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Machines for underground mines — Mobile machines working underground — Safety

Part 1: Rubber tyred vehicles

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National foreword

This British Standard is the UK implementation of EN 1889-1:2011. It supersedes BS EN 1889-1:2003 which is withdrawn.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 1889-1:2011) has been prepared by Technical Committee CEN/TC 196 “Machines for underground mines - 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of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by January 2012.

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 1889-1:2003.

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 EU Directive.

For relationship with EU Directive, 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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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 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 rubber tyred vehicles are used underground.

After approval by CEN this document will be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by DAV + 6 months and conflicting national standards shall be withdrawn.

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

When compiling this standard it has been assumed that:

a) components are:

   1) designed in accordance with the good engineering practice and calculation codes, taking account of shocks and vibration, including all failure modes;

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

   3) free of defects;

b) harmful materials, such as asbestos are not used;

c) components are kept in good repair and working order, so that the required dimensions remain fulfilled despite wear.

1 Scope

1.1 This European Standard specifies the safety requirements and tests for self-propelled rubber tyred vehicles as defined in 3.1 intended primarily for use in underground mining (i.e. as mine vehicles) and other underground workings (e.g. as tunnelling vehicles). The electrical supply voltage is limited to 1100 A.C. and 1500 D.C.

1.2 This European Standard deals with all significant hazards, hazardous situations and hazardous events, applying to self-propelled, rubber-tyred vehicles, subject to being used according to their intended purpose and prevailing manufacturer's conditions and within the scope of foreseeable misuse. This European Standard describes appropriate action to be taken to avoid or minimize the risk of significant hazards.

1.3 This European Standard does not include rubber tyred drilling rigs, which are covered by EN 791, or earth-moving machinery not intended primarily for use in underground mines, which are covered by EN 474 (all parts). This European Standard does not take account of specific hazards associated with special-purpose vehicles, e.g. tankers, explosives vehicles.

This standard does not cover the use and operation of rubber-tyred vehicles being remotely controlled or operation in potentially explosive atmospheres.

1.4 This European Standard applies to vehicles which are manufactured after the date of issue of this standard.

2 Normative references

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

EN 286-2, *Simple unfired pressure vessels designed to contain air or nitrogen — Part 2: Pressure vessels for air braking and auxiliary systems for motor vehicles and their trailers*

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

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

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

EN ISO 4413, *Hydraulic fluid power - General rules and safety requirements for systems and their components (ISO 4413:2010)*

EN ISO 4414, *Pneumatic fluid power - General rules and safety requirements for systems and their components (ISO 4414:2010)*

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

EN 1837, *Safety of machinery — Integral lighting of machines*

EN 12096:1997, *Mechanical vibration — Declaration and verification of vibration emission values*

EN 12254, *Screens for laser working places — Safety requirements and testing*

EN 13309, *Construction machinery — Electromagnetic compatibility of machines with internal power supply*

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

EN 60332-1-1, *Tests on electric and optical fibre cables under fire conditions — Part 1-1: Test for vertical flame propagation for a single insulated wire or cable — Apparatus (IEC 60332-1-1:2004)*

EN 60332-1-2, *Tests on electric and optical fibre cables under fire conditions — Part 1-2: Test for vertical flame propagation for a single insulated wire or cable — Procedure for 1 kW pre-mixed flame (IEC 60332-1-2:2004)*

EN 60332-2-1, *Tests on electric and optical fibre cables under fire conditions — Part 2-1: Test for vertical flame propagation for a single small insulated wire or cable — Apparatus (IEC 60332-2-1:2004)*

EN 60332-2-2, *Tests on electric and optical fibre cables under fire conditions — Part 2-2: Test for vertical flame propagation for a single small insulated wire or cable — Procedure for diffusion flame (IEC 60332-2-2:2004)*

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

EN 60825-4, *Safety of laser products — Part 4: Laser guards (IEC 60825-4:2006)*

EN ISO 2860, *Earth-moving machinery — Minimum access dimensions (ISO 2860:1992)*

EN ISO 2867, *Earth-moving machinery — Access systems (ISO 2867:2006, including Cor 1:2008)*

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

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

EN ISO 3450:2008, *Earth-moving machinery — Braking systems of rubber-tyred machines — Systems and performance requirements and test procedures (ISO 3450:1996)*

EN ISO 3471, *Earth moving machinery — Roll-over protective structures — Laboratory tests and performance requirements (ISO 3471:2008)*

EN ISO 4871:1996, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

EN ISO 6682, *Earth-moving machinery — Zones of comfort and reach for controls (ISO 6682:1986, including Amd 1:1989)*

EN ISO 6683, *Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests (ISO 6683:2005)*

EN ISO 7096:2008, *Earth-moving machinery — Laboratory evaluation of operator seat vibration (ISO 7096:2000)*

EN ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals (ISO 7731:2003)*

EN ISO 8030, *Rubber and plastics hoses — Method of test for flammability (ISO 8030:1995)*

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 13732-1, *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, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857:2008)*

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 3864-4, *Graphical symbols — Safety colours and safety signs — Part 4: Colorimetric and photometric properties of safety sign materials*

ISO 5006:2006, *Earth-moving machinery — Operator's field of view — Test method and performance criteria*

ISO 5010, *Earth-moving machinery — Rubber-tyred machines — Steering requirements*

ISO 6393, *Earth-moving machinery — Determination of sound power level — Stationary test conditions*

ISO 6396:2008, *Earth-moving machinery — Determination of emission sound pressure level at operator's position — Dynamic test conditions*

ISO 6405-1, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

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*

ISO 7745, *Hydraulic fluid power — Fire-resistant (FR) fluids — Requirements and guidelines for use*

ISO 9244, *Earth-moving machinery — Machine safety labels — General principles*

ISO 9533, *Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria*

ISO 10533, *Earth-moving machinery — Lift-arm support devices*

ISO 10570, *Earth-moving machinery — Articulated frame lock — Performance requirements*

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 13333, *Earth-moving machinery — Dumper body support and operator's cab tilt support devices*

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
vehicle
self-propelled rubber tyred machine running on the mine floor, designed for carrying persons, carrying or loading material or mineral, or with attached equipment designed to be used in mining operations

NOTE 1 Examples of such vehicles are: loader, trucks, supplies/materials vehicles, service vehicles and personnel carriers.

NOTE 2 Vehicles covered by this standard are designed to operate in mines which have restricted widths and heights, therefore the machines are more compact so as to safely negotiate the mine roadways.

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

3.3
braking systems
elements which combine together to brake and hold the vehicle

NOTE Such systems consist of a control, means of power transmission and the brake itself.

3.3.1
service braking system
primary system used for stopping and holding the vehicle

3.3.2
secondary braking system
braking system that can be applied manually or automatically to stop the vehicle

3.3.3
parking braking system
system used to hold a stopped vehicle in the stationary condition

3.4
service weight
operating weight of the vehicle without payload and driver

3.5
maximum vehicle weight
operating weight of the fully laden vehicle (i.e. with payload according to the volume times specific weight of the bulk material) which includes the heaviest combination of cab, canopy, ROPS or FOPS with all their components and mountings, and equipment intended by the manufacturer of the vehicle, a driver of 80 kg and full fuel tank and full lubricating, hydraulic and cooling systems

3.6
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

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 according to EN ISO 12100 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

Nr	Significant hazards	Relevant clause/subclause of this standard
4.1	**Mechanical hazards due to:**	
4.1.1	— machine parts or workpieces, e.g.: a) shape; b) relative location; c) mass and stability; d) inadequacy of mechanical strength	5.1, 5.2, 5.3, 5.12
4.1.2	Crushing hazard	5.1.2, 5.1.5, 5.3, 5.12
4.1.3	Shearing hazard	5.1.2, 5.1.5, 5.3, 5.12
4.1.4	Cutting or severing hazard	5.1.2, 5.1.5, 5.12
4.1.5	Entanglement hazard	5.1.2, 5.12
4.1.6	Drawing-in or trapping hazard	5.1.2, 5.12
4.1.7	Impact hazard	5.1.2, 5.1.5, 5.3, 5.12
4.1.8	Stabbing or puncture hazard	5.1.2, 5.1.5, 5.12
4.1.9	Friction or abrasion hazard	5.1.2, 5.12
4.1.10	High pressure fluid injection hazard	5.4.1
4.1.11	Collision hazard	5.8, 5.12.4.5
4.2	**Electrical hazard due to:**	
4.2.1	Contact of person with live parts (direct contact)	5.5
4.2.2	Contact of person with parts which have become live under faulty conditions (indirect contact)	5.5
4.2.3	Electrostatic phenomena	5.5.1

Nr	Significant hazards	Relevant clause/subclause of this standard
4.3	**Thermal hazards**, resulting in:	
4.3.1	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	5.1.1, 5.1.6, 5.4.1, 5.4.2, 5.13
4.3.2	Damage to health by hot or cold working environment	5.12
4.4	**Noise hazards**	5.14
4.5	**Vibration hazards:**	5.12.4
4.6	**Radiation hazards:**	5.15
4.7	**Hazards generated by materials and substances** (and their constituent elements) processed or used by the machinery	
4.7.1	Hazards from contact with or inhalation of harmful fluid, gases, mists, fumes and dusts	5.4.1, 5.4.2, 5.6
4.7.2	Fire or explosion hazard	5.4.1, 5.4.2, 5.5, 5.6, 5.7, 5.13
4.8	**Hazards generated by neglecting ergonomic principles in machinery design, e.g. hazards from:**	
4.8.1	Unhealthy postures or excessive effort	5.11, 5.12
4.8.2	Inadequate consideration of hand-arm or foot-leg anatomy	5.12
4.8.4	Inadequate area lighting	5.8
4.8.5	Mental overload and underload, stress	5.11
4.8.6	Human error	5.11
4.9	**Unexpected start-up/over-run/over-speed (or any similar malfunction) from:**	
4.9.1	Failure/disorder of the control system	5.4, 5.5, 5.10, 5.11
4.9.2	Impossibility of stopping the machine in the best possible conditions	5.10, 5.11
4.10	Failure of the power supply	5.4, 5.5, 5.6, 5.10, 5.11,
4.11	Failure of the control circuit	5.4, 5.5, 5.10, 5.11

Nr	Significant hazards	Relevant clause/subclause of this standard
4.12	Errors of fitting	7
4.13	Falling or ejected objects or fluids	5.4
4.14	Loss of stability/overturning of machinery	5.1.4, 5.2, 5.3, 5.12
4.15	**Relating to the travelling function:**	
4.15.1	Movement when starting the engine	5.10
4.15.2	Movement without a driver at the driving position	5.10.4
4.15.3	Movement without all parts in a safe position	5.11.1.2
4.15.5	Excessive oscillations when moving	5.1.4
4.15.6	Insufficient ability of machinery to be slowed down, stopped and immobilised	5.10, 5.11
4.16	**Linked to the work position (inc. driving station) on machine:**	
4.16.1	Fall of persons during access to (or at/from) the work position	5.12
4.16.2	Exhaust gases/lack of oxygen at the work position	5.6.1, 5.6.2, 5.6.3
4.16.3	Fire (flammability of the cab, lack of extinguishing means)	5.12, 5.13
4.16.4	Mechanical hazards at the work position: a) rollover; b) fall of objects, penetration by objects;	 5.12 5.12
4.16.5	Insufficient visibility from the work positions	5.12
4.16.6	Inadequate lighting	5.8
4.16.7	Inadequate seating	5.12.4
4.17	**Due to the control system:**	
4.17.1	Inadequate location of manual controls	5.11
4.17.2	Inadequate design of manual controls and their mode of operation	5.11
4.18	**From handling the machine (lack of**	5.1.4

Nr	Significant hazards	Relevant clause/subclause of this standard
	stability)	
4.19	**Due to the power source and to the transmission of power:**	
4.19.1	Hazards from the engine and the batteries	5.5, 5.6
4.19.2	Hazards from couplings and towing	5.1, 5.3
4.20	**From/to third persons:**	
4.20.1	Unauthorised start-up/use	5.11
4.20.2	Lack or inadequacy of visual or acoustic warning means	5.9
4.21	**Insufficient instructions for the driver/operator**	7.1, 7.3

5 Safety requirements and/or safety measures

5.1 General requirements

5.1.1 Machinery shall comply with the safety requirements and/or protective measures of this clause.

In addition the machine shall be designed according to the principles of EN ISO 12100:2010 for hazards relevant but not significant and which are not dealt with by this document.

For the application of EN 547-1, EN 547-2 and EN 547-3, EN 953, EN 1837, EN ISO 4413, EN ISO 4414, EN ISO 7731, EN ISO 13732-1 and EN 60204-1 the manufacturer shall carry out an adequate risk assessment for the requirements thereof where choice is necessary.

5.1.2 Where the risk of crushing and/or shearing by moving parts is given protection devices according to EN 953 shall be provided. Fixed guards that are to be removed as a part of maintenance, described in the operator's manual, shall be fixed by systems that can be opened or removed only with tools. These guards fixing systems shall remain attached to the guards or to the machinery when the guards are removed. Where possible, guards shall be incapable of remaining in place without their fixings.

The requirement of EN 349 and EN ISO 13857 shall be considered.

5.1.3 Vehicles shall have facilities for secure storage of any safety equipment (e.g. cap lamp, filter self-rescuer) to ensure that those safety equipment cannot cause a hazard due to inadvertent movement of the vehicle.

NOTE Safety equipment according to national rules and/or user requirements.

5.1.4 Stabilizer or similar devices shall be lockable in their retracted positions for travelling.

5.1.5 Vehicles shall be provided with facilities for the attachments of load restrain devices to secure loose equipment or material intended to be carried.

5.1.6 Exhaust systems which can be reached and touched during operation, access or maintenance shall be guarded in accordance with EN 953 considering touchable surface temperatures defined in EN ISO 13732-1.

5.2 Design to facilitate handling

Lifting points shall be provided for easy handling of heavy parts and components. They shall be designed to have a minimum safety factor of 4 times of the intended load carrying capacity.

Where any such lifting points can be used to lift or move the whole vehicle this factor of safety shall relate to the service weight of the vehicle. 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.

Vehicles shall be fitted with tie-down points or any attachment points to anchor the vehicle to prevent the movement of the vehicle during transportation or maintenance. Articulated steered vehicles shall be fitted with a steering frame lock conforming to ISO 10570.

5.3 Towing devices

If the vehicle is equipped with towing devices (hooks, ears, etc.) the manufacturer shall provide information regarding the maximum permitted gross trailer weight which can be towed for braked and unbreaked trailers and the relevant roadway conditions.

The gross trailer weight shall be based on the static friction available for the intended roadway conditions with the vehicle unloaded. The manufacturer shall specify any ballast requirements where necessary.

The towing devices on the vehicle shall have a breaking strength not less than 3 times the gross trailer weight.

5.4 Fluid power systems

5.4.1 Hydraulic systems

5.4.1.1 Hydraulic systems shall be designed and installed to conform with EN ISO 4413.

5.4.1.2 Hydraulic systems (hydrostatic and hydrokinetic) shall be designed to enable non-toxic fluids as defined in the 7th SHCMOEI Report to be used to minimize risks to health. In addition, they 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 separated from any unprotected electrical cable or equipment (see 5.5.2.3),and any part of the vehicle, 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 covered/protected to prevent flammable fluid under pressure being ejected from a leak or a burst onto a hot surface as defined in paragraph a) above.

NOTE National legislation implementing EU Directive 07/30/EC can require the use of fire resistant fluids in hydraulic systems.

5.4.1.3 Hydropneumatic accumulators shall conform to EN ISO 4413.

5.4.1.4 Hydraulic fluid tanks shall be protected against corrosion and be secured to the vehicle and incorporated in such a way (e.g. inside the rigid structure of the vehicle) that they are protected against mechanical damage.

5.4.1.5 The filling apertures of hydraulic fluid tanks shall be easily accessible and reachable when standing on the floor. If this is not possible then facilities and/or equipment shall be provided to allow easy

access. The filling aperture shall be designed and positioned in such a way that any overflow or escape of hydraulic fluid is prevented on any gradient for which the vehicle is designed.

Any cap fitted shall be secured to prevent unintended loosing in service and shall require an intentional action to release it. It shall remain permanently attached to the vehicle in open position.

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

5.4.1.6 All fluid tanks shall be provided with 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 vehicle outside the hydraulic system.

5.4.1.7 Hydraulic pressure relief valves shall discharge the fluid back into the system only.

5.4.1.8 Hydraulic pressure 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 factor of the hose assembly (complete with end fittings) shall be 4 times against burst pressure.

Hydraulic lines shall be designed to take into account the twisting or movement of the vehicle.

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 shall be guarded, see 5.1.1 and 5.1.2. Parts or components can be considered as guards.

Hydraulic lines shall be limited and be designed to minimise possibility of leakage during operation.

5.4.1.9 Hydraulic fluid tanks shall be fitted with a mechanically protected fluid level indicator showing at least the maximum and minimum operating levels.

5.4.1.10 Means shall be provided to monitor hydraulic fluid temperature and to warn the driver when the fluid temperature approaches the maximum temperature specified by the manufacturer.

5.4.1.11 The design of the system shall be such that overheating of the fluid beyond the fluid and component rated temperature specified by the manufacturer does not occur.

5.4.1.12 Pressurized equipment e.g. tanks, pumps, valves, hydraulic cylinders, switches, level indicators and lines, e.g. pipes and hoses containing fluids shall be designed according to good engineering practise.

5.4.2 Pneumatic systems

5.4.2.1 Pneumatic systems shall be designed and installed in accordance with EN ISO 4414.

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

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

5.4.2.4 Simple air pressure vessels shall be designed and tested in accordance with EN 286-2.

5.5 Electrical equipment

5.5.1 General

5.5.1.1 Electrical equipment shall be designed, manufactured and installed in accordance with EN 60204-1.

5.5.1.2 All electric circuits, except for those cables between the starting battery and the starter motor on diesel-powered vehicles, shall be protected by suitable fuses or protective devices in accordance with 7.2 and 7.3 of EN 60204-1:2006.

5.5.1.3 Where the chassis or frame of the vehicle is used as a current-carrying conductor, protection against electric shock by direct contact shall be provided by the limitation of voltage on the frame to a maximum of 25 V AC or 60 V DC (see 6.4 of EN 60204-1:2006).

5.5.2 Cables

5.5.2.1 Cables outside of the enclosures shall be flexible; the outer sheath shall be flame-retardant, self-extinguishing in accordance with EN 60332-1-1 and EN 60332-2-1, and as appropriate with EN 60332-1-2 or EN 60332-2-2. They shall be chemically resistant to oils, battery electrolyte, etc. in accordance with 13.1 of EN 60204-1:2006. In addition, cables for control, communication and monitoring circuits shall also be of adequate mechanical strength in accordance with 12.6 of EN 60204-1:2006.

5.5.2.2 All power conductors used in cables shall be manufactured of stranded copper or a material of at least equivalent flexibility and conductivity.

5.5.2.3 All power cables shall be separated (e.g. achieved by the use of mechanical barriers or by a distance of at least 150 mm) from any fuel, lubrication or hydraulic lines, except if the cable is armoured or otherwise mechanically protected, or where hydraulic or fuel lines and cables terminate at the same components, or fire-resistant fluid is used in the hydraulic lines.

5.5.2.4 Cables shall be installed against mechanical vibration to avoid damage of the isolation (e.g. by rubbing or chafing) or the enclosed conductors to fail due to flexing fatigue.

NOTE The use of screened cable in conjunction with leakage to frame monitoring allows advanced warning of insulation failure which may result in short circuit of the power conductors.

5.5.3 Battery-powered vehicles

5.5.3.1 Battery powered vehicles shall be provided with a main switch to switch off the power supply.

NOTE 1 Commonly this can be achieved by:

1) a switch disconnector or disconnector mounted on the battery container; or

2) a switch disconnector or disconnector combined in one unit with positive and negative plugs, mounted on the vehicle; or

3) a mid-point switch disconnector or disconnector mounted on the container and used in conjunction with separate positive and negative plugs and sockets also mounted on the container, to allow the take-off leads to be disconnected for battery changing. It should only be possible to disconnect the plugs and sockets by use of a special tool after the mid-point switch disconnector has been opened. In this case, a separate switch disconnector mounted on the vehicle should also be provided.

NOTE 2 For changing and re-charging the batteries, it should only be possible:

1) to disconnect the battery sockets and plugs after the switch disconnector has been opened;

2) to connect the battery sockets and plugs before the switch disconnector can be closed.

5.5.3.2 Vehicles where batteries are used for traction shall meet the following requirements:

a) The battery terminals and other live parts of the battery shall be protected against contact, e.g. by insulating covers or caps.

b) Means shall be provided to disconnect the battery power. The disconnection switch shall be reachable by the seated driver. If this is not possible, an electrical remote tripping device shall be provided which can be operated by the driver in seated position. Operation of the disconnection shall automatically apply the vehicle's parking or secondary brake.

c) Disconnection switches or devices shall operate automatically if an external short-circuit occurs, or in the case of rigid connection (i.e. guided rigid plug and socket) between battery and vehicle, if the battery is removed before separating the contacts.

d) All circuits on the vehicle shall be connected to the outgoing side of the switch disconnector with the exception of the control and lighting circuits if they do not exceed 24 V.

NOTE This subclause does not prevent the use of a supplementary disconnection switch for auxiliary equipment of the vehicle or trailer.

5.5.3.3 Battery containers shall meet the following requirements:

a) The battery shall be located in a robust, vented, fire resistant container. The container shall be provided with lifting devices to allow it to be lifted or removed from the vehicle without causing damage to the cells. Suitable ventilation openings shall be provided in the battery container, compartment and/or cover so that dangerous accumulations of gases do not occur when the equipment is operated in accordance with the manufacturer's instructions. In assessing suitable ventilation, accumulations of electrolytic gases shall be kept below 2 % in air, to avoid danger of ignition.

NOTE The ventilation requirements do not normally apply to the battery container during recharging, (see 7.1.3).

b) The finish of internal surfaces of battery containers shall be resistant to the chemical effects of the electrolyte.

c) Means shall be provided to prevent horizontal movement of the battery container during the operation of the vehicle. Such means shall be capable of withstanding likely external mechanical stresses during normal service.

d) Batteries shall be covered. Metal covers shall be designed that an air space of at least 30 mm above the live parts of the battery is given.

e) The covers shall be so constructed that no force is transmitted to or contact is made with the battery cells or connectors when a force of 980 N is applied to the cover over any area 200 mm x 200 mm. The cover shall be fitted in such a way that its displacement needs an intentional human action.

f) Means shall be provided to enable the cover of the battery container to be locked in a closed position.

g) The cover of the battery container shall be designed to prevent water or solid material from entering the container, or blocking any ventilation openings. A solid top is necessary to stop roof water and falling solid material, the sides and base shall conform to IP 23 of EN 60529 as a minimum.

h) Where the risk is given that foreign material and or electrolyte can accumulate on the cell tops or within the container, the container shall be so designed that easy cleaning is possible.

i) Sparking or hot components which can reach a temperature of 300 °C or more shall be so located that explosive electrolytic gas/air mixtures cannot be present. Battery connectors may be accepted as non sparking components provided they are not used as an emergency switching-off device.

5.5.3.4 The battery charge volume shall be indicated to the driver. In addition a warning device shall indicate to the driver if the charge is below 50 % of the voltage at full load condition.

NOTE 1 A higher level of the discharge can be allowed depending on local conditions (see Introduction).

NOTE 2 Additionally, a device can be provided which automatically isolates the battery if the driver continues to operate the vehicle after a predetermined period of discharge warning is given.

5.5.3.5 Where means are incorporated to allow the vehicle to change its own battery under power, there shall be a device incorporated to apply the brakes in case that the vehicle travels beyond the safe extent of the cable, prior to reaching the full length of the cable.

5.5.4 Cable or cable-reel powered vehicles

5.5.4.1 The first terminal box at the cable entry point on the vehicle shall be provided with an earth terminal to allow the protective earth conductor in the flexible trailing cable to be connected.

5.5.4.2 An easily accessible switch connector shall be fitted close to the cable entry point on the vehicle, on the outgoing side of the cable reel slip rings.

5.5.4.3 Means shall be provided on the vehicle to allow the driver to switch off the power supply to the cable. The switch-off device shall be located within the reach of the seated driver.

5.5.4.4 The core diameter of the cable reel shall be determined by the cable manufacturers' recommended minimum bending radius.

5.5.4.5 The cable reel shall be designed such that under all operating conditions the cable manufacturers' maximum permissible temperature is not exceeded.

5.5.4.6 The cable reel shall have a limiting device which prevents the cable being over tensioned or under tensioned.

5.5.4.7 The cable reel shall be capable of reeling in the cable at all speeds up to the maximum speed of the vehicle.

5.5.4.8 A device shall be provided to switch-off the vehicle drive system in case that the cable reel becomes either empty or exceeds its permissible maximum diameter (so as to prevent damage to the cable) and an automatic braking of the vehicle shall be applied.

5.5.5 Trolley powered vehicles

5.5.5.1 A means shall be provided to secure safely the current collectors in the lowered position safely, without the driver leaving the cab.

5.5.5.2 Current collectors shall be suitable for both directions of travel without needing to be reversed, and be laterally restrained to maintain operation.

5.5.5.3 Contact rollers shall not be used for trolley operation.

5.5.5.4 Live parts of the current collector shall be insulated with the exception of parts which are in direct contact with the overhead lines, considering the allowed wear. All other metal parts shall be electrically bonded to the frame of the vehicle.

The driver's cab shall have a roof which is so arranged to prevent accidental contact of the driver with any live conductor when he is in the cab.

5.5.5.5 The overcurrent protection of traction current cables shall be located as close as possible to the collector. The vehicle shall be so designed that the current collector is automatically lowered from the power supply if the over-current protection is activated.

5.5.5.6 In the case of combined trolley/battery vehicles, the design of the traction circuit shall be such that the battery cannot energize the current collector or the overhead conductor under any circumstances.

5.5.6 Electro-magnetic compatibility (EMC)

Underground mobile machines shall comply with the requirements of electromagnetic compatibility as specified in EN 13309.

5.6 Vehicles powered by diesel engine

5.6.1 Only reciprocating internal combustion engines shall be used which meet the requirements of EN 1679-1 operating with a fuel having a flash point exceeding 55 ^{o}C. The engine shall meet the emission limits as required according to Directive 2004/26/CE.

5.6.2 Diesel engine exhaust gases shall be so directed that the penetration of the exhaust gas into the driver's cab and / or personnel compartment is avoided.

In addition exhaust pipes shall be so directed that the risk of personnel in the close proximity during operation is avoided.

5.6.3 Where batteries are fitted for starting purposes and/or feeding other power circuits, the following shall apply:

a) Batteries shall be positioned and secured to prevent mechanical damage. Spillage of liquid shall not be possible on components of the vehicle.

b) Non-sealed batteries shall be housed and vented.

c) The finish of internal surfaces of battery containers shall be resistant to the chemical effects of the electrolyte.

d) The battery terminals shall be protected against contact, e.g. by insulating covers or shrouds.

e) A switch disconnector shall be fitted close to the battery.

5.7 Fuel systems

5.7.1 Fuel tanks shall be manufactured from steel, protected against corrosion, fixed to the vehicle and be incorporated in such a way that they are protected against mechanical damage (e.g. inside the rigid structure of the vehicle).

The tank shall conform to a pressure tightness test at a minimum pressure of 20 kPa for a period of at least 15 min, no leakage shall be visible after the test.

5.7.2 The filler inlets of fuel tanks shall be easily accessible. The filling aperture shall be designed and positioned in such a way that any overflow or escape of fuel is prevented on any gradient for which the vehicle is designed. Any cap fitted shall be secured to prevent unintended loosening in service and shall require an intentional action to release it. When released it shall remain permanently attached to the vehicle in open position.

5.7.3 Fuel tanks shall be vented to maintain atmospheric pressure within the tank by use of a breather filter rated not greater than 125 μm and prevent the ingress of foreign material by use of a tank filler filter rated not greater than 250 μm

5.7.4 Fuel tanks shall have a supply shut-off device. See also EN 1679-1.

5.7.5 In the event of leakage of any fuel pipe on the suction side of the fuel pump, the fuel system shall be designed to avoid flow of fuel from the tank either by gravity or by siphon.

5.7.6 Fuel lines shall be:

a) metal piping or steel braided flexible hoses;

b) so installed taking into account the effects of mechanical vibration, corrosion and heat; joints shall remain visible.

Line connections shall be minimised in number and be designed to provide reliable protection against leaks during operation.

5.7.7 Fuel tanks shall be fitted with devices in accordance with 5.4.1.6.

5.8 Lighting

5.8.1 Lighting systems for the safe use of the machine and the effective provision of the visual task within and/or on the machine shall be design and installed in compliance with EN 1837.

5.8.2 At the front, vehicles shall be equipped with two dipped head lamps for travelling. Lamp fittings shall be adjustable for the alignment of light cones.

5.8.3 Vehicles shall be equipped at the rear with two red tail lamps. In addition, the rear of vehicles shall comply with one of the following:

a) two red reflectors each of at least 20 cm² area

or

b) two red triangular reflectors of 0,15 m side length, or reflecting film of at least equivalent area and of the same form and colour may be fitted.

5.8.4 All vehicles shall be equipped with a minimum of one reversing lamp.

5.8.5 Vehicles having a maximum speed exceeding 35 km/h due to their design, shall be equipped with two stop lamps at the rear.

5.8.6 Vehicles normally operating in both directions (such as loaders) shall have dipping lamps for travelling purposes in both driving directions. When equipped with these lamps, red tail lamps and reversing lamps may be eliminated.

5.8.7 All protective systems for the glass of lights and reflectors shall allow easy cleaning.

NOTE Vehicles may be equipped with additional independent working lamps, illuminating specific parts of the vehicle or the working area during operation.

5.9 Warning devices and safety signs

5.9.1 There shall be a manually operated, audible alert signal to warn personnel in the working area of impending danger. Audible warnings shall conform to EN ISO 7331, the A-weighed sound pressure level shall be >93 dB(A), measured according to ISO 9533.

It shall be possible to operate the means of audible warnings from each driving position.

5.9.2 An automatic audible or visual warning signal shall be provided for reversing to warn bystanders.

5.9.3 Safety signs shall be equipped in accordance with ISO 9244.

5.10 Braking

5.10.1 General requirements

5.10.1.1 Vehicles shall be fitted with service, secondary and parking brakes. The brakes shall be tested in accordance with Annex A.

5.10.1.2 Where common components are used for service and secondary brakes any failure in one of those components shall not reduce the capability to stop the vehicle at a level required for the secondary braking system (see Annex A and 5.10.3.1).

5.10.1.3 At least one of the braking systems shall be designed on fail-safe principles in accordance with 3.18 of EN ISO 12100:2010, e.g. brake application by spring applied and powered release. Where brakes can be automatically applied, the system shall be so designed that they can only be released by a control provided for the purpose.

5.10.1.4 The time interval between initiation of either the service or the secondary brake and the development of 90 % of the minimum required brake effort shall not exceed 2 s.

5.10.1.5 The design and construction of the braking systems shall:

a) allow the vehicle to function without significant difference in either direction of travel;

b) allow the vehicle to move freely for towing purposes.

Additionally:

1) Brake shoes/pads and linings shall be fire resistant.

2) Pressure test point connections or indication shall be fitted to hydraulic and pneumatic brake systems allowing to detect loss of pressure at the brake actuator level.

3) Pneumatic brake systems shall have easily accessible facilities for drainage of liquid.

5.10.1.6 Where brake systems use an energy reservoir, a pressure gauge with scale divisions shall be located in the driver's field of vision. The minimum pressure required shall be indicated by either a red mark on the pressure gauge, or a warning device in accordance with 5.6 of EN ISO 3450:2008.

5.10.1.7 A means shall be provided which either prevents the vehicle being driven or provides the driver with a visual or audible warning if the secondary or parking brakes are fully or partially applied.

5.10.1.8 Pneumatic or hydraulic brake systems shall be designed as dual circuit systems such that at least two wheels on opposing sides of the vehicle are braked in the event of a leak.

5.10.1.9 All brake systems shall be designed, constructed and installed such that contamination of and/or its effect on the brake components are minimised.

5.10.1.10 Provision shall be made for examination for brake wear and for brake fluid level in reservoir.

5.10.1.11 Oil-immersed brakes shall be provided with a visual or audible warning to warn the driver if there is a risk of excessive temperatures occurring which could reduce brake performance below the requirement of the secondary brake system.

5.10.1.12 The force required to operate braking controls shall conform to EN ISO 3450.

5.10.2 Service brake

5.10.2.1 The service brake system shall be designed such that a braking effort equivalent to at least 35 % of maximum vehicle weight is achieved.

Where applicable the brake effort shall increase proportionately with increasing brake application pedal force or pedal travel.

5.10.2.2 Notwithstanding the requirements of 5.10.2.1, the service brake shall be capable of retarding the laden vehicle at a minimum of 1 m/s² on the maximum permitted gradient for the vehicle.

The service braking action may be performed by means of the hydrostatic transmission system if the performance requirements in 5.10.2.1 and 5.10.2.2 are fulfilled.

5.10.2.3 Where the application of the service brake depends on accumulated hydraulic or pneumatic energy, the design shall ensure that the energy supply is assured regardless of demands from other equipment and that either:

a) the secondary brake shall be automatically actuated if the supply pressure falls to the minimum specified pressure necessary for braking; or

b) the system shall be capable of sustaining at least five consecutive full applications of the service brakes from the accumulated energy alone; on the fifth application, the service brake effort shall be not less than that measured for the secondary brake effort (see 5.10.3).

5.10.2.4 The service brake shall be resistant to heat fade. Manufacturers shall specify in the vehicle's operating manuals the maximum distance that the fully laden vehicle can travel down specified gradients before limiting conditions occur. Appropriate means shall be provided to maintain this characteristic within the intended use.

5.10.3 Secondary brake system

5.10.3.1 The secondary brake system shall be designed such that a braking effort equivalent to at least 25 % of maximum vehicle weight is achieved.

5.10.3.2 The secondary brake system shall also meet the requirement of 5.10.2.2. Hydrostatic transmission shall not be used as the secondary braking system.

5.10.3.3 For vehicles with hydrostatic transmission acting as a service brake system (see 5.10.2.2) the secondary brake system shall independently achieve the braking performance specified for the service brake.

5.10.3.4 The secondary braking system may be a combination from service brake and parking brake.

5.10.4 Parking brake

5.10.4.1 The parking brake shall be capable of holding the maximum vehicle weight stationary on the maximum gradient on which the vehicle is designed to operate without assistance from any other braking device, with a safety factor of 1,2 (see A.2.3).

Notwithstanding the above, the minimum requirement for the parking brake is that it shall be capable of holding the fully laden vehicle on a 20 % slope, also with a safety factor of 1,2.

5.10.4.2 Parking brakes shall mechanically be applied.

5.10.4.3 The parking brake shall be so designed that inadvertent release is not possible, e.g. by the use of a latching device.

5.10.4.4 The brake shall act directly on the wheels or mechanically through any positive transmission. Any parking brake shall be on the wheel side of any clutch, coupling or hydrostatic transmission.

5.10.4.5 The parking brake shall be capable of being applied by the driver whilst he is at the driving position. Any control for parking brake disconnect for towing operation shall be located outside the drivers position.

5.10.5 Brake testing

Testing of the braking systems shall be undertaken in accordance with Annex A.

5.11 Control systems and devices

5.11.1 General

5.11.1.1 The control system shall be designed to meet the requirements of performance level PLc as defined in EN ISO 13849-1.

5.11.1.2 Each vehicle shall be equipped with a device to prevent it from being started by unauthorised persons.

5.11.1.3 The control layout shall be generally based on EN ISO 6682.

5.11.2 Control devices

5.11.2.1 Control devices shall be arranged and located based on EN ISO 6682 and have dimensions conforming to EN 547-3 so that they can be operated easily and safely.

The free space between each control and its surroundings shall not be less than:

a) 50 mm for hand-operated controls that require a force of > 50 N;

b) 25 mm for hand-operated controls that require a force of ≤ 50 N;

c) 10 mm between rows of push buttons or switches;

d) 15 mm between separate push buttons;

e) 50 mm for pedals.

NOTE The width of pedal should be 115 mm.

5.11.2.2 Controls, which can cause a hazard due to inadvertent activation, shall be so arranged or deactivated or guarded as to minimize the risk, e.g. when the operator gets into or out of the operator's station and also when the operator is seated at the controls. The deactivation device shall either be self-acting or by compulsory actuation of the relevant device.

5.11.2.3 On vehicles with more than one driving position, the layout of the control devices shall be identical at each driving position.

5.11.2.4 The speed control device shall be of the hold to run type.

5.11.2.5 When the driver is at the intended driving position all the control devices necessary for operation of the vehicle (e.g. starting, stopping, speed control, horn, lights) shall be within reach of the driver considering EN ISO 6682.

5.11.2.6 The control devices shall only be controlled from one driver's position at a time. Means shall be provided to ensure that the use of other control positions is prevented.

This shall not apply to the secondary or parking brake control devices and fire extinguishing systems.

5.11.3 Steering system

Steering system shall comply with ISO 5010.

5.11.4 Display

5.11.4.1 Displays shall be located in the recommended zone of vision in accordance with EN 894-2.

5.11.4.2 Each display shall be marked by clear symbols in accordance with ISO 6405. Where relevant, the limits of normal operation shall be clearly marked.

5.11.4.3 On vehicles with more than one driving position the arrangement of display equipment required for operation shall be identical at each driving position.

5.11.4.4 Display information

5.11.4.4.1 The following display information shall be provided at each driving position, where appropriate to the particular type of vehicle:

a) speed;

b) pressure of pneumatic or hydraulic brake systems;

c) parking brake applied.

5.11.4.4.2 In addition for example the following can be provided:

a) fuel level or battery charge;

b) hydraulic reservoir level;

c) engine oil pressure;

d) temperature of oil-immersed brakes;

e) pressure in hydrostatic drives if service braking is hydrostatic;

f) cooling water temperature;

g) hydraulic transmission temperature;

h) running time or distance travelled meter;

i) service hours meter;

j) fire fighting system operating pressures.

5.11.4.4.3 Display equipment on vehicles fitted with windscreens shall be illuminated.

5.12 Driver and passengers position

5.12.1 Protection

5.12.1.1 The seats shall be so located to minimise the likelihood of injuries e.g. from accidental contact with the roof or sides of the roadway and moving parts of the vehicle (e.g. wheels).

5.12.1.2 If facilities against roll over, over turn and falling objects are present, they shall conform to EN ISO 3471 and/or EN ISO 3449. Vehicles with roll over protective systems shall be equipped with safety belts on the seated driver and passenger position(s) according to EN ISO 6683.

5.12.2 Access systems

5.12.2.1 Safe access to the places shall be provided in accordance with the requirements of EN ISO 2867.

5.12.2.2 An emergency exit shall be provided on a different side from the normal exit.

5.12.2.3 Devices shall be provided to enable doors to retain in open and closed position, means shall be provided to prevent inadvertent opening.

5.12.2.4 The operation of door locks shall be provided from inside and outside.

5.12.3 Visibility

5.12.3.1 Mobile machines shall be designed so that the operator has sufficient visibility from the operator's station in relation to the travel and work areas of the machine. The driver's visibility shall be measured according to ISO 5006:2006, 8.3.2.

If the direct view is restricted and where hazards due to restricted visibility exist, indirect visibility with, e.g. mirrors, CCTV, or detective systems, e.g. Ultra sonic warning device, shall be provided.

5.12.3.2 Any glazing shall be made of safety glass, or of other material which provides at least equal safety.

5.12.3.3 Windscreen wipers, washers, demisters, etc, shall be provided if the conditions under which the vehicle is to be used make these necessary.

5.12.4 Interior space, dimensions, seats, vibration

5.12.4.1 The driver's position shall be based on the requirements as specified in EN ISO 3411. The horizontal seating surface height (see Figure 2, dimension 3E of EN ISO 3411:2007) and the dimension R1 (see Figure 4, dimension R1 of EN ISO 3411:2007) may be reduced where the available height is restricted.

5.12.4.2 The interior shall be free from sharp edges and corners, which might cause personal injuries and shall comply with ISO 12508:1994.

5.12.4.3 The dimensions of driver seats shall comply with the requirements of ISO 11112:1995. Every seat shall offer a stable position.

Any settings for adjusting seats to the size of the driver shall comply with the requirements of ISO 11112:1995, Table 1. Settings shall be changeable without the use of any tools.

5.12.4.4 With respect to its features for reducing any vibration transmitted to the driver, the driver’s seat shall comply with the requirements of EN ISO 7096:2008

5.12.4.5 Depending on the maximum speed of a vehicle, seats shall be equipped with a suitable restraining system according to EN ISO 6683.

5.12.4.6 A space intended for the safekeeping of the operator's manual and other instructions shall be provided near the operator's station

5.13 Fire protection

5.13.1 Components such as fuel tanks, fuel lines, cables, opening of battery container and the hydraulic system including associated lines and other similar items that can ignite, due to operating heat of the machine shall be arranged and guarded to avoid fire.

NOTE 1 It is recommended that materials used in the construction of vehicles should be fire resistant.

NOTE 2 See also the specific requirements for those components and equipment.

Exhaust systems shall be so designed that they cannot ignite the fuel system, hydraulic system or vehicle tyres.

Brake systems shall be so designed and installed that the emitted heat cannot ignite the fuel system, hydraulic system or tyres.

Vehicle suspension systems shall be so designed that in the event of their failure, the tyres will not abrade on the vehicle body.

5.13.2 Provision shall be made for fitting the required number of portable fire extinguisher suitable in type and size for the fire type and load, protected against heat and mechanical shock and vibration.

5.13.3 Diesel powered vehicles used in coal mines and diesel powered vehicles used in non-coal mines having an engine power exceeding 65 kW shall be equipped with a on-board fire extinguishing system. It shall be possible to initiate operation of the system from the cab.

The extinguishing system shall cover the diesel engine and other parts at risk from fire, e.g. transmission and hydraulic systems.

5.13.4 Vehicles designed for use in coal mines with hydraulic systems not containing fire resistant fluids shall be equipped with automatic operating fire extinguishing systems.

5.13.5 The engine shall be shut down automatically in the event of actuation of any on-board automatic fire extinguisher, possibly subject to a time delay according to the agreement with the manufacturer of the fire extinguishing system.

5.13.6 Components and parts of vehicles designed for use in coal mines shall be so designed that the outside surface temperature does not exceed 150 °C.

5.13.7 Where single conductor cables are used, they shall be designed and installed so as to avoid any hazard arising from induced current from magnetising fields, for example by causing dangerous levels of eddy currents to flow in adjacent metalwork, resulting in dangerous heating in the metallic frame of the vehicle.

5.13.8 Power transmission belts shall conform to ISO 1813.

5.13.9 In the case of vehicles operating in coal mines the monitoring device on hydraulic systems referred to in 5.4.1.12 shall also be designed to cut off automatically the power supply to the pump according to the manufacturer's specified temperature.

5.13.10 In the case of vehicles operating in coal mines the pneumatic systems shall incorporate a device which will automatically disconnect the power supply to the compressor in the event that the temperature of the air being discharged exceeding a value in the range 150 °C.

5.14 Noise

5.14.1 Noise reduction

5.14.1.1 Noise reduction at source at the design stage

Machinery shall be so designed and constructed that risks resulting from noise emission are reduced to the lowest level taking account of technical progress and the availability of means of reducing noise, in particular, at source.

When designing machinery, the available information and technical measures to control noise at source shall be taken into account. Guidelines for the design of low-noise machinery are given in EN ISO 11688-1:1998.

NOTE 1 EN ISO 11688-2:2000 gives useful information on noise generation mechanisms in machinery.

NOTE 2 In mining machinery, the main sources of noise are the engine and the hydraulic components and the cooling system. The engines are subject to an exhaust emission regulation without any requirements for noise emission in underground areas.

5.14.1.2 Noise reductions by protective measures

In addition to 5.14.1.1, it is recommended to equip the machines with protective measures/devices to reduce the noise emitted.

For example, the following measures may be applied:

— a cab;

— enclosure of the engine(s) and cooling system;

— exhaust muffle.

5.14.2 Information on noise emission

5.14.2.1 General

Information on noise emission shall be given by the manufacturer in the operation manual, see 7.1.

5.14.2.2 Sound Power level

Measurement to determine the sound power level shall be made according to ISO 6395.

5.14.2.3 Noise emission measurement at the driver's position

The sound pressure level at the driver's position shall be measured according to ISO 6396:2008.

NOTE 1 On machines fitted with a cab, the sound pressure level at the driver's seat should not exceed 85 dB(A).

NOTE 2 Noise emission values obtained from measurements are the way to verify the result of the noise reduction measures taken at the design stage (see 5.14.1.1 and 5.14.1.2).

5.15 Radiation

If radiating equipment is used on a vehicle, such as laser or measuring equipment, based on radio-active emissions, the relevant safety standards, e.g. EN 12254, EN 60825-4 and the instructions of the manufacturer of the appropriate component shall be complied with.

5.16 Stability

Mobile machinery with working equipment and/or attachments and optional equipment shall be designed and constructed so that stability is provided under all intended operating conditions including maintenance, assembling, dismantling, and transportation, as specified by the manufacturer in the operation manual.

5.17 Maintenance

5.17.1 General

Machines shall be designed and built so that the routine lubrication and maintenance operations can be carried out safely, whenever possible with the engine stopped. Where it is only possible to undertake checks or maintenance with the engine running, the safe procedure shall be described in the operation manual.

Openings intended for maintenance purposes shall comply with EN ISO 2860.

Preferable the design of the machine shall permit lubrication and filling of tanks from the ground.

5.17.2 Frequent maintenance

Components (batteries, lubrication fittings, filters etc.) which require frequent maintenance shall be easily accessible for checking and changing.

A lockable storage box shall be provided on the machine for tools and accessories as recommended by the manufacturer.

5.17.3 Support devices

On machines where maintenance can only be performed with equipment in a raised position, such equipment shall be mechanically secured with a device according to ISO 10533 and ISO 13333.

If the support device(s) is required for daily maintenance, then it shall be permanently fixed to the machine or be stored on a safe place on the machine.

Engine access panels shall be provided with a support device in open position.

5.17.4 Tilt-able cab support device

If the operator's cab has an integral tilt system for maintenance, servicing or other non-operational purpose, the cab or system shall be equipped with a support device to hold the cab in the fully raised or tilted position. This system shall meet the requirements of ISO 13333.

When a cab is tilted, a locking system of the controls shall be available to avoid unintended movement of the machine and equipment/attachment actuated by the controls located in the cab.

6 Verification of safety requirements

Verification shall be accomplished in accordance with Annex B.

NOTE Testing requirements according to ISO and EN standards referred to in this standard, should be made together with Annex B.

7 Information for use

7.1 Instruction handbook

7.1.1 General

The manufacturer of the vehicle shall provide, at the time of delivery, instruction handbook(s) containing information for the safe operation and maintenance of the vehicle. in the language of the country for which the machine is intended to be used. The instruction handbook shall be in accordance with 6.4.5 of EN ISO 12100:2010. This information shall include the duties and conditions under which the equipment is intended to be used, in particular with regard to:

— its intended use;

— any prohibitions on use, including restrictions in the area of trolley wire systems and information on any limitations of ambient operating temperatures, extremes of humidity;

— an overall description and drawing of the vehicle together with schematic diagrams of the electrical, hydraulic and pneumatic systems and the arrangement of controls, wear tolerances, etc.

— its main parameters, including a dimension of the machine, carrying capacity, gradient, speed, any limiting factors such as altitude and field of view etc.

— exhaust emission data;

— load per axle.

7.1.2 Instructions commissioning

The information shall include the need for a risk assessment concerning the relationship with the environment in which the vehicle is used.

Instructions for assembly/commissioning shall include:

— where necessary, verification of the correct re-assembly;

— verification of the addition of the required fluids, sand, etc;

— verification of the battery charging;

— verification of the control systems;

— verification of the safety devices;

— functional tests.

When the vehicle is supplied unassembled, the manufacturer shall provide with the equipment specifications preferably with drawings showing:

— instructions for assembly and installations;

— the maximum weights and dimensions and lifting points of the separate components supplied;

— the methods for safe handling of the components;

— electric, hydraulic and pneumatic connections;

— any special equipment for assembly and settings.

7.1.3 Instructions for the use of the equipment

The instruction handbook shall include, in addition to 6.4.5.1 a), b), c) and d) of EN ISO 12100:2010, the following requirements:

— information to operate the vehicle without exceeding the safe working or trailing load for all foreseen conditions of speed, gradient and roadway;

— a statement, that only competent personnel shall start, operate or interfere with the normal working of the equipment;

— the cleaning requirements in order to avoid dangerous accumulation of material/mineral;

— specification for fuels, lubricants and hydraulic fluids, including health and safety data sheets;

— instructions on lifting and crane age;

— information on procedures, attachments and facilities for towing;

— information on any ballast requirements (see 5.3);

— instruction that no modifications shall be carried out on the vehicle without reference to the manufacturer;

— instructions on the capacity and type of fire extinguisher to be used;

— instructions for operation of fire extinguishing equipment;

— information on the location of monitoring points, e.g. for fluid temperatures and pressures;

— information relating to safe working limits as shown on displays and on procedures to be followed in case of warning signals shown on displays;

— information on safe parking;

— information for put the vehicle out of use;

— information on operating restrictions to prevent brake fade occurring;

— information on safety for charging and changing of traction batteries;

— an operational checklist for the vehicle before starting by the driver;

— information on the need for the user to instruct the operator in restriction of use, in relation to the toxic emissions from the exhaust;

— advice about the possible hazards that can occur by leaning out of the vehicle;

— warning of the risk of pedestrian in the operating area of the vehicle;

— information about use of gloves when touching hot surfaces (such as dip sticks, radiator cap);

— advice on the need of doors and covers are fastened during operation;

— explanation of the pictograms fixed to the machine;

— advice on the use of the restraint systems;

— information of operators visibility; if the visibility according to 5.12.3 is restricted, instructions for safe operation shall be provided.

7.1.4 Instruction for maintenance

The instruction handbook shall be in accordance with 6.4.5.1 e) of EN ISO 12100:2010 and shall specify in particular:

— the technical knowledge and skills of the maintenance staff, specially for particular operations which need specific competence, and shall specify that all adjustments, whether mechanical or electrical, shall only be carried out by persons authorised to do so in accordance with a safe system of work and the manufacturer's instructions;

— the conditions under which maintenance works and rectification of faults can be performed e.g. the equipment is isolated, protected against unexpected start-up and measures taken against unexpected movements;

— a list of consumable parts (e.g. filters, drive belts) as well as the approximate frequency of verification and discard criteria;

— a list of wearing parts (e.g. brakes, clutches, tyres) as well as the approximate frequency of verification and discard criteria;

— a list of periodic checks, tests and adjustments;

— safe access means and room, e.g. platform, etc.;

— information of replacement of additional items removed to gain access during the maintenance procedure including covers and doors, etc;

— lifting and jacking points;

— instructions for maintenance and replenishment of fire extinguishing equipment;

— information on safety precautions for maintenance of traction batteries;

— special tools, e.g. insulated tools for battery maintenance, and wear measuring gauges;

— type of hoses used for fuel lines and hydraulic system;

— disposal instructions;

— data for verification of the braking systems, methods of testing and adjustment;

— inspection and renew if required of any marking on the vehicle.

7.1.5 Information on noise emission

The operation manual shall contain information on the sound power and the emission sound pressure level at the driver's position:

— the A-weighted sound power level emitted by the machine, where the equivalent continuous A-weighted emission sound pressure level exceeds 80 dB;

— the equivalent continuous A-weighted emission sound pressure level at the driver's position (see 5.14.2.3) where this exceeds 70 dB; where this level does not exceed 70 dB, this fact shall be indicated.

The declaration of these values shall have the format of a single number declaration as defined in EN ISO 4871:1996.

NOTE 1 EN ISO 4871:1996 provides a method to determine noise emission values to be declared and to verify the declared values. The methodology is based on the use of the measured values and measurement uncertainties. The latter are the uncertainty associated to the measurement procedure (which is determined by the grade of accuracy of the measurement method used) and the production uncertainty (variation of noise emission from one machine to another of the same type made by the same manufacturer).

NOTE 2 To the sound emission values declared in the operation manual under consideration of the recommendations above the uncertainties of these values should be calculated in accordance with ISO 6395:2008 (Annex N) for the sound power level and in accordance of ISO 6396:2008 (Annex A) for the emission sound pressure level.

NOTE 3 Information about noise emission should also be given in sales literature.

7.1.6 Information concerning hand-arm and whole-body vibration imission

The operation manual shall include information on hand-arm and whole-body vibration transmitted by the machine as follows:

— The vibration total value to which the hand-arms are subjected, if it exceeds 2,5 m/s^2. Where this value does not exceed 2,5 m/s^2, this must be mentioned.

  Experience has shown that the magnitude of hand-arm vibration on the steering wheel or control levers of mining machines with a (seated) ride-on operator is in general significantly below 2,5 m/s². In this case, it is sufficient to mention that the acceleration is below this limit.

— The highest root mean square of weighted acceleration to which the body is subjected, if it exceeds 0,5 m/s^2. Where this value does not exceed 0,5 m/s^2, this must be mentioned. The particular operating conditions of the machine relevant for the determination of this single value shall be indicated.

NOTE 1 This single whole-body imission value is determined under particular operating and terrain conditions and is therefore not representative for the various conditions in accordance with the intended use of the machine. Consequently, this single whole-body vibration imission value declared by the manufacturer in accordance with this European Standard is not intended to determine the whole-body vibration exposure to the operator using this machine.

NOTE 2 Information to the uncertainty of vibration measurements and the declaration and verification of vibration values are given in EN 12096:1997. For the estimation of the uncertainty are indicated in Table D.1 values of 0,4 and 0,5 of the measured vibration value in dependency on the vibration level.

Complementarily the operation manual may contain the following information, representative for the whole-body vibration imission at the operating conditions in accordance with the intended use of the machine:

— This machine is equipped with an operator‘s seat, which meets the criteria of EN ISO 7096:2008 representing vertical vibration input under severe but typical operating conditions. This seat is tested with the input spectral class EM...[1)] and has a seat transmissibility factor SEAT=....[2)].

— The whole-body vibration imission of the machine under representative operating conditions (according to the intended use of the machine) varies from below 0,5 m/s^2 to a maximum short term level for which the seat is designed in order to meet EN ISO 7096:2008, which is ….m/s^2 [3)] for this machine.

1) E.g. EM3 for a wheel loader according to Table 4 of EN ISO 7096:2000.

2) Given by the seat manufacturer.

NOTE 3 This method to determine the expected range of whole-body vibration imission is related to representative measurement data obtained for elaborating EN ISO 7096:2008.

NOTE 4 According to the state of the art the appropriate design of the operator's seat is the most effective construction measure to minimize whole-body vibration imission of a particular machine family.

NOTE 5 Due to different test track and test conditions the values of different manufacturers are not directly comparable.

7.2 Marking

7.2.1 The vehicle shall be fitted with a legible, easily visible metal plate marked (etched, engraved or stamped) marked with the following minimum information:

— business name and full address of the manufacturer and, where applicable, his authorised representative;

— designation of the machine;

— CE marking;

— designation of series or type;

— serial number, if any;

— year of construction, that is the year in which the manufacturing process is completed;

— nominal power, expressed in kilowatts (kW);

— operating voltage and frequency for electrically powered vehicles;

— mass of the most usual configuration in kilogramms (kg);

and, where appropriate:

— maximum drawbar pull provided for at the coupling hook, in Newtons (N);

— maximum vertical load provided for on the coupling hook, in Newtons (N).

NOTE The type plate does not remove the necessity for other markings required by other standards e.g. electrical equipment standards.

7.2.2 Attachment points for lifting, handling, transport, assembly and dismantling shall be permanently marked.

7.2.3 Where the vehicle is constructed in separate sections or sub-assemblies to facilitate handling and transport, the weight of each such section or sub-assembly and the position of lifting points shall be permanently and unambiguously marked on it.

7.3 Warnings

7.3.1 Danger zones, as defined in 3.11 of EN ISO 12100:2010 (e.g. brakes, transmission belts, fans) shall be identified and marked in accordance with ISO 3864.

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3) Maximum short term level $a_{wS12\ max}$ will be determined as follows: $a_{wS12\ max} = SEAT \times a^*_{wP12}$; machine specific value a^*_{wP12}, see Table 4 of EN ISO 7096:2000.

The following pictograms shall be displayed in the cab:

Symbols	Referent	Colours
	Warning. Articulation areas Crushing hazard	Background: yellow Triangular band: black Symbol: black
	Warning. Battery box. Risk of explosion	Background: yellow Triangular band: black Symbol: black
	Warning. Fan blades	Background: yellow Triangular band: black Symbol: black
	Warning. Fan belts	Background: yellow Triangular band: black Symbol: black
	Warning. Wheels	Background: yellow Triangular band: black Symbol: black

7.3.2 In the case of trolley vehicles, warning signs shall be provided on the vehicle indicating the presence of power supply live conductors.

Annex A
(normative)

Brake testing

A.1 Test conditions

A.1.1 Precautions specified by the manufacturer shall be considered while carrying out performance tests.

A.1.2 The tests shall be performed with instruments which determine:

a) the vehicle deceleration, such that compliance with 5.10.2 and 5.10.3 can be measured and/or calculated;

b) the maximum force applied to the braking control to achieve this deceleration;

c) the response time; and

d) where applicable, pulling force for parking brake testing.

A.1.3 Where possible, the engine shall be disengaged from the transmission during the braking tests. Where the engine cannot be disengaged from the transmission, the highest gear consistent with the test speed shall be selected.

In the case of hydrostatic transmission, the transmission circuit shall be bypassed when testing any other braking system.

A.1.4 The test speed shall be the maximum speed of the vehicle, at level surface, except that if the maximum speed of the vehicle exceeds 32 km/h, the test speed may be any speed between 32 km/h and the maximum speed.

A.1.5 The test course shall consist of a hard, dry surface with a well-compacted base.

NOTE Ground moisture can be present to the extent that it does not adversely affect the braking test.

The test course shall have a gradient of not more than 3 % at right angles to the direction of travel.

The approach to the test course shall be of sufficient length and smoothness to ensure the required vehicle speed is reached before the brakes are applied.

A.1.6 Tests shall be performed at maximum vehicle weight with axle load distribution as specified by the manufacturer.

Where the vehicle braking system is designed to produce reduced braking effort in unladen conditions, tests of the unladen vehicle shall also be performed.

A.1.7 All parameters relating to braking systems, e.g. tyre size and pressure, brake adjustment, etc, shall be within the vehicle manufacturer's specifications. All braking system pressures shall be within the vehicle manufacturer's specification range. No manual adjustment(s) shall be made to the braking system during any single performance test.

A.1.8 Retarders shall not be used during the tests.

A.1.9 Blades, buckets, dozers and other equipment shall be carried in the transport position recommended by the manufacturer.

A.1.10 All brake tests shall be performed with burnished (conditioned) brakes.

The burnishing procedure shall be checked by consulting the brake manufacturer.

A.1.11 All fluids, e.g. engine and transmission oils, shall be at normal operating temperature before commencing test.

A.2 Performance of tests

A.2.1 Control force (see 5.10.1.12)

The forces applied to the braking system controls in order to achieve the maximum braking effort shall be measured and shall not exceed the values given in 7.1.1, Table 1 of EN ISO 3450:2008.

A.2.2 Stored energy for hydraulic brakes (see 5.10.2.3)

NOTE For this test, a test point is required in the brake line near the brakes to enable actuating pressure to be monitored.

The service brake reservoir shall be fully charged and than the power supply shall be shut-off.

Five full service brake applications shall be made with the vehicle stationary, and the brake actuating pressure noted at the end of the fifth application.

The vehicle shall then undergo a dynamic service brake test (see A.2.4) from the test speed with the driver controlling the service brake pressure to the value noted.

The performance of the service brake in this test shall conform to 5.10.2.3 and 5.10.3.

Where a warning device is provided, it shall be tested in accordance with 7.4 of EN ISO 3450:2008.

A.2.3 Parking brake (see 5.10.4)

A.2.3.1 Where the parking brake is also the secondary brake, a holding test is not required. The dynamic tests (see A.2.4) to confirm compliance with the requirements of 5.10.3 for the secondary brake are deemed to show that the parking brake requirements of 5.10.4.1 are also met, i.e. the 1,2 safety factor required by 5.10.4.1 is covered by the difference between static and dynamic friction inherent in the brake and the residual braking effort from the secondary brake on the maximum gradient.

A.2.3.2 Where the parking brake is separate from the secondary brake, it shall be subjected to:

a) a dynamic test, or

b) a static gradient test, or

c) a pull test.

A.2.3.2.1 **Dynamic test**

A dynamic test shall be performed according to A.2.4.2 with the parking brake. If the brake meets the requirements of 5.10.3, then as described in A.2.3.1 above, it is deemed to have met the parking brake requirement of 5.10.4.1.

A.2.3.2.2 Gradient test

The vehicle shall be positioned on a slope 1,2 times the maximum gradient on which it is designed to operate (e.g. if maximum operating gradient is 20 %, test gradient is 24 %), and the parking brake applied. The brake shall be capable of holding the machine stationary.

The test gradient may be either a roadway or a tilt platform with skid-resistant surface.

A.2.3.2.3 Pull test

A pulling force shall be applied to the stationary vehicle with the parking brake applied and with the transmission in neutral on a test course with no more than 1 % downward slope in the direction of travel.

The pulling force shall be applied horizontally. The force achieved shall equal or exceed F in newtons according to the following equation:

$$F = G/100 \times M \times g$$

where

M is the maximum vehicle weight, in kg;

g is the acceleration due to gravity, in m/s² ;

G is the maximum gradient on which the vehicle is designed to operate, as a percentage (not less than 15 %).

A.2.4 Dynamic tests

All dynamic tests, with the exception of the heat fade test (see A.2.4.1.3) shall be performed with cold brakes as defined in 7.6.2 of EN ISO 3450:2008. Additionally, totally enclosed brakes, including oil-immersed brakes, shall be considered cold if the temperature measured on the outside of the housing closest to the brake is below 50 °C or within the manufacturer's specifications.

A.2.4.1 Service brake

A.2.4.1.1 Brake effort

The maximum brake effort shall be determined as the minimum result of a test series of at least four individual tests. In the case of vehicles designed for normal operation in either direction, there shall be at least two individual tests in each direction. The requirements of 5.10.2.1 and 5.10.2.2 shall be met in any direction.

A.2.4.1.2 Brake application time

The brake application time shall be determined either from the recorded measurements of the tests in A.2.4.1.1 above, or, in the case of brakes applied or released by fluid pressure, it may be determined by timed static pressure tests using a pressure transducer to measure brake actuating pressure. In this case, the result shall be the maximum of at least four individual tests, and shall conform to 5.10.1.4.

A.2.4.1.3 Heat fade

The service brakes shall be applied and released for seven consecutive stops at, or as near as possible, to the maximum speed and deceleration of the vehicle without skidding. After each stop the initial test speed shall be regained quickly using maximum acceleration. An eighth stop shall be made with measured deceleration. On the eighth test, the brake effort shall be not less than that specified in 5.10.2.1 and 5.10.2.2. The information gained in

the heat fade tests shall be used in determining the specified gradient and load operating conditions for the vehicle.

A.2.4.2 Secondary brake

Tests to determine the brake effort and brake application time of the secondary brake shall be as described for the service brake in A.2.4.1.1 and A.2.4.1.2.

A.2.5 Test report

The test report shall conform to Clause 8 of EN ISO 3450:2008 where appropriate.

Annex B
(normative)

Verification data for safety requirements

Table B.1 — Verification data for safety requirements

T = Type testing EN 1889-1 M = Manufacturing test (on every machine built)

Clause	Calcu-lation check (1)	Design check (2)	Comp-liance (3a)	Measure-ment (3b)	Visual Examina-tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.1.1									
5.1.2		T	T	T+M					
5.1.3		T	T+M						
5.1.4		T	T+M						
5.1.5		T	T+M	T					
5.1.6									
5.2	T	T	T+M		M				
5.3	T	T	T+M						
5.4.1.1		T	T						
5.4.1.2		T	T+M						
5.4.1.3		T	T+M						
5.4.1.4		T	T		M				
5.4.1.5		T	T		M				
5.4.1.6		T	T+M						
5.4.1.7	T	T	T					T+M	
5.4.1.8	T	T	T+M						M

Table B.1 *(continued)*

Clause	Calcu-lation chec k (1)	Design check (2)	Comp- lianc e (3a)	Measure-ment (3b)	Visual Examina -tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.4.1.9		T	T		M				
5.4.1.10	T	T	T				T+M		
5.4.1.11	T	T							M
5.4.1.12	T	T							
5.4.2.1		T	T						
5.4.2.2		T	T+M						
5.4.2.3		T			M				
5.4.2.4		T							M
5.5.1.1		T	T+M						
5.5.1.2		T	T+M						
5.5.1.3		T	T+M						
5.5.2.1		T	T		T+M				
5.5.2.2		T			T+M				
5.5.2.3		T	T+M	T+M					
5.5.2.4		T	T		M				M
5.5.3.1		T	T+M						
5.5.3.2		T	T+M						
5.5.3.3	T	T	T+M	T+M					
5.5.3.4		T	T+M						
5.5.3.5		T	T+M						
5.5.4.1		T	T+M						
5.5.4.2	T	T	T+M						

Table B.1 *(continued)*

Clause	Calcu-lation chec k (1)	Design check (2)	Comp-lianc e (3a)	Measure-ment (3b)	Visual Examina -tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.5.4.3		T	T+M						
5.5.4.4		T	T						
5.5.4.5	T	T	T						
5.5.4.6	T	T	T+M						
5.5.4.7	T	T	T+M						
5.5.4.8		T	T+M						
5.5.5.1		T							
5.5.5.2		T	T+M				M		
5.5.5.3		T	T	T+M					
5.5.5.4		T	T		T+M				
5.5.5.5		T	T+M				T+M		
5.5.5.6		T	T						
5.6.1		T							M
5.6.2		T	T						
5.6.3			T	T+M					
5.7.1	T	T	T+M						
5.7.2		T	T	T	M				
5.7.3		T	T		M				
5.7.4		T			M				
5.7.5		T							

Table B.1 *(continued)*

Clause	Calcu-lation chec k (1)	Design check (2)	Comp- lianc e (3a)	Measure-ment (3b)	Visual Examina -tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.7.6		T	T+M						
5.7.7		T	T+M						
5.8.1		T	T		T+M				M
5.8.2		T	T+M						
5.8.3		T							
5.8.4		T	T+M						
5.8.5		T	T+M						
5.8.6		T	T+M						
5.8.7		T	T						
5.9.1		T	T				M		
5.9.2		T	T				M		
5.9.3		T							
5.10.1.1	T	T							
5.10.1.2	T	T							
5.10.1.3		T	T						
5.10.1.4	T	T	T						
5.10.1.5		T	T+M			T+M			
5.10.1.6		T	T+M						
5.10.1.7		T	T+M						
5.10.1.8		T	T						
5.10.1.9		T	T						
5.10.1.10		T	T						
5.10.1.11	T	T	T+M						
5.10.1.12	T	T	T+M						
5.10.2.1	T	T	T			T+M			

Table B.1 *(continued)*

Clause	Calcu-lation chec k (1)	Design check (2)	Comp-lianc e (3a)	Measure-ment (3b)	Visual Examina -tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.10.2.2	T	T	T			T+M			
5.10.2.3		T	T+M						
5.10.2.4	T	T	T			T			
5.10.3.1	T	T	T			T+M			
5.10.3.2		T	T			T+M			
5.10.3.3		T	T			T			
5.10.3.4		T	T						
5.10.4.1	T	T	T	M		M			
5.10.4.2		T	T+M						
5.10.4.3		T	T+M						
5.10.4.4		T	T						
5.10.4.5		T	T+M						
5.11.1.1		T	T						
5.11.1.2		T	T				T+M		
5.11.1.3		T	T						
5.11.2.1		T	T	T	T+M				
5.11.2.2		T	T						
5.11.2.3		T	T+M						
5.11.2.4		T	T+M						
5.11.2.5		T	T+M						
5.11.2.6		T	T				T+M		
5.11.3		T	T+M						

Table B.1 *(continued)*

Clause	Calcu-lation chec k (1)	Design check (2)	Comp- lianc e (3a)	Measure-ment (3b)	Visual Examina -tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.11.4.1		T	T						
5.11.4.2		T							
5.11.4.3		T	T						
5.11.4.4.1		T	T				T+M		
5.11.4.4.2		T	T				T+M		
5.11.4.4.3		T	T				T+M		
5.12.1.1		T	T						
5.12.1.2	T	T	T+M						
5.12.2.1		T	T+M						
5.12.2.2		T	T+M						
5.12.2.3		T	T				M		
5.12.2.4		T	T				M		
5.12.3.1		T	T+M						
5.12.3.2		T	T				T+M		
5.12.3.3		T	T				M		
5.12.4.1		T	T						
5.12.4.2		T	T+M						
5.12.4.3		T	T+M						
5.12.4.4		T							
5.12.4.5		T	T						
5.12.4.6		T	T		M				
5.13.1		T	T+M						
5.13.2		T	T+M						
5.13.3	T	T	T+M						
5.13.4		T	T	T					
5.13.5		T	T				T+M		

Table B.1 *(continued)*

Clause	Calcu-lation chec k (1)	Design check (2)	Comp- lianc e (3a)	Measure-ment (3b)	Visual Examina -tion (3c)	Dynamic test (4)	Functional test (5)	Protection device test (6)	Other suppliers docume-ntation (7)
5.13.6		T	T						
5.13.7	T	T	T+M						
5.13.8		T	T+M						
5.13.9		T	T						M
5.13.10		T	T				M		M
5.14				T					
5.15			T	T			M		T
5.16	T	T					T+M		
5.17			T						

Type verification:

1. **Calculation check**, the result of which being that the calculations are correct made according to the standard requirements or not. Another possibility of calculation check is to replace, if the results are equivalent, by tests with stress measurement.

2. **Design check**, the result of which being to prove that the design requirements of the standard have been matched “on paper” or not.

3. Individual verification of each type covering:
   — **Compliance verification** (manufacturing check), the results of which being to prove that the machine is built according to the design and that the materials and their assemblies comply with the design documents and are sound. This check may include any means of verification e.g.*

   — ***Measurement,** the result of which being that the stated measurable parameters have been met with the tolerances required in the C standard or accepted (e.g. given in other general standards such as tolerances on dimensions)

   — ***Visual examination**, the result of which only being to establish that something is present (a guard or a marking for example) without any appreciation of the quality and characteristics thereof.

4. **Dynamic test(s)**: tests out of the range of functional tests, the results of which being to establish that the dynamic testing requirements are satisfied, that all safety devices and their adjustments are adequate and the result of their actuation is as intended.

5. **Functional tests**: the results of which showing that in its normal cycle or part of cycle, the machine works as intended, including all safety devices. Where only parts of machines are in the scope of the standard, these tests show that the adequate signals intended to be forwarded to the main control system of the final machine are available and comply with the requirements and with the technical documentation.

6. **Test of overloading protection devices**: the result of which being to show that these safety devices work.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2006/42/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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