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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

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English Version

## Tunnelling machinery - Safety requirements

Machines pour la construction de tunnels - Exigences de  
sécurité

Tunnelbaumaschinen - Sicherheitstechnische  
Anforderungen

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If this draft becomes a European Standard, 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.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

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prEN 16191:2010 (E)

## Foreword

This document (prEN 16191:2010) 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 document is currently submitted to the CEN Enquiry.

This document will supersede EN 12336:2005+A1:2008, EN 815:1996+A2:2008.

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.

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## Introduction

This European Standard is a type C standard as stated in EN ISO 12100-1:2003.

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

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.

In this European Standard it is assumed that:

- only competent persons operate the machine;
- components without specific requirements are:
  - designed in accordance with the usual engineering practice and calculation codes, including all failure modes;
  - of sound mechanical and electrical construction according to the state of the art;
  - made of materials with adequate strength and of suitable quality;
  - made of no harmful materials, such as asbestos;
- components are kept in good repair and working order, so that the required characteristics remain despite wear;
- the installation allows a safe use of the machine;
- the user considers the special instructions and particular conditions given by the manufacturer to use the machinery and equipment under particular conditions of use (e.g. ground conditions).

**prEN 16191:2010 (E)****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 specifies the essential safety requirements for the design, installation, maintenance, and information for use of such machinery.

This European Standard also covers reasonably foreseeable misuse of such machinery in that compliance with the requirements of clause 5 mitigates the risk arising from such misuse.

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

As microtunnelling, thrust boring and auger boring machines do not expose persons to noise, noise is not a significant hazard for such machines.

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

Tunneling machinery operating below ground level does not present a significant EMC hazard to machinery operating on the surface.

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

- air locks and associated equipment which can form an integral part of tunnelling machinery (see EN 12110:2002) and used for hyperbaric working;
- 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 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 deals with all significant hazards, hazardous situations and events relevant to tunnelling machinery when used as intended and under the conditions foreseen by the manufacturer (see Clause 4).

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 referenced documents are indispensable for the application of this European Standard. 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+A1:2007, *Portable fire extinguishers — Part 7: Characteristics, performance requirements and test methods*
- EN 620:2002, *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 982:1996+A1:2008, *Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*
- EN 983:1996+A1:2008, *Safety of machinery — Safety requirements for fluid power systems and their components — Pneumatics*
- EN 1088:1995+A2:2008, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*
- EN 1837:1999, *Safety of machinery — Integral lighting of machines*
- EN 13309:2000, *Construction machinery - Electromagnetic compatibility of machines with internal electrical power supply*
- EN 13478:2001+A1:2008 *Safety of machinery - Fire prevention and protection*
- EN 60079-0:2006, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements (IEC 60079-0:2004, 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 60204-32:2008, *Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*
- EN 60439-1:1999, *Low-voltage switchgear and controlgear assemblies — Part 1: Type-tested and partially type-tested assemblies (IEC 60439-1:1999)*
- 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 intended to be installed in places where unskilled persons have access for their use; distribution boards (IEC 60439-3:1991, 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)*

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- 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 60947-2:2006, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers (IEC 60947-2:2006)*
- EN 60947-3:2009, *Low-voltage switchgear and controlgear - Part 3: Switches, disconnectors, switch- disconnectors and fuse-combination units (IEC 60947-3:2008)*
- 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 ISO 2860:2008, *Earth-moving machinery — Minimum access dimensions (ISO 2860:1992)*
- 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 4871:1996, *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 11202:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Survey method in situ (ISO 11202:1995)*
- EN ISO 11688-1:1998, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1:1995)*
- EN ISO 11688-2:2000, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 2: Introduction to the physics of low-noise design (ISO/TR 11688-2:1998)*
- EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*
- EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)* 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 13849-1:2006, *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 a 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 3864-1:2002, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

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*

### 3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 12100-1:2003 and the following apply.

#### 3.1 tunnelling machinery

is the generic term for machines and equipment used in the excavation and construction of tunnels and shafts, as described in 3.2 to 3.19

#### 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. 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 bulkhead. Passage of material through the bulkhead may be controlled. 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 3.9

NOTE Telescopic shield machine is also known as a double shield machine.

#### 3.5 unshielded tunnel boring machine

a 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.

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

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

NOTE 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

**prEN 16191:2010 (E)****3.7 shaft boring machine**

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

**3.8 micro tunnelling machine**

a 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 gripping system**

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

**3.10 excavation chamber**

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

**3.11 towed back-up equipment**

steel construction normally towed behind or attached and moving with the machine which accommodates equipment, to provide the machine with services for its operation and its crew with facilities for their work and comfort

**3.12 stationary back-up equipment**

equipment for operation or control of pipe jacking and micro tunnelling equipment, thrust boring and auger boring machines which is installed at the bottom of an access shaft or on the surface adjacent thereto

**3.13 pipe jacking rig**

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

**3.14 intermediate jacking station**

structure having the same external dimensions as the pipe and containing a number of hydraulic jacks used to drive a section of pipe string through the ground. Intermediate jacking stations subdivide a long pipe string into sections

**3.15 thrust boring machine**

machine for constructing pipelines by displacement

**3.16 auger boring machine**

non-steerable machine for constructing pipelines using continuous flight augers for excavation and spoil removal. See figure A 6.

**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 boring operation and the advance of the tunnelling machinery is controlled

### 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 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

the 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

services which are maintained in the event of a loss of the main power supply

### 3.29 rescue chamber

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

## 4 List of significant hazards

This clause contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.