

Mobile road construction machinery — Safety —

Part 1: Common requirements

The European Standard EN 500-1:2006 has the status of a
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National foreword

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Foreword

This document (EN 500-1:2006) has been prepared by Technical Committee CEN/TC 151 "Construction equipment and building material machines — Safety", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2007, and conflicting national standards shall be withdrawn at the latest by October 2008.

This document supersedes EN 500-1:1995.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

EN 500 "Mobile road construction machinery — Safety" comprises the following parts:

- Part 1: Common requirements;
- Part 2: Specific requirements for road-milling machines;
- Part 3: Specific requirements for soil-stabilising machines and recycling machines;
- Part 4: Specific requirements for compaction machines;
- Part 6: Specific requirements for paver-finishers.

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

Introduction

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

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

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.

1 Scope

1.1 This part of EN 500 specifies the common safety requirements for mobile road construction machinery¹⁾. The EN 500 series is applicable to mobile road construction machinery as listed in Annex A. When no specific standard exists, EN 500-1 applies.

It specifies common requirements for the design and construction of mobile road construction machinery in order to protect workers from accidents and health hazards which could occur during operation, loading, transport and maintenance.

Additional specific requirements for certain types of mobile road construction machinery are given in parts 2 to 4 and 6 of this standard.

This part of this standard gives safety requirements for all types of mobile road construction machinery and shall be used in conjunction with one of the parts 2 to 4 and 6. These machine-specific parts do not repeat the requirements from part 1 but add to or replace the requirements for the type of mobile road construction machinery in question.

Machine-specific requirements in parts 2 to 4 and 6 take precedence over the respective requirements of this standard.

For types of mobile road construction machinery not dealt with in parts 2 to 4 and 6, EN 500-1 applies.

1.2 This European Standard deals with all significant hazards, hazardous situations and events relevant to mobile road construction machinery, when they are used as intended and under conditions of misuse which are reasonably foreseeable (see Clause 4).

This European Standard specifies the appropriate technical measures to eliminate or reduce risks arising from the significant hazards as specified in Clause 4.

1.3 This European Standard applies to machines which are manufactured after the date of publication of this European Standard by CEN.

1) For travelling on traffic roads, the national traffic regulations apply.

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.

CR 1030-1:1995, *Hand-arm vibration — Guidelines for vibration hazards reduction — Part 1: Engineering methods by design of machinery*

EN 3-7:2004, *Portable fire extinguishers — Part 7: Characteristics, performance requirements and test methods*

EN 286-2:1992, *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 418:1992, *Safety of machinery — Emergency stop equipment, functional aspects — Principles for design*

EN 811:1996, *Safety of machinery — Safety distances to prevent danger zones being reached by the lower limbs*

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

EN 12643:1997, *Earth-moving machinery — Rubber-tyred machines — Steering requirements (ISO 5010:1992 modified)*

EN 13309:2000, *Construction machinery — Electromagnetic compatibility of machines with internal electrical power supply*

EN 60204-1:1997, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:1997)*

EN 60529:1991, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

EN 61310-1:1995, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, auditory and tactile signals (IEC 61310-1:1995)*

EN ISO 2860:1999, *Earth-moving machinery — Minimum access dimensions (ISO 2860:1992)*

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

prEN ISO 3411:2005, *Earth-moving machinery — Human physical dimensions of operators and minimum operator space envelope (ISO/DIS 3411:2005)*

EN ISO 3457:2003, *Earth-moving machinery — Guards — Definitions and requirements (ISO 3457:2003)*

EN ISO 3744:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane (ISO 3744:1994)*

EN ISO 3746:1995, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746:1995)*

EN ISO 5353:1998, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point (ISO 5353:1995)*

EN ISO 6682:1995, *Earth-moving machinery — Zones of comfort and reach for controls (ISO 6682:1986 including Amendment 1:1989)*

EN ISO 11201:1995, *Acoustics — Noise emitted by machinery and equipment — Measurement of emission sound pressure levels at a work station and at other specified positions — Engineering method in an essentially free field over a reflecting plane (ISO 11201:1995)*

EN 500-1:2006 (E)

EN ISO 11688-1:1998, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1:1995)*

EN ISO 12100-1:2003, *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology (ISO 12100-1:2003)*

EN ISO 12100-2:2003, *Safety of machinery — Basic concepts, general principles for design — Part 2: Technical principles (ISO 12100-2:2003)*

IEC 60364-4-41:2001, *Low-voltage electrical installations — Part 4- 41: Protection for safety — Protection against electric shock*

IEC 60364-5-55:2001, *Electrical installations of buildings — Part 5-55: Selection and erection of electrical equipment — Other equipment*

ISO 3795:1989, *Road vehicles and tractors and machinery for agriculture and forestry — Determination of burning behaviour of interior materials*

ISO 5006-1:1991, *Earth-moving machinery — Operator's field of view — Part 1: Test method*

ISO 6405-1:2004, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

ISO 6750:2005, *Earth-moving machinery — Operator's manual — Content and format*

ISO 9244:1995, *Earth-moving machinery — Safety signs and hazard pictorials — General principles*

ISO 9533:1989, *Earth-moving machinery — Machine-mounted forward and reverse audible warning alarm — Sound test method*

ISO 10261:2002, *Earth-moving machinery — Product identification numbering system*

ISO 10570:2004, *Earth-moving machinery — Articulated frame lock — Performance requirements*

ISO 11112:1995, *Earth-moving machinery — Operator's seat — Dimensions and requirements*

ISO 11862:1993, *Earth-moving machinery — Auxiliary starting aid electrical connector*

ISO 12508:1994, *Earth-moving machinery — Operator station and maintenance areas — Bluntness of edges*

ISO 12509:2004, *Earth-moving machinery — Lighting, signalling and marking lights, and reflex-reflector devices*

ISO 13333:1994, *Earth-moving machinery — Dumper body support and operator's cab tilt support devices*

ISO 14396:2002, *Reciprocating internal combustion engines — Determination and method for the measurement of engine power — Additional requirements for exhaust emission tests in accordance with ISO 8178*

ECE R34, Annex 5, *Uniform provisions concerning the approval of vehicles with regard to the prevention of fire risks. Testing of fuel tanks of a plastic material*

3 Terms and definitions

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

3.1

mobile road construction machinery

machine intended for construction, maintenance and marking of roads

NOTE The machines are listed in Annex A.

3.2

machine mass

3.2.1

operating mass

mass of the base machine with all standard equipment, with or without cab, with or without ROPS etc., with operator (75 kg) plus half full fuel tank and all fluid systems, when applicable, with sprinkler water tank half full

3.2.2

maximum mass

operating mass with all components required for their attachment to the base machine (e.g. ballast and all combinable options), and full sprinkler water tank

3.3

hold-to-run control

device by which the operating function is only carried out as long as the control is actuated. The operation is automatically reset into hazardless conditions as the control is released

3.4

pedestrian-controlled machine

self-propelled mobile road construction machine where the control of the machine is undertaken by an attending operator or by remote control

4 List of significant hazards

This clause contains all significant hazards, as far as they are treated in the set of standards for mobile road construction machinery, identified by risk assessment as significant for mobile road construction machinery defined in 1.1 and which require action to eliminate or reduce risk.

The risks arising from the hazards listed in Annex F are eliminated or minimised by combining the technical measures given in Clause 5 and those given in the machine-specific parts.

5 Safety requirements and/or protective measures

5.1 General

Mobile road construction machinery shall comply with the safety requirements and/or protective measures of this clause.

In addition, the machines shall be designed according to the principles of EN ISO 12100 for hazards relevant but not significant which are not dealt with by this European Standard (e.g. sharp edges).

5.2 Lighting, signalling and marking lights and reflex-reflector devices

Self-propelled mobile road construction machines for ride-on operators shall be fitted with working lights.

Lighting, signalling and marking lights and reflex-reflector devices shall comply with the appropriate clauses of ISO 12509.

5.3 Operation and handling

5.3.1 Uncontrolled motion

Machine-, equipment- or attachment-movement from the holding position (except for setting controls by the operator), e.g. due to drifting and/or creeping (e.g. caused by leakage of oil) shall only be possible in such a way that these do not create a hazard to exposed persons. For additional requirements, see machine-specific parts of EN 500.

5.3.2 Retrieval, transportation, lifting and towing

5.3.2.1 General

The devices for retrieval, tie-down, lifting and towing may be the same if allowed by the configuration of the machine.

5.3.2.2 Lifting (slinging) points for lifting and loading

Appropriate lifting points (e.g. lugs, lifting-eyes or -lugs) shall be fitted to ensure safe loading, retrieval and transportation.

The attachments shall facilitate reliable fitting of the lifting tackles and be arranged in such a way as to contribute to safe anchoring of the machine during lifting and recovery.

For mobile road construction machinery with an operating mass less or equal to 40 kg, such lifting points can have the form of a handle.

The method of lifting heavy attachments, components and machines which are transported in parts shall be described in the instruction handbook.

Lifting points shall to be easily identified on the machine, e.g. marked by symbol 7.23 of ISO 6405-1:2004, and described in the instruction handbook.

5.3.2.3 Tie-down points

Appropriate tie-down points shall be provided for the safe transportation of the machines.

Tie down points shall to be easily identified on the machine, e.g. marked by symbol 7.27 of ISO 6405-1:2004, and described in the instruction handbook.

5.3.2.4 Towing points

Mobile road construction machinery with an operating mass greater than 2 000 kg shall be equipped with towing points (hooks, rings, ears) to allow slow towing and retrieval out of possible danger-zone. Their location, permissible forces, the procedure of towing as well as the maximum towing speed shall be clearly described in the instruction handbook.

5.3.2.5 Fixing of movable elements

Means shall be available to prevent moving of movable parts which could exceed the permissible transport width during transport (e.g. hydraulic or mechanical devices).

5.3.3 Pedestrian-controlled machinery

The maximum travel speed of mobile road construction machinery controlled by an attending operator shall be limited to 6 km/h. If the controls are located at the rear of the machine, the reverse speed shall be limited to 2,5 km/h.

When operating downhill at the maximum gradeability, the travel speed of the machine shall not increase more than 2 m/min with the speed selector in its pre-set position.

5.3.4 Steering system

Mobile road construction machinery shall be provided with a steering system that ensures safe steering with consideration to the rated speed of the machine and its stopping capability. Rubber-tyred mobile road construction machinery with a ride-on operator, having a speed capability exceeding 20 km/h, shall be equipped with a steering system that conforms to EN 12643. The steering shall be such that the movement of the steering control corresponds to the intended direction of steering.

5.3.5 Tyres and rims

Rims shall be easily identified (see e.g. ISO 4250-3). Instructions regarding safety rules, pressure, inflation and checking shall be provided in the operation manual.

Special precautions shall be taken when ballasted tyres are used and warnings shall be specified in the instruction handbook.

5.3.6 Storage facilities

Easily accessible storage facilities for the instruction handbook and for any special tools supplied shall be provided.

5.4 Operator's station

5.4.1 General

The operator's station shall meet the following minimum requirements:

- operator's space envelope shall conform to prEN ISO 3411;
- edges shall be shaped in accordance with ISO 12508;
- the engine exhaust system shall direct the exhaust gas away from the operator and of the air inlet into the cab;
- floor material shall be slip-resistant (see 5.9);
- mobile road construction 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 that are necessary for the intended use of the machine;
- if the requirements cannot be met by direct view and through rear view mirrors and where hazards due to restricted visibility exist, indirect visibility with, preferably CCTV or detecting systems, e.g. ultra-sonic warning device, can additionally be provided.

NOTE Visibility standards are under preparation.

5.4.2 Operator's station with cab

Mobile road construction machinery with an operating mass > 4 500 kg shall be so designed that an operator's cab can be fitted. Cabs shall meet the following minimum requirements:

- the operator shall be protected against foreseeable environmental and extreme climatic conditions. Provisions shall be made for installation of the following systems: adjustable heating and ventilation, defrosting and pressurisation, if required;
- enclosure openings shall meet the requirements of EN ISO 2867;
- it shall be possible to keep doors, windows and hoods opened or closed. Uncontrolled self-acting and movement shall not occur. In the case of horizontally divided doors, the locking devices shall be rigid and located at the inner side of the upper door. The locking devices shall be able to be safely operated from the related operator's place;
- doors and windows latched in open positions shall not extend beyond the main outer dimensions of the machine, when the machine is in intended operation;
- an easily accessible emergency exit shall be provided and marked if the cab is provided with only one access door. The marking shall be in accordance with EN 61310-1. Roof windows can also be used as an emergency exit. If the emergency exit shall be insured by a hammer pane breaker, it shall be provided and stored in the cabin, at the hand of the operator;
- front windows shall be provided with motor-driven wipers, washers and a demister. This requirement shall apply for all directions of travel considered in the design of the machine;
- inner lighting shall be provided (capable to function with the engine stopped);
- if a heating and ventilation system is fitted, it shall:
 - either comply with ISO 10263-4;
 - or have a capacity of increasing the temperature of the air inside the cab and maintain a temperature of + 18°C at expected ambient temperature. The capacity of the heating system shall have a ΔT of + 28 K within 30 min.

Measurement of the heating system capacity shall be made at three points. The three points shall be located in a vertical plane through the SIP and parallel to the longitudinal axis of the machine as follows (see Figure 1):

- a filament position centre-point as defined in ISO 5006-1;
- at the SIP as defined in EN ISO 5353;
- 100 mm above floor plate and 600 mm in front of SIP.

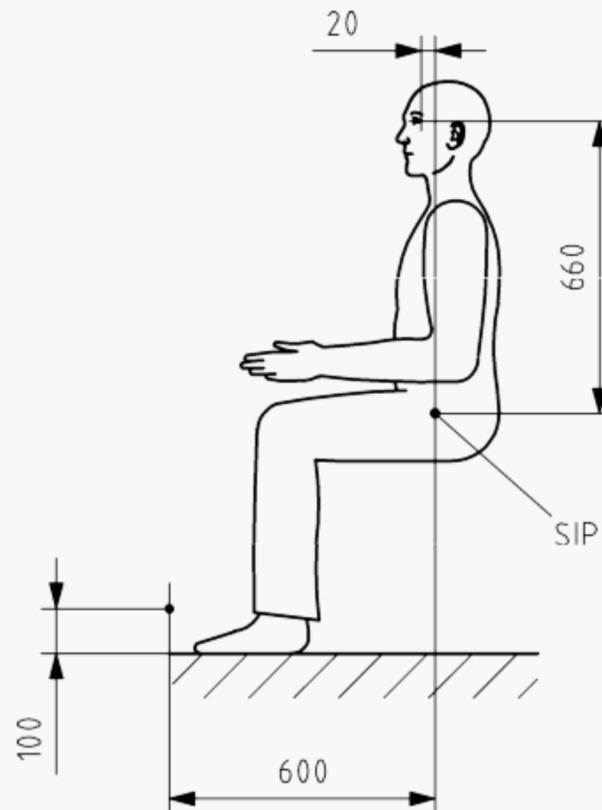


Figure 1 — Location of measuring points

Alternatively the heating capacity can be determined by calculation.

The ventilation system shall be capable of providing the cab with fresh air at the minimum of 20 m³/h. If a filter is required due to operating environment conditions, it should be tested according to ISO 10263-2.

NOTE The filter element selection depends on the operating environment conditions.

- windows including roof windows shall be made of safety glass or other material which provides similar performance (see e.g. ECE R43). Roof windows do not need to fulfil additional safety requirements;
- if the cab needs to be tilted for maintenance and service, it shall be equipped with a tilt support device according to ISO 13333.

5.5 Operator's seat

Machinery with provision for a seated operator shall be fitted with an adjustable seat to support the operator in a position that allows the operator to control the machine under all expected operating conditions.

Dimensions and adjustment of the seat shall comply with ISO 11112.

If a suspension system is fitted, it shall be adjustable to the operator's weight of at least from 55 kg to 110 kg.

5.6 Controls and indicators

5.6.1 General

The main controls and indicators (hand levers, pedals, switches etc.) shall be designed and arranged so that:

- a) they are of easy access in accordance with EN ISO 2860, EN ISO 6682 and prEN ISO 3411;
- b) their function is clearly identified (see ISO 6405-1) in the operator's station and explained in the instruction handbook (see Clause 6);

- c) the movement to activate the controls and indicators shall correspond to the intended effect or common practice except otherwise required by application;
- d) when a control is designed and constructed to carry out several functions, e.g. keyboard, joystick control, the activated function shall be clearly identified.

5.6.2 Controls

5.6.2.1 Neutral position

All controls shall return to their neutral position when control of them is released unless such functions dictate otherwise, such as:

- continuously activated;
- automatically activated;
- having a functionally related detent position.

5.6.2.2 Operating force

The operating forces of the controls shall not exceed the values given in Table 1.

Table 1 — Operating forces

Controls operated by	Controls	Maximum force N
Hand	lever forward/backward	230
	lever, sideways	100
	lever, upwards	400
	lever, downwards	300
Foot	pedal	450
	treadle centre pivoted	230
Toe	pedal	90
Fingertip	lever or switch	20

5.6.2.3 Controls located on or close to hot surfaces

Controls shall not become warmer than 45 °C during operation at an ambient temperature of 25 °C and shall be situated sufficiently far away from warm areas to ensure that burns are prevented (see EN 563).

5.6.2.4 Inadvertent activation

Controls which can cause a hazard due to inadvertent activation shall be so arranged or deactivated or guarded that they cannot be activated inadvertently and in particular when the operator gets into/out of the operator's station.

5.6.2.5 Remote control

The controls of remote control devices shall correspond to the function of the controls on the machine.

NOTE An ISO standard (ISO 15817) has recently been published. Investigation should be made for reference.

5.6.2.6 Travel control on ride-on mobile road construction machines

Ride-on operated machines where the travel controls are accessible from the ground shall be equipped with devices (e.g. doors, windows, guards or by interlocking systems) to minimise the possibility of uncontrolled travelling of the machine by actuating the control if the operator is not on the operator's station.

5.6.2.7 Pedals

Pedals shall have an appropriate size, shape and be adequately spaced. The pedal shall have slip-resistant surface and be easy to clean.

5.6.2.8 Machines with additional driver's positions

If there are two or more driver's positions, each position shall be provided with all the required controls.

5.7 Starting

5.7.1 Machines with electric, pneumatic or hydraulic engine/motor starter shall be equipped with a neutral start function which shall prevent starting the engine, unless the dangerous functions are set into the hazardless mode.

The function of the neutral start procedure shall be described in the instruction handbook.

5.7.2 Mobile road construction machinery shall be so designed that unauthorised access to engine motor start and operation is prevented.

In case of electrical starter, unauthorised engine/motor start may be prevented by one of the following means:

- a lockable cab;
- a lockable cover for the starter switch;
- a starter key-lock (see ISO 10264);
- a lockable battery isolation switch.

5.7.3 The starting devices for engines/motors shall be so located and designed that the operator is protected against hazards that may occur when starting.

This can be achieved e.g. by means of:

- electrical starter;
- pneumatic starter;
- hydraulic starter;
- spring tension starter;
- starting crank;
- reversing starter.

Starting cranks shall conform to Annex B. Easily accessible storage facilities for starting cranks, e.g. a retaining bracket, shall be provided.

The use of the starting device shall be described in the instruction handbook.

5.8 Stopping

5.8.1 Emergency stop

An emergency stop shall be fitted within the zone of comfort as specified in EN ISO 6682. It shall stop all dangerous functions of the machine. The emergency stop shall meet the requirements of EN 418.

5.8.2 Hold-to-run control

Hold-to-run control for travelling shall be provided on all walk-behind operated machines with a speed capability exceeding 0,5 km/h.

5.8.3 Braking systems

Mobile road construction machinery shall be equipped with a service, secondary and a parking brake system, efficient under all conditions of service, load, speed, state of ground and slope foreseen by the manufacturer and corresponding to the situations normally encountered.

5.9 Access systems to the operator's station and to maintenance points

Access systems shall conform to EN ISO 2860, ISO 12508 and EN ISO 2867 except that the lowest steps of the access systems to the operator's station shall not be situated more than 600 mm above the ground level.

All surfaces of the access system shall be permanently slip-resistant (see 3.6 and 4.1.5 in EN ISO 2867:2006).

Walkways to operator's stations and platforms shall be provided with guard-rails if the vertical drop exceeds 1 m. Otherwise the requirements of EN ISO 2867 shall be met.

5.10 Protection

5.10.1 General

If mobile road construction machines are intended to be used in contaminated environment, special precautions to protect the operator (e.g. fresh air filter systems or compressed-air equipment) shall be taken. Hazardous areas which can be reached from operator's stations and their access and other machine-dependent work places shall be provided with appropriate protection devices.

NOTE 1 An amendment to EN 474 is under development. Investigation should be made for reference.

NOTE 2 ROPS and FOPS are not required for road construction machinery with the exception of the requirement for ROPS for rollers and compactors as specified in EN 500-4.

5.10.2 Guards

5.10.2.1 General

Guards shall be designed to be securely held in place and to prevent access to hazardous areas and parts.

Guards shall comply with EN ISO 3457.

Engine cowlings are considered as a separating protection device.

For safety distances between moving parts and protection devices, see EN ISO 3457 and EN 811.

Access under guards shall be prevented according to Annex A of EN 811:1996. If the height of the opening under a guard is lower than or equal to 200 mm, Annex C applies.

NOTE Use of warning signs is described in 5.14.

5.10.2.2 Movable guards

Guards in areas where frequent access for maintenance and inspection work is necessary, shall be movable and captivated to the machine. They shall, as far as possible, remain attached to the machine when opened.

Guards shall be fitted with a support system (e.g. springs, gas cylinders) to secure them in the opened position up to a wind speed of 8 m/s.

5.10.2.3 Fixed guards

Guards in areas, where access for maintenance and inspection work is rarely necessary, may be fixed to the machine. Opening of such guards shall only be possible with tools or keys.

5.10.3 Articulated frame lock

Mobile road construction machinery with pivot articulated components shall be equipped with an integral, rigid locking device to prevent pivoting during maintenance and/or transport. The locking device shall meet the requirements of ISO 10570, but with a safety factor of 1,5 in accordance with 4.4 of ISO 10570:2004.

5.11 Pressurised systems

5.11.1 Pipes, fittings and hoses

Pipes, fittings and hoses shall be installed in such a manner that they are protected against mechanical and/or thermal damage. Visual inspections of hoses and fittings shall be possible except those located inside frames. Pressure lines containing fluid with a pressure of more than 5 MPa (50 bar) and/or having a temperature over 50 °C passing near the operator's station (in a distance of 1,0 m or less from the operator) shall be installed or covered in such a way that the operator is protected in the event of a failure and/or rupture in the pressurised installation. Pipes and hoses shall be fitted, installed and, if necessary, sustained in such a way that contact with hot surfaces, abrasion and other external damage is possibly avoided.

It shall be possible to reduce the residual pressure in any pressurised system if the pressure means a hazard.

Any part or component which may divert a possible jet of fluid can be considered as sufficient protection device.

If there is a hazard, it shall be possible to release the remaining pressure in pressurised systems.

5.11.2 Fuel tanks

Fuel tanks shall withstand an internal pressure of 30 kPa (0,3 bar) without permanent deformation or leakage.

If fuel tanks are made of polymer material, those tanks shall have a resistance to fire according to Annex 5 of ECE R34 excluding Clause 1.

5.11.3 Pressure vessels

Simple pressure vessels shall comply with EN 286-2.

5.11.4 Hydraulic tanks

Hydraulic tanks are not considered as pressure vessels.

NOTE The Pressure Equipment Directive states no requirement because of the low pressure and/or capacity of the tanks.

5.12 Fire protection

The floor of the operator's station as well as the interior, upholstery and insulation of the cab shall be made of fire-resistant materials. The maximum burning rate shall be 200 mm/min when tested in accordance with ISO 3795.

EN 500-1:2006 (E)

The following shall be foreseen for machines with a ride-on operator: either a place to receive a fire extinguisher easily accessible by the operator (e.g. described in the instruction manual) or an integrated fixed system of fire extinction.

5.13 Hot surfaces

Hot surfaces which can be reached from operator's stations and their access and other machine-dependent work places shall be so designed, arranged and/or protected that the risk of being burned is minimised (see EN 563 as well as machine-specific parts).

5.14 Signal devices and warning signs

5.14.1 Mobile road construction machinery intended for ride-on operator shall be fitted with an acoustic warning signal device (horn). The A-weighted sound pressure level generated shall be at least 93 dB measured in accordance with ISO 9533 and at a distance of 7 m from the front of the machine. It shall be possible to activate the acoustic warning signal device from the operator's station.

5.14.2 The pivoting area of pivot-articulated machines shall be marked on both sides. The warning sign shall be designed in accordance with Figure E.3 of Annex E. The sides of the triangle shall measure at least 60 mm and the dimensions shall comply with Table 7 of EN 61310-1:1995.

5.14.3 If residual hazards remain on a machine or its equipment and/or attachments, warning/safety signs according to Annex E shall be affixed to the machine.

Any additional notes required to the signs shall be written in the same language as the instruction handbook (see machine-specific parts of EN 500 for technical measures dealing with this requirement).

5.15 Liquid gas units

Liquid gas units used on mobile road construction machines shall comply with Annex D.

5.16 Electrical and electronic systems

5.16.1 General

Electrical components and conductors shall be installed in order to avoid damage from exposure to environmental conditions which can cause deterioration. Electrical components insulation should have flame-retardant properties. Lead-through, e.g. through frames and bulkheads, shall be protected from abrasion.

Electrical wires/cables not protected by over-current devices shall not be strapped in direct contact of pipes and hoses containing fuel or flammable gas.

EN 60204-1 applies with its relevant parts.

In order to avoid incorrect connections, electric wires and cables used to connect components in electric circuits shall be marked and identified (see e.g. ISO 9247 + A1).

For the design of electronic parts and systems see ISO 15998 as guidance.

5.16.2 Degree of protection

Depending on the location/installation of electrical and electronic components, a minimum degree of protection in accordance with EN 60529 is required:

- all components installed exterior of the machine or directly exposed to the environment shall have a minimum degree of protection for the foreseeable operating condition;
- for all components installed in the operator's cab or protected against the environment, the protection shall allow a correct function under foreseeable conditions.

5.16.3 Over-current protective devices

All electric equipment, except starter motor, shall be protected with an over-current device (e.g. fuse).

5.16.4 Batteries

The battery shall be firmly attached in a ventilated space. The location shall have an easy access. The battery shall be easily removable. The batteries shall be provided with handles and/or grips.

Batteries and/or battery locations shall be designed and built or covered to minimise the risk to the operator caused by battery acid or acid vapours in the event of overturning of the machine.

The positive connector shall be covered with insulation material.

The correct fitting of battery cable to the battery connector shall be marked (e.g. by +/- signs).

5.16.5 Battery disconnection

It shall be possible to disconnect the battery easily. If this is not possible, an easily accessible isolator switch shall be provided and easily identified, e.g. by symbol 7.40 of ISO 6405-1:2004.

5.16.6 Electric connectors

If connectors for auxiliary starting aids and/or consumers are provided, they shall be designed in accordance with ISO 11862.

The connectors shall be located so that short cuts and sparks are avoided.

5.16.7 Electrically powered machines

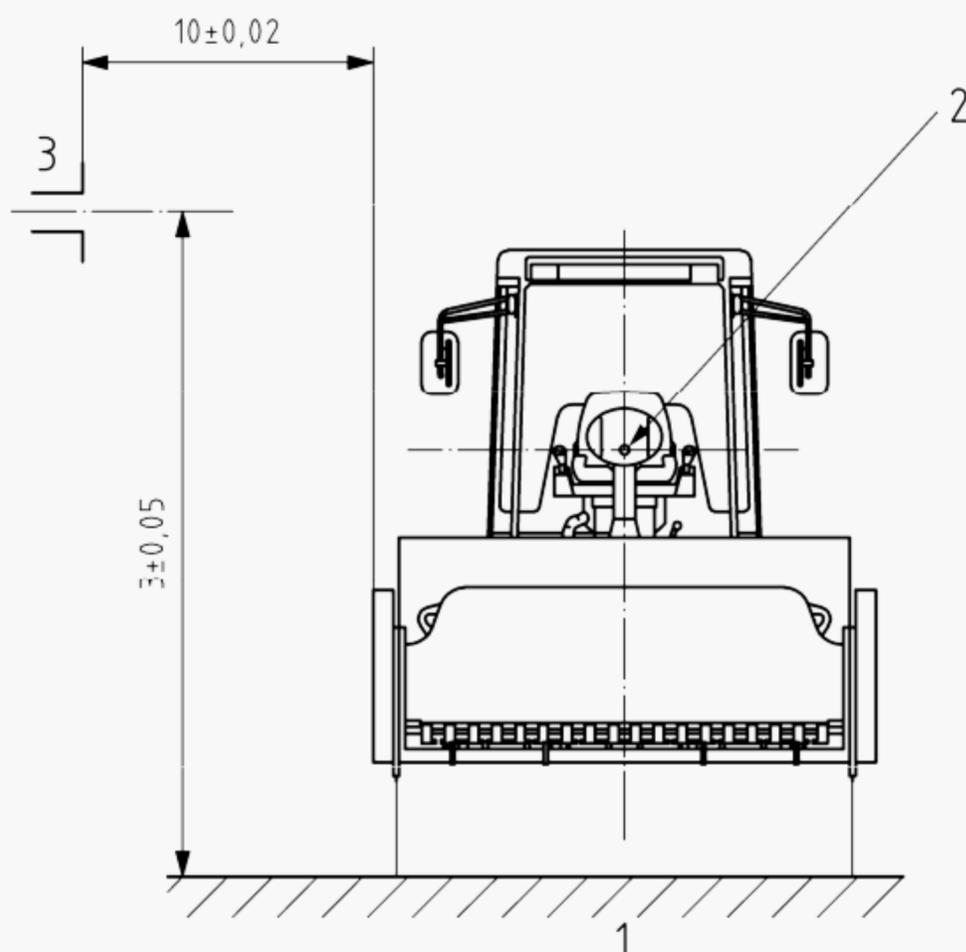
Mobile road construction machines using electrical power as main energy source shall meet the requirements of EN 60204-1 for the energy source and all electrically powered systems.

For machines having self-contained electrical power supply of more than AC 50 V or DC 120 V, IEC 60364-4-41 and IEC 60364-5-55 shall be considered.

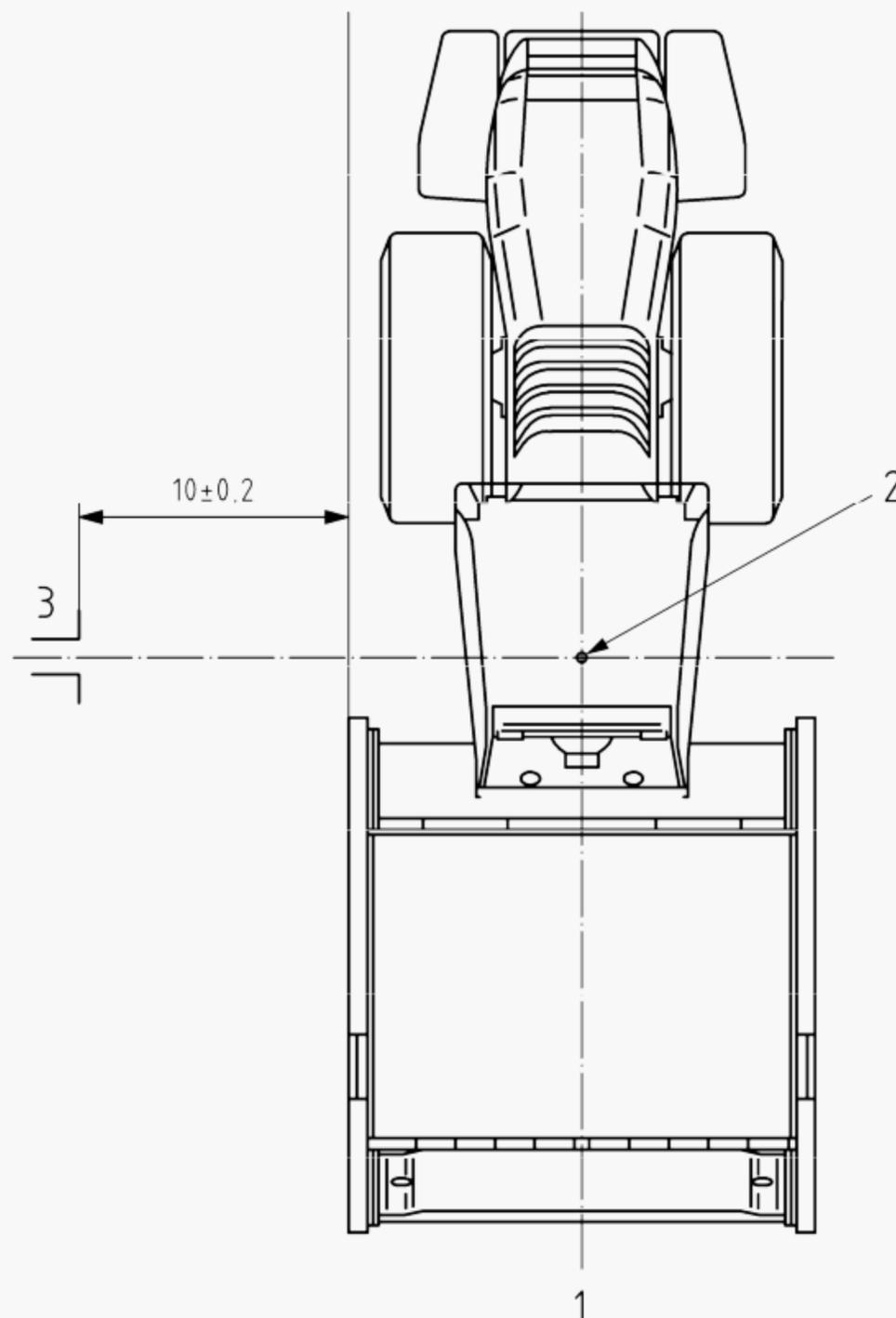
5.17 Electro-magnetic compatibility (EMC)

Mobile road construction machinery shall comply with the requirements of electromagnetic compatibility as specified in EN 13309. For the antenna location, see Figures 2 and 3.

Dimensions in meters



a) Dipole antenna in position to measure vertical component of radiation

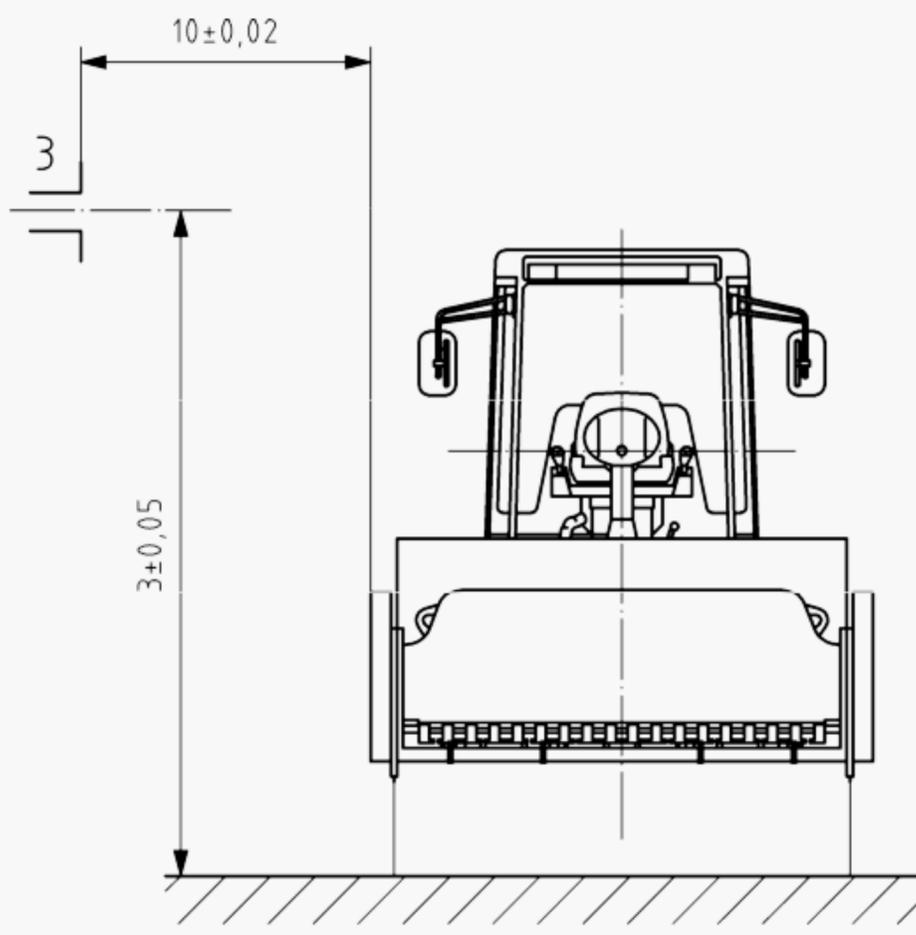


b) Dipole antenna in position to measure horizontal component of radiation

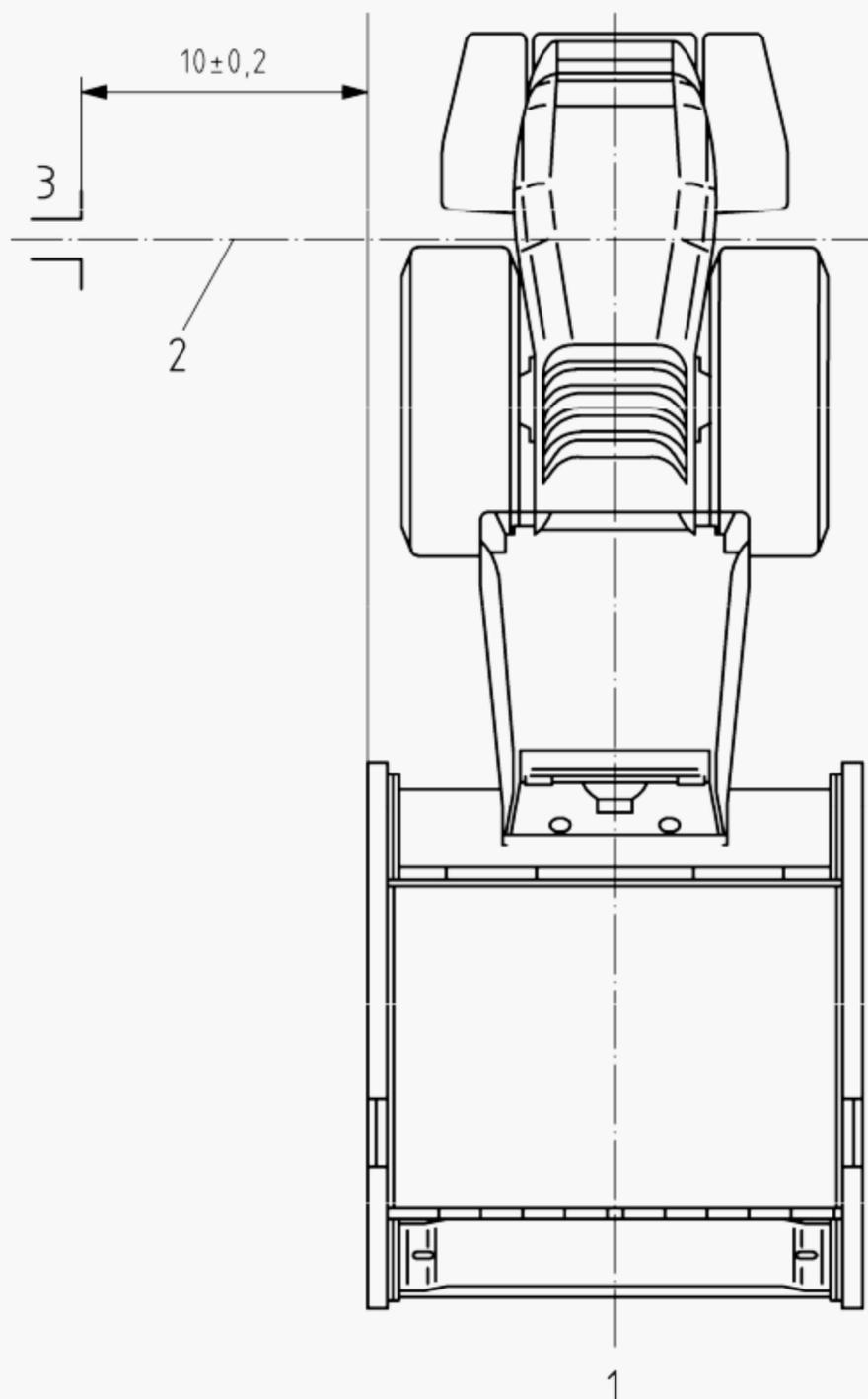
Key

- 1 elevation plan
- 2 seat index point
- 3 dipole antenna

Figure 2 — Position of the antenna relative to mobile road construction machinery with diesel engine



a) Dipole antenna in position to measure vertical component of radiation



b) Dipole antenna in position to measure horizontal component of radiation

Key

- 1 elevation plan
- 2 engine centreline
- 3 dipole antenna

Figure 3 — Position of the antenna relative to mobile road construction machinery with spark ignition engine

5.18 Noise and vibration

5.18.1 General

For mobile road construction machinery, the main sources of noise are the engine and the hydraulic components, the cooling system, and the compaction process. The main source for vibration is the compaction process.

The regulatory use in mobile road construction machinery of engines with reduced exhaust emission results in engines with a more powerful and consequently noisier cooling system which conflicts with the reduction of noise at the design stage.

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5.18.2 Principles of noise reduction by design, at source and by protective devices

The principles of noise reduction according to EN ISO 11688-1 shall be taken into account when designing mobile road construction machinery.

NOTE EN ISO 11688-2 gives useful information on noise generation mechanisms in machinery. It is recommended to equip the machines with protective measures/devices to reduce the noise emitted.

For example the following measures may be applied:

- enclosure of the engine(s) and cooling system;
- exhaust mufflers.

5.18.3 Information on noise emission

Information on noise emission determined according to the relevant machine-specific noise test code shall be given in the instruction handbook.

For machines covered by EN 500-1 for which no noise test code exists, noise emission shall be determined as follows:

- for the A-weighted sound power level, use preferably EN ISO 3744, or EN ISO 3746 if it is shown that EN ISO 3744 is not applicable;

NOTE Road milling machines, compaction machines and the finishers covered by EN 500 are covered by the directive 2000/14/EC.

- for the A-weighted emission sound pressure level at the operator's position, use EN ISO 11201.

5.18.4 Principles for a reduction of vibration at source by design

The principle of vibration reduction, where relevant, shall be taken into account when designing machines. The information and technical measures to control vibration on the hand-arm system given in CR 1030-1 shall be taken into account. See machine-specific parts of EN 500.

5.18.5 Information on hand-arm vibration

Information on hand-arm vibration shall be given in the instruction handbook if relevant (see EN 500-4 and Clause 7).

5.19 Conveyors

Conveyors shall be provided with safeguards to protect persons from crushing and shearing hazards and hazards caused by dust or ejected material.

6 Verification of safety requirements and/or protective measures

Verification of safety requirements and/or protective measures shall be achieved by one or more of the following, as appropriate,

- a) Measurement (e.g. for noise see 5.18.3 and for vibrations see 5.18.5);
- b) visual examination;
- c) test where a method is prescribed in the standard referred to in any particular requirement;
- d) calculation.

7 Information for the user

7.1 Warning signals and devices

Annex E applies.

7.2 Instruction handbook

The instruction handbook shall give instructions for operation and maintenance and checking for safety-relevant systems and components in one of the official languages of the country in which the machine is to be used. The manual shall be supplied with the machine. The format and content shall comply with ISO 6750 and Clause 6 of EN ISO 12100-2:2003.

The intended use of the machinery including attachments, tools and accessories under the conditions foreseen by the manufacturer shall be stated. The correct assembly and use of attachments and accessories shall be stated in the instruction handbook. Separate manuals, e.g. for interchangeable equipment, are acceptable.

Terms, definitions, units and symbols shall comply with the relevant international standards (see e.g. ISO 9244).

The instruction handbook shall especially contain the following information:

- machine description;
- description of instrumentation and operator's controls;
- noise emission:
 - A-weighted emission sound pressure level at workstations, where this exceeds 70 dB; where this level does not exceed 70 dB, this fact shall be indicated;
 - A-weighted sound power level emitted by the machinery where the A-weighted emission sound pressure level at workstations exceeds 85 dB;
- vibrations transmitted by hand-held and hand-guided machinery: the weighted root mean square acceleration value to which the arms are subjected if it exceeds $2,5 \text{ m/s}^2$ as determined by the appropriate test code. Where the acceleration does not exceed $2,5 \text{ m/s}^2$, this shall be mentioned;
- if, after taking technical measures for noise control at source, noise emission levels are so high that further protection of the operator is necessary, the instruction handbook shall recommend possible measures to reduce noise emission further (e.g. low-noise operating modes if any exist) and, if necessary, the wearing of personal hearing protectors;
- whether personal protection equipment is necessary;
- safety-relevant technical data;
- the need of a well trained and competent operator;
- operator and other personnel should fully acquaint themselves with the instruction handbook before operating the machine;
- description of danger zones around the machine and advice that all personnel have to be kept out of the danger zone during operation;
- advice concerning the stability of the machine including its attachments;
- when the machine is operated in conditions that deviate from those criteria (e.g. on soft or uneven ground, on a slope), these conditions shall be taken into account by the operator;

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- operating instructions (e.g. use of intended access systems, use of restrain system);
- safety advice for operation in areas where special hazards exist (e.g. consideration of local rules when operating: close to overhead electric lines, in tunnel application, in contaminated areas);
- safety advice for retrieving, towing and transportation (clear indication of attachment points for retrieving and towing respectively attachment points for transportation);
- safety advice for lifting of the machine, heavy attachments or parts of the machine;
- safety advice for maintenance and repair;
- safety advice for preservation and storage;
- safety precautions to minimise possible chemical hazards during operation, maintenance and dismantling;
- the necessary safety signs and hazard pictorials including their labelling (see Annex E as a guidance);
- instructions regarding safety rules, pressure, inflation and checking of tyres and rims.

7.3 Marking

The minimum markings shall include:

- a) name and address of the manufacturer;
- b) mandatory marking¹⁾;
- c) designation of series or type, if any;
- d) year of construction;
- e) serial or identification number, if any, e.g. according to ISO 10261;
- f) operating mass in kg according to definition in 3.2;
- g) rated power in kW according to ISO 14396.

NOTE For the output of engines with load patterns characterised by a constant output at constant rpm (blocked continuous rated power) and used in mobile road construction machinery, it is convenient to specify the rated power according to ISO 3046-1.

The operating mass and the permitted maximum axle loads of wheeled machines shall be indicated. In the case of crawler-type machines, the maximum operating mass (including all additional devices) shall be indicated.

If it is possible to ballast the machine, the operating mass of the machine, including the maximum ballast, shall be additionally indicated.

All data given shall indicate the configuration of the machine, as it is delivered by the manufacturer.

1) For machines and their related products intended to be put on the market in EEA, CE marking as defined in the European applicable directive(s), e.g. Machinery, Low Voltage, Explosive Atmosphere, Gas Appliances.

Annex A (normative)

List of mobile road construction machinery

A.1 General

For the purpose of this European Standard, the following machines are considered to be mobile road construction machines:

NOTE Joint cutters are covered by EN 13862. Concrete block laying machines are covered by EN 12629.. Road surface treatment machines are covered by EN 13020.

A.2 Compaction machines and machines for preparation and completion of embankments

	Specific requirements in:
rollers	EN 500-4
— static rollers	
— vibratory rollers	
— rubber-tyred rollers	
vibratory plates	EN 500-4
vibratory and high frequency rammers	EN 500-4
explosion rammers	EN 500-4
soil-stabilisation machines	EN 500-3
paver-finishers	EN 500-6
slipform pavers	EN 500-6
concrete-finishing machines	EN 500-6
joint sealing machines	
edge-tamping and cutting machines	
feeders	

A.3 Machines for road maintenance

Specific requirements in

road-milling machines EN 500-2

road surface pre-heaters

road-marking machines

joint and crack-milling machines

road surface roughening machines

asphalt-recycling machines

asphalt-surfacing improvers

re-pavers

re-mixers

Annex B (normative)

Handle starting equipment

B.1 Introduction

This annex will be replaced by a relevant type B-standard when available.

It is the distance over which the force can act upon the operator, rather than the kick-back force itself, that creates the main hazard.

When an internal combustion engine which is being manually started using a starting handle suddenly changes its direction of rotation, the handle is subject to acceleration in the opposite direction (see Figure B.1).

The resulting angular velocity is at a maximum at the point of disengagement. Due to its inertia, the handle will turn further until all the kinetic energy has been expended in overcoming friction and the force exerted by the operator or until it comes up against the stop.

For this reason, the kick-back travel and angle are larger, by an undefined amount, than the disengagement travel and angle respectively.

Therefore, the limiting of the kick-back force cannot be accepted as a measure to prevent accidents when correctly using a starting handle. The main concern is to limit the kick-back travel to prevent accidents.

B.2 Safety requirements

B.2.1 Scope

This annex applies to handle starting equipment on internal combustion engines.

B.2.2 Terms and definitions

For the purposes of this annex, the following terms and definitions apply.

B.2.2.1

handle starting equipment

equipment for starting an internal combustion engine by the use of a handle, such that the required torque for starting can be exercised upon the starting shaft by the operator

B.2.2.2

automatic disengagement device

device which automatically breaks the connection between the starting handle and the engine in the event of kick-back, thus preventing the handle from being turned by the engine

B.2.2.3

guide

part of the handle starting equipment which guides the starting handle during starting but prevents its being thrown out accidentally after disengagement

B.2.2.4

kick-back limiter

part of the handle starting equipment which, when used in accordance with the instructions and when maintained correctly, prevents or limits the kick-back travel to such an extent as to avoid the risk of injury

B.2.2.5

kick-back

sudden change of direction of rotation of the starting handle, caused by compression or combustion pressure when starting

B.2.2.6

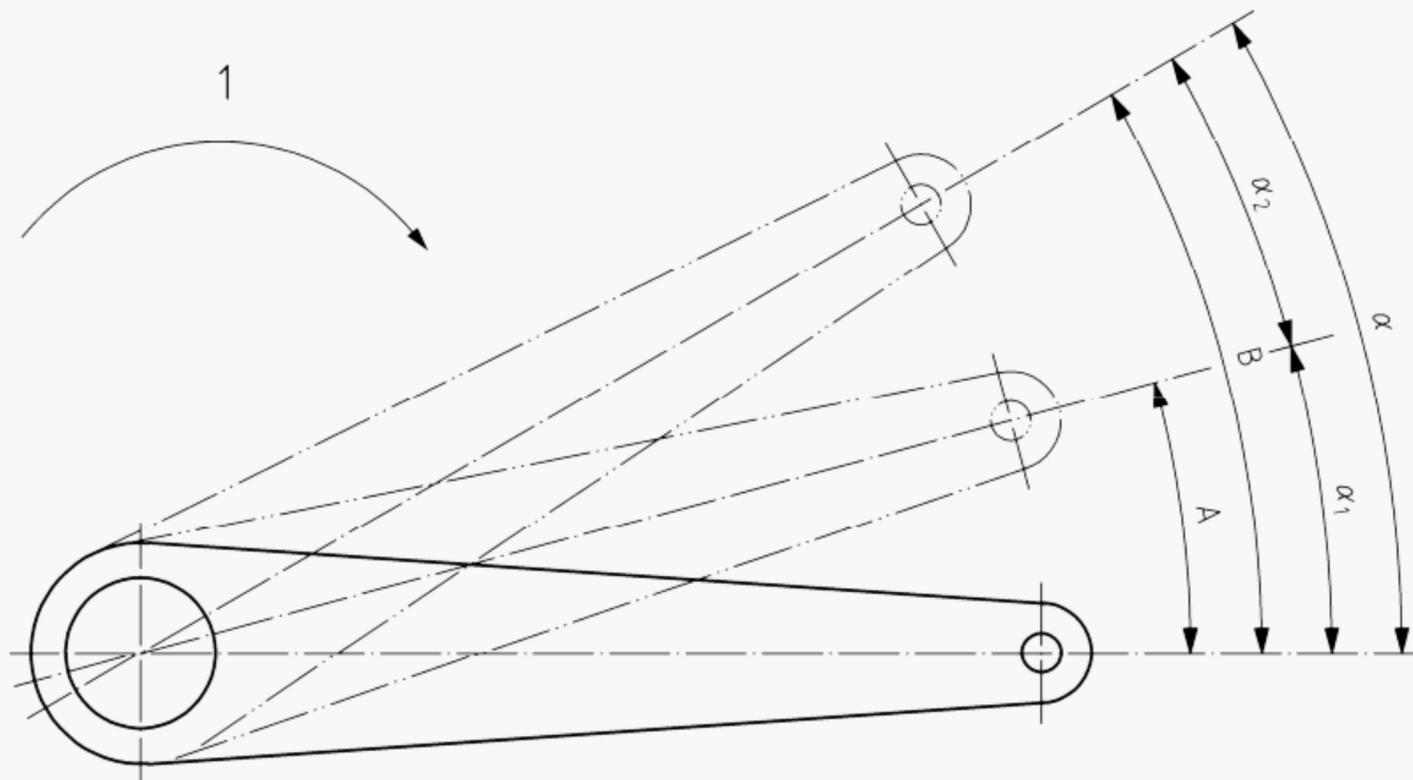
disengagement travel

distance which the grip of the handle travels from the moment of change of direction up to the disengagement of the handle from the starting shaft, measured at the centre of the grip (see Figure B.1)

B.2.2.7

angle of disengagement

angle through which the shank of the starting handle turns from the moment of change of direction up to the disengagement of the handle from the starting shaft (see Figure B.1)



Key

- 1 starting direction
- A disengagement travel
- B kick-back travel

- α_1 disengagement angle (area of energy absorption)
- α_2 area of decrease in energy
- α kick-back angle

Figure B.1 — Direction of rotation of handle when starting engine

B.2.2.8

kick-back travel

distance which the grip of the handle travels from the moment of change of direction until it comes to rest, measured at the centre of the grip

B.2.2.9

kick-back angle

angle through which the shank of the starting handle turns from the moment of change of direction until it comes to rest

B.2.3 General safety requirements

B.2.3.1 The handle starting equipment shall be equipped with an automatic disengagement device which disengages the drive between the starting handle and the engine in the event of the engine kicking back (see B.2.2.2). The handle shall be further prevented from re-engaging when the engine is running.

B.2.3.2 The handle starting equipment shall be fitted with a guide as described in B.2.2.3 which allows the disengaged handle to be removed from the engine only, for example, when the handle is not being turned or only very slowly or when turning it in the direction opposite to the starting rotation.

B.2.3.3 The starting handle shall be fitted with a non-removable grip which can freely rotate and shall ensure safe operation when used properly. These requirements also apply to the use of sleeves.

B.2.3.4 Starting handles shall be permanently marked with the manufacturer's or supplier's identification.

B.2.4 Requirements in the event of kick-back

The angle of disengagement shall not exceed 35°, and the disengagement travel shall not exceed 100 mm.

B.2.5 Tests

B.2.5.1 Checking angle of disengagement and travel

The requirements of B.2.4 shall be checked on the basis of the manufacturer's data and by tests according to B.3.

B.2.5.2 Checking other requirements

All other requirements shall be checked on the basis of the manufacturer's design data and by functional tests. These checks shall include a visual check of the starting pin, the starting dog and the starting handle guide with regard to safe operating conditions. It shall also include a visual check of the manufacturer's identification.

B.2.6 Test report

The test report shall contain at least the following:

- a) starting handle identification:
 - 1) type;
 - 2) name and address of the manufacturer/supplier;
- b) engine identification:
 - 1) type;
 - 2) name and address of the manufacturer/supplier;
- c) description of the kick-back limiter;
- d) angle of disengagement;
- e) disengagement travel;
- f) methods used for measuring according to B.2.6 d) and B.2.6 e);
- g) result of the test in accordance with B.2.5.2;
- h) date of test.

B.3 Method of testing the angle of disengagement

B.3.1 General

This subclause describes the testing of the angle of disengagement and travel of a starting handle and the safety requirements of the manual starting system in accordance with B.2.4.

B.3.2 Testing of the disengagement travel

Figures B.2 and B.3 show the system schematically for clockwise and anti-clockwise engines.

The testing of the disengagement travel of a starting handle shall be carried out on the type of internal combustion engine for which the handle was designed. Set the stop so that the handle lies horizontally. For the first test, hang a test mass of 5 kg from the centre of the grip. The flywheel is then smoothly turned in the opposite direction with the lever.

The distance moved before disengagement occurs is measured on the scale using a mark on the shank of the starting handle. Repeat the above procedure with a 50 kg test mass.

B.3.3 Testing of the angle of disengagement

The angle of disengagement is tested in accordance with B.3.3, except that the linear scale is replaced by an angular scale. The angle of disengagement can also be calculated.

B.3.4 Tolerance

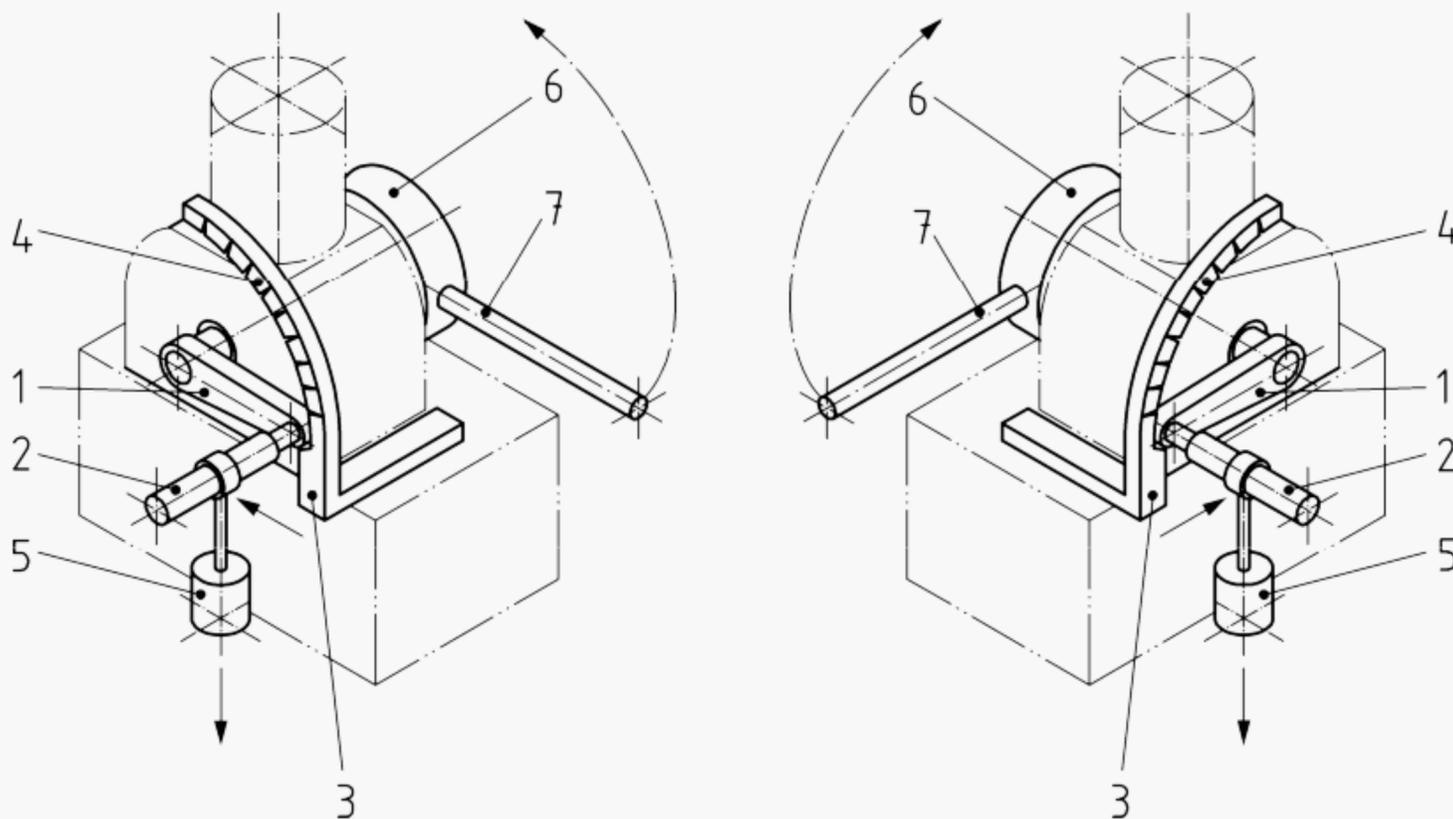
The angle should be measured to the nearest degree, and the travel to the nearest 2 mm.

B.3.5 Number of tests

Ten tests shall be carried out with each test mass on the handle.

B.3.6 Test report

The report shall show the largest measured angle and travel determined during the 10 tests.



- Key**
- | | | |
|------------------------|-------------|---------|
| 1 starting handle | 4 scale | 7 lever |
| 2 starting handle grip | 5 test mass | |
| 3 stop | 6 flywheel | |

Figure B.2 — Testing device for a clockwise engine

Figure B.3 — Testing device for an anti-clockwise engine

Annex C (normative)

Impending free movement under protective measures

The opening dimensions given in Table C.1 refer to the narrowest dimension of a slot opening, the side of a square opening and the diameter of a round opening. Openings > 240 mm will allow access for the whole body. Figure C.1 shows the correlation of the opening B and the safety distance A.

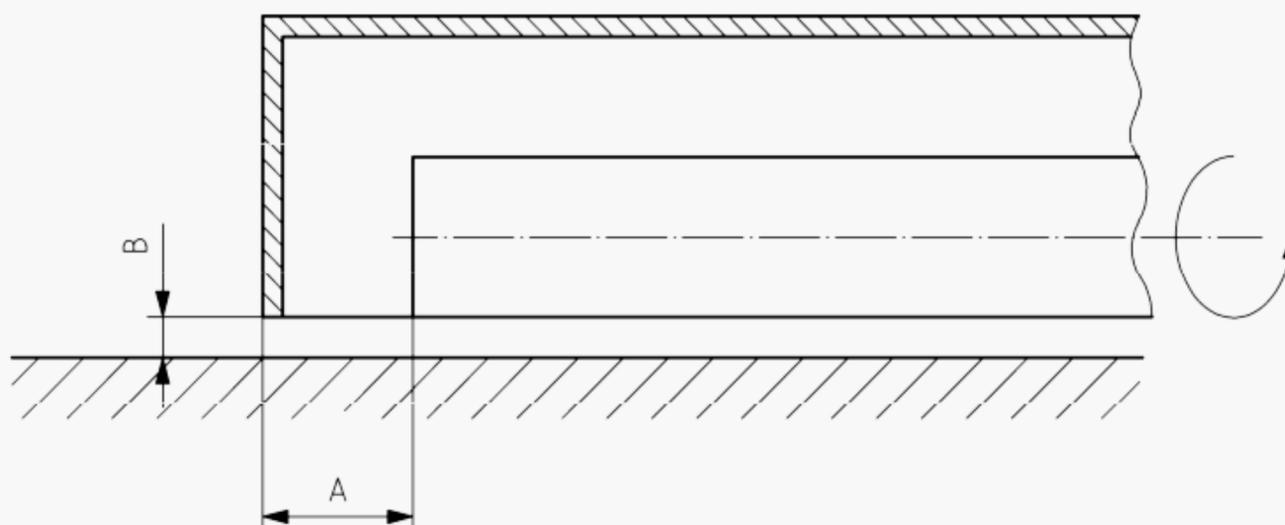


Figure C.1

Table C.1

Dimensions in mm			
Part of lower limb	Opening dimension B	Safety distance A	
		Slot	Square or round
Toe tip	$B \leq 5$	0	0
Toe	$5 < B \leq 15$	≥ 10	0
	$15 < B \leq 35$	$\geq 80^a$	≥ 25
Foot	$35 < B \leq 70$	≥ 150	≥ 50
	$70 < B \leq 90$	≥ 150	≥ 80
Leg up to knee	$90 < B \leq 100$	≥ 540	≥ 130
	$100 < B \leq 110$	$\geq 540^b$	≥ 130
Leg up to crotch	$110 < B \leq 200$ $B > 200^c$	$\geq 1\ 050$	$\geq 1\ 050$

^a If the length of the slot opening is < 90 mm, the distance can be reduced to 50 mm.
^b If the length of the slot opening is < 110 mm, the distance can be reduced to 130 mm.
^c For openings > 200 mm, Annex A of EN 811:1996 shall be used.

Annex D (normative)

Liquid gas units on mobile road construction machinery

D.1 Scope

This annex specifies safety requirements of liquid gas units used on road construction machinery.

D.2 Definitions

For the purposes of this annex, the following terms and definitions apply.

D.2.1

liquid gas

flammable gas of propane, propene (propylene), butane, butene (butylene) and mixtures thereof

D.2.2

liquid gas unit

consisting of supply and consumer units

D.2.2.1

supply unit

equipment consisting of all components, e.g. gas tanks, cylinders (bottles), propellant gas tanks, vaporiser units, that are necessary to supply consumer units, including the controls and the shut-off device

D.2.2.2

consumer unit

equipment consisting of the consumer devices for burning purposes, including the gas lines and the equipment components after the main shut-off device

D.2.3

consumer devices

burner for use with vaporised gas and infrared burners

D.2.4

main shut-off devices

devices by means of which the total consumer unit can be cut off from the supply unit. This can also be a tank shut-off valve

D.2.5

connection pressure value

rated low pressure (in bar or Pa) at the gas connection of the consumer device

D.2.6

connection flow value

rated gas consumption in kg/h or g/h of a consumer unit at rated thermal load

D.2.7

flame monitors

devices which:

- will either maintain the flow of gas dependent upon the control function of a flame sensor or interrupt the flow of gas after the flame has been extinguished (ignition control)

or

- are influenced by a control circuit and monitor the presence of a flame and independent hereof either open or close the flow of gas to a consumer unit (automatic and semiautomatic ignition control);
- report the presence or respectively the expiration of a flame to a control unit or a switching device (semi-automatic flame monitor)

or

- will react to the signals of a connected flame sensor if a flame is not available and interrupt the gas supply within a safety period via a switching device and shut-down the gas line, and in addition reacting to signals of regulators, sensors and limits, and activate the starting-up or shutting-down phase of a consumer device according to a determined programme (fully automatic gas furnaces)

D.2.8

heater banks

consumer units according to D.3.5 for area-warming or pre-heating of road surfaces. Heater banks consist of numerous infrared heaters in close configuration arranged on one level.

Heater banks are defined as “close packed heater banks” if they comply with the following requirements:

- they are for out-door use only and are operated so close to the road surface that a mutual ignition of adjacent heaters is guaranteed;
- the operating temperature shall reach or exceed the ignition temperature at least 75 % of the total heater bank area;
- the power density related to the total heater bank area shall be at least 50 kW/m²;
- the connection flow value according to D.3.7 shall not exceed 60 kg/h;
- the number of infrared heaters shall be at least 9 per heater bank, arranged 3 by 3

D.2.9

stable burning furnaces

furnaces which are supplied independently of the heater banks and of which the flame will not be extinguished when subjected to wind speeds of up to 33 km/h transverse to the air intake port and transverse to the flame. They are specified as consumer units according to D.3.3.2

D.2.10

turbo gas furnaces

furnaces where the combustion air is supplied via a blower

D.3 Safety requirements

D.3.1 General

Liquid gas units used on road construction machinery shall comply with the safety requirements and/or measures of this annex.

D.3.2 General requirements

D.3.2.1 The gas-pressurised components shall remain tight, also when subjected to chemical, thermal and mechanical loads during normal operation.

D.3.2.2 Consumer units shall be tightly connected to supply units. Connectors of consumer units to single cylinders (bottles) shall be so designed that a tight connection is ensured.

D.3.2.3 The discharge of unburned gas from consumer units during ignition and at unintentional extinguish during operation shall be limited by appropriate devices to a safe level.

D.3.2.4 For hand-held burners, special precaution devices according to D.3.2.3 are not mandatory if the operation necessitates continuous observance of the flame.

D.3.2.5 Heater banks shall be provided with at least one stable burning pilot flame to ensure continuous re-ignition.

For close packed heater banks which can constantly be controlled by the operator during operation, the stable burning pilot flame is not mandatory.

D.3.2.6 The gas supply to turbo gas furnaces shall be automatically switched off if there is a pressure-drop or loss of combustion air.

D.3.2.7 The components of consumer units which are designed for a lower operating pressure than the supply units shall be equipped with self-acting devices to prevent pressures exceeding the permissible pressure of components over the consumer units. These devices shall also be designed to prevent gas discharge to the atmosphere.

D.3.2.8 An easily accessible and clearly visible main shut-off device shall be located between the supply unit and consumer unit. For single gas cylinder (bottle) installations, this requirement is fulfilled if the cylinder (bottle) is fitted with a shut-off valve.

D.3.2.9 If the gas is supplied from numerous tanks connected together of which each can be shut-off separately, check-valves shall be fitted to ensure that a bypass flow of gas is prevented.

D.3.3 Configuration and fixation of liquid gas units

D.3.3.1 Liquid gas units shall be so installed and secured to ensure protection against mechanical damage.

D.3.3.2 Devices shall be available to prevent hoses, pipes or valves being damaged or loosened by axially rotating gas cylinders (bottles) or propellant gas tanks.

D.3.3.3 Supply units as defined by the manufacturer.

D.3.3.4 Consumer units shall only be connected to:

- tanks,
- permanently affixed propellant gas tanks
- or
- a maximum of 8 gas cylinders (bottles) with max. 33 kg filling weight each.

D.3.4 Connection of consumer unit by pipe systems

D.3.4.1 Suitable pipe systems shall be used when connecting consumer units to supply units.

NOTE Pipe systems are classified as suitable if they can withstand the foreseen chemical, thermal and mechanical loads on the inside and the outside and if they are made of non-corrosive metallic material.

D.3.4.2 Pipe systems between supply units and consumer units shall be so installed that they are protected against chemical, thermal and mechanical damage from the outside.

D.3.4.3 Consumer units shall be connected to supply units by firmly affixed pipe systems.

D.3.4.4 The consumer devices of a consumer unit shall be connected to each other by permanently installed pipe systems.

D.3.4.5 In exceptions of D.3.4.3, flexible hoses may be used to enable the connection of gas cylinders (bottles) or if special operating conditions require it.

NOTE Such special operating conditions are:

- if consumer units have to be movable for intended use;
- if consumer units or their components are subject to oscillations, vibrations or impact shocks.

D.3.4.6 If pipe systems or sections of the pipe systems can be shut off, it shall not be possible to trap un-vaporised gas inside those systems.

D.3.5 Connection of consumer units by hose systems

D.3.5.1 Only suitable hose systems shall be used. Hose systems are classified as suitable if they do withstand foreseen chemical, thermal and mechanical loads at inside and outside.

NOTE These are e.g. hose systems which:

- conform to EN 1762 or EN 1763-1;
- are tested at a pressure of 3,3 MPa (33 bar) and designed to withstand high mechanical loads
or
- are made of non-corrosive metallic material.

D.3.5.2 Hose systems shall be so installed that they are protected against foreseeable chemical, thermal and mechanical damages.

D.3.5.3 Consumer units which are connected by hose systems shall be equipped with safety devices to ensure that gas leakage cannot cause a hazard.

NOTE This requirement can be fulfilled e.g. by use of hose rupture valves.

D.3.5.4 If non-corrosive metallic hoses are installed between supply units and the permanently affixed pipe systems of consumer units as well as between permanently affixed pipe systems of supply units and consumer units, the safety devices according to D.3.5.3 is not required.

D.3.6 Combustion and flame stability

Efficient combustion and flame stability shall be ensured.

NOTE Efficient combustion is ensured if the CO content of the undiluted exhaust fumes inside the enclosed combustion chamber does not exceed 0,1 Vol.%.

D.3.7 Ignition devices

D.3.7.1 Consumer units shall be equipped with suitable ignition devices to ensure safe and efficient ignition.

NOTE 1 Safe and efficient ignition means ignition without the risk of detonation or flame back-fire.

NOTE 2 Suitable ignition devices for heater banks are e.g. hand-held burners if the arrangement of the infrared heaters allows safe and efficient ignition.

D.3.7.2 Ignition devices and consumer devices shall be equipped with separate gas supply lines and shut-off devices.

D.3.7.3 Brackets or fixing devices shall be available to rest hand-held burners.

D.3.8 Fixing devices for gas cylinders (bottles)

Gas cylinders (bottles) shall be secured against tip-over in their storage position.

D.3.9 Electrical power supply

The electrical power supply of mobile road construction machinery equipped with liquid gas tanks or cylinders shall have a disconnection device to shut-off the electrical power supply in the event of hazard.

NOTE An easily accessible isolator switch will fulfil this requirement.

D.3.10 Fire precautions

Suitable fire extinguishers shall be installed on the machine and shall be easily accessible.

Fire extinguishers shall meet the requirements of EN 3-7. The following minimum number and type of extinguishers according to the whole capacity of all containers installed on the machine is required:

- from 0,25 m³ to 1,0 m³ 1 fire extinguisher of a capacity of 6 kg, fire class B and C;
- over 1,0 m³ to 5,0 m³ 2 fire extinguishers of a capacity of 6 kg, fire class B and C;
- over 5,0 m³ 2 fire extinguishers of a capacity of 12 kg, fire class B and C.

D.4 Marking

The most important safety-related information (e.g. filling instructions or starting procedure) shall be legible and indelible fixed to the machine or to the liquid gas unit in an abridged version.

This abridged version shall also be included in the instruction handbook and the spare parts manual of the liquid gas unit.

D.5 Instruction handbook

Clause 6 applies with the following addition:

An instruction handbook shall be supplied for liquid gas units used on mobile road construction machines. The instruction handbook shall contain instructions for the safe operation and maintenance of liquid gas units in at least one of the official languages of the country in which the machine is intended to be put on the market.

The instruction handbook shall at least contain the following indications and advice:

- circuit drawings of the liquid gas unit with designation of the individual components and description of the safety and control devices;
- the need for a well-trained and competent operator;
- tightness tests on lines, valves and connectors (e.g. via spray or other foaming substances);
- safe ignition of the consumer devices;
- instructions in the event of malfunctions;
- instructions in case of hazardous situations (e.g. fire);
- instructions in the event of critical excess of pressures inside liquid gas systems;

- instructions for safe, reliable and tight connections together with data of suitable sealing substances;
- regular checks and inspections;
- maintenance and testing of fire-extinguishers.

Annex E (normative)

Requirements for non-text safety signs used on mobile road construction machinery

E.1 General

Safety signs and hazard pictorials shall follow the general principles in ISO 9244 and be of general nature and preferably without text. They shall be permanently affixed to mobile road construction machinery and be shown and described in the instruction handbook. The location on the machine shall be illustrated in the manual.

The warnings on the signs shall be indelible and shall be legible at the distance necessary to ensure the safety of persons required to be in the vicinity.

E.2 Safety alert symbol (see Figure E.1)

The safety alert symbol shall be used as outlined in Figure 7 of ISO 9244:1995. It shall be primarily used to warn casual spectators approaching machine whilst operating. The safety alert symbol should also be used with hazard description pictorials (see E.1.2).

E.3 Non-text hazard pictorials

Additional hazard pictorials combined with a safety alert symbol shall warn the operator or service personnel when doing maintenance or service work at the machine. The safety signs shall be in two-panel format with either vertical or horizontal figuration (see Figures E.2 to E.5).

Formats are described in Clause 4 of ISO 9244:1995.

E.4 Dimensions

Minimum recommended dimensions for two-panel format safety signs shall be according to ISO 9244:1995, Figure 13. Larger or smaller sizes may be used if required.

Safety signs, warning casual spectators approaching the machine whilst working, shall be legible from outside the danger zone.

E.5 Colours of safety signs

The colours of pictorial panels, border and panel separation lines shall follow 9.2.2, 9.2.3, 9.2.4 and 9.5 of ISO 9244:1995.

E.6 Location

Warning signs and hazard pictorials shall be distinctively located at a clearly visible location as close as possible to the hazardous area or part of the machine.



Figure E.1 — Safety alert symbol

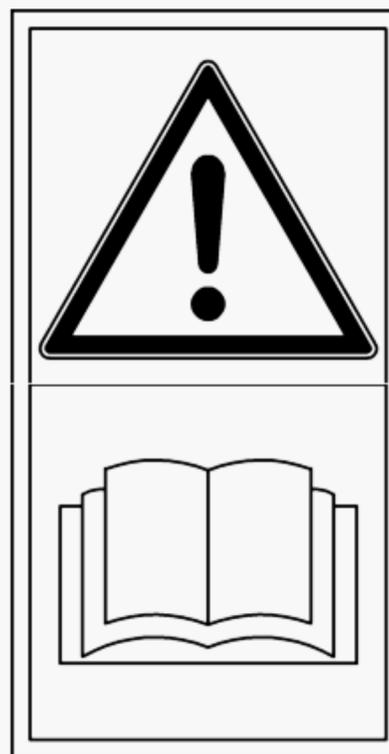


Figure E.2 — Read instruction handbook



Figure E.3 — Crushing hazard

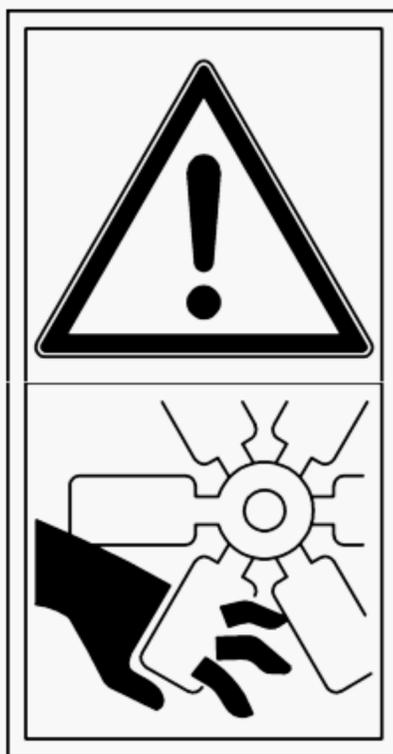


Figure E.4 — Cutting hazards



Figure E.5 — Hot surfaces

NOTE The safety alert symbol in the upper pictorial panel may be replaced by hazard avoidance pictorials if there is a need to present visual instructions on how the hazard should be avoided.

Annex F (normative)

List of significant hazards

The list of hazards contains all hazards, as far as they are treated in this standard, identified by risk assessments, significant for this type of machinery and which require action to eliminate or reduce risk.

List according to Annex A of EN 1050:1996.

Table F.1 — List of significant hazards

No.	Hazards	Clause of EN 500-1
Hazards, hazardous situations and hazardous events		
1	Mechanical hazards due to:	
	– machine parts and workpieces, e.g. shape, location, mass and stability, mass and velocity, mechanical strength	5
	– accumulation of energy inside the machine, e.g.: elastic elements (springs), liquids and gases under pressure, effect of vacuum	5.11.2, 5.11.3
1.1	Crushing hazard	5.4.2, 5.10.2
1.2	Shearing hazard	5.4.1, 5.10
1.3	Cutting or severing hazard	5.4.1
1.5	Drawing-in or trapping hazard	5, 5.3.4, 5.10
1.6	Impact hazard	5.10
1.7	Stabbing or puncture hazard	5.10
1.8	Friction or abrasion hazard	5.11.1
1.9	High-pressure fluid injection or ejection hazard	5.11.1, 5.11.3
2	Electrical hazards due to:	
2.1	Contact of persons with live parts	5.16.3, 5.16.4, 5.16.5, 5.16.6
2.4	Electrostatic phenomena	5.16, 5.17
2.5	Thermal radiation or other phenomena such as the projection of molten particles and chemical effects from short circuits, overloads etc.	5.15, 5.16
3	Thermal hazards resulting in:	
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by radiation of heat sources	5.11.1, 5.12, 5.13, 5.15
3.2	Damage to health by hot or cold working environment	5.4.2

Table F.1 (continued)

No.	Hazards	Clause of EN 500-1
4	Hazards generated by noise resulting in:	
4.1	Hearing loss (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	5.18, 7
4.2	Interference with speech communication, acoustic, signals etc.	5.14.1, 5.18, 7
5	Hazards generated by vibration	
5.1	Hand-arm vibrations	5.18.4, 5.18.5
6	Hazards generated by radiation	
6.1	Low frequency, radio frequency radiation, micro waves	5.17
6.2	Infrared, visible and ultraviolet light	5.6.2.5
7	Hazards generated by materials and substances , processed or used by the machinery	
7.1	Hazards from contact with/or inhalation of harmful fluids, gases, mists, fumes and dusts	5.4.2, 5.15
7.2	Fire or explosion hazard	5.12, 5.15, Annex D
8	Hazards generated by neglecting ergonomic principles in machinery design as , e.g. hazards from:	
8.1	Unhealthy postures or excessive effort	5.4, 5.5, 5.6
8.2	Inadequate consideration of hand-arm or foot-leg anatomy	5.4, 5.5, 5.6
8.3	Neglected use of personal protection equipment	7
8.4	Inadequate local lighting	5.4.2
8.5	Mental overload and under-load, stress	5.18, 7
8.6	Human error, human behaviour	5.6 to 5.19
8.7	Inadequate design, location or identification of manual controls	5.4 to 5.9
8.8	Inadequate design or location of visual display units	5.6
8.9	Neglecting principles of safety integration	5.3, 5.4.2, 5.6, 5.7, 5.8, 7
8.10	Inadequate guards and protection devices	5.4.2, 5.10
8.11	Inadequate operating position	5.4, 5.5, 5.6
8.12	Inadequate design of adjustment, service and maintenance places and access to these places	5.9
9	Combination of hazards	5.4.1
10	Unexpected start-up, unexpected overrun/over-speed (or similar malfunction) from:	
10.1	Failure/disorder of control system	5.6
10.3	External influences on electrical equipment	5.16, 5.17
10.5	Errors in the software	5.6, 5.16, 5.17

Table F.1 (continued)

No.	Hazards	Clause of EN 500-1
10.6	Errors made by the operator (due to mismatch of machinery with human characteristics and abilities, see No 8.7)	5.6, 5.7, 5.8, 5.9
11	Impossibility of stopping the machine in the best possible conditions	5.6, 5.8
13	Failure of the power/energy supply	5.7, 5.16
14	Failure of the control circuit	5.6, 5.16
15	Errors of fitting	5.11.1
17	Falling or ejected objects or fluids	5.11
19	Slip, trip and fall of persons (related to machinery)	5.6.2.7, 5.9
Additional hazards, hazardous situations and hazardous events due to mobility		
20	Relating to travelling function	
20.1	Movement when starting the engine	5.7
20.2	Movement without a driver at the driving position	5.6.2.4, 5.6.2.6
20.3	Movement without all parts in a safe position	5.6.2.4, 5.5.2.8
20.4	Travelling function	5.3.3, 5.6, 5.7, 5.8
20.5	Excessive oscillation when moving	5.3.3
20.6	Insufficient ability of machinery to be slowed down, stopped and immobilised	5.8
20.7	Remote control	5.6.2.5
21	Linked to the work position (including driving station) on the machine	
21.1	Fall of persons during access to (or at/from) the drive/work position(s)	5.9
21.2	Exhaust gases/lack of oxygen at the work position	5.4.1, 5.10.1, 5.15
21.3	Fire (flammability of the cab, lack of extinguishing means)	5.12
21.4	Mechanical hazards at the work position:	
	rollover	5.10 of EN 500-4:2006
21.5	Insufficient visibility from the drive/work position(s)	5.4.1
21.6	Inadequate work/drive lighting	5.2
21.7	Inadequate seating	5.5
21.8	Noise at the work position	5.18
21.9	Vibration at the drive/work position(s)	7
21.10	Insufficient means for evacuation/emergency exit	5.4.2
22	Due to control system	
22.1	Inadequate design of energy/control circuits	5.3.3, 5.6, 5.7, 5.8, 5.16

Table F.1 (continued)

No.	Hazards	Clause of EN 500-1
22.2	Inadequate location of manual controls	5.6, 5.7, 5.8
22.3	Inadequate design of manual controls and their mode of operation	5.6.2
23	From handling the machine (lack of stability)	5.3, 7
24	Due to the power source and to the transmission of power	
24.1	Hazards from the engine and the batteries	5.7.3, 5.16.4, 5.16.5
24.2	Hazards from transmission of power between machines	
24.3	Hazards from retrieval, transportation, lifting and towing	5.3.2
25	From/to third persons	
25.1	Unauthorised start-up/use	5.7.2
25.2	Drift of a part away from its stopping position	5.6.2.8
25.3	Lack or inadequacy of visual or acoustic warning means	5.14
26	Insufficient instructions for the driver/operator (instruction handbook, signs, warnings and markings)	5.14, 5.18.3, 7

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 98/37/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 Machinery 98/37/EC amended by 98/79/EC.

Once this standard is cited in the Official Journal of the European Communities 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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