BS EN 16228-2:2014

BSI Standards Publication

Drilling and foundation equipment — Safety

Part 2: Mobile drill rigs for civil and geo-technical engineering, quarrying and mining

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National foreword

This British Standard is the UK implementation of EN 16228-2:2014. Together with BS EN 16228-1:2014, BS EN 16228-3:2014, BS EN 16228-4:2014, BS EN 16228-5:2014, BS EN 16228-6:2014 and BS EN 16228-7:2014, it supersedes BS EN 791:1995+A1:2009 and BS EN 996:1995+A3:2009, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/513, Construction equipment and plant and site safety.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Drilling and foundation equipment - Safety - Part 2: Mobile drill rigs for civil and geotechnical engineering, quarrying and mining

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Geräte für Bohr- und Gründungsarbeiten - Sicherheit - Teil 2: Mobile Bohrgeräte für Tiefbau, Geotechnik und Gewinnung

This European Standard was approved by CEN on 6 March 2014.

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Foreword

This document (EN 16228-2:2014) 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of an identical text or by endorsement, at the latest by November 2014 and conflicting national standards shall be withdrawn at the latest by November 2014.

This document supersedes EN 791:1995+A1:2009 and EN 996:1995+A3:2009.

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.

This European Standard is divided into several parts and covers drilling and foundation equipment.

Part 1 contains requirements that are/may be common to all drilling and foundation equipment. Other parts contain additional requirements for specific machines that supplement or modify the requirements of part 1. Compliance with the clauses of part 1 together with those of a relevant specific part of this standard giving requirements for a particular machine provides one means of conforming with the essential health and safety requirements of the Directive concerned.

When a relevant specific part does not exist, part 1 can help to establish the requirements for the machine, but will not by itself provide a means of conforming to the relevant essential health and safety requirements of the Directive.

This European Standard, EN 16228, *Drillling and foundation equipment – Safety*, consists of the following parts:

— *Part 1: Common requirements*

— *Part 2: Mobile drill rigs for civil and geotechnical engineering, quarrying and mining*

— *Part 3: Horizontal directional drilling equipment (HDD)*

— *Part 4: Foundation equipment*

— *Part 5: Diaphragm walling equipment*

— *Part 6: Jetting, grouting and injection equipment*

— *Part 7: Interchangeable auxiliary equipment*

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Introduction

This document is a type C standard as stated in EN ISO 12100.

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

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.

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1 Scope

This European Standard, together with part 1, deals with all significant hazards for mobile drill rigs for civil and geotechnical engineering, quarrying and mining when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer associated with the whole life time of the machine (see Clause 4).

The requirements of this part are complementary to the common requirements formulated in EN 16228-1:2014.

This document does not repeat the requirements from EN 16228-1, but adds or replaces the requirements for application for mobile drill rigs.

In this document the general term “mobile drill rig” covers several different types of machines for use in:

— civil engineering;

— geotechnical engineering (including ground investigation, anchoring, soil nailing, mini-piling, ground stabilization, grouting);

— water well drilling;

— geothermal installations;

— landfill drilling;

— underpinning, tunnelling, mining and quarrying;

— for use above ground as well as underground.

Typically, the process of drilling involves the addition of drill rods, tubes, casings or augers etc., normally threaded, as the borehole extends to depth.

NOTE 1 For machines with torque greater than 35 kNm see EN 16228–4 initially.

NOTE 2 The term “drill rigs” includes rigs with a separate power pack supplied by the rig manufacturer.

2 Normative references

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

EN 280:2013, *Mobile elevating work platforms - Design calculations - Stability criteria - Construction - Safety - Examinations and tests*

EN 16228-1:2014, *Drilling and foundation equipment — Safety — Part 1: Common requirements*

EN ISO 3449:2008, *Earth-moving machinery - Falling-object protective structures - Laboratory tests and performance requirements (ISO 3449:2005)*

EN ISO 3450:2011, *Earth-moving machinery - Wheeled or high-speed rubber-tracked machines - Performance requirements and test procedures for brake systems (ISO 3450:2011)*

EN ISO 12100:2010, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100:2010)*

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3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010, EN 16228-1:2014 and the following apply.

NOTE Examples of drilling and foundation equipment are given in Annex A of EN 16228–1:2014.

3.1
drill rig
machine for drilling in soil or rock utilising either percussive, rotary or vibration principles (or a combination of principles) which may involve the addition of drill rods, tubes, casings or augers etc., normally threaded, as the hole extends

3.1.1
drill jumbo
rock drill rig specifically designed for and solely intended to be used underground, for drilling blast holes in rock, rock bolting or anchoring in tunnels, mines or similar underground structures

Note 1 to entry: These machines are designed for multi directional drilling, e.g. upwards, sidewise, downwards, forward and any combination of this and can be fitted with one or more feed beams and a boom mounted working platform. Most of these machines are rubber-tyred; see figures in Annex A of EN 16228–1.

3.1.2
pre-armouring machine
machine specifically designed for and solely intended to be used underground, for advanced roof and side wall ground reinforcement, e.g. pre-armouring, fore-poling, spiling etc., in a horizontal or almost horizontal orientation

Note 1 to entry: The machine can be fitted with one or more feed beams and a boom mounted working platform. Reinforcement bar loader may be present depending on the reinforcement technology.

3.2
mast
structure for supporting guiding the drilling tools

3.3
feed beam
structure on which drill head is mounted providing linear movement to the head

3.4
feed beam extension
structure for linear movement of mast or feed beam

3.5
boom
structure for positioning of the mast or feed beam

3.6
drill string
structure transforming the rotation and/or percussion energy from the drill/rotation unit in to the drill hole

3.7
boom mounted working platform
working platform used for raising or lowering personnel, consisting of a platform fitted onto a (articulated/telescopic) boom

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3.8
drill mast attachment
interchangeable equipment comprising a feed beam which can be mounted on a carrier machine such as a 360° excavator in place of the bucket

3.9
rubber-tyred drill rig for underground use
machine for drilling blastholes, rockbolts or anchors in tunnels, mines or similar underground structures

Note 1 to entry: It can be fitted with one or more feed beams and a boom mounted platform.

3.10
motion detector
device detecting access to the danger zone

3.11
full drill cycle automation mode
operating mode in which the machine drills a pre-programmed hole pattern automatically.

Note 1 to entry: This includes automatic boom and/or feed positioning.

3.12
single hole automation mode
operating mode in which the machine, initiated by the operator, drills the full length of the drill rod and then adds rods automatically; when the pre-programmed hole length has been drilled the machine stops and the rods may be removed automatically or semi mechanized

3.13
single rod automation mode
operating mode in which the machine, initiated by the operator, drills the full length of the single drill rod and then returns automatically

3.14
manual rod handling mode
operating mode in which the machine, initiated by the operator, drills one rod and then stops; additional rods may be added and removed manually into rod adding clamps or directly into the drill string

4 List of additional significant hazards

Clause 4 of EN 16228-1:2014 applies with the following Table 1.

Table 1 of EN 16228-1:2014 and Table 1 of this document contain all hazards, hazardous situations and events, identified by risk assessments as significant for mobile drill rigs and which require action to eliminate or reduce risk.

Hazards generally occur under the following conditions:

— in transportation to and from the work site;

— in rigging and dismantling on the work site;

— in service on the work site;

— when moving on the work site;

— out of service on the work site;

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— in storage at the plant depot or on the work site;

— maintenance.

Table 1 — List of additional significant hazards and associated requirements

No.	Hazard	Relevant clause(s) in this standard
1	Mechanical hazards	
1.1	Stability	5.3, 5.8
1.2	Crushing	5.5, 5.6
1.3	Shearing	5.5, 5.6
1.4	Cutting and severing	5.5, 5.6
1.5	Entanglement	5.5, 5.6, 5.7
1.6	Kinetic energy	5.9, 5.10, Annex B
1.7	Falling or ejected object	5.2
1.8	Uncontrolled loading, overloading	5.2, 5.8
1.9	Lifting of person	5.2
1.10	Insufficient instructions for the driver/operator	7.1, 7.2
2	Thermal hazards	
2.1	Fire	5.4
4	Hazards generated by noise, resulting in:	
4.1	Hearing losses and physiological disorders	Annex A
4.2	Accidents due to interference with speech communication and warning signals	Annex A

5 Safety requirements and/or protective measures

5.1 General

Drill rigs shall comply with the requirements of EN 16228-1:2014, as far as not modified or replaced by the requirements of this part.

5.2 Boom mounted working platforms for underground use

Subclause 5.13.2 of EN 16228-1:2014 does not apply.

When a drill rig for underground use is equipped with a boom mounted working platform intended for use in an area where there is risk of object fall, the person(s) on the platform shall have adequate protection. A suitably designed protective structure, FOPS shall be provided over the platform.

Level I of EN ISO 3449:2008 shall be the minimum requirement (e.g. underground pre-armouring machines). Level II shall be chosen where there is the risk of rock fall.

NOTE The FOPS may be adjustable taking into account the various functions to be performed from the platform.

Drill rigs equipped with one or more boom mounted platforms shall comply with EN 280:2013.

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Drill jumbos and pre-armouring machines are exempted from the following requirements of EN 280:2013:

— a device that prevents driving of the vehicle when the boom mounted platform is not in its transport position;

— a device that prevents movement of the platform while the stabilizers are not set;

— a device that prevents adjustment of the stabilizers while the boom mounted platform is not in its transport position;

— a device, located in the operators compartment, that indicates that the boom mounted platform is not in its transport position;

— a load sensing system;

— an adjustment for uneven ground for base plates on stabilizing jacks.

NOTE The exceptions are justified for the following reasons:

— the primary function of the stabilizers is for use during drilling;

— the need to maneuver in narrow tunnels;

— risk of rock fall;

— size and weight of machine.

Drill jumbos and pre-armouring machines are exempted from the requirements of EN 280:2013, 5.7.4. The boom mounted working platform shall be operated from both the platform and the operator's station. Only one control position shall be active at a time except for stop controls and emergency stop. In case of emergency, e.g. rock fall, it shall be possible to override the controls of the platform by the control at the operator’s station.

Overturning of drill jumbos and pre-armouring machines, due to overload of the platform, of a drill rig for underground use and equipped with a boom mounted working platform is not considered a significant hazard due to the size and weight of the rig. However overload of the boom and platform shall be prevented by restricting the platform size according to EN 280:2013, 5.4.1.6, or by mechanical, hydraulic or electronic protection systems. The platform shall be subject to a static load test according to EN 280:2013, 6.1.4.3.

Any overload prevention system fitted shall not prevent the platform being lowered.

5.3 Requirements for strength and stability

5.3.1 Stability calculation - Tipping angle

Subclause 5.2.3.5 of EN 16228-1:2014 applies with the following modification(s).

The stability angles α shall not be less than 10° in any directions when tramming and be not less than 5° under any other conditions.

For rubber-tyred drill rigs for underground use, the stability angle of 10° includes also a margin for the effects of the dynamic forces from acceleration and braking of the total drill rig.

5.3.2 Operating conditions

5.3.2.1 General

Subclause 5.2.3.6 of EN 16228-1:2014 applies with the following additions.

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The stability of the drill rig shall be calculated for the operating conditions as described in subclauses 5.3.2.2, 5.3.2.3 and 5.3.2.4, which shall be stated in the operator's manual.

5.3.2.2 In service – during operation

The calculation shall be carried out for the most unfavourable combination of conditions that may occur with the following additional examples:

— booms, service platforms and feed extension in advanced positions and turned to the limit of the working area. The rated load shall be applied to the service platform;

— steering turned in the extreme and most unfavourable position (articulated carrier);

— mast at the utmost front upward position and maximum forward mast inclination;

— attachments at their highest position;

— maximum pulling force on the rope suspended tool in the bore hole.

5.3.2.3 Tramming

Stability in tramming shall be calculated for the conditions specified in the operator's manual, taking into account the most unfavourable case.

5.3.2.4 Travelling and operating on slopes

The stability calculations shall be done for the most unfavourable combinations of gradient and load condition as specified in the operator's manual.

5.4 Fire protection

Subclause 5.26 of EN 16228-1:2014 applies with the following additions.

For the fire protection of mobile drill rigs intended for use underground, there shall be a fixed on-board, fire extinguishing system covering the diesel engine compartment and battery installation, e.g. unfused cables. For remotely controlled, unmanned or partly manned mobile drill rigs, the triggering system shall be automatic.

On remotely controlled mobile drill rigs it shall be possible to trigger the fire extinguishing system from the control panel and/or (if applicable) from the monitoring position.

5.5 Guards

Subclause 5.23.2.2.2 of EN 16228-1:2014 applies with the following additions.

For drilling machines that do not have significant hazards caused by feed movement of the rotary head, (e.g. rotary head is higher than 1 600 mm from ground level), the guarding of the moving parts involved in the working process may be restricted to the guarding of the rotating parts, to prevent the operator inadvertently coming in contact with moving parts when working in close proximity to the drill string.

When drill rigs are equipped with guards, these guards shall comply with the following:

— maximum height of the bottom edge of the guard shall be up to 500 mm from ground level or not more than 200 mm above the upper clamps/jaws;

— the upper level of the guard shall prevent unintentional access to the moving parts up to 1 600 mm from ground level and/or such height above ground level where persons have operational access.

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The design of the guard shall ensure a sufficient visibility of the working area.

5.6 Protection against moving parts on specific machine types

5.6.1 General

All drill rigs shall comply with subclause 5.23 of EN 16228-1:2014 with the following exceptions only:

— underground pre-armouring machine (see 5.6.2);

— drill jumbo (see 5.6.3).

5.6.2 Underground pre-armouring machine

Subclause 5.23.2 of EN 16228-1:2014 does not apply, except 5.23.2.2.4.

The installation of the drill string prior to operation is regarded as a rigging operation to be done with the use of external means such as cranes.

For the rigging operation the restricted operating mode is used as in subclause 5.23.2.2.4 of EN 16228-1:2014.

If there is a need of addition and removal of rod during the drilling process it shall be done by a mechanized rod handling device fitted on the machine.

Machines with a boom mounted platform shall be fitted with a mode selector or an interlocking function to allow platform operations only when movements of rotation and feed and motions for positioning the drill string are prevented.

The machine shall be fitted with a remote control system with all controls of hold to run type except feed and rotation.

NOTE The use of the remote control removes the operator from the danger zone and gives sufficient visibility of the working process.

The sensitive protective devices as in 5.23.2.2.3 of EN 16228-1:2014 should be fitted if the work environment allows it to be done without creating additional hazards due to their malfunction.

5.6.3 Drill jumbo

5.6.3.1 General

Subclause 5.23.2 of EN 16228-1:2014 does not apply, except 5.23.2.2.4.

The drill jumbo shall be so designed, constructed and equipped that manual operation in the danger zone is minimized.

5.6.3.2 Restricted access to the rotating parts danger zone

Drill jumbos shall have motion detectors to detect access of persons to the danger zone formed by rotating parts. According to operational mode, choice and application of these detectors are defined in 5.6.3.3, 5.6.3.4 and 5.6.3.5.

NOTE There might be other technical solutions than motion detectors that can achieve the same or higher level of protection. This in combination with the rock walls does limit access to the danger zone.

The area beyond the technical limits of the motion detector should be job site controlled.

5.6.3.3 Full drill cycle automation mode

If the machine is operating in full drill cycle automation mode, the drilling shall stop if someone passes the motion detector. Restart shall only be possible after the operator has made sure that no one is in the rotating parts danger zone and has reset the motion detector system.

5.6.3.4 Single hole automation mode, Single rod automation mode and manual rod handling mode

If the machine is in single hole automation mode, single rod automation mode or manual rod handling mode, a visual signal shall warn the operator if someone passes the motion detector.

NOTE During single hole automation mode, single rod automation mode and manual rod handling mode there is a need for an operator to be in the vicinity of the feed beams, on the service platform or on the ground.

5.6.3.5 Drill jumbos operated by remote control

For remote controlled drill jumbos where the drilling is in direct line of sight from the operator, 5.6.3.2 does not apply. A safeguard shall be selected from the following:

— a system that detects the operator entering the danger zone whilst the drill string is rotating, e.g. motion detector on the stationary remote control panel. When the system detects the operator, the restricted operating mode (see 5.23.2.2.4 of EN 16228-1:2014) shall be activated; or;

— equipped with a system, capable of detecting the operator carrying the remote control approaching the rotating parts involved in the process. When the system detects the operator/remote control unit, all movements shall be stopped.

NOTE The system described in the second indent above might be RFID (radio frequency identification) tag based and fitted in the remote control box.

For remote controlled drill jumbos where the drilling is not in direct line of sight from the operator, 5.6.3.2 applies. The drilling shall stop if someone passes the motion detector. Restart shall only be possible after the operator has made sure that no one is in the rotating parts danger zone and has reset the motion detector. This type of remote controlled drill jumbo shall be fitted with a CCTV system.

5.6.3.6 Manual rod handling

If the rods are handled manually when threading during extension drilling, the protective measures shall be selected from the following:

— mechanized rod handling device to add drill rods to the drill string or;

— installing the drill steel in place between shank adapter and previous rod before starting the rotation or;

— the threading operation shall be carried out in restricted operating mode enabled by a switch limiting the rotation speed to 60 rpm.

5.7 Rod/auger guide

When the drill string is driven by a universal joint, a rod/auger guide shall be fitted.

5.8 Winches, draw-works and ropes for movement on slopes

Subclause 5.8 of EN 16228-1:2014 applies with the following additions.

If the drill rig is intended for operation on slopes having a gradient angle higher than 20°, a winch shall be installed to prevent the drill rig from sliding down the slope. For these winches the following requirements apply.

The relative rated pulling force, *f*, on the third layer of the rope on the winch drum, shall be chosen in accordance with the operating gradients stated below:

f > 0,50 for a gradient angle of < 40 °

f > 0,40 for a gradient angle of < 35 °

f > 0,30 for a gradient angle of < 30 °

f > 0,20 for a gradient angle of < 25 °

where

$$f = \frac{Pulling\ \ force\ in\ Newton}{Mass\ of\ \ drill\ rig \times g}$$

Flanges on drums shall be designed to extend at least two rope diameters beyond the outer wrap of rope in all operating conditions. In specific installations where this is not feasible, other means shall be taken in order to prevent the rope to be spooled off the drum like mechanical stop or other devices.

Winches for free fall operation shall not be used.

The braking capacity of the winch shall not be less than 1,2 times the pulling force but not exceed 1,6 times the pulling force.

The wire rope safety factor shall not be less than 3.

The application of a winch shall not be included as a support in the stability calculation.

5.9 Operating position(s)

Subclause 5.14 of EN 16228-1:2014 applies with the following addition.

Rubber-tyred drill rig for underground use shall be provided with a restraint system for operators seat at the tramming position, e.g. safety belt.

5.10 Brakes of the carrier machine

5.10.1 General

Subclause 5.7 of EN 16228-1:2014 applies with the following addition.

For rubber-tyred rigs intended to operate at slope angles steeper than 10°, it shall be possible to slow down, stop and hold at rest self-propelled rigs so as to ensure safety under all conditions of service, speed, ground conditions and gradients as specified by the manufacturer.

Braking systems may use common components, however in the case of a failure of any single component other than a tyre; the braking system shall be capable of bringing the drill rig to a halt in accordance with the performance requirements specified for the secondary braking system.

It shall not be possible from the operator's position to disconnect the brakes from the wheels or tracks.

Where the operation of the service braking system depends on accumulated hydraulic or pneumatic energy and in case the power source becomes inoperative, the system shall be capable of sustaining at least five

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consecutive applications of the brakes. On the fifth application the brake performance shall not be less than that specified for the secondary braking system.

Where braking systems use an energy reservoir, a warning device complying with EN ISO 3450:2011, 4.9, shall be provided.

A mobile drill rig, which has any type of remote control for moving, shall be so designed that in case the driver should lose control for any reason, the machine shall stop automatically.

NOTE For truck, tractor and trailer mounted mobile drill rigs the relevant road traffic regulations regarding the vehicle brakes apply.

5.10.2 General requirements for wheel mounted mobile drill rigs

Wheel mounted mobile drill rigs shall be equipped with:

— a service braking system;

— a secondary braking system;

— a parking braking system.

The braking system controls shall fulfil the requirements of EN ISO 3450:2011, 4.3. Pneumatic and hydraulic braking systems shall be designed as dual circuit systems such that at least two wheels on opposite sides of the vehicle is braked in the event of a leak. Provisions for examining or testing brake wear and brake fluid level in any reservoir shall be made.

5.10.3 Service braking system for wheel mounted mobile drill rigs

The service braking system shall give a braking force, in N, equivalent to not less than 35 % of the maximum drill rig mass multiplied by 9,81. For manoeuvring and holding mobile drill rigs on steep slopes see also 5.8. In addition to this requirement, the service brake system shall be capable of retarding the drill rig with at least 1 m/s^2 on the maximum permitted gradient as specified by the manufacturer. For mobile drill rigs with hydrostatic transmission, service braking action may be performed by means of the hydrostatic transmission if the performance requirements given above are fulfilled.

The service brake shall be resistant to fade due to heat, see B.3, B.4 and B.5.

5.10.4 Secondary braking system for wheel mounted mobile drill rigs

A secondary braking system shall be provided to stop the drill rig in any condition of service, speed, ground and gradient as specified by the manufacturer, in the event of any failure in the service braking system.

The secondary braking system shall give a braking force in N, equivalent to not less than 25 % of the maximum drill rig mass multiplied by 9,81.

In addition to this requirement, the secondary brake system shall be capable of retarding the drill rig with at least 1 m/s^2 on the maximum permitted gradient as specified by the manufacturer. To achieve this brake force, the parking brake may be used in addition.

For mobile drill rigs with a hydrostatic service brake, the secondary braking system shall also achieve independently the braking performance specified in the service brake.

5.10.5 Parking braking system for rubber-tyred rigs

A purely mechanical parking braking system for holding machines in a stationary position shall be provided.

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The parking braking system shall be latching.

The parking braking system shall be able to hold the drill rig on the steepest slope it is allowed to operate on, up to a maximum of 20°, according to the manufacturer's specification with a safety factor of 1,2. For operating on slopes steeper than 20°, see 5.8.

5.10.6 Verification of brakes

The brakes of a wheel mounted drill rig shall be tested in accordance with the requirements in Annex B.

The brakes of crawler mounted mobile drill rigs shall be tested in accordance with B.7. The parking brakes of towed mobile drill rigs shall be tested according to B.7.

NOTE These verifications are not necessary for any machine which is certified to meet the requirements of road traffic regulations.

5.10.7 Braking systems for skid steer wheel mounted drill rigs

For skid steer chassis, the same rules as for crawler mounted drill rigs of EN 16228-1:2014 shall apply. Braking action shall be possible on all wheels.

6 Verification of the safety requirements and/or protective measures

6.1 General

Safety requirements and/or protective measures of Clauses 5 and 7 of this European Standard shall be verified according to Table 2 below. It includes the following types of verification:

a) design check: the result of which being to establish that the design documents comply with the requirements of this European Standard;

b) calculation: the results of which being to establish that the requirements of this European Standard have been met;

c) visual verification: the result of which only being to establish that something is present (e.g. a guard, a marking, a document);

d) measurement: the result of which shows that the required numerical values have been met (e.g. geometric dimensions, safety distances, resistance of insulation of the electric circuits, noise, vibrations);

e) functional tests: the result of which shows that the adequate signals intended to be forwarded to the main control system of the complete machine are available and comply with the requirements and with the technical documentation;

f) special verification: the procedure being given or in the referred clause.

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Table 2 — Verification of safety requirements and/or protective measures

Clause number	Title	a) Design check	b) Calculation	c) Visual verification	d) Measurement	e) Functional test	f) Special verification (see the end of this table)
5	Safety requirements and/or protective measures						
5.1	General	x					1
5.2	Boom mounted working platforms for underground use	x				x	1
5.3	Requirements for strength and stability						
5.3.1	Stability calculation - Tipping angle	x	x				1
5.3.2	Operating conditions	x	x				1
5.3.2.2	In service – during operation	x	x				
5.3.2.3	Tramming	x	x				
5.3.2.4	Traveling and operating on slopes	x	x				
5.4	Fire protection						1
5.5	Guards	x			x	x	1
5.6	Protection against moving parts on specific machine types						1
5.6.2	Underground pre-armouring machine	x				x	1
5.6.3	Drill jumbos	x					1
5.6.3.1	General	x					1
5.6.3.2	Restricted access to the rotating parts danger zone	x		x		x	1
5.6.3.3	Full drill cycle automation mode	x				x	
5.6.3.4	Single hole automation mode, Single rod automation mode and manual rod handling mode	x				x	
5.6.3.5	Drill jumbos operated by remote control	x				x	1
5.6.3.6	Manual rod handling	x			x	x	
5.7	Rod/auger guide	x		x			
5.8	Winches, draw-works and ropes for movement on slopes	x			x	x	1
5.9	Operating position(s)	x		x			1
5.10	Brakes of the carrier machine						1
5.10.1	General	x				x	1
5.10.2	General requirements for wheel	x				x	1

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Clause number	Title	a) Design check	b) Calculation	c) Visual verification	d) Measurement	e) Functional test	f) Special verification (see the end of this table)
	mounted mobile drill rigs						
5.10.3	Service braking system for wheel mounted mobile drill rigs	x			x	x	
5.10.4	Secondary braking system for wheel mounted mobile drill rigs	x			x	x	
5.10.5	Parking braking system for rubber-tyred rigs	x		x	x	x	
5.10.6	Verification of brakes			x	x		
5.10.7	Braking systems for skid steer wheel mounted drill rigs	x				x	1
7	Information for use						
7.1	General			x			
7.2	Drill rigs for underground operation			x			
1 Verification by reference to the standard which is mentioned in the corresponding clause.							

6.2 Functional test

Subclause 6.2.2 of EN 16228-1:2014 applies with the following exemptions.

Subclauses 6.2.2.2 and 6.2.2.3 of EN 16228-1:2014 do not apply to drill rigs not fitted with an auxiliary hoist for consumables or materials.

7 Information for use

7.1 General

Clause 7 of EN 16228-1:2014 applies with following additions.

The following information shall be given:

— instructions for remote control operation that the operator shall be able to observe the drilling process while operating;

— instructions on stability and other essential restrictions of use which are of immediate importance shall be given clearly visible at the driver's and operator's position and in the instruction manual, e.g. maximum allowed gradient angle for slopes when tramming or drilling;

— instructions in the operator's manuals how to add and remove rods and bits in a safe way when threading or doing extension drilling.

7.2 Drill rigs for underground operation

The following information shall be given:

— the area in front of the drill rig, i.e. between the carrier and the tunnel face, within the danger zone, shall be a restricted access area when drilling. Information about the restricted access area and the residual risks within the restricted access area shall be provided in the operational manual. Warning signs shall be provided on the rig;

— instructions on how to use the danger zone access detection system in the different operation modes;

— instructions on how to complement the danger zone access detection system if the rock wall is not limiting the danger zone;

— for the underground pre-armouring machines, instructions/drawings showing the hazardous area in order to require to the work site organisation to provide fences or barrier around the forbidden area;

— warning signs and lights shall be applied to the machine, forbidding the entry into the danger area close to the drill string;

— instructions/drawings showing the hazardous area in the instruction manual in order to require to the work site organisation to provide fences or barrier around the forbidden area;

— instructions to stop drilling when working from boom-mounted platforms.

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Annex A
(normative)

Noise test code

A.1 General

Annex B of EN 16228-1:2014 applies with the additions in A.2 to A.4.

A.2 Non-Percussive mobile drill rigs (Rotary Drilling)

For non-percussive drill rigs the influence of the process is eliminated by allowing the drill rig to work at full speed, but without the drilling tool engaged.

During the noise emission tests the rotary drill rig shall be operated under no load. Conditions as defined in B.2.4 of EN 16228-1:2014.

The tool shall be attached to the rotary head. Pumps and compressors shall operate during the test. The flushing medium flow shall be shut off, if possible.

A.3 Percussive mobile drill rigs (Percussive and Rotary-percussive)

For percussive drill rigs the major source of noise is the percussive drill itself and the drill steel. Therefore the drill rig shall drill in rock or a concrete block at rated performance level.

During the noise emission tests, drilling shall be performed in rock or a concrete block at rated performance level.

The drill bit shall be drilled at least 0,1 m into the rock or concrete before the measurement starts.

A.4 Information to be recorded and reported

— Type of rock or concrete;

— data necessary to operate the machine at its tested performance level.

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Annex B
(normative)

Brake test for mobile drill rigs excluding truck and tractor mounted drill rigs

B.1 Test conditions

The following values shall be measured:

— the retardation of the drill rig to ensure compliance with 5.10.3 and 5.10.4;

— the maximum force applied to the brake control to achieve the desired brake force;

— the pulling force for brake test, where applicable.

Where possible the engine shall be disengaged from the transmission in the brake test and where this is not possible the highest gear consistent with the test speed shall be selected.

In cases where a hydrostatic transmission braking system is used, the transmission circuit shall be bypassed when testing the secondary brake system.

The test speed shall be the maximum achievable speed on a level surface.

The test course shall consist of a hard, dry surface with a well compacted base. Ground moisture may be present to the extent that it does not adversely affect the braking test. The test course shall not have a slope more than 3 % at right angles to the direction of travel.

Test shall be performed with maximum drill rig mass and under moving conditions as specified by the manufacturer.

All parameters relating to the brake system, e.g. tyre size, brake adjustment and pressures in the brake system etc., shall be as specified by the manufacturer of the mobile drill rig. No manual adjustments shall be made to the braking system during any single performance test.

All brake tests shall be performed with burnished (conditioned) brakes. The burnishing procedure shall be checked by consulting the brake manufacturer.

Immediately prior to a test, the drill rig shall be operated until the fluids, e.g. engine and transmission oils, are at normal temperature.

B.2 Performance of the tests

The forces applied to the brake system controls in order to achieve the maximum brake forces shall be measured and shall not exceed the values stated in EN ISO 3450:2011, 7.1.1, Table 2.

For the test on brake systems using stored energy, a test point is required in the brake line near the brakes to enable actuating pressure to be monitored.

The service brake energy reservoir shall be fully charged and the power source then made inoperative. Five full service brake applications shall be made with the machine stationary and the brake actuating pressure noted at the end of the fifth application.

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The drill rig shall then undergo a dynamic service brake test, see B.4. The drill rig shall be operated at the test speed and the driver shall control the service brake pressure to the value noted after the fifth test above.

The performance of the service brake in this test shall comply with the requirements of 5.10.3. Where a warning device is provided, it shall be tested in accordance with EN ISO 3450:2011, 7.4.

B.3 Dynamic tests for wheel mounted mobile drill rigs

All dynamic tests shall be performed with cold brakes as defined in EN ISO 3450:2011, 3.12. 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 value specified by the manufacturer.

B.4 Service brake test

The maximum brake force shall be determined as the minimum result of a test series of at least four individual tests. In the case of mobile drill rigs designed for normal operation in either direction there shall be at least two individual tests in each direction. In this case the requirements of 5.10.3 shall be met for both directions.

B.5 Heat fade test

The service brakes shall be applied and released for seven consecutive stops at or as near as possible to maximum retardation of the drill rig without skidding. After each stop, the initial test speed shall be regained as quickly as possible using maximum acceleration. An eighth stop shall be made with measured retardation.

The brake force shall not be lower than the minimum value measured in the test described in B.4.

B.6 Secondary brake test

Tests to determine the brake force shall be as described for the service brake in B.4 and the performance shall comply with 5.10.4 and B.4.

B.7 Parking brake test

Where the parking brake is separate from the secondary brake it shall be subjected to either:

— a static gradient test or;

— a pull test.

In the gradient test the drill rig shall be positioned on a slope 1,2 times the maximum gradient on which it is designed to operate (e.g. if the maximum operating gradient is 20 %, the test gradient shall be 24 %). The brake shall be applied and shall hold the drill rig stationary. The test gradient may be either a roadway or a tilt platform with skid-resistant surface.

In the pull test a pulling force shall be applied to the drill rig and the parking brake shall be applied. The transmission shall be in a neutral position. The test course shall not have a slope more than 1 % in the direction of travel.

The pulling force, *F*, shall be applied horizontally near the ground and be at least equal to:

$$F = \frac{1{,}2 \cdot M \cdot g \cdot S}{100}$$

where

F is the pulling force in N;

M is the maximum mass of the drill rig in kg;

g is the acceleration due to gravity in m/s^2

S is the maximum gradient on which the drill rig is designed to operate, expressed as a percentage.

B.8 Test report

The test report shall be drawn up in the format of EN ISO 3450:2011, Clause 8, where appropriate.

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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 and of part 1 of the series 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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[1] EN 16228-4:2014, *Drilling and foundation equipment — Safety — Part 4: Foundation equipment*

[2] EN ISO 13855:2010, *Safety of machinery - Positioning of safeguards with respect to the approach speeds of parts of the human body (ISO 13855:2010)*

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