Standard is a type C standard as stated in EN ISO 12100:2010.

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

The intended use of the machinery is agreed between the manufacturer and the user taking into account information on predicted ground conditions provided by the user.

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 over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

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1 Scope

This European Standard is applicable to tunnelling machinery as defined in Clause 3 used for the construction of tunnels, shafts and other underground excavations.

It deals with all significant hazards, hazardous situations and events relevant to such machinery when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer (see Clause 4).

This European Standard covers monitoring for hazardous atmospheres within the confines of the tunnelling machinery.

Hand-arm and whole-body vibration are not considered as significant hazard for tunnelling machinery.

The following items and applications are not covered by this European Standard:

- the additional requirements for the use of tunnelling machinery under hyperbaric conditions;
- the additional requirements for use of tunnelling machinery in potentially explosive atmospheres;

NOTE For the application in potentially explosive atmospheres see EN 1710:2005+A1:2008 for guidance.

- ancillary tools and equipment which are not an integral part of the tunnelling machinery but used on or with the machinery;
- services (e.g. power supply, water, pipes, compressed air, etc.) supplied to the tunnelling machinery;
- loading and transport equipment which is not an integral part of the tunnelling machinery, e.g. man riders, locomotives, grout cars, segment cars, muck cars and shaft hoisting equipment.

This European Standard is not applicable to road headers, continuous miners and impact rippers.

This European Standard is not applicable to tunnelling machinery which is manufactured before the date of publication of this European Standard by CEN.

2 Normative references

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

EN 3-7:2004+A1:2007, *Portable fire extinguishers - Part 7: Characteristics, performance requirements and test methods*

EN 363:2008, *Personal fall protection equipment - Personal fall protection systems*

EN 620:2002+A1:2010, *Continuous handling equipment and systems - Safety and EMC requirements for fixed belt conveyors for bulk materials*

EN 894-3:2000+A1:2008, *Safety of machinery - Ergonomics requirements for the design of displays and control actuators - Part 3: Control actuators*

EN 953:1997+A1:2009, *Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards*

EN 981:1996+A1:2008, *Safety of machinery - System of auditory and visual danger and information signals*

EN 1837:1999+A1:2009, *Safety of machinery - Integral lighting of machines*

EN 1993-1-1:2005, *Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings*

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EN 12110:2014, *Tunnelling machines — Air locks — Safety requirements*

EN 13309:2010, *Construction machinery - Electromagnetic compatibility of machines with internal power supply*

EN 13478:2001+A1:2008, *Safety of machinery - Fire prevention and protection*

EN 14973:2006+A1:2008, *Conveyor belts for use in underground installations - Electrical and flammability safety requirements*

EN 16228-1:2014, *Drilling and foundation equipment — Safety — Part 1: Common requirements*

EN 16228-2:2014, *Drilling and foundation equipment — Safety — Part 2: Mobile drill rigs for civil and geotechnical engineering, quarrying and mining*

EN 60076-2:2011, *Power transformers — Part 2: Temperature rise for liquid-immersed transformers (IEC 60076-2:2011)*

EN 60079-0:2012, *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2011, modified)*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60204-11:2000, *Safety of machinery — Electrical equipment of machines — Part 11: Requirements for HV equipment for voltages above 1000 V a.c. or 1500 V d.c. and not exceeding 36 kV (IEC 60204-11:2000)*

EN 60439-2:2000, *Low-voltage switchgear and controlgear assemblies — Part 2: Particular requirements for busbar trunking systems (busways) (IEC 60439-2:2000)*

EN 60439-3:1991, *Low-voltage switchgear and controlgear assemblies — Part 3: Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access for their use - Distribution boards (IEC 60439-3:1990, modified)*

EN 60439-4:2004, *Low-voltage switchgear and controlgear assemblies — Part 4: Particular requirements for assemblies for construction sites (ACS) (IEC 60439-4:2004)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 60825-1:2007, *Safety of laser products — Part 1: Equipment classification and requirements (IEC 60825-1:2007)*

EN 60947-1:2007, *Low-voltage switchgear and controlgear — Part 1: General rules (IEC 60947-1:2007)*

EN 61008-1:2012, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) — Part 1: General rules (IEC 61008-1:2010, modified)*

EN 61310-1:2008, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals (IEC 61310-1:2007)*

EN 61439-1:2011, *Low-voltage switchgear and controlgear assemblies — Part 1: General rules (IEC 61439-1:2011)*

EN ISO 3411:2007, *Earth-moving machinery - Physical dimensions of operators and minimum operator space envelope (ISO 3411:2007)*

EN ISO 3449:2008, *Earth-moving machinery - Falling-object protective structures - Laboratory tests and performance requirements (ISO 3449:2005)*

EN ISO 3457:2008, *Earth-moving machinery - Guards - Definitions and requirements (ISO 3457:2003)*

- EN ISO 4413:2010, *Hydraulic fluid power - General rules and safety requirements for systems and their components (ISO 4413:2010)*
- EN ISO 4414:2010, *Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010)*
- EN ISO 4871:2009, *Acoustics - Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*
- EN ISO 7096:2008, *Earth-moving machinery - Laboratory evaluation of operator seat vibration (ISO 7096:2000)*
- EN ISO 11202:2010, *Acoustics - Noise emitted by machinery and equipment - Determination of emission sound pressure levels at a work station and at other specified positions applying approximate environmental corrections (ISO 11202:2010)*
- EN ISO 11688-1:2009, *Acoustics - Recommended practice for the design of low-noise machinery and equipment - Part 1: Planning (ISO/TR 11688-1:1995)*
- EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*
- EN ISO 12922:2012, *Lubricants, industrial oils and related products (class L) - Family H (Hydraulic systems) - Specifications for hydraulic fluids in categories HFAE, HFAS, HFB, HFC, HFDR and HFDU (ISO 12922:2012)*
- EN ISO 13732-1:2008, *Ergonomics of the thermal environment - Methods for the assessment of human responses to contact with surfaces - Part 1: Hot surfaces (ISO 13732-1:2006)*
- EN ISO 13849-1:2008, *Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design (ISO 13849-1:2006)*
- EN ISO 13850:2008, *Safety of machinery - Emergency stop - Principles for design (ISO 13850:2006)*
- EN ISO 14122-1:2001, *Safety of machinery - Permanent means of access to machinery - Part 1: Choice of fixed means of access between two levels (ISO 14122-1:2001)*
- EN ISO 14122-2:2001, *Safety of machinery - Permanent means of access to machinery - Part 2: Working platforms and walkways (ISO 14122-2:2001)*
- EN ISO 14122-3:2001, *Safety of machinery - Permanent means of access to machinery - Part 3: Stairs, stepladders and guard-rails (ISO 14122-3:2001)*
- EN ISO 14122-4:2004, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders (ISO 14122-4:2004)*
- ISO 3795:1989, *Road vehicles, and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*
- ISO 3864-1:2011, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*
- ISO 6405-1:2004, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*
- ISO 11112:1995, *Earth-moving machinery — Operator's seat — Dimensions and requirements*
- ISO 12508:1994, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*
- ISO 15817:2012, *Earth-moving machinery — Safety requirements for remote operator control systems*

EN 16191:2014 (E)**3 Terms and definitions**

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and the following apply.

3.1**tunnelling machinery**

machine used in the excavation and construction of tunnels and shafts, as described in 3.2 to 3.10

3.2**shield machine**

steerable ground support structure within which tunnel excavation takes place by manual, mechanical or hydraulic means. Erection of tunnel support may take place within the shield machine

Note 1 to entry: The shield machine is propelled forward by reaction onto the tunnel lining. See Figure A.1. Shield machines provide lateral and/or radial ground support. In addition they can provide various types of face support and ground water control.

3.3**shielded tunnel boring machine**

shield machine for full face excavation, having one or more rotating cutter heads in which the cutter head(s) may be separated from the rest of the shield by a shield bulkhead. Passage of material through the shield bulkhead may be controlled

Note 1 to entry: Reaction forces caused by the excavation process are transferred into the tunnel lining. See Figure A.2.

3.4**telescopic shield machine**

shielded tunnel boring machine as defined in 3.3 equipped with a gripping system as described in 3.12

Note 1 to entry: Telescopic shield machine is also known as a double shield machine.

3.5**unshielded tunnel boring machine**

machine for mechanical excavation using a rotating cutter head. The machine has no shield for ground support but can have a shield for the protection of the cutter head. See Figure A.3

Note 1 to entry: The torque and thrust reactions are resisted by anchoring the complete machinery against the ground by means of a gripping system.

3.6**reaming machine**

unshielded tunnel boring machine used to enlarge a pilot tunnel in one or more steps

Note 1 to entry: In most cases unshielded tunnel boring machinery work the full face of the tunnel. However, in some cases the tunnel is driven in two or more phases, by starting with a pilot hole which is enlarged in one or more steps. This method is called reaming. The machines used are in principle the same as an unshielded tunnel boring machine driving the whole tunnel area in one step.

3.7**shaft boring machine**

tunnelling machine as defined in 3.2 to 3.6 designed to operate in the vertical or near vertical direction

3.8**micro tunnelling machine**

shielded tunnel boring machine designed for non-man entry operation (except for maintenance purposes when out of service) which is remotely controlled by an operator from outside the tunnel. See Figure A.4

3.9**thrust boring machine**

machine for constructing pipelines by displacement

3.10**auger boring machine**

non-steerable machine for constructing pipelines using continuous flight augers for excavation and spoil removal

3.11**partial face excavation equipment**

cutter boom or backhoe excavator installed in a shield machine, see Figure A.1

3.12**gripping system**

equipment for the transfer of the reactive forces caused by the excavation process into the tunnel wall

3.13**regripping**

process of disengaging the gripping system, relocating and re-engaging the gripping system

3.14**excavation chamber**

front part of a shield between ground face and shield bulkhead, into which the ground is excavated

3.15**back-up equipment**

steel construction which accommodates equipment, to provide the machine with services for its operation and its crew with facilities for their work and comfort

Note 1 to entry: For tunnelling machinery described in 3.2 to 3.7 the back-up equipment is normally towed behind the machine i.e. it is "towed back-up equipment" whereas for pipe jacking and micro tunnelling equipment, thrust boring and auger boring machines, the back-up equipment is installed at the bottom of an access shaft or on the surface adjacent thereto.

3.16**pipe jacking rig**

hydraulic jacking equipment, used to drive a pipe string through the ground to form a tunnel lining

3.17**lining erection equipment (Erector)**

handling and erecting equipment for tunnel lining segments, situated within or immediately behind a shield machine

3.18**erecting device**

equipment for handling and erection of other ground support elements such as steel ribs, situated within a tunnel boring machine and its back-up equipment

3.19**rockbolting device**

equipment for drilling and installation of rock bolts, situated within or behind an unshielded tunnel boring machine

3.20**probe drilling equipment**

drilling equipment for ground investigation ahead of and around the tunnel

3.21**control station**

any location on a tunnelling machinery or back-up equipment from where one or more functions of the tunnelling machinery, back-up equipment or their separate working units can be controlled by an operator

3.22**main control station**

control station from where the excavation operation and the advance of the tunnelling machinery is controlled

EN 16191:2014 (E)**3.23****walkway**

part of the access system that permits walking or moving between locations on a tunnelling machinery

3.24**access opening**

opening within tunnelling machinery through which a man may pass to access servicing points, for example (e.g.) in the shield bulkhead or the cutterhead

3.25**servicing point**

any location on a tunnelling machinery or back-up equipment where maintenance or servicing is carried out

3.26**working area**

area on or in tunnelling machinery, where work is performed, for example (e.g.) rock bolt installation, ring beam erection, segment handling and ring erection, services extension

3.27**trailing cable**

power cable which extends from the towed back-up equipment to the tunnel power supply normally stowed on the cable drum or cable trail

3.28**essential services**

service which is maintained in the event of a loss of the main power supply

3.29**refuge chamber**

enclosed space which provides life support for persons trapped in tunnel by smoke, fume or gas

3.30**air lock**

self-contained pressure vessel with one or more compartments that permits passage between areas of different pressure

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[SOURCE: EN 12110:2014, 3.3]

3.31**shield bulkhead**

structure which separates the excavation chamber from the tunnel

3.32**internal diameter**

internal diameter of the lining through which the backup equipment is being towed. For unshielded machines, the internal diameter is that within the planned rock support

4 List of significant hazards

This clause contains all the significant hazards, hazardous situations and events, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

Noise is not a significant hazard for micro tunnelling, thrust boring and auger boring machines as they do not expose persons to noise.

Table 1 — List of significant hazards

	Hazards	Relevant clause/Subclause in this European Standard
4.1	Mechanical hazards	
a)	Crushing hazard	5.2.4, 5.2.7, 5.2.10, 5.2.12, 5.4.1, 5.4.4, 5.4.5, 5.5.1, 5.5.2, 5.5.4.3, 5.16.2, 5.17.2,
b)	Friction or abrasive hazard	5.2.1
c)	High pressure fluid injection hazard	5.2.3, 5.3.1, 5.11
d)	Loss of stability and structural collapse	5.2.6, 5.2.7, 5.2.9, 5.2.12, 5.16.2
e)	Slip, trip and fall hazards	5.2.5.2, 5.2.6, 5.2.10, 5.4.4, 5.6
4.2	Electrical hazards	
a)	Electrical contact, direct or indirect	5.10
b)	External influences on electrical equipment	5.5.3, 5.10.9
4.3	Thermal hazards	5.2.2
4.4	Hazards generated by noise	
a)	Hearing damage, tinnitus, physiological disorders, accidents due to interference with speech communication and perception of danger signals	5.3.1, 5.9
4.5	Hazards generated by radiation	
a)	Laser	5.7
4.6	Hazards generated by materials and substances	
a)	Materials processed, used or exhausted by machinery	5.8.2, 5.15
b)	Dust and gas	5.3.1, 5.5.5, 5.8
c)	Fire or explosion	5.2.3, 5.4.3, 5.5.5, 5.8.4, 5.10.3, 5.10.4, 5.12
d)	Falling objects, face collapse and flood	5.2.4, 5.2.11, 5.4.4, 5.5.5, 5.16.2
4.7	Hazards generated by neglect of ergonomics principles	
a)	Unhealthy posture or excessive efforts	5.2.5, 5.2.10, 5.3.2, 5.3.3, 5.13, 5.14
b)	Inadequate lighting	5.10.7, 5.10.8, 5.14
4.8	Hazards caused by failure of energy supply	
a)	Failure of energy supply	5.2.5.2, 5.2.6.2, 5.4.4, 5.5.1, 5.5.6, 5.11, 5.14
b)	Failure of control system	5.5, 5.11
4.9	Hazards caused by missing and/or incorrectly positioned safety related measures	
a)	All kinds of guards	5.2.10, 5.4, 5.15
b)	All kinds of safety related devices	5.4, 5.5, 5.6, 5.14
c)	Starting and stopping devices	5.2.6, 5.3.3, 5.5.2, 5.5.4,
d)	Safety signs and tags, all kinds of information of warning devices	5.2.4, 5.2.5, 5.2.6, 5.2.7, 5.2.11, 5.4, 5.4.1, 5.5.1, 5.5.5, 5.6, 5.7, 5.8, 5.11, 5.12, 5.16.2, 5.16.3, 7.2.1, 7.2.4, D.3
e)	Energy supply disconnecting devices	5.10.2, 5.10.6