



**SLOVENSKI STANDARD**  
**SIST EN 815:2000+A2:2008**  
**01-december-2008**

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**Varnost strojev za vrtnanje predorov (TBM) in jaškov (SBM) v kamnini - Varnostne zahteve**

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

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

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

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**Ta slovenski standard je istoveten z: EN 815:1996+A2:2008**

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**ICS:**

91.220	Gradbena oprema	Construction equipment
93.060	Gradnja predorov	Tunnel construction

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EUROPEAN STANDARD

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## Safety of unshielded tunnel boring machines and rodless shaft boring machines for rock - Safety requirements

Sécurité de tunneliers sans boucliers et des machines foreuses pour puits sans tige de traction - Exigences de sécurité

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

This European Standard was approved by CEN on 5 August 1996 and includes Amendment 1 approved by CEN on 22 December 2004 and Amendment 2 approved by CEN on 9 July 2008.

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 Management Centre or to any CEN member.

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
## Contents



Page

Foreword.....	5
Introduction .....	6
<b>1 Scope .....</b>	<b>6</b>
<b>1.1 Field of application .....</b>	<b>6</b>
<b>1.2 Description of the machines.....</b>	<b>6</b>
<b>1.3 Hazards .....</b>	<b>7</b>
<b>1.4 This European Standard applies primarily to machines which are manufactured after the date of approval of this European Standard. ....</b>	<b>7</b>
<b>2 Normative references .....</b>	<b>7</b>
<b>3 Definitions .....</b>	<b>8</b>
<b>4 List of significant hazards .....</b>	<b>10</b>
<b>4.1 Mechanical hazards .....</b>	<b>10</b>
<b>4.2 Electrical hazards .....</b>	<b>10</b>
<b>4.3 Thermal hazards .....</b>	<b>10</b>
<b>4.4 Hazards generated by noise .....</b>	<b>10</b>
<b>4.5 Hazards generated by vibrations .....</b>	<b>10</b>
<b>4.6 Hazards generated by laser .....</b>	<b>10</b>
<b>4.7 Hazards generated by materials and substances .....</b>	<b>10</b>
<b>4.8 Hazards generated by neglect of ergonomic principles.....</b>	<b>10</b>
<b>4.9 Hazards caused by failure of energy supply .....</b>	<b>10</b>
<b>4.10 Hazards caused by missing and/or incorrectly positioned safety related measures .....</b>	<b>11</b>
<b>5 Safety requirements and/or provisions .....</b>	<b>11</b>
<b>5.1 General safety requirements .....</b>	<b>11</b>
<b>5.1.1 Contact surfaces.....</b>	<b>11</b>
<b>5.1.1.1 Hazards due to sharp and rough parts .....</b>	<b>11</b>
<b>5.1.1.2 Hazards due to hot surfaces .....</b>	<b>11</b>
<b>5.1.2 Hoses and pipes under pressure .....</b>	<b>11</b>
<b>5.2 Cutter head .....</b>	<b>12</b>
<b>5.3 Handling of heavy loads .....</b>	<b>12</b>
<b>5.3.1 Transport and lifting.....</b>	<b>12</b>
<b>5.3.2 Handling of machine parts.....</b>	<b>13</b>
<b>5.3.3 Handling of elements for rock support.....</b>	<b>13</b>
<b>5.4 Gripping and regripping.....</b>	<b>13</b>
<b>5.5 Access to and egress from operating positions and servicing points .....</b>	<b>13</b>
<b>5.5.1 General.....</b>	<b>13</b>
<b>5.5.2 Walkways .....</b>	<b>14</b>
<b>5.5.3 Access openings .....</b>	<b>15</b>
<b>5.6 Protection against falling objects and flood .....</b>	<b>15</b>
<b>5.6.1 Falling objects.....</b>	<b>15</b>
<b>5.6.2 Flood .....</b>	<b>16</b>
<b>5.7 Control points .....</b>	<b>16</b>
<b>5.7.1 Ergonomics .....</b>	<b>16</b>
<b>5.7.2 Visibility .....</b>	<b>16</b>
<b>5.7.3 Cab .....</b>	<b>16</b>
<b>5.8 Guards and protective devices .....</b>	<b>17</b>
<b>5.8.1 General.....</b>	<b>17</b>
<b>5.8.2 Specification of guards .....</b>	<b>17</b>
<b>5.8.3 Access to cutter head .....</b>	<b>17</b>
<b>5.8.4 Conveyor .....</b>	<b>17</b>

5.9	Control systems and devices .....	17
5.9.1	General .....	17
5.9.2	Control systems .....	17
5.9.3	Control devices.....	18
5.9.4	Starting, warning systems, stopping and emergency stopping.....	19
5.9.4.1	Starting.....	19
5.9.4.2	Warning systems .....	19
5.9.4.3	Stopping.....	20
5.9.4.4	Emergency stopping .....	20
5.9.5	Failure of the power supply.....	21
5.10	Towing connection.....	21
5.11	Laser guidance .....	21
5.12	Ventilation, control of dust and gas .....	22
5.12.1	General .....	22
5.12.2	Dust suppression .....	22
5.12.3	Dedusting .....	22
5.12.4	Atmospheric changes .....	22
5.12.4.1	General.....	22
5.12.4.2	Methane monitoring.....	22
5.12.4.3	Monitoring for other gases .....	23
5.13	Noise .....	23
5.14	Electrical equipment .....	23
5.14.1	General .....	23
5.14.2	Protective measures .....	24
5.14.3	Cables and leads .....	24
5.14.4	Transformers .....	24
5.14.5	Bonding .....	24
5.14.6	Switch gear .....	24
5.14.7	Lighting.....	25
5.14.8	Emergency lighting .....	25
5.15	Isolation of power supply .....	25
5.16	Energy supply other than electricity .....	25
5.17	Fire protection .....	26
5.17.1	Fire extinguishing system .....	26
5.17.2	Fixed fire extinguishing systems.....	26
5.17.3	Installation of portable fire extinguishers.....	27
5.17.4	Water sprays .....	27
5.18	Storage of safety equipment for personnel.....	27
5.19	Indicators.....	27
5.19.1	Marking .....	27
5.19.2	Warning signs.....	28
5.19.3	Warning devices .....	28
5.19.4	Symbols.....	28
5.20	Maintenance .....	28
6	Verification of safety measures and/or provisions.....	28
7	Information for use .....	29
7.1	General .....	29
7.2	Instruction handbooks.....	29
7.2.1	General .....	29
7.2.2	Identification of handbooks.....	29
7.2.3	Content of operator's handbook.....	30
7.2.4	Content of maintenance handbook .....	31
7.2.5	Spare parts list.....	32
Annex A	(normative) Protective measures for electrical accessories and lighting.....	33
Annex B	(informative) Bibliography .....	34
Annex C	(informative) Figures .....	35

**EN 815:1996+A2:2008 (E)**

**Annex ZA (informative)  Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/EC  .....39**

**Annex ZB (informative)  Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC  .....40**

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## Foreword

This document (EN 815:1996+A2:2008) 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 2009, and conflicting national standards shall be withdrawn at the latest by December 2009.

This document includes Amendment 1, approved by CEN on 2004-12-22 and Amendment 2, approved by CEN on 2008-07-09.

This document supersedes EN 815:1996.

The start and finish of text introduced or altered by amendment is indicated in the text by tags  $\boxed{A_1}$   $\boxed{A_1}$  and  $\boxed{A_2}$   $\boxed{A_2}$ .

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).

$\boxed{A_2}$  For relationship with EU Directive(s), see informative Annexes ZA and ZB, which are integral parts of this document.  $\boxed{A_2}$

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.

## 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.

## 2 Normative references

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, *Portable fire extinguishers*  
<https://standards.iteh.ai/catalog/standards/sist/10a40011-19e4-4232-a46e-8bb12e8d7bd0/sist-en-815-2000a2-2008>

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.*

**EN 815:1996+A2:2008 (E)**

prEN 953:1992, *Safety of machinery – General requirements for the design and construction of guards (fixed, moveable)*.

EN 954-1, *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*.

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.

#### 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.

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## 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.

<b>4.1 Mechanical hazards</b>	<b>See clause</b>
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
<b>4.2 Electrical hazards</b>	
a) Electrical contact, direct or indirect	5.14, 5.15
b) External influences on electrical equipment	5.14
<b>4.3 Thermal hazards</b>	5.1.1.2, 7.2.3
<b>4.4 Hazards generated by noise</b>	5.13
<b>4.5 Hazards generated by vibrations</b>	5.7.1, 5.7.3
<b>4.6 Hazards generated by laser</b>	5.11
<b>4.7 Hazards generated by materials and substances</b>	
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
<b>4.8 Hazards generated by neglect of ergonomic principles</b>	
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
<b>4.9 Hazards caused by failure of energy supply</b>	
a) Failure of energy supply	5.9.5, 5.16
b) Failure of control system	5.9

#### 4.10 Hazards caused by missing and/or incorrectly positioned safety related measures See clause

- |  |                      |
|--|----------------------|
| a) All kinds of guards   | 5.8                  |
| b) All kinds of safety related devices                                       | 5.9, 5.10, 5.12      |
| c) Starting and stopping devices   | 5.9.3, 5.9.4         |
| d) Safety signs and tags   | 5.19.2               |
| e) All kinds of information or warning devices                               | 5.9.4.2, 5.19, 7.2.3 |
| f) Emergency stop devices  | 5.9.4.4              |
| g) Safe handling of machinery and parts                                      | 5.3                  |
| h) Essential equipment and accessories for safe adjusting and/or maintaining | 7.2.3, 7.2.4         |
| i) Equipment for evacuating gases  | 5.12                 |

## 5 Safety requirements and/or provisions

Machinery shall comply with the safety requirements and/or technical provisions of this clause and in addition with EN 292-2:1991 and EN 292-2:1991 for hazards relevant but not significant which are not covered by this standard.

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### 5.1 General safety requirements

This clause gives the requirements and measures for those hazards, for which particular action appears necessary. So for applicable requirements and measures which are already contained in other standards, specifically in EN 292 in its annex A or in type B – standards, reference is made to them, to relevant subclauses and to the applicable performance category.

Unless stipulated otherwise in this standard, the BM shall satisfy the general safety requirements – as appropriate – set down in type A or B standards and particularly in EN 292 with special reference to annex A of part 2.

#### 5.1.1 Contact surfaces

##### 5.1.1.1 Hazards due to sharp and rough parts

Accessible parts of a BM shall be designed and manufactured to avoid an exposed person's contact with sharp edges, angles or rough surfaces which are likely to cause injury. See 3.1 of EN 292-2.

##### 5.1.1.2 Hazards due to hot surfaces

Where there is a risk of human contact with hot surfaces, protective covers for cases of normal access shall be provided. For other cases warning signs shall be provided. See EN 563.

#### 5.1.2 Hoses and pipes under pressure

Hoses, pipes and fittings shall be able to withstand the stresses from the pressure. The hoses shall be marked with the rated working pressure. The requirements of prEN 982 and prEN 983 shall be complied with.