SLOVENSKI STANDARD
SIST EN 1889-2:2004

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Stroji za podzemne rudnike – Mobilni stroji za podzemne rudnike – Varnost – 2. del: Tirne lokomotive

Machines for underground mines - Mobile machines working underground - Safety - Part 2: Rail locomotives

Maschinen für den Bergbau unter Tage - Bewegliche Maschinen für die Verwendung unter Tage - Sicherheit - Teil 2: Lokomotiven

Machines pour l'exploitation de mines souterraines - Machines mobile souterraines - Sécurité - Partie 2: Locomotives sur rails

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This European Standard was approved by CEN on 13 February 2003.

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Contents

Foreword

This document (EN 1889-2:2003) has been prepared by Technical Committee CEN/TC 196, "Machines for underground mines - Safety", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by December 2003, and conflicting national standards shall be withdrawn at the latest by December 2003.

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 EC Directive(s).

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

Annexes A, B, C, D and E are normative.

This document includes a Bibliography.

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

Introduction

This European Standard is a type C standard as stated in EN 1070.

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

The standard takes into account the current state of the art and technical facilities to use in order to exclude or prevent, as far as possible, hazards when rail locomotives are used underground.

When compiling this standard it has been assumed that:

— components are:

a) designed in accordance with good engineering practice, taking account of expected shocks and vibrations and calculation codes, including all failure modes;

b) of sound mechanical and electrical construction;

c) made of materials with adequate strength and of suitable quality; and

d) free of defects.

— harmful materials, such as asbestos are not used;

— components are kept in good repair and working order, so that the required dimensions remain fulfilled despite wear;

— negotiations have taken place between the manufacturer or authorised representative, purchaser and/or user (e.g. for fire resistant fluids, safety equipment and load restraining devices).

1 Scope

1.1 This European standard specifies the safety requirements and tests for rail locomotives for use in underground mining (i.e. mine locomotives) and other underground workings (e.g. tunnelling locomotives).

1.2 This European standard deals with the technical requirements to minimise the hazards listed in clause 4 which can arise during the commissioning, the operation and the maintenance of locomotives when carried out in accordance with the specifications given by the manufacturer or his authorised representative.

This European standard does not address the special hazards associated with the rack drive of rack and pinion locomotives.

1.3 This European standard does not deal with radiation and vibration. It does not address remote control locomotives or operation in potentially explosive atmospheres. Hazards due to noise are excluded from this standard, but a separate standard is in preparation where hazards due to noise will be addressed.**1.4** This European standard applies to locomotives which are manufactured after the date of issue of this standard.

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

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

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

EN 418:1992, *Safety of Machinery — Emergency stop equipment, functional aspects — Principles for design*

EN 457, *Safety of machinery — Auditory danger signals — General requirements, design and testing (ISO 7731:1986, modified).*

EN 547-1, *Safety of machinery — Human body measurements — Part 1: Principles for determining the dimensions required for openings for whole body access into machinery*

EN 547-2, *Safety of machinery — Human body measurements — Part 2: Principles for determining the dimensions required for access openings*

EN 547-3, *Safety of machinery — Human body measurements — Part 3: Anthropometric data*

EN 563, *Safety of machinery — Temperatures of touchable surfaces — Ergonomics data to establish temperature limit values for hot surfaces*

EN 894-1, *Safety of machinery — Ergonomic requirements for the design of displays and control actuators — Part 1: General principles for human interactions with displays and control actuators*

EN 894-2, *Safety of machinery — Ergonomic requirements for the design of displays and control actuators — Part 2: Displays*

EN 894-3, *Safety of Machinery — Ergonomic requirements for the design of displays and control actuators — Part 3: Control actuators*

EN 953, *Safety of machinery — Guards — General requirements for the design and construction of fixed and moveable guards*

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

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

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

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

EN 1070:1998, *Safety of machinery — Terminology*

EN 1679-1, *Reciprocating internal combustion engines — Safety — Part 1: Compression ignition engines*

EN 13202:2000, *Ergonomics of the thermal environment — Temperatures of touchable hot surfaces - Guidance for establishing surface temperature limit values in production standards with the aid of EN 563*

EN 60204-1:1998, *Safety of Machinery — Electrical equipment of machines — Part 1: General requirements*

EN ISO 3411, *Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope (ISO 3411:1995)*

EN ISO 8030, *Rubber and plastic hoses — Method of test for flammability*

ISO 1813, *Belt drives — V-ribbed belts, joined V-belts and V-belts including wide section belts and hexagonal belts — Electrical conductivity of antistatic belts: Characteristics and methods of test*

ISO 3864, *Safety colours and safety signs*

ISO 6405-1, *Operation and maintenance of earth moving machinery — Specification for common symbols for operator controls and other displays*

ISO 6405-2, *Earth-moving machinery – Symbols for operator controls and other displays - Part 2: Specific symbols for machines, equipment and accessories.*

ISO 6805, *Rubber hoses and hose assemblies for underground mining — Wire-reinforced hydraulic types for coal mining — Specification*

IEC 60332-1, *Tests on electric cables under fire conditions — Part 1: Test on a single vertical insulated wire or cable*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions together, where appropriate, with those in EN 1070:1998 apply:

3.1
locomotive
self-powered uncaptivated vehicle running on a track of rails underground in mines or other underground workings, designed for hauling persons, materials or mineral

3.2
driver
designated person suitably trained, qualified by knowledge and practical experience and provided with the necessary instructions to ensure safe operation of the locomotive

3.3
service weight
sum of

- the weight of the serviceable locomotive;
- the weight of the driver (800 N);
- two-thirds of the weight of the fuel stock.

3.4
braked weight
service weight of the locomotive less the weight of any unbraked wheels and the weight carried by them

3.5
brake ratio
ratio of the brake force acting between the locomotive and the rails against the direction of travel, and the braked weight of the locomotive

3.6
skidding
when the circumferential speed of braked wheels is lower than the speed of the locomotive beyond the normal creep speed. In the extreme case the circumferential speed is zero (wheels locked)

3.7
slipping
when the circumferential speed of driven wheels is greater than the speed of the locomotive beyond the normal creep speed of the driven wheels

3.8
battery locomotive
electric locomotive which obtains its power from a battery or batteries

3.9
trolley locomotive
electric locomotive which obtains its power from a roadway conductor

3.10
battery/trolley (compound) locomotive
electric locomotive which obtains its power either from a battery or from a roadway conductor

3.11
diesel locomotive
diesel locomotive which obtains its power from a reciprocating internal combustion engine

3.12
mid-point switch disconnector
device designed to disconnect the power of a traction battery at a place where the voltage between the positive take-off lead and the mid-point switch disconnector is approximately equal to that between the mid-point switch disconnector and the negative take-off lead

3.13
braking systems
all the elements which combine together to brake and hold the locomotive. Such systems consist of a control, means of power transmission and the brake itself

3.13.1
service braking system
primary system used for stopping and holding the locomotive

3.13.2
emergency braking system
additional braking system other than the service braking system, that can be applied manually or automatically to stop the locomotive

3.13.3
parking braking system
system used to hold a stopped locomotive in the stationary condition

3.14
firedamp
flammable gas, consisting mainly of methane, found naturally in mines

4 List of significant hazards

Table 1 contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk.

Table 1 — List of significant hazards with associated requirements

EN 1050:1996, annex A	Hazards according to EN 1050:1996, annex A	Relevant clause/subclause of this standard
1	**Mechanical hazards due to:**	5.1, 5.1.7, 5.2, 5.3, 5.13
	- machine parts or workpieces, e.g.:	
	a) shape;	
	b) relative location;	
	c) mass and stability;	
	e) inadequacy of mechanical strength;	
1.1	Crushing hazard	5.1.2, 5.1.3, 5.3, 5.13
1.2	Shearing hazard	5.1.2, 5.1.3, 5.3, 5.13
1.3	Cutting or severing hazard	5.1.2, 5.1.3, 5.13
1.4	Entanglement hazard	5.1.2, 5.1.3
1.5	Drawing-in or trapping hazard	5.1.2, 5.1.3, 5.13
1.6	Impact hazard	5.1.2, 5.1.3, 5.1.5, 5.3, 5.13
1.7	Stabbing or puncture hazard	5.1.2, 5.1.3, 5.13
1.8	Friction or abrasion hazard	5.1.2, 5.1.3, 5.13
1.9	High pressure fluid injection or ejection hazard	5.4.1, 5.4.2
2	**Electrical hazard due to:**	
2.1	Contact of person with live parts (direct contact)	5.5
2.2	Contact of person with parts which have become live under faulty conditions (indirect contact)	5.5
2.4	Electrostatic phenomena	5.5.1
3	**Thermal hazards**, resulting in:	
3.1	Burns and scalds by contact with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources	5.1, 5.4.1,5.4.2, 5.14
3.2	Damage to health by hot or cold working environment	5.13
7	**Hazards generated by materials and substances** (and their constituent elements) processed or used by the machinery	
7.1	Hazards from contact with or inhalation of harmful fluid, gases, mists, fumes and dusts	5.4.1, 5.4.2, 5.6
7.2	Fire or explosion hazard	5.4.2, 5.5, 5.6, 5.7, 5.14
8	**Hazards generated by neglecting ergonomic principles in machinery design, e.g. hazards from:**	
8.1	Unhealthy postures or excessive effort	5.12, 5.13
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	5.13
8.4	Inadequate area lighting	5.8
8.5	Mental overload and underload, stress	5.12
8.6	Human error	5.12

Table 1 — List of significant hazards with associated requirements (continued)

EN 1050:1996, annex A	Hazards according to EN 1050:1996, annex A	Relevant clause/subclause of this standard
10	**Unexpected start-up/over-run/over-speed** (or any similar malfunction) from:	
10.1	Failure/disorder of control supply	5.4, 5.5, 5.11, 5.12
11	Impossibility of stopping the machine in the best possible conditions	5.10, 5.11
13	Failure of the power supply	5.4, 5.5, 5.6, 5.11, 5.12
14	Failure of the control circuit	5.4, 5.5, 5.11, 5.12
15	Errors of fitting	7.1.1, 7.1.2, 7.1.4
17	Falling or ejected objects or fluids	5.4
18	Loss of stability/overturning of machinery	5.1, 5.2, 5.3, 5.13
20	**Relating to the travelling function:**	
20.1	Movement when starting the engine	5.11,
20.2	Movement without a driver at the driving position	5.11.4.4
20.3	Movement without all parts in a safe position	5.12.1.2
20.5	Excessive oscillations when moving	5.1.4
20.6	Insufficient ability of machinery to be slowed down, stopped and immobilised	5.11, 5.12
21	**Linked to the work position (inc. driving station) on machine:**	
21.1	Fall of persons during access to (or at/from) the work position	5.13.3, 5.13.5
21.2	Exhaust gases/lack of oxygen at the work position	5.6.1, 5.6.2, 5.6.3
21.3	Fire (flammability of the cab, lack of extinguishing means)	5.13, 5.14
21.4	Mechanical hazards at the work position:	
	c) fall of objects, penetration by objects;	5.13
21.5	Insufficient visibility from the work positions	5.13
21.6	Inadequate lighting	5.8, 5.12.3.5
21.7	Inadequate seating	5.13.7
22	**Due to the control system:**	
22.1	Inadequate location of manual controls	5.12
22.2	Inadequate design of manual controls and their mode of operation	5.12
23	From handling the machine (lack of stability)	5.1.4
24	**Due to the power source and to the transmission of power:**	
24.1	Hazards from the engine and the batteries	5.5, 5.6
24.3	Hazards from couplings and towing	5.1, 5.3
25	**From/to third persons:**	
25.1	Unauthorised start-up/use	5.12

Table 1 — List of significant hazards with associated requirements (continued)

EN 1050:1996, annex A	Hazards according to EN 1050:1996, annex A	Relevant clause/subclause of this standard
25.3	Lack or inadequacy of visual or acoustic warning means	5.9
26	**Insufficient instructions for the driver/operator**	7.1, 7.3
29	**Hazards generated by neglecting ergonomic principles**	5.13.1, 5.13.4, 5.13.6
29.1	Insufficient visibility from the driving position	
30	**Mechanical hazards/events due to:**	
30.2	Failing accelerator or brake control of machinery running on rails	5.11, 5.12
30.3	Failing or lack of deadman's control of machinery running on rails	5.11.1.7
32	**Fire and explosion**	5.4, 5.5, 5.6, 5.7, 5.14
33	**Emission of dust, gases etc.**	5.6

5 Safety requirements and/or safety measures

5.1 General/basic requirements

5.1.1 For the application of EN 953, EN 982, EN 983, EN 457, EN 563, EN 547 and EN 60204-1 the manufacturer shall carry out an adequate risk assessment for the requirements thereof where choice is necessary.

NOTE This specific risk assessment is part of the general risk assessment relating to the hazards not covered by this C standard.

For hazards which are not covered by this standard, machinery shall conform as appropriate to EN 292.

5.1.2 All moving parts, with the exception of the wheels, drive lines and articulation area, shall be provided with guards according to EN 953.

Gaps between guards and moving parts shall conform to EN 349 and EN 294.

5.1.3 Where hinged guards or covers can self-close, they shall be fitted with a support system to secure them in the open position.

5.1.4 Locomotives shall be fitted with suspension and shock absorbing systems to ensure that all wheels maintain contact with the rails and to absorb shock loading from the track. In the event of failure of the suspension system, no part of the locomotive shall contact moving parts of the running gear or be below than the upper level of the rails. This also applies to driver's cabs having their own bogie, e.g. driver's cabs of articulated locomotives.

NOTE Suspension systems with self-damping, e.g. multi-leaf springs, may not need a separate shock absorbing system.

5.1.5 The front faces of locomotives shall be painted in a safety colour in accordance with ISO 3864.

Locomotives shall have facilities for stowing any safety equipment (see also introduction, on negotiations).

5.1.6 For unintentional contact the temperature of hot surfaces inside of the locomotive are based on annex B of EN 13202:2000 for 0,5 s contact time. For the parts that require handling during maintenance the temperature of the touchable surface shall be in accordance with EN 563 for 5 s contact time. Where this limit cannot be achieved, see 7.1.3.

Exhaust pipes within reach during operation which exceed the touchable surface temperatures given in EN 13202 for 0,5 s shall be guarded against unintentional contact in accordance with EN 953.

5.1.7 With the exception of couplings and the current collector (for trolley locomotives), all other components shall be contained within the profile of the locomotive such that they are protected against accidental damage.

5.2 Design to facilitate handling

Where purpose-designed attachment points are provided they shall be designed to have a calculated minimum factor of safety of 4 on ultimate breaking load in relation to their intended load carrying capacity. They shall be shaped to suit the lifting means intended by the manufacturer, see 7.1.2. They shall be clearly and permanently marked with their load carrying capacity, e.g. by welding. Where any such attachment points could be used to lift or move the whole locomotive this factor of safety shall relate to the service weight of the locomotive.

Articulated locomotives shall be fitted with means to avoid relative movements between parts.

5.3 Couplings

5.3.1 Locomotives shall be equipped with couplings to absorb and to transfer the tensile and compressive forces to the locomotive frame. The couplings and all parts of the locomotive lying in line with it shall be designed with a minimum safety factor of 10 against failure in relation to the maximum drawbar pull of the locomotive (or locomotives where these are designed to be used in tandem), for a minimum coefficient of static friction of 0,25 for steel tyres and 0,40 for rubber or polymer derivative tyres.

NOTE Characteristics of the coupling are discussed between the manufacturer and the user, see introduction on negotiation.

5.3.2 In the fully compressed position of the coupling, it shall be possible to move freely a non-deformable sphere of 250 mm diameter between the front face of the locomotive and a vertical plane perpendicular to the longitudinal axis of the locomotive at the extreme end of the coupling.

5.3.3 If it is intended that safety chains are to be used the attachment points of these shall have a minimum breaking strength of not less than 2½ times the weight of the locomotive.

5.4 Fluid power systems

5.4.1 Hydraulic systems

5.4.1.1 Hydraulic systems shall be designed and installed to conform to EN 982.

5.4.1.2 Hydraulic systems (hydrostatic and hydrokinetic) shall be designed to enable non-toxic fluids as defined in the 7th SHCMOEI Report [1] to be used to minimize risks to health.

5.4.1.3 Hydraulic systems (hydrostatic and hydrokinetic) on locomotives shall be designed such that fire-resistant fluids can be used to minimise fire hazards (ISO 7745 and SHCMOEI 7th report) or the following precautions shall be taken for all systems exceeding 10 l total capacity:

a) Hydraulic lines (rigid metal and flexible pipelines) shall be segregated from any unprotected electrical cable or equipment (see 5.5.2.3), or any part of the locomotive, the surface of which, can become sufficiently hot to reach 80 % of the flashpoint of the hydraulic fluid for which the system has been designed.

b) Hydraulic lines shall be shrouded to prevent flammable fluid under pressure being ejected from a leak or a burst onto a hot surface as defined in paragraph a) above, or outside the profile of the locomotive.

NOTE National legislation implementing EU Directive 92/104/EEC can require the use of fire resistant fluids in hydraulic systems, see introduction on negotiation.

5.4.1.4 Hydropneumatic accumulators shall conform to EN 982.

5.4.1.5 Reservoirs for hydraulic fluids shall be protected against corrosion, be secured to the locomotive and incorporated in such a way (e.g. inside the rigid structure of the locomotive) that they are protected against mechanical damage.

5.4.1.6 The filling apertures of reservoirs for hydraulic fluids shall be within reach of an operator standing at rail level, otherwise means of access shall be provided. The filling aperture shall be designed and positioned in such a way that any overflow or escape of hydraulic fluid is prevented under foreseeable operating conditions, including derailment.

Any cap fitted shall be secured to prevent it working loose in service and shall require an intentional action to release it. When released it shall remain permanently attached to the locomotive.

The location and marking of the filling point for any hydraulic system shall be designed to avoid the inadvertent introduction of other substances (e.g. liquid fuel, water, sand) into the hydraulic system.

5.4.1.7 Reservoirs for fluids shall have a drainage device at their lowest point. Provision shall be made for free flow and safe catchment of fluid without coming into the proximity of hot parts or electrical equipment. The design intent shall be to prevent any fluid residues collecting in parts of the locomotive outside the hydraulic system.

5.4.1.8 Hydraulic pressure relief valves shall only allow hydraulic fluid to be discharged back into the system.

5.4.1.9 Hydraulic lines shall be designed as rigid metal lines or as flexible hoses.

Materials for hydraulic hoses and their components shall be in accordance with ISO 6805 and shall be fire-resistant so that it will self extinguish within 30 s of removal of the flame in accordance with EN ISO 8030. Safety factors of the hose assembly (including end fittings), shall be 2:1 for the dynamic pressure and 3:1 for burst pressure.

Hydraulic lines shall be designed to take into account the relative movement between components.

NOTE Where hose re-inforced with steel wire is used consideration needs to be given to fatigue aspects.

Hydraulic hoses containing fluid with a pressure exceeding 5 MPa (50 bar) and/or having a temperature exceeding 50 °C and located within 1 m of the driver or operator shall be guarded, see 5.1.1 and 5.1.2. Parts or components can be considered as guards.

NOTE Line connections should be limited in number and designed to minimise any possibility of leakage during operation.

5.4.1.10 Tanks for hydraulic fluid shall be fitted with a mechanically protected fluid level indicator with at least minimum and maximum operating levels.

5.4.1.11 Means shall be provided to monitor hydraulic fluid temperature and to warn the driver when the fluid temperature approaches the maximum specified by the manufacturer (see also 5.14).

5.4.1.12 The design of the system shall be such that overheating of the fluid beyond the fluid and component manufacturer's rated temperature is not exceeded.

5.4.2 Pneumatic systems

5.4.2.1 Pneumatic systems shall be designed and installed in accordance with EN 983.

5.4.2.2 Compressors shall be designed to operate either on a lubricant which is resistant to carbonization (e.g. synthetic oils), or fitted with temperature monitoring.

5.4.2.3 A filter shall be incorporated in every compressor air intake system to prevent the ingress of foreign material.