



SLOVENSKI STANDARD
SIST EN 815:2000
01-april-2000

Safety of unshielded tunnel boring machines and rodless shaft boring machines for rock

Safety of unshielded tunnel boring machines and rodless shaft boring machines for rock

Sicherheit von Tunnelbohrmaschinen ohne Schild und gestängelosen Schachtbohrmaschinen zum Einsatz in Fels

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Sécurité des tunneliers sans bouclier et des machines foreuses pour puits sans tige de traction

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Ta slovenski standard je istoveten z: EN 815:1996

ICS:

91.220	Gradbena oprema	Construction equipment
93.060	Gradnja predorov	Tunnel construction

SIST EN 815:2000

en

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EUROPEAN STANDARD

EN 815

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 1996

ICS 93.060

Descriptors: safety of machines, excavating equipments, drilling equipments, accident prevention, hazards, safety measures, design, operating stations, human factors engineering, control devices, safety devices, towing attachments, fire protection, maintenance, marking, information, utilization

English version

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Sicherheit von Tunnelbohrmaschinen ohne Schild und gestängellosen Schachtbohrmaschinen zum Einsatz in Fels

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard 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of an identical text or by endorsement, at the latest by March 1997, and conflicting national standards shall be withdrawn at the latest March 1997.

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 EU Directive(s).

For relationship with EU Directives, see informative Annex ZA, which is an integral part of this standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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0 Introduction

This European Standard is a Type C-standard as defined in EN 292-1:1991.

The machinery concerned and the extent to which hazards are covered is indicated in the scope of this standard.

1 Scope

1.1 Field of application

This standard is applicable to unshielded tunnel boring machines, TBM's, and rodless shaft boring machines, SBM's, and their towed or attached back-up equipment for driving tunnels or shafts in rock where the whole area is excavated in one or more steps by mechanical means. It specifies essential safety requirements for the design, construction and maintenance of such machines when used in non-explosive atmosphere together with the methods of verification. The standard specifies monitoring for hazardous atmosphere.

For TBM's and SBM's which are to be used continuously in explosive atmosphere, additional relevant standards also apply.

This European Standard deals with all significant hazards pertinent to unshielded tunnel boring machines and rodless shaft boring machines for rock, when they are used as intended and under the conditions foreseen by the manufacturer (see clause 4). This European Standard specifies the appropriate technical measures to eliminate or reduce risks arising from the significant hazards.

1.2 Description of the machines

The general term "unshielded tunnel boring machines" encompasses various kinds of machines for mechanical excavation of underground openings such as tunnels and inclined shafts. This is done in a continuous process, without blasting, using a rotating cutter head.

Depending on the hardness of the material being excavated, tools of different types are used to cut the rock. Normally, rolling discs are employed in medium to very hard rock. All tunnel boring machines, TBM's, and rodless shaft boring machines, SBM's, have the tools mounted on a cutter head which rotates under thrust against the rock. The torque required to rotate the cutter head is developed by electric or hydraulic motors and the thrust is normally delivered by hydraulically powered cylinders.

The torque and thrust reactions created by a TBM or SBM have to be resisted by anchoring the complete machine inside the bore itself by means of a gripping system which is reset after each boring stroke and allows the machine to be steered in the desired direction.

TBM's normally operate in a near to horizontal direction but can also be used to drive inclined tunnels. When the incline becomes too steep, a second anchoring system will be provided to prevent the machine from sliding down while the primary grippers are reset.

In most cases TBM's 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 a TBM driving the whole tunnel area in one step.

SBM's resemble closely TBM's but operate in vertical direction. The shaft is in many cases sunk in a multistage operation, that is (i.e.), first a pilot hole is bored using a raise bore machine and the pilot hole is reamed by using the SBM. Normally for this method, the shaft bottom is already undercut to provide adequate room for the muck and its removal. The full face of the shaft can also be bored in one step. In this case the muck is transported to the top of the shaft.

TBM's and SBM's intended for work in unstable rock are provided with equipment for the erection and handling of rock reinforcement and/or lining.

The specified requirements of this standard conform to the European Standards EN 292-1 and EN 292-2 .

1.3 Hazards

This standard deals with all identified significant hazards caused by TBM's and SBM's, when they are used under the conditions stated by the manufacturer in the operator's handbook.

NOTE: When TBM's and SBM's are to be used in explosive atmospheres the additional relevant standards apply.

1.4 This European Standard applies primarily to machines which are manufactured after the date of approval of this European standard.

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2 Normative references (standards.iteh.ai)

This European Standard incorporates by dated or undated references, 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.

EN 3:1975	Fire fighting - Portable Fire Extinguishers
EN 292-1:1991	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology

EN 292-2:1991 + A1:1995	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications
EN 418:1992	Safety of machinery - Emergency stop equipment, functional aspects principles for design
prEN 547-1:1994	Safety of machinery - Human body measurements - Part 1: Principles for determining the dimensions required for openings for whole body access into machinery
prEN 547-2:1994	Safety of machinery - Human body measurements - Part 2: Principles for determining the dimensions required for access openings
EN 563:1994	Safety of machinery - Temperatures of touchable surfaces - Ergonomics data to establish temperature limit values for hot surfaces
prEN 894-1:1992	Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 1: Human interactions with displays and control actuators
prEN 894-2:1992	Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 2: Displays
prEN 894-3:1993	Safety of machinery - Ergonomic requirements for the design of displays and control actuators - Part 3: Control actuators
prEN 953: 1992	Safety of machinery - General requirements for the design and construction of guards (fixed, moveable)
EN 954-1:1996	Safety of machinery - Safety related parts of control systems -Part 1: General principles for design
EN 981:1995	Safety of machinery - System of danger and non-danger signals with sound and light
EN 982:1996	Safety requirements for fluid power systems and components - Hydraulics
EN 983:1996	Safety requirements for fluid power systems and components - Pneumatics
ENV 1070:1993	Safety of machinery - Terminology
EN 23411:1988	Earth-moving machinery - Human physical dimensions of operators and minimum operator space envelope
EN 50014:1992	Electric apparatus for potentially explosive atmospheres - General requirements

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EN 61310-1:1995	Safety of Machinery - Indicating, marking and actuating principles - Part 1: Visual, audible and tactile signals
EN 61310-2:1995	Safety of Machinery - Indicating, marking and actuating principles -Part 2: Marking
EN 60204:1993	Safety of machinery - Electrical equipment of machines- Part 1: General requirements
EN 60439-1:1993	Low voltage switch gear and control gear assemblies - Part 1: Requirements for type-tested and partially type-tested assemblies
EN 60529:1991	Classification of degrees of protection provided by enclosures
EN 60825:1994	Laser - Radiation safety of laser products, equipment classification, requirements and user's guide
EN 60947-1:1991	Low voltage switch gear and control gear - Part 1: General rules
EN ISO 3457:1995	Earth-moving machinery - Guards and shields - Definitions and specifications
ISO 3795:1989	Road vehicles, tractors and machinery for agriculture and forestry - Determination of burning behaviour of interior materials
ISO 3864:1984	Safety colours and safety signs
EN ISO 11202:1996	Acoustics - Noise emitted by machinery and equipment - Measurement of emission sound pressure levels at the work station and at other specified positions - Survey method in situ

3 Definitions

For the purposes of this European Standard the definitions stated in ENV 1070:1993 apply.

Additional definitions specifically needed for this European Standard are added below:

[SIST EN 815:2000](https://standards.iteh.ai/catalog/standards/sist/4a4c0975-f6bc-4c48-b66a-6b1688c1782/sist-en-815-2000)

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3.1 Unshielded tunnel boring machine (TBM): Machine for full face mechanical excavation of underground openings such as tunnels and inclined shafts using a rotating cutter head. The machine has no shield for tunnel support but can have a shield for the protection of the cutter head. See figure C. 2.

3.2 Reaming TBM: Tunnel boring machine that enlarges a pilot hole in one or more steps.

- 3.3 Shaft boring machine, SBM:** Rodless shaft boring machine operating downwards in a vertical direction. The SBM may ream a pilot hole in one or more steps in which case the muck is falling down to an undercut space. See figure C.1. The full face can also be bored in one step (blind boring). In this case the muck is removed up to the top of the shaft.
- 3.4 BM:** Abbreviation for boring machines, covering all machines according to 3.1 - 3.3 for which common specifications apply.
- 3.5 Back-up equipment:** Assembly of equipment, normally towed behind or attached to a BM to provide the BM with services for the operation and its crew with facilities for their work and comfort. See figure C.2.
- 3.6 Erecting device:** Tunnel support erection and handling equipment situated within a TBM and its back-up equipment which is used to install any tunnel support which acts structurally to maintain the tunnel void.
- 3.7 Main control point:** The control point from where the boring operation and advance of the BM is controlled.
- 3.8 Control point:** Any location from where one or more functions of the BM or its separate working units are controlled by an operator.
- 3.9 Exposed person:** Any person wholly or partially in a danger zone.
- 3.10 Walkway:** Part of the access system that permits walking or crawling between locations on a BM and its back-up equipment.
- 3.11 Walkway surface:** The footpath within the walkway.
- 3.12 Access opening:** Opening within a BM and its back-up equipment, for example (e.g.) in the bulkhead or the cutter head through which man access may be made to servicing points.
- 3.13 Servicing point:** Any location on a BM and its back-up equipment where maintenance or servicing is normally carried out.

4 List of significant hazards

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

4.1	Mechanical hazards	See clause
	a) Crushing hazard	5.2, 5.3, 5.5, 5.6, 5.8.3, 5.8.4, 7.2.3, 7.2.4
	b) Friction or abrasive hazard	5.1.1.1
	c) High pressure fluid ejection hazard	5.1.2
	d) Loss of stability	5.4, 7.2.3
	e) Slip, trip and fall hazards	5.5
4.2	Electrical hazards	
	a) Electrical contact, direct or indirect	5.14, 5.15
	b) External influences on electrical equipment	5.14
4.3	Thermal hazards	
		5.1.1.2, 7.2.3
4.4	Hazards generated by noise	
		5.13
4.5	Hazards generated by vibrations	
		5.7.1, 5.7.3
4.6	Hazards generated by laser	
		5.11
4.7	Hazards generated by materials and substances	
	a) Dust and gas	5.12
	b) Fire or explosion	5.7.3, 5.12, 5.16, 5.17, 7.2.3
	c) Falling objects and flood	5.6
4.8	Hazards generated by neglect of ergonomic principles	
	a) Unhealthy posture or excessive efforts	5.7.1, 5.7.2, 5.7.3
	b) Neglected use of personal protection equipment	5.13, 5.18, 7.2.3
	c) Inadequate local lighting	5.14.7, 5.14.8