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Mining and earth-moving machinery — Rock drill rigs and rock reinforcement rigs —

Part 2: Safety requirements

Engins d'exploitation minière et de terrassement — Appareils de forage et de renfort de roches —

Partie 2: Exigences de sécurité

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 82, *Mining*, in cooperation with Technical Committee ISO/TC 127, *Earth-moving machinery*.

A list of all parts in the ISO 18758 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

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

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

— machine manufacturers;

— mining companies;

— health and safety bodies (regulators, accident prevention organisations, market surveillance, etc.).

Others that can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups are:

— machine operators;

— service providers, e.g. for maintenance;

— third party system and technology providers.

The above-mentioned stakeholder groups have been given the possibility to participate at the drafting process of this document.

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

When requirements of this type C standard are different from those which are stated in type A or B standards, the requirements of this type C standard take precedence over the requirements of the other standards, for rock drill rigs and rock reinforcement rigs that have been designed and built according to the requirements of this type C standard.

The following assumptions were made in writing this document:

a) the operators of the machines are well trained professionals and aware of potential risks of the working environment (see ISO/IEC GUIDE 51:2014, 6.1 a);

b) the machines are operated according to the instructions given by the manufacturer, such as operator's instructions (see ISO/IEC GUIDE 51:2014, 7.4.2.2);

c) administrative controls are in place for preventing unauthorized entry of persons to the area where machines are working (see ISO/IEC GUIDE 51:2014, 6.2.2 and note).

For increased readability of this document, rock drill rigs and rock reinforcement rigs are called rigs.

Mining and earth-moving machinery — Rock drill rigs and rock reinforcement rigs —

Part 2: Safety requirements

1 Scope

This document specifies the safety requirements for rock drill rigs and rock reinforcement rigs designed for the following underground or surface operations:

a) blast hole drilling;

b) rock reinforcement;

c) drilling for secondary breaking;

d) dimensional stone drilling;

e) mineral prospecting, e.g. utilizing core drilling or reverse circulation;

f) water and methane drainage drilling;

g) raise boring.

NOTE Rigs can be designed for more than one of the operations above. See ISO 18758-1 for vocabulary.

This document is also applicable to earth-moving machinery as defined in ISO 6165, modified to become a rock drill rig or rock reinforcement rig.

This document is not applicable to the following machines: drill rigs for soil and rock mixture; (geothermal drill rigs, water well drill rigs, water jet drill rigs, micro pile drill rigs; surface horizontal directional drill rigs (HDD) as defined in ISO 21467), kelly drill rigs (and casing drivers); cable tool drill rigs; pre-armouring machines; sonic drill rigs; shaft sinking drill rigs; crane attached drill rigs; drill rigs on derricks; scaling machines.

This document deals with the significant hazards, hazardous situations or hazardous events, as listed in Annex E, relevant to rock drill rigs and rock reinforcement rigs (see ISO 18758-1), when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer.

This document is not applicable to rigs manufactured before the date of its publication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 2631-1, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

ISO 2867, *Earth-moving machinery — Access systems*

ISO 3449, *Earth-moving machinery — Falling-object protective structures — Laboratory tests and performance requirements*

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

ISO 3457:2003, *Earth–moving machinery — Guards — Definitions and requirements*

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

ISO 3864-2, *Graphical symbols — Safety colours and safety signs — Part 2: Design principles for product safety labels*

ISO 4302:2016, *Cranes — Wind load assessment*

ISO 4309, *Cranes — Wire ropes — Care and maintenance, inspection and discard*

ISO 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

ISO 4871, *Acoustics — Declaration and verification of noise emission values of machinery and equipment*

ISO 5006:2017, *Earth–moving machinery — Operator's field of view — Test method and performance criteria*

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

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

ISO 6405-2, *Earth-moving machinery — Symbols for operator controls and other displays — Part 2: Symbols for specific machines, equipment and accessories*

ISO 6682, *Earth-moving machinery — Zones of comfort and reach for controls*

ISO 6683, *Earth-moving machinery — Seat belts and seat belt anchorages — Performance requirements and tests*

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

ISO 7731, *Ergonomics — Danger signals for public and work areas — Auditory danger signals*

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

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

ISO 10262, *Earth-moving machinery — Hydraulic excavators — Laboratory tests and performance requirements for operator protective guards*

ISO 10263-1, *Earth-moving machinery — Operator enclosure environment — Part 1: Terms and definitions*

ISO 10263-2, *Earth-moving machinery — Operator enclosure environment — Part 2: Air filter element test method*

ISO 10263-3, *Earth-moving machinery — Operator enclosure environment — Part 3: Pressurization test method*

ISO 10263-4, *Earth-moving machinery — Operator enclosure environment — Part 4: Heating, ventilating and air conditioning (HVAC) test method and performance*

ISO 10263-5, *Earth-moving machinery — Operator enclosure environment — Part 5: Windscreen defrosting system test method*

ISO 10263-6, *Earth-moving machinery — Operator enclosure environment — Part 6: Determination of effect of solar heating*

ISO 10264, *Earth-moving machinery — Key-locked starting systems*

ISO 10265, *Earth-moving machinery — Crawler machines — Performance requirements and test procedures for braking systems*

ISO 10532, *Earth-moving machinery — Machine-mounted retrieval device — Performance requirements*

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

ISO 10968, *Earth-moving machinery — Operator's controls*

ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections*

ISO 11203, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level*

ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction*

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

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

ISO 13732-1, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO/TS 13732-2, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 2: Human contact with surfaces at moderate temperature*

ISO 13732-3, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 3: Cold surfaces*

ISO 13766, *Earth-moving machinery — Electromagnetic compatibility*

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

ISO 13850, *Safety of machinery — Emergency stop function — Principles for design*

ISO 13851, *Safety of machinery — Two-hand control devices — Functional aspects and design principles*

ISO 13856-1, *Safety of machinery — Pressure-sensitive protective devices — Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors*

ISO 13856-2, *Safety of machinery — Pressure-sensitive protective devices — Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*

ISO 13856-3, *Safety of machinery — Pressure-sensitive protective devices — Part 3: General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices*

ISO 14118, *Safety of machinery — Prevention of unexpected start–up*

ISO 14567, *Personal protective equipment for protection against falls from a height — Single-point anchor devices*

ISO 14990-1, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 1: General requirements*

ISO 14990-2, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 2: Particular requirements for externally-powered machines*

ISO 14990-3, *Earth-moving machinery — Electrical safety of machines utilizing electric drives and related components and systems — Part 3: Particular requirements for self-powered machines*

ISO 15817, *Earth-moving machinery — Safety requirements for remote operator control systems*

ISO 15818, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements*

ISO 16001, *Earth–moving machinery — Hazard detection systems and visual aids — Performance requirements and tests*

ISO 16368, *Mobile elevating work platforms — Design, calculations, safety requirements and test methods*

ISO 16528-1, *Boilers and pressure vessels — Part 1: Performance requirements*

ISO 16528-2, *Boilers and pressure vessels — Part 2: Procedures for fulfilling the requirements of ISO 16528-1*

ISO 20381, *Mobile elevating work platforms — Symbols for operator controls and other displays*

IEC 60073, *Basic and Safety Principles for Man–Machine Interface, Maring and Identification — Coding Principles for Indication Devices and Actuators*

IEC 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 61000-6–2, *Electromagnetic compatibility (EMC) — Part 6–2: Generic standards — Immunity for industrial environments*

IEC 61000-6–4, *Electromagnetic compatibility (EMC) — Part 6–4: Generic standards — Emission standard for industrial environments*

IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

IEC 61310-2, *Safety of machinery — Indication, marking and actuation — Part 2: Requirements for marking*

IEC 61310-3, *Safety of machinery — Indication, marking and actuation — Part 3: Requirements for the location and operation of actuators*

EN 14492-1, *Cranes — Power driven winches and hoists — Part 1: Power driven winches*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 4309, ISO 6682, ISO 6750, ISO 10968, ISO 12100 and ISO 18758-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Safety requirements

4.1 General requirements

4.1.1 General

Machinery shall comply with the safety requirements of this document. In addition, the machine shall be designed according to the principles of ISO 12100 for hazards which are not dealt with by this document.

4.1.2 Ergonomics

The rig shall be designed according to ergonomic principles to minimise fatigue and stress on the operator. Consideration shall be given to the fact that operators can wear heavy gloves, footwear and other personal protective equipment.

4.1.3 Hot and cold surfaces and sharp edges

Where there is a risk of human contact with hot or cold surfaces, such surfaces shall be protected by guards or covers in accordance with Clause 8 of ISO 3457:2003 after being evaluated using ISO 13732-1, ISO/TS 13732-2 and ISO 13732-3. Surfaces and edges shall meet the requirements of ISO 12508.

4.1.4 Hoses, pipes and fittings under pressure

a) Pipes, hoses and fittings shall be able to withstand the stresses from the pressure. The hoses shall be marked with the rated working pressure. The requirements of ISO 4413 and ISO 4414 shall be met.

b) Where there is a risk that a rupture of a hose or pipe at the operator's position could cause hazard to the operator, the hoses and pipes in this area shall be provided with protective guards in accordance with ISO 3457:2003, Clause 9, or, in the case of compressible substance, with a means of restraining the hose from whipping.

c) Hoses meant to have an open end (e.g. air, grout and mud) shall have means to be restrained against freeing themselves when they are not in use.

4.1.5 Handling of the rig and its parts

a) There shall be defined lifting points or devices for lifting the whole rig or parts of it. The lifting points may also be used for holding and securing the machine during transport. Lifting points on the machine shall be in accordance with ISO 15818.

b) Components and parts of a rig which require to be manually handled shall be designed in such a way as to allow safe manual handling. If the weight or forms of components prevent safe manual handling, they shall be so designed that lifting accessories can be safely used.

c) On articulated carriers there shall be a mechanical locking device for locking the articulation joint during maintenance, lifting and transport. The articulation frame lock shall comply with ISO 10570.

d) Retrieving points (hooks, ears, etc.) shall be provided on the machine. They shall comply with ISO 10532.

4.1.6 Access to operating positions and servicing points

a) Access systems shall be provided to the operator's station and to routine maintenance points. Access systems shall comply with ISO 2867.

b) Minimum access dimensions shall comply with ISO 2860.

c) When doors, windows and flaps are designed to open and close freely, and can be blown or unintentionally fall closed creating a hazard, it shall be possible to secure them in both closed and open positions. For surface applications, wind force while drilling, as presented in Annex B, should be considered.

d) The maintainability guidelines of ISO 12510 should be used.

e) If provided, anchor devices for personal fall protection equipment shall comply with ISO 14567.

4.1.7 Isolation of external electrical energy sources

a) Rigs supplied with external electrical energy shall be fitted with means to isolate them from all energy sources. Such devices shall be clearly identified and it shall be possible to lock them if reconnection could endanger exposed persons. The requirements of ISO 14118 and IEC 60204-1 shall be met.

b) After the energy is shut off, it shall be possible to dissipate any energy remaining or stored in the circuits of the rig without risk to exposed persons.

c) As an exception from the above requirements, certain circuits may remain connected to their energy sources, e.g. to hold parts in position, to protect information, to provide interior lighting. These circuits shall be clearly identified in the instruction handbook. They shall have permanent warning labels.

4.1.8 Prevention of unexpected start-up

Rigs shall comply with ISO 14118.

4.2 Driving, tramming and operating position

4.2.1 General

The driving, tramming and operator positions shall be designed so that all manoeuvres necessary for moving and operating the rig can be performed by the operator minimising risk to himself or to other persons.

To protect the operator from noise, dust and environmental conditions, an enclosed operator cab should be provided on machines with an on-board operator station.

There are types of rigs or operating conditions where it is not appropriate or possible to provide an operator cab. Examples of such situations include:

a) a small size of the machine, e.g. for restricted access applications;

b) the size or layout of the machine prevents an operator cab from being mounted on the machine in a position from which the operator can view the operations;

c) the controls for driving, tramming and travelling may be located in a different position than the drilling controls.

4.2.2 Operator's position

4.2.2.1 Operator cab (operator enclosure)

If the machine is fitted with an operator cab, the following applies:

a) there shall be an operator protective structure in accordance with 4.2.4.1;

b) required space, leg room, etc. should be in accordance with ISO 3411 and ISO 6682;

c) if there is a seated operator’s position, seatbelts shall be provided that shall be in accordance with ISO 6683;

d) a seat, unless the operator has to work in a standing position, shall provide the operator with a comfortable and stable working position and shall be easily adaptable to operators of different weight and height. ISO 11112 should be used for guidance. The seat shall be designed to reduce vibrations transmitted to the operator to the lowest level that can be reasonably achieved, in accordance with 4.17.3;

e) for determining the seat index point, ISO 5353 should be used for guidance;

f) the material of the interior of the operator cab shall be in accordance with the requirements of 4.16.1 and 4.16.2;

g) there shall be either an emergency exit in accordance with ISO 2867, on a different side of the operator cab from that where the normal exit is situated, e.g. in the form of knock-out windows or knock-out panels, or tools shall be provided for breaking the window unless normal exit/entrance is for both sides of the machine;

h) there shall be an isolation against vibration of the floor in accordance with 4.17.3;

i) there shall be a protection against noise in accordance with 4.17.2;

j) operator enclosure environment shall be designed using ISO 10263 (all parts) as applicable to the surrounding environmental conditions;

k) windows shall be made of safety glass or other material that provides similar safety performance. The glazing may be adapted to the protection level required as per the risks existing in the use environment. See, for example, ECE R43, EN 356, EN 13123-2, EN 13124-2 and EN 15152-2;

l) there shall be window cleaning devices for each window essential for visibility during operations;

m) if provided, the filling point of the tank of the window washers shall be easily accessible.

4.2.2.2 Operator canopy

Provisions 4.2.2.1 a) to h) apply to operator canopies.

4.2.2.3 Elevating operator station

In addition to the provisions for operator cabs and operator canopies, the following applies to elevating operator stations.

a) The lift and descent speed of the operator's station shall not exceed 0,6 m/s under normal operating conditions or 0,4 m/s in case of hydraulic line rupture. The operator's station shall not exceed ±15° on horizontal tilting.

b) If service or maintenance work has to be done with a raised station, a mechanical support device shall be provided. The device shall meet the performance requirements of ISO 13333:1994, Clause 4.

c) The elevating control shall be clearly marked and protected against unintentional activation.

d) In case of failure of the source of energy, engine stop or hydraulic system failure, it shall be possible for the operator to lower the station to the lowest position (irrespective of the actual position) or to leave the station safely, e.g. by steps or stairs.

e) Access shall be in accordance with ISO 2867.

f) Load holding cylinders in accordance with 4.13.2 shall be provided to prevent the station from falling. As an alternative, a loader lowering control device in accordance with ISO 8643 may be used.

4.2.2.4 Tilting operator cab

In addition to the requirements of 4.2.2.3, the following applies to tilting operator cabs:

a) if the operator cab front, when tilted, becomes a part of the falling object protective structure, it shall comply with 4.2.4.1;

b) if a slewing seat is used, it should be adapted to the tilting conditions, for example by damping seat slew;

c) operator controls shall be adapted as appropriate;

d) emergency egress in tilting position shall be provided.

4.2.2.5 Tramming stand

Where a ride-on operator's position is provided on the machine for the purposes of tramming the machine, it shall be provided with:

a) a grab rail for the operator stability when riding. This grab rail shall be capable of withstanding a horizontal force of 900 N applied in line with the operator's standing position, without permanent deformation;

b) anti-slip surface;

c) if the rig is not intended to be trammed from the ground, there shall be provisions to prevent tramming from the ground.

4.2.2.6 Remote controlled and autonomous rigs

An operator's station is not required on remote controlled or autonomous rigs.

4.2.2.7 Boom-mounted working platforms for underground use

When a rig for underground use is equipped with a boom-mounted working platform intended for use in an area where there is a risk of falling objects, all persons on the platform shall have adequate protection. A suitably designed falling objects protective structure (FOPS) in accordance with Table 1 shall be provided over part of the platform. The FOPS may be adjustable taking into account the various functions to be performed from the platform.

Rigs equipped with boom-mounted working platforms shall comply with ISO 16368 but are exempted from the following requirements of ISO 16368:

a) providing a device that prevents driving of the rig when the boom-mounted platform is not in its transport position;

b) providing a device that prevents movement of the platform while the stabilizers are not set;

c) providing a device that prevents adjustment of the stabilizers while the boom-mounted platform is not in its transport position;

d) providing a device, located in the operators compartment, that indicates that the boom-mounted platform is not in its transport position;

e) providing a load sensing system;

f) providing an adjustment for uneven ground for base plates on stabilizing jacks.

NOTE The exemptions are justified for the following reasons:

a) the primary function of the stabilizers is for use during drilling;

b) the need to manoeuvre in narrow tunnels;

c) risk of rock fall;

d) the size and weight of the machine.

The boom-mounted working platform shall be operable 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, for example rock fall, it shall be possible to override the controls of the platform by the control at the operator's station.

Overturning of a rig for underground use and equipped with a boom-mounted working platform, due to overload of the 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 ISO 16368, or by mechanical, hydraulic or electronic protection systems. The platform shall be subject to a static load test according to ISO 16368.

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

4.2.2.8 Temporary roof support

If a temporary roof support (TRS) system is fitted, it shall be designed in accordance with Annex A.

4.2.3 Visibility

The visibility from the operator station of the rig shall be evaluated in accordance with ISO 5006:2017, 10.4 and Clause 12.

If object detection systems and visibility aids are used, they shall comply with ISO 16001.

4.2.4 Operator protective structures

4.2.4.1 Selection criteria

If an operator station is provided on the machine, the operator protective structures shall be in accordance with Table 1:

Table 1 — Operator protective structure selection criteria

Type of operators station	ISO 3449 FOPS level 2 or Static calculation according to 4.2.4.2	ISO 3471 ROPS	ISO 10262 Front guard
Surface rig operator cab	Required	Required	Not required
Surface rig operator cab large rig >25 tons	Required	Not required	Not required
Underground operator cab	Required	Not required	Not required
Underground operator canopy	Required	Not required	Not required
Underground adjustable height operator canopy	Required	Not required	Not required
Underground boom-mounted working platform	Required	Not required	Not required
Underground elevating operator cab	Required	Not required	Not required
Underground elevating operator canopy	Required	Not required	Not required
Underground tilting operator canopy	Required	Not required	Required
Tramming stand	Not required	Not required	Not required
Rigs operated from the ground level	Not required	Not required	Not required

For low profile machines and space restrictions due to working environment and physical size of the machine, the requirements of ISO 3449 can require adaptation to suit the application.

ISO 12117-2 may be used as an alternative to ISO 3471 on excavator-based rigs.

4.2.4.2 Static calculation for the operator protective structure

The protective structure shall be designed to have a minimum structural capacity to elastically support a rated design load of:

a) vertical load - a static uniform load of 8,2 tonnes, or a force equivalent to a static load of 105 kPa, distributed uniformly over the greatest plan view area of the operator canopy roof, whichever is the lesser; and

b) horizontal load - a static uniform load of two tonnes applied horizontally to the edge of the operator canopy roof in both longitudinal and lateral directions.

4.3 Controls, functions and systems

4.3.1 General

Control systems shall comply with IEC 60204-1:2006, Clauses 9, 10 and 11, ISO 4413, ISO 4414 and ISO 13849-1.

NOTE 1 ISO/TR 22100-2 gives information on how ISO 12100 relates to ISO 13849-1.

NOTE 2 Requirements for autonomous machines are given in ISO 17757.

4.3.2 Starting

Starting of the rig's main power source shall only be possible by an intentional actuation of the starting control device.

Unauthorised starting shall be prevented by the provision of suitable safeguards, e.g. lockable operator cab, lockable starting switch complying with ISO 10264 or lockable electric isolator switch. If a higher level of security is required, refer to ISO 22448.

4.3.3 Stopping – Normal stopping

The rig shall be fitted with a stopping device by which drilling or other operating functions are brought safely to a complete stop.

4.3.4 Failure of the power supply

An interruption of the power supply and a re-establishment after an interruption shall not lead to a dangerous situation, in particular:

a) it shall only be possible to restart a rig by an intentional action;

b) the rig shall not be prevented from stopping if the stop command has been given;

c) no part of the machine or a tool shall fall or be ejected;

d) stopping, automatic or manual, of moving parts shall operate without undue delay;

e) guards and other protective devices shall remain effective.

A power failure or a hydraulic or pneumatic pressure drop shall not cause any dangerous movements or actions. Such failures shall not prevent the emergency stop systems from functioning.

4.4 Control devices

4.4.1 General

a) Control devices shall comply with ISO 10968. Placement shall be in accordance with ISO 6682.

b) In addition, ISO 9355-1, ISO 9355-2, ISO 9355-3 and ISO 9241 (all parts) should be used as for guidance.

c) Where there is more than one operator's position for controlling the drilling process, the rig shall be provided with a mode selector to intentionally select the control position which shall be used.

d) When a control is designed and constructed to carry out several functions, e.g. keyboard control, the activated operation shall be clearly identified.

e) The on-board control devices on the control station shall be located so that the operator cannot reach the rotating parts or a two-hand control device shall be used.

f) If two-hand control devices are used, they shall comply with ISO 13851.

g) Accidental actuation of the controls shall be prevented when such actuation can cause a hazard.

4.4.2 Control system of remote controlled and automated rigs

a) Remote operator control shall be designed in accordance with ISO 15817.

b) The rig's control circuits shall be so designed that the operations either stop in case of an interruption or break down of the control link between the operator and the rig, or stop when the initiated drilling sequence has been completed.

c) An unmanned, automatically operated rig's control system shall be designed with an integrated diagnostic system that shuts down the operation when a fault or an abnormal operational behaviour is detected by the system.

d) Resetting, after a fault in part of the system, shall not restart any automatic function.

e) Restarting of the operation shall only be possible by an intentional action by the operator.

f) The rig shall be provided with a selector switch for selecting local or remote control mode. The local control shall always have priority over the remote control.

4.4.3 Emergency stop and safety devices

4.4.3.1 Emergency stops

There shall be an emergency stop at every operating or driving position placed within easy reach of the operator, and additional emergency stops shall be fitted on the rig, being safely and easily accessible from outside of the rig. The emergency stops shall comply with ISO 13850.

4.4.3.2 Safety device for stopping of rotation and feed

Surface rigs with a feed beam, where there is a risk that personnel can be caught and injured by the rotating member, shall be equipped with additional trip devices in the immediate area of the rotating drill string accessible to personnel. The trip devices shall be installed to provide the greatest likelihood practicable for being automatically tripped by a part of the body and to be within reach of a person who may be entangled. The trip device shall meet the relevant requirements of ISO 13856-1, ISO 13856-2, or ISO 13856-3.

If the rig is equipped with a mechanical drill rod/pipe handling system, a trip device on the accessible side of the drill rod/pipe is sufficient. See also 4.9.

When actuating the trip device, any residual energy in the system shall be contained or released so as to not cause any dangerous movements.

The trip device shall, after actuation, remain engaged until manually reset. This manual resetting shall not start the machine but only permit restarting by the normal starting procedures.

NOTE This safety device can have the same function as the emergency stop.

Such a trip device is not feasible underground, due to contact with rock wall and falling stones.

4.4.4 Operating instrumentation

Visual display of machine operation should be in accordance with ISO 6011.

4.5 Stability

Stability calculations and verifications shall be in accordance with Annex B.

4.6 Steering

a) The steering system of wheeled machines with rubber tyres shall be designed in accordance with ISO 5010. Testing on a steering test course in accordance with ISO 5010 is not required.

b) A secondary steering system is not required on rigs.

4.7 Carrier brakes

4.7.1 General

a) 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.

b) 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 rig to a halt in accordance with the performance requirements specified for the secondary braking system.

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

d) Where the operation of the service braking system depends on accumulated hydraulic or pneumatic energy, in case the power source becomes inoperative, the system shall be capable of sustaining at least five consecutive applications of the brakes. On the fifth application, the brake performance shall not be less than that specified for the secondary braking system.

e) Where braking systems use an energy reservoir, a pressure gauge shall be located in the driver's field of vision. The minimum pressure required shall be marked on the pressure gauge by a red mark. Alternatively, a warning device complying with ISO 3450 may be provided.

f) A rig with 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.

4.7.2 General requirements for wheel-mounted rigs

a) Wheel-mounted rigs shall be equipped with:

   1) a service braking system;

   2) a secondary braking system;

   3) a parking braking system.

b) The braking system controls shall meet the requirements of ISO 3450:2011, 4.3.

c) Pneumatic and hydraulic braking systems shall be designed as dual circuit systems such that at least two wheels on opposite sides of the vehicle are braked in the event of a leak.

d) Means for examining brake wear and brake fluid level in any reservoir shall be provided.

4.7.3 Service braking system for wheel-mounted rigs

a) The service braking system shall give a braking force, in N, equivalent to not less than 35 % of the maximum rig mass multiplied by 9,81. For manoeuvring and holding rigs on steep slopes, see also 4.19.2.

b) The service brake system shall be capable of retarding the rig with at least 1 m/s^2 on the maximum permitted gradient as specified by the manufacturer.

c) For rigs with hydrostatic transmission, service braking action may be performed by means of the hydrostatic transmission, if the performance requirements given in 4.7.1 a) are met.

d) The service brake shall be resistant to heat fade.

4.7.4 Secondary braking system for wheel-mounted rigs

a) A secondary braking system shall be provided to stop the 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.

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

c) The secondary brake system shall be capable of retarding the 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.

d) For rigs with a hydrostatic service brake, the secondary braking system shall also achieve independently the braking performance specified for the service brake.

4.7.5 Parking braking system for wheel-mounted rigs

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

b) The parking braking system shall be able to hold the 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 4.19.2.

4.7.6 Braking systems for crawler-mounted rigs

Braking systems for crawler-mounted rigs shall comply with ISO 10265.

4.7.7 Braking systems for "skid steer" wheel-mounted rigs

For skid steer chassis the same rules as for crawler-mounted rigs shall apply. Braking action shall be possible on all wheels.

4.8 Tyres and rims

Tyre loads and inflation pressures should use ISO 4250-2 for guidance.

NOTE Tyre designation and dimensions are given in ISO 4250-1 and rim dimensions are given in ISO 4250-3.

4.9 Protection against moving parts

4.9.1 General

The moving parts of a rig shall be designed, built and laid out to avoid hazards as described in ISO 12100.

Rotating transmission parts such as drive shafts, couplings, belt drives, which are within reach of personnel, shall be provided with guards to prevent contact. Guards shall comply with ISO 3457.

4.9.2 Moving parts involved in the working process

4.9.2.1 General

The rig shall be so designed, constructed and equipped that manual operation in the hazard zone is minimised and that the operators do not have to perform a hazardous operation or place themselves in a hazardous location.

4.9.2.2 Rigs using threaded drill string connections

A powered drill rod break out system shall be installed on rigs using threaded drill rods. The break out system shall obviate the need to use hand tools in the break out operation.

The following designs are examples of some of the acceptable powered drill rod break out systems:

a) on rigs with top hammers, the percussive mechanism is regarded as being a part of the powered drill rod break out system;

b) on rotary top drive rigs, the controlled reverse rotation of the head drive, together with the use of a chuck device or equivalent lockable rotating connection, is regarded as being a powered drill rod break out system;

c) on rotary spindle rigs, the controlled reverse rotation of the chuck, or an equivalent lockable rotating connection and the rotation of the spindle, is regarded as being a part of a powered drill rod break out system.

4.9.2.3 Manual rod handling

There shall be provisions for supporting the drill rod when making a powered connection, to avoid contact with a rotating drilling component.

EXAMPLES Horizontal drill string support, deep chuck (roof bolt systems).

4.9.2.4 Drilling consumables handling systems

If the mass of a drill consumable, for example drill rod, bit or bolt, down the hole hammer (DTH) or mesh, causes an operator to handle more than 25 kg, the rig shall be provided with a mechanised handling system.

See ISO 11228-1 for recommended limits for manual lifting and carrying.

If the application of a rig does not allow the use of a mechanised handling system, the rig shall be fitted with a lifting device allowing safe transfer of the components from the storage location to the drill axis and vice versa.

NOTE A swingable rotary head with a chuck or a travelling block with an elevator, lifting cap, pulling out flange, lifting sling or similar is considered as being sufficient.

If the application of the rig does not allow the use of a mechanised drilling consumable handling system or lifting device, the manufacturer shall specify instructions for use. See 6.5.4.2.

4.9.2.5 Two-person operation

When there is a need for an operator or a helper to work on the rig in the working area or hazard zone as a two-man operation and this involves activation of one or several machine functions, the following design requirements apply:

a) there shall be sufficient visibility from the operator station, or other means, for the operator to ensure the helper is clear of hazards created by operator actions;

b) when the operation is designed to be performed as a two-person operation, the design shall prevent operation by one person;

c) the operator and helper shall have immediate access to an emergency stop in all situations;

d) the area where the work is to be carried out shall be properly illuminated;

e) communication between the helper and the supervisor at the main operator's position shall be possible to be established in a reliable manner;

f) if practically possible, the helper shall be provided with similar operator protection system as the operator.

4.9.2.6 Rotating parts hazard mitigation

Rotating parts should be guarded in compliance with ISO 14120 to prevent the operator from inadvertently coming in contact with rotating parts when working in close proximity to the drill string.

When physical guards are not possible, the machine design shall have provisions to mitigate the hazards. Examples include two-hand control, proximity detection, control locations.

4.10 Electrical installations

4.10.1 Electric power installation

The electric power installation of rigs shall comply with the requirements of IEC 60204-1.

NOTE Clauses 4, 5, 6, 14, 15 and 16 of IEC 60204-1:2006 are of significant interest.

Electrical components and conductors should be installed in such a way as to minimise damage from exposure to environmental conditions (corresponding to the intended use of the machine) which can cause deterioration. Lead-through, e.g. through frames and bulkheads, shall be protected from abrasion.

Electrical wires/cables shall not be strapped in direct contact with pipes and hoses containing fuel.

An earth fault protection system shall be provided for electrically powered rigs.

In order to avoid incorrect connections, electrical wires and cables used to connect components in electric circuits shall be marked and identified. ISO 9247 should be used for guidance. (This requirement does not apply to the electrical circuits of anti-theft systems.)

Electrical systems not covered by IEC 60204-1 shall comply with ISO 14990-1, ISO 14990-2, and ISO 14990-3.

4.10.2 Electromagnetic compatibility (EMC)

a) Rigs connected to an external electrical power source shall comply with IEC 61000-6-2 and IEC 61000-6-4 with regard to electromagnetic compatibility (EMC).

b) Rigs powered by internal combustion engines shall comply with ISO 13766.

4.10.3 Battery installation

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

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

b) non-sealed batteries shall be housed in a ventilated space and contain a drain path for fluids to escape;

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

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

e) a switch disconnect shall be fitted close to the battery. A starter isolator shall be provided when live testing or system diagnostics are required;

f) the battery housing shall be designed and constructed in such a way as to prevent the electrolyte being ejected on to the operator in the event of rollover or tip over and to avoid the accumulation of vapours in places occupied by operators.

4.11 Machines powered by diesel engine

a) Exhaust systems which can be reached and touched during operation, access or maintenance shall be guarded in accordance with ISO 3457, considering touchable surface temperatures defined in ISO 13732-1.

b) The engine exhaust system shall release the exhaust gas away from the operator and from the air inlet of the operator cab and away from other personnel stations on the machine.

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

d) A means to release the engine cooling system pressure shall be provided that addresses the risk of human exposure to hot water/steam.

e) Underground rig diesel engines shall be designed to use a fuel which has a flash point exceeding 55 °C.

f) Underground rig exhaust shall not be discharged upwards or downwards. Exhaust pipes directed upwards shall have an outlet that redirects exhaust.

g) For electric start systems, an auxiliary starting aid electrical connector shall be provided that complies with ISO 11862.

4.12 Fuel systems

4.12.1 Fuel tanks

a) Fuel tanks shall be provided with a fluid level indicator.

b) Fuel tanks shall be protected against corrosion, be fixed to the machine and be incorporated in such a way that they are protected against mechanical damage (for example by placing the fuel tank within the rigid structure of the machine).

c) Non-metallic fuel tanks shall comply with ISO 21507.

d) Metallic fuel tanks shall comply with the pressurization and spill requirements of ISO 21507.

4.12.2 Fuel tank filler inlet

a) The filler inlets of fuel tanks shall be easily accessible for filling.

b) The filler inlets of fuel tanks shall be located outside the operator cab.

c) The filling aperture shall be designed and positioned in such a way that any overflow or escape of fuel is prevented on any gradient for which the machine is designed.

d) The filler inlets of fuel tanks shall have provisions for lockable filler caps.

e) Fuel caps shall be secured to prevent unintended loosening in service and shall require an intentional action to release them. When released, they shall remain permanently attached to the machine in open position.

4.12.3 Fuel tank vent system

a) Fuel tanks shall have a vent system to control pressure within the tank during filling.

b) Fuel tanks shall be vented to maintain atmospheric pressure within the tank.

c) Fuel tanks shall prevent the ingress of foreign material.

4.13 Hydraulic system

4.13.1 General

The hydraulic system shall comply with ISO 4413.

4.13.2 Load holding cylinders

Load holding cylinders shall be fitted with a safety device to prevent unintended movement caused by failure of an external pipe or hose [excluding those pipes indicated in c) below]. The device shall only be released by an external force. They shall be either:

a) integral with the cylinder; or

b) directly and rigidly flange-mounted; or

c) placed close to the cylinder and connected to it by means of rigid pipes (as short as possible), having welded or flanged connections and being calculated in the same way as the cylinder.

4.14 Pneumatic installations

a) Pneumatic systems shall be designed and installed in accordance with ISO 4414.

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

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

d) On a pneumatically powered rig, a main line valve shall be provided on the rig.

e) Simple pressure vessels shall be designed and tested in accordance with ISO 4414, ISO 16528-1 and ISO 16528-2.

4.15 Lighting

4.15.1 Working light

For underground work, the rig shall be fitted with working light illuminating the area within the reach of the drilling booms, giving a minimum illumination of 100 lux apart from natural shadows from feeds and booms.

For other drilling operations, lighting shall be fitted giving an illumination of at least 100 lux of the area around the point of drilling.

For surface rigs specified to work in darkness and non-lit conditions, lighting shall be fitted giving an illumination of at least 100 lux of the area around the point of drilling and winching apart from natural shadows from the feeds and booms.

NOTE This document does not specify how to measure illumination. For related standards see ISO/TC 274 – Light and lighting.

4.15.2 Illumination when tramming

For self-propelled rigs tramming in darkness, lighting shall be provided giving an illumination of at least 10 lux, 7 m in front and behind the rig when all positioning units are in their transport position. The 7 m shall be measured from the most fore and rear part of the rig. Measurement shall be carried out 1 m from ground level and as wide as the body of the rig.

ISO 12509 should be used for guidance.

4.15.3 Internal operator cab or operator canopy lighting and access lighting

The operator cab shall be fitted with a fixed inner lighting system that shall be able to function with the engine stopped, so that it is possible to illuminate the operator's station such that the operator's manual can be read. This is not required for underground rigs.

Access illumination shall be provided in accordance with ISO 2867.

NOTE This includes lighting up the ladder, pathway on the machine and the ground next to the machine.

4.16 Fire protection

4.16.1 General

Materials used in the construction of rigs shall be fire resistant as far as practicable.

Wherever practicable, hydraulic fluid lines routing shall be separated from high temperature components or shielding shall be provided to prevent spray in the event of rupture or leak.

NOTE 1 ISO 13649, on fire prevention guidelines for earth-moving machinery, is currently being developed by ISO/TC 127/SC 2.

NOTE 2 ISO 19353:2015, on fire prevention and fire protection on machinery, could be useful for guidance even though it is not applicable to moving machinery.

4.16.2 Operator cab interior upholstery

Operator cab interior upholstery shall be made of flame retardant material which has a linear velocity of flame propagation of maximum 250 mm/min when tested in accordance with ISO 3795.

4.16.3 Portable fire extinguishers

Provision shall be made for mounting portable fire extinguishers, protected against heat and mechanical shock and vibration, as follows:

a) a location shall be in the immediate vicinity of the operator;

b) if there are more than one fire extinguisher location on the rig, they shall be placed on different sides of the rig;

c) a location shall be accessible from the ground level or platform, on surface rigs or rigs not equipped with an on-board fire suppression system.

This does not apply to underground coal rigs.

4.16.4 Fire suppression systems

For the fire protection of self-propelled diesel powered rigs intended for use underground, the rig shall be designed for fitting a fixed on-board fire suppression system covering the high risk areas identified in a fire risk assessment. It shall be possible to trigger the system manually from at least two locations.

For remotely controlled, unmanned or partly manned underground mobile rigs equipped with a fire suppression system, the following also applies:

a) the triggering system shall be automatic; and

b) it shall be possible to trigger the fire suppression system from the control panel or from the monitoring position.

4.16.5 Engine shutdown

The engine or motor shall be shut down automatically in the event of actuation of any on-board fire suppression system.

A time delay may be applied by the user for safe positioning of the machine.

4.16.6 Single conductor cables

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

4.16.7 Monitoring device

In the case of machines operating in coal mines, the pneumatic systems should incorporate a device to warn the operator in the event that the temperature of the air being discharged from the air compressor exceeds 150 °C.

4.17 Noise and vibration

4.17.1 General

The noise and vibration levels during drilling are heavily influenced by the drilling process as well as by the environment. Hence, the test conditions of Annex C are designed to give a value which is repeatable and only conditionally comparable with values obtained in a real operation. The operator's significant exposure to noise and vibration occurs during drilling.

NOTE Driving and tramming are of short duration and therefore has little or no influence on the total noise emission and vibration exposure.

4.17.2 Noise

a) Rigs shall be so designed that risks resulting from the emission of airborne noise are reduced to a low level taking account of technical progress and the availability of means of reducing noise, in particular at source. ISO 11688-1, ISO 11688-2 and ISO 15667 should be used for guidance for the design of low-noise machinery and equipment.

b) The measurement of the noise emission from the rig and the noise level at the operators' positions shall be measured in accordance with Annex C and shall be stated in the operator's instructions, see 6.5.4.1.

c) Within the operator cab, the A-weighted emission sound pressure level at the operator's position (measured value plus uncertainty) should not exceed 80 dB (A) and shall not exceed 85 dB (A) when tested in accordance with Annex C.

4.17.3 Vibration

Rigs shall be so designed that the risk to the operator resulting from vibration is reduced to a low level taking account of technical progress. Vibrations during drilling affecting the whole body of the operator, sitting, or standing at the working position, shall be measured in accordance with Annex D and shall be stated in the operator's instructions.

4.18 Dust suppression

Rigs should have means to reduce dust at source such as:

a) use of water as flushing medium;

b) use of water mist;

c) adding an additive to the flushing air such as water or foam;

d) use of any dust suppression/extraction method, for example cyclone, filtration device.

The dust control device should be in operation when drilling is started.

4.19 Winches and ropes

4.19.1 Winches, ropes and sheaves for lifting and feed

Winches, ropes and sheaves for lifting which are integral parts of the rig shall meet the following minimum safety requirements, or comply with EN 14492-1.

Rope safety factors:

a) for running ropes in the normal operating case: 3,0;

b) for running ropes in the exceptional operating case: 2,0;

NOTE Exceptional operations can only be initiated by an intentional, controlled action.

c) for erection ropes, guy ropes, pendant ropes: 2,5;

d) for feed ropes: 3,0.

Diameters should not be less than:

a) winch drum pitch: 12,5 *d*;

b) pulley in any rope system: 12,5 *d*;

where *d* is the diameter of the rope.

All pulley assemblies shall be provided with devices preventing the rope from disengaging.

Rope end connections using U-bolted clamps shall not be used.

There shall always remain at least three wraps of rope on the winch drum. The rope fastening on the drum shall be such that the fastening strength is at least 70 % of the maximum allowed rope load.

The maximum line pull on the first rope layer of the draw-works/winch shall be indicated on the data plate of the winch.

Winches used vertically or an incline shall be equipped with:

a) a service brake system;

b) a holding brake system.

The holding brake systems shall act automatically and prevent an unintentional running back of the load, if the winch control levers are not actuated or in the case of failure of the energy supply.

The brake systems may use common components. The load lowering valves of hydraulically powered winches or lowering devices are considered to be service brake systems.

Both brake systems shall each hold a minimum of 1,3 times the maximum allowed line pull. The service brake shall enable the operator to retard and stop a descending load smoothly.

If the service brake is coupled to the winch by means of a disengageable clutch, a device shall be installed, which is visible to the operator and indicates whether the clutch is engaged or not.

Drill mast winches shall have a limiting device stopping the lifting movement by influencing the winch control, before the mechanical end position is reached. For winches with a capacity equal to or less than 20 kN, a mechanical limit stopping device without influence on the winch control is sufficient.

Activation of the free-fall function of the winch shall only be possible by actuation of two independent controls simultaneously. Both controls shall be of the hold-to-run type.

When a winch is designed for several functions, including a free-fall function, a key operated control shall be additionally fitted, which allows the free-fall function to be operated.

4.19.2 Winches for operating a rig on slopes

A winch shall be installed on rigs intended to operate and travel on slopes with a gradient angle higher than 20°, to prevent the rig from sliding down the slope. For those 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

$$f = F/m \times g \tag{1}$$

where

F is the pulling force, in N;

m is the mass of the drill rig, in kg;

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

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 a 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.

4.20 Roller and leaf chains

Roller and leaf chains, which can be an integral part of the feed system of a rig and are directly involved in the pull-down and pull-up operation, shall meet the following:

a) they should be selected with a safety factor, i.e. minimum breaking force in relation to maximum load, of 3,5;

b) an adequate and safe means of tensioning shall be provided, if the design requires it;

c) where possible, chains shall wrap 180° around sprockets or guide pulleys.

4.21 Masts and feed beams

Mechanically raised masts and feed beams shall be equipped with a safety device designed to engage automatically in the event of failure of the lifting mechanism to prevent the mast from falling. For hydraulically raised masts and feed beams, see 4.13.

Locking pins or other removable devices for holding erected masts and feed beams in place shall be secured against unintentional loosening. Pins or securing devices shall be captive and attached at the locking point using a chain or similar.

Due consideration shall be given to stresses caused by the asymmetrical racking of drill rods or rod magazines.

4.22 Maintenance

Rigs should be designed to be maintainable in accordance with ISO 12510.

5 Verification of safety requirements

5.1 General

It is necessary to verify that the requirements of this document have been incorporated in the design and manufacturing of rigs. Either one or a combination of the following shall be used to verify that the requirements of Clause 4 have been met:

a) measurement;

b) visual examination;

c) as appropriate, testing by means of a method prescribed in the standard and referred to in any particular requirement;

d) assessment of the contents of the documentation required to be kept by the manufacturer, for example evidence that bought-in components, such as windscreens, have been manufactured to the required standard.

The manufacturer shall have a quality management system in place, such as ISO 9001.

5.2 Brake verification

5.2.1 General

a) The brakes of a wheel-mounted rig shall be verified in accordance with this clause.

b) The brakes of crawler-mounted and skid steer rigs shall be verified in accordance with ISO 10265.

c) The parking brakes of towed rigs shall be verified in accordance with this clause.

5.2.2 What to measure

The following values shall be measured:

a) the retardation of the rig;

b) the maximum force applied to the brake control to achieve the desired brake force;

c) the pulling force for brake test, where applicable.

5.2.3 Test conditions

a) 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.

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

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

d) 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.

e) The test course shall not have a slope of more than 3 % in the direction of travel.

f) The test shall be performed with maximum rig mass and under moving conditions as specified by the manufacturer.

g) 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 rig. No manual adjustments shall be made to the braking system during any single performance test.

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

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

5.2.4 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 ISO 3450:2011, 6.1, Table 1.

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.

The rig shall then undergo a dynamic service brake test. The 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 5.6.3. Where a warning device is provided, it shall be tested in accordance with ISO 3450.

5.2.4.1 Dynamic tests for wheel-mounted rigs

All dynamic tests shall be performed with cold brakes as defined in ISO 3450:2011, 3.11. 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.

5.2.4.1.1 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 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 4.7.3 shall be met for both directions.

5.2.4.1.2 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 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 service brake test above.

5.2.4.1.3 Secondary brake test

Tests to determine the brake force shall be as described for the service brake. The brake performance shall comply with 4.7.4.

5.2.4.2 Parking brake test

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

a) a static gradient test; or

b) a pull test.

In the gradient test, the 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 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 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, in N, shall be applied horizontally near the ground and be at least equal to:

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

where

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

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

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

5.2.5 Test report

The test report shall be drawn up in the format specified in ISO 3450:2011, Clause 7.

6 Information for use

6.1 General

Information for use shall be drawn up in accordance with ISO 12100:2010, 6.4. Detailed requirements are given in 6.2 to 6.6.

6.2 Nature of information for use

The information for use shall be provided on the rig in the following forms:

a) safety signals;

b) system for the measurement of inclination as regards stability;

c) safety labels;

d) data plates;

e) symbols for operator controls and other displays;

f) operator's manual.

6.3 Signals and warning devices

ISO 12100:2010, 6.4.3, applies with the following additions.

a) Safety signals shall be unambiguous and easily perceived and be designed in accordance with IEC 60073 and IEC 61310 (all parts).

b) The operator shall have the facility to check the operation of all essential warning devices at all times.

c) There shall be a manually operated, audible alert signal (horn) to warn personnel in the working area of impending danger. It shall be possible to operate the audible warning from each driving or operating position including (if applicable) a remotely situated monitoring position. The audible alert signal shall meet the requirements in ISO 7731 (sound pressure level, 1/3 octave or listening test) or ISO 9533. During the test, the machine shall be operated at full engine speed. Alternative compliance could be confirmed by calculation.

d) There shall also be an automatic, audible or visual warning signal given when reversing. If an audible reverse alarm is used, it shall conform to ISO 9533.

e) A remotely controlled or unmanned, automatically operating rig shall be provided with a visual warning light which shall be automatically actuated before starting and when the rig is working in remote control or automatic mode. This does not apply to remotely controlled rig with the control panel situated in the vicinity of the rig and where there is a direct visual contact between the operator and the rig.

6.4 System for the measurement of inclination as regards stability

a) For checking the stability under tramming, the rig shall be equipped with a measuring system, for example an inclinometer.

b) The measuring system shall show the operator the actual absolute forward, backward and lateral inclination of the drill mast (when this is relevant to the stability).

c) If major parts of the rig can be moved horizontally and this has an effect on the stability, the operator shall be able to determine the position of these parts from the operator's position.

6.5 Safety signs and labels

a) Safety signs and labels shall be provided in accordance with ISO 9244 or ISO 3864-2.

NOTE Registered safety signs are found in ISO 7010.

b) The instruction handbook shall indicate the location and content of safety signs and other instructions that appear on the machine. For examples see ISO 6750:2005, Figure 3.

NOTE ISO 6750 is currently under revision. Figure 3 will be updated to reflect current ISO 9244 safety labels.

c) A remotely controlled or unmanned, automatically operated rig shall be equipped with signs warning that the rig is remotely or automatically operated. For guidance, see ISO 15817.

d) Any circuits presenting a hazard and still connected to their energy sources when the mains power is switched off shall have a warning label.

e) Maximum allowed gradient angle for slopes when tramming or drilling shall be given clearly visible at the driver's and operator's position and be explained in the instruction manual.

6.6 Marking

6.6.1 Rig data plate

The data plate of the rig shall give at least the following information:

a) the business name of the manufacturer or brand of the machine;

b) the designation of the machinery;

c) serial number;

d) installed diesel engine power, in kW;

e) rated voltage, frequency and installed power of the externally powered electrical installation;

f) compliance marking where required.

6.6.2 Data plate of boom-mounted work platform

The data plate shall give at least the following information:

a) the number of persons permitted on the platform;

b) the maximum working load (operator and supplies/equipment);

c) compliance marking where required.

6.6.3 Symbols for operator controls and other displays

Symbols for operator controls and other displays on the rig shall be in accordance with ISO 6405-1 and ISO 6405-2. Symbols on the boom-mounted working platform shall be in accordance with ISO 20381.

6.7 Instruction handbooks for rigs

6.7.1 General requirements on instruction handbooks

The instruction handbooks shall be drawn up according to ISO 12100:2010, 6.4.5. ISO 6750 and IEC 82079-1 should be used for guidance.

6.7.2 Types of instructions

The following instructions shall be supplied with each rig:

a) operator's instructions, 6.5.4;

b) transport instructions, 6.5.5;

c) assembly instructions, where applicable, 6.5.6;

d) maintenance instructions, 6.5.7;

e) spare parts list, 6.5.8.

The operator's instructions shall be available in a dedicated place on the machine.

Each instruction handbook shall contain the web address to the manufacturer and other contact details.

6.7.3 Identification of instruction handbook

Each instruction handbook shall be easily identified by:

a) manufacturer or brand name and logo;

b) type designation, model name of the rig;

c) serial number of the rig, if applicable;

d) type of instruction (see 6.5.2), to be mentioned in the title of the instruction;

e) publication year.

6.7.4 Content of the operator's instruction handbook

6.7.4.1 Information about the rig

The information about the rig shall include:

a) names and web addresses, or a reference to a list, of authorized repair and service agents;

b) the same information as on the data plate (see 6.4.1);

c) a description of the operator's controls and directions of movements;

d) an explanation of symbols used on operator panels and safety labels and other labels;

e) a general view of the rig and its attachments;

f) the necessary drawings, diagrams and illustrations, of sufficient size to be clear, showing the designation of major components, their functions, locations and relationships with the whole rig.

6.7.4.2 Instructions for the use of the rig

The operator's instructions shall contain at least the following information and instructions for the intended use of the rig on the following topics, where applicable.

a) General:

   1) specification of the intended use of the machine;

   2) complete instructions for the operation of the machine;

   3) warnings against actions which can cause injuries to the operator or other personnel.

b) Working environment:

   1) the temperature range for which the rig is designed;

   2) instructions to remove ice under sub-zero temperature conditions;

   3) instructions for the use of equipment for monitoring the ambient atmospheric conditions when working in a confined space.

c) Personal protection equipment:

   1) instructions for personal protective equipment (PPE);

2) instructions on the use of safety harnesses, anchoring points and escape equipment.

d) Training required:

1) operators shall be given practical training in the operation of the rig with special emphasis on safety precautions.

e) Setting up:

1) modular assembly and disassembly of the rig;

2) location of retrieving points, permissible forces, the correct use when towing and maximum towing speed and distance;

3) safety precautions to be taken when transporting, assembling and dismantling the rig, parts and attachments;

4) erection and securing of drilling masts, derricks and feed beams;

5) residual risks that remain and the prevention measures that shall be taken by the user.

f) Driving, tramming and operating position:

1) figure showing the hazard zones of the rig during tramming;

2) visibility information for the operator's instructions in accordance with ISO 5006:2017, Clause 12;

3) instructions to restrict access during any slewing movements;

4) limitation of conditions for tramming shall be given, if applicable.

g) Controls, functions, systems and devices:

1) the need to check the emergency stops and trip devices for their proper function before start of each shift and after tramming;

h) Stability:

1) full information on matters of stability, so as to enable proper parking, driving and operation of the rig;

2) maximum allowed gradient angle for parking, drilling and tramming conditions;

3) specific instructions for tramming on slopes, including the use of the winch;

4) the minimum wind speed, above which it is necessary to stop drilling and put the rig in parking position, where applicable;

5) the measures which are necessary when the wind force exceeds the value allowed for parked and out of service condition, where applicable;

6) maximum ground pressure occurring under working conditions.

i) Protection against moving parts:

1) instructions shall be given how to replace drill rods, pipes and bits in a safe way with the help of the rotation mechanism and other auxiliary means which are available, for example when threading or doing extension drilling;

2) if the application of the rig does not allow the use of a mechanised drilling consumable handling system or lifting device, the manufacturer shall specify instructions for use;

3) figures showing the hazard zones of the rig during drilling;

4) information about the required no access area for a remotely controlled or unmanned, automatically operated rig;

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

6) information about the safe area from which the operator can control the rig with the remote control box, e.g. safety distance between the operator and the rig;

7) information about residual hazards.

j) Electrical installations:

1) information on any circuits still connected to their energy sources when the mains power is switched off.

k) Machines powered by diesel engine:

1) instruction for operating rigs in confined conditions specifying that the exhaust gases shall be directed in such a way that they do not return to the working area and create a hazard.

l) Noise and vibration:

1) the A-weighted sound pressure level at the operator's position, if exceeding 70 dB, measured as specified in Annex C. Should the sound pressure level not exceed 70 dB, this shall be indicated;

2) the A-weighted continuous sound power level emitted by the machine, as measured in accordance with Annex C, if the A-weighted emission sound pressure level at any workstation exceeds 80 dB;

3) vibration information in accordance with Annex D.

m) Winches and ropes:

1) a load/speed diagram for the winches and draw-works.

6.7.4.3 Non intended use

Non intended uses shall be listed as far as practical and foreseeable. For rigs this includes:

a) lifting and transporting loads or people and goods;

b) supporting objects;

c) cleaning stopes and drill locations using the feed;

d) using jacks as support structure during tramming;

e) using the boom to traverse rough terrain;

f) moving boulders with feeder;

g) overturning entire rig;

h) using the boom as support structure during tramming;

i) scaling rock.

6.7.4.4 Rigs for underground operation

For rigs for underground operation, the following instructions shall be included:

a) instructions specifying that the area in front of the rig, i.e. between the carrier and the tunnel face, within the hazard zone, shall be a restricted access area when drilling;

b) information about the restricted access area and the residual risks within the restricted access area shall be provided;

c) instructions on how to use any hazard zone access detection system in the different operation modes;

d) instructions on how to complement any hazard zone access detection system if the rock wall is not limiting the hazard zone;

e) instructions on how warning signs and lights shall be applied to the machine, forbidding the entry into the hazardous area close to the drill string;

f) instructions and 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 hazard area;

g) instructions for working from boom-mounted platforms;

h) instructions on how to place the booms to negotiate narrow paths, taking the sweep radius of the booms into account.

6.7.4.5 Instructions for two-person operation

When there is a need for an operator or a helper to work on the rig in the working area or danger zone, and this involves activation of one or several machine functions, such work shall only be done under the following conditions, and these requirements shall be added in the maintenance manual:

a) there shall always be two people present, both being fully instructed on the safety issues. One of them shall supervise the safety of the service personnel doing the work;

b) the supervisor shall be experienced in the operation of the machine;

c) the supervisor shall have immediate access to an emergency stop in all situations;

d) the area where the service work is to be carried out shall be properly illuminated;

e) communication between the service person and the supervisor at the main operator's position shall be established in a reliable manner;

f) only when the rig is shut down completely and the means of starting are isolated is a person allowed to perform repair and maintenance work alone on the rig.

6.7.4.6 Information for emergency situations

Information shall be included to instruct the operator on how to handle an emergency situation:

a) how the emergency stops and trip devices according to 4.4.3 are installed and function;

b) the location and use of fire extinguishers or fire extinguish systems;

c) how to use emergency exits;

d) instructions of when and how to use safety harness or escape/recovery equipment.

6.7.5 Transport instructions

The transport instructions shall at least contain:

a) information regarding means for towing and the procedure of towing the mobile rig in the event of a breakdown;

b) information of tying down points and the procedure of securing the rig during transportation;

c) information of lifting points and the procedure of lifting the rig.

6.7.6 Assembly instructions

If the rig is not delivered in one piece, an assembly instruction shall be provided.

EXAMPLE A knock down kit of a rig to an underground mine.

6.7.7 Maintenance instructions

The maintenance instructions shall at least contain:

a) names and addresses, or a reference to a list, of authorized repair and service agents;

b) daily, weekly and other scheduled maintenance intervals;

c) precautions to be observed during maintenance and service;

d) specification of oils, lubricants and hydraulic fluids;

e) instructions on the maintenance of fire extinguishing systems;

f) methods to safely remove or replace components and parts;

g) methods to safely remove and replace ropes;

h) information about measuring points and locations of diagnostic fault finding equipment, clearly marked in pictures and tables;

i) drawings and functional diagrams for electric, hydraulic and pneumatic circuits. Illustrations shall be of sufficient size to be clear and show the designation of major components, their functions, locations and relationships in the whole rig;

j) instructions of how to use special tools provided by the manufacturer;

k) instructions for frequency of checking and for replacement of parts which are classified by the manufacturer to be of particular importance for safety. Methods to check the wear of such parts shall be given and the criteria for their repair, adjustment or replacement;

l) instructions on checking and replacing worn safety signs and operator instruction signs;

m) instructions for the examination and maintenance of wire ropes, see ISO 4309;

n) instructions for the examination and maintenance of winches and travelling block;

o) special warnings against actions which can cause injuries to the repairer or other personnel;

p) instructions for required personal protective equipment (PPE).

See also ISO 12510.

6.7.8 Spare parts list

The spare parts list shall contain all relevant spare parts with unambiguous identification and information on the location of the part in the rig.

6.7.9 Use of terms related to safety

ISO 6750:2005, Clause 5, applies.

6.7.10 Format of operator's manual

ISO 6750:2005, Annex A, applies.

6.7.11 Supplier's declaration of conformity

a) If a supplier's declaration of conformity is issued, it shall comply with ISO/IEC 17050-1.

b) Documentation supporting the supplier's declaration of conformity shall be in accordance with ISO/IEC 17050-2.

6.8 Training manual

a) For operator training, ISO 7130 should be used for guidance.

b) For mobile elevating work platforms operator training, ISO 18878 should be used for guidance.

c) For training of mechanics, ISO 8152 should be used for guidance.

Annex A
(normative)

Temporary roof support (TRS) systems

Persons shall work or travel between the support device of the TRS system and another support, and the distance between the support device of the TRS system and support to the left, right or beyond the TRS system, shall not exceed 1,5 m.

Each TRS system shall meet each of the following.

1) The TRS system shall elastically support a deadweight load measured in kN of at least 22 times each square meter of roof intended to be supported, but in no case less than 56 kN.

2) The controls that position and set the TRS system shall be:

   i) operable from under permanently supported roof; or

   ii) located in a compartment, which includes a deck, that provides the equipment operator with overhead and lateral protection, and has the structural capacity to elastically support a deadweight load of at least 80 kN.

3) All jacks affecting the capacity of the TRS system and compartment shall have check valves or equivalent devices that will prevent rapid collapse in the event of a system failure.

4) Except for the main tram controls, tram controls for positioning the equipment to set the TRS system shall limit the speed of the equipment to a maximum of 0,4 m/s.

The support capacity of each TRS system and the structural capacity of each compartment shall be certified by a registered engineer as meeting the applicable requirements of this annex.

NOTE The requirements of this annex correspond to the USA MSHA regulation 30 CFR Ch. I (7–1–15 Edition) § 75.209 Automated Temporary Roof Support (ATRS) systems, paragraph (d) through (f).

Annex B
(normative)

Stability

B.1 General stability criteria

Rigs (e.g. see Figure B.1) shall be so designed and constructed that they are sufficiently stable under the intended operating conditions, e.g. transport, tramming, parking and drilling and that there is no risk of overturning and falling. The stability shall be verified by calculation.

The stability criteria and calculations given in B.2 refer to mobile and stationary rigs but are not applicable to rigs fixed to the ground or a foundation. For those rigs the moments from weights and forces shall be taken into account when calculating and designing the anchoring of the rig.

The stability angles, α, as defined in B.2 shall not be less than 10° in any directions when tramming and be not less than 5° under any other conditions.

When the rig is intended to work, tram or be parked on a plane deviating from the horizontal, the verification of stability shall include the maximum allowed slope angle under the most unfavourable conditions as specified and stated in the operator's instructions. The stability angle shall comply with the above mentioned limits, i.e. the safety margin of 10° and 5° respectively shall be added to the specified operational slope angle. The margins above take into account the dynamic effects such as accelerating and braking.

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

Detailed instructions regarding the restrictions and special measures to be taken when drilling, tramming or parking shall be given in the operator's instructions, see 6.5.4.2.

B.2 Definitions for stability calculations

The following factors and symbols shall be used to calculate the stability:

G_t is the total weight of the rig including all equipment;

X_t is the abscissa of the total centre of gravity referred to the tipping line;

Y_t is the ordinate of the total centre of gravity referred to the tipping line;

α_s is the static stability angle ($\alpha_s = \arctan X_t/Y_t$);

M_w is the overturning moment of wind forces;

M_a is the overturning moment of centrifugal forces;

M_f is the overturning moment of other working forces;

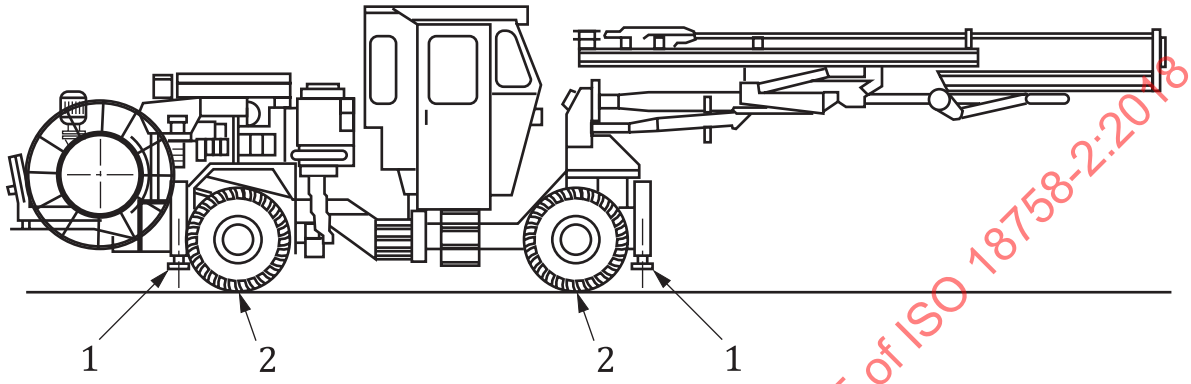
M_r $= M_w + M_a + M_f$, i.e. is the total overturning moment;

M_s = $G_t \cdot X_t$, i.e. is the total stabilizing moment;

Δx = M_r/G_t, i.e.is the apparent horizontal displacement of the centre of gravity, equivalent to the effect of the overturning moments;

α_d is the dynamic stability angle, i.e. α_d = arctan $(X_t - \Delta x)Y_t$.

Tipping lines are defined in ISO 18758-1 and also shown in Figures B.2 to B.6. The stability angles are illustrated in Figure B.6.



Key

1 jack support points

2 wheel support points

Figure B.1 — Wheel-mounted rig

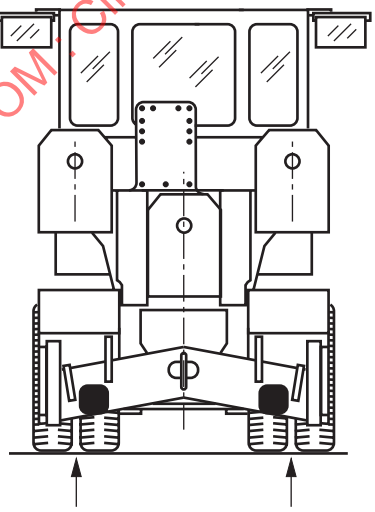
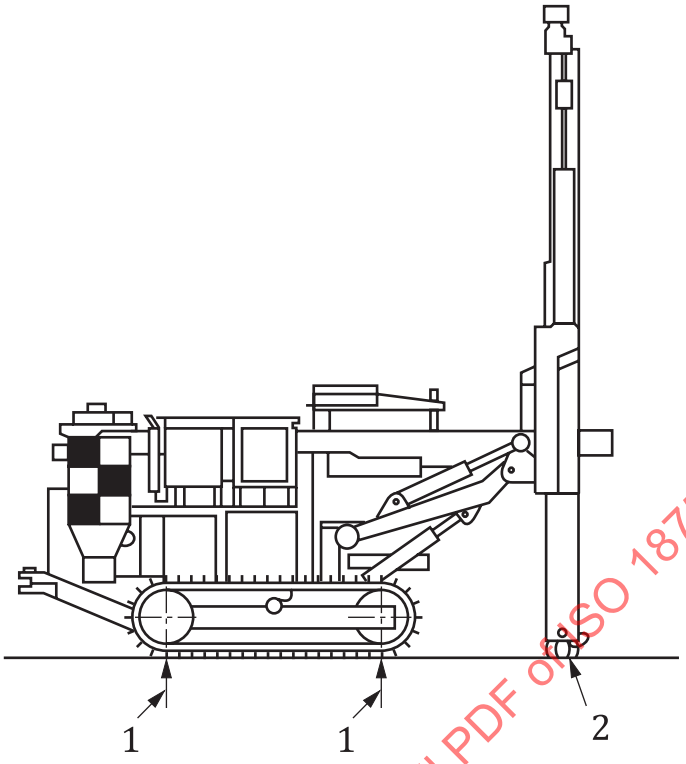


Figure B.2 — Tipping lines for wheel-mounted carrier when tramming



Key

1 tipping lines, see Figure B.6

2 possible support point

Figure B.3 — Crawler-mounted rig

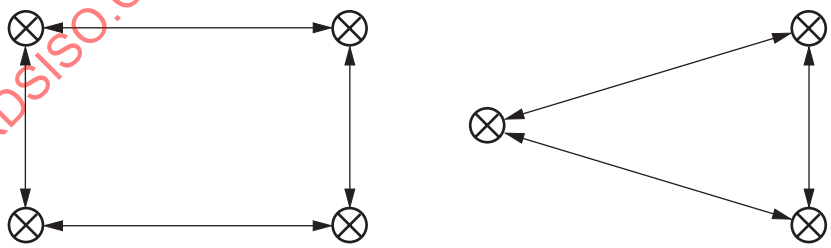
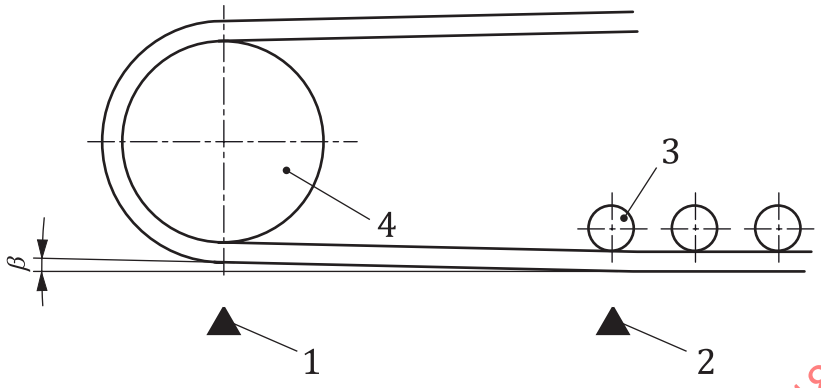
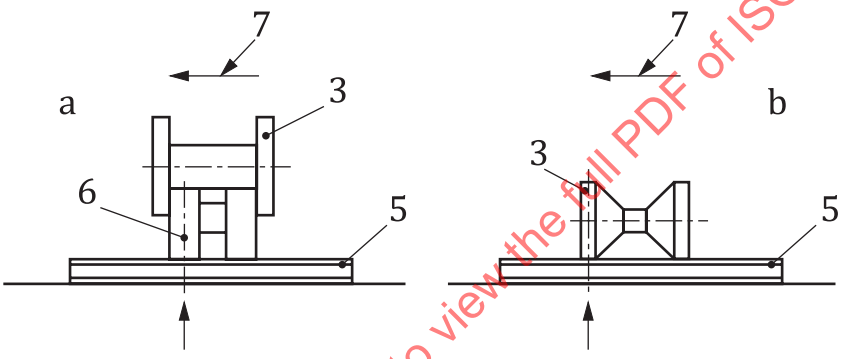


Figure B.4 — A pair of support points form a tipping line



a) Tipping line in direction of travel

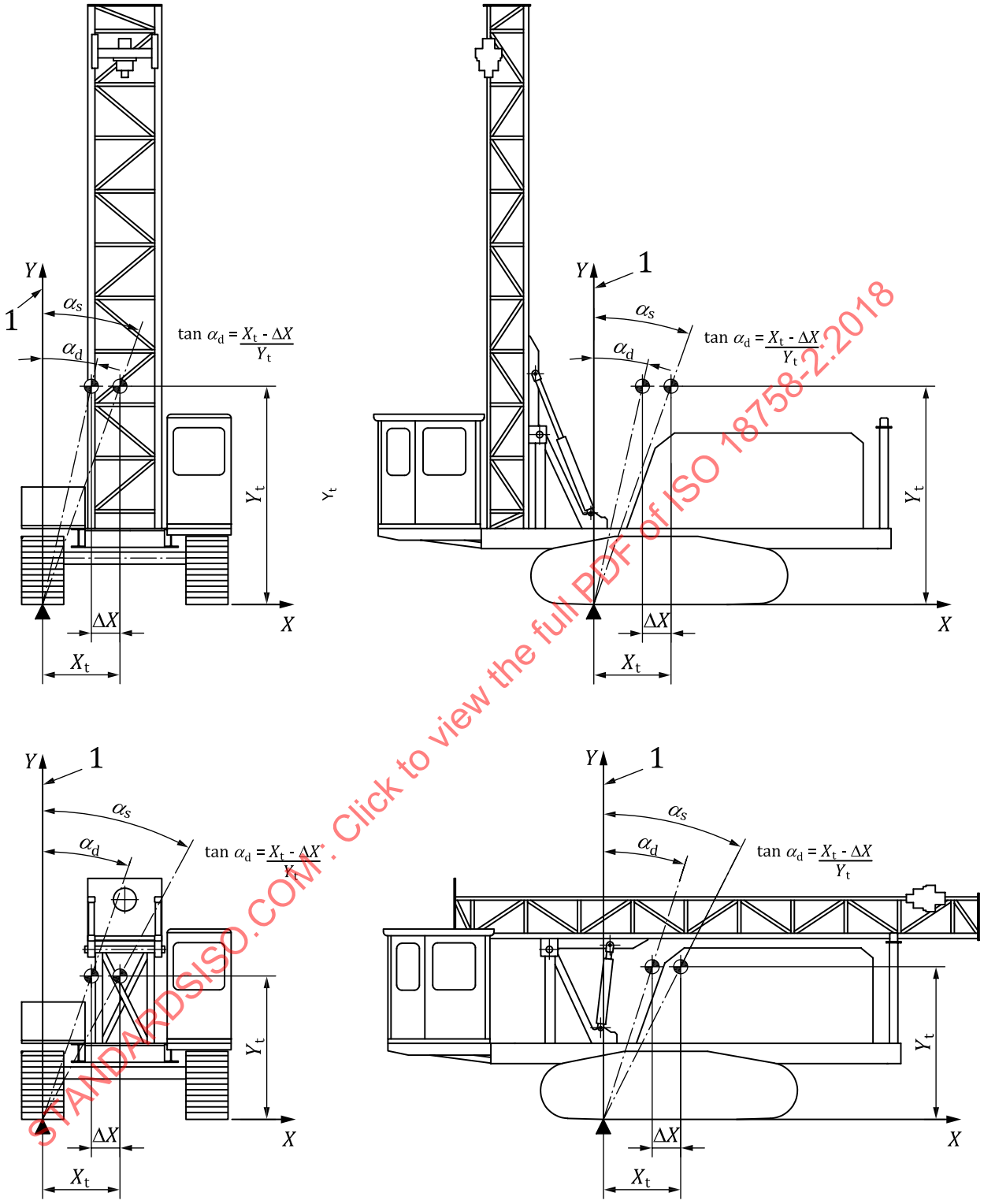


b) Tipping line perpendicular to the direction of travel

Key

1	choose 1 if beta is lower than or equal to 2 degrees	6	chain link
2	choose 2 if beta is greater than 2 degrees	7	outward direction
3	roller	a	Chain type track.
4	drive or idler	b	Shoe type track.
5	shoe		

Figure B.5 — Tipping lines of crawlers



Key

1 tipping line

Figure B.6 — Stability angle

B.3 Verification of stability

B.3.1 General

The stability shall be verified by calculations based on operating conditions stated in B.3.6 and factors according to B.3.2 through B.3.5 influencing the stability.

Weights and positions of centres of gravity of single parts of the rig including the carrier, which have a significant effect on the stability and which are input data for the stability calculation, shall be verified by calculation or weighing.

The calculations shall be based on the rig standing on a firm plane with a mast inclination as specified and stated in the operator's instructions and for the tipping line giving the lowest stability.

B.3.2 Centre of gravity

The position of the total centre of gravity (X_t ; X_t) and the total weight, G_t, shall be measured by testing or calculated using the centres of gravity and weights of all parts of the rig.

In the case when a single main part is movable, the calculation shall be based on the position giving the condition of lowest stability, e.g. the rotary drive in its highest position, drill mast positioned as far out as possible and having its greatest forward inclination as specified in the operator's instructions.

For rigs with operator-controlled track oscillation, the displacement of the centre of gravity of the rig at the limits of the oscillating movements shall be taken into account in the stability calculations.

NOTE The final tipping lines remain the same as defined in ISO 18758-1.

B.3.3 Dynamic forces

For rigs having a turnable superstructure, the centrifugal force which acts on the centre of gravity of the rotating masses shall be taken into account in the calculation of stability.

B.3.4 Wind force

The wind force shall be taken into account in the stability calculation. The wind force shall be assumed to act on the rig, including stacked drill rods and other equipment, adding to the overturning moment.

The wind forces shall be calculated according to ISO 4302:2016, 5.3 and 6.2. The dynamic air pressure, q, from the wind shall be chosen as follows:

While drilling:

q = 250 Pa (corresponding to a wind speed of 20 m/s).

Under parked and out of service conditions:

q = 800 Pa (corresponding to 36 m/s) for areas up to 20 m above ground;

q = 1 100 Pa (corresponding to 42 m/s) for areas between 20 m and 100 m above ground.

B.3.5 Other working forces

Other working forces that can influence the stability shall be taken into account when calculating the stability, e.g.:

a) the winch force between drill mast and drilling tool in the bore hole. The drill string and tool shall not be regarded as a support when only a rope is being used for pulling up the drilling tool;

b) in the case of drilling down, the drill string shall not be considered as a support;

c) in the case of upwards drilling, it shall be checked that the available feed forces do not make the rear part of the rig lift.

B.3.6 Operating conditions

The stability of the rig shall be calculated for the operating conditions a) to c) below, which shall be stated in the operator's instructions.

a) **Working**

The calculation shall be carried out for the most unfavourable combination of conditions that can occur, for example:

— 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;

— most unfavourable choice of tipping line;

— wind coming from the most unfavourable direction;

— centrifugal force applied to the super structure;

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

The effect of overturning moments is equivalent to, and can be taken into account as, an apparent horizontal forward displacement Δx of the total centre of gravity of the rig.

The total apparent displacement of the centre of gravity is expressed as follows:

$$\Delta x = (M_w + M_a + M_f)/G_t$$

where the moments due to wind, centrifugal and other forces are calculated in the most unfavourable simultaneous combination that can occur as foreseen in the operator's instructions.

The stability angle is calculated as:

$$\tan \alpha_d = (X_t - \Delta x)/Y_t$$

b) **Tramming**

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

c) **Working on slopes**

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

B.3.7 System for the measurement of inclination as regards stability

For checking the stability under tramming condition and whilst working with a capacity table, the rig shall be equipped with a measuring system, e.g. an inclinometer. The measuring system shall show the operator the actual absolute forward, backward and lateral inclination of the drill mast (when this is relevant to the stability). If major parts of the rig can be moved horizontally and this has an effect on

the stability, the operator shall be able to determine the position of these parts from the operator's position.

A simple system for measuring the absolute inclination of the rig shall be provided, e.g. a bubble level or a pendulum system.

B.3.8 Stability of truck and trailer-mounted rigs

In addition to the above mentioned criteria, when a rig and its auxiliary equipment is mounted on a truck or trailer chassis, the weight distribution, the axle and tyre loading shall be within the limits specified by the vehicle manufacturer.

Consideration shall be given to the effect of the vehicle suspension.

Annex C
(normative)

Noise test code

C.1 General

This test code, together with additional requirements in relevant parts of the standard, specifies how to carry out efficiently and under standardized conditions the determination and declaration of the noise emission characteristics of rigs.

Noise emission characteristics include emission sound pressure levels at operator's positions and the sound power level. The determination of these quantities is necessary for:

— manufacturers to declare the noise emitted;

— comparing the noise emitted by machines in the family concerned.

The use of this noise test code ensures reproducibility of the determination of the noise emission characteristics within specified limits determined by the grade of accuracy of the basic noise measurement method used. Noise measurement methods allowed by this document are engineering methods, grade 2, as defined in ISO 3740:—[1)] and ISO 11200:2014.

Noise emission from rigs is generated by the machine itself and to a large extent also by the process. Noise can vary with the type of ground or rock in which the rig is operating. For a type test, an operation at fully specified conditions is necessary so that a sufficiently good reproducibility is achieved.

C.2 Operation of the rigs during noise and vibration tests

C.2.1 General

Before carrying out any measurement, the engine and the hydraulic system of the rigs shall be brought to their normal working temperature following the instruction of the manufacturer, and all relevant safety-related procedures given in the instruction book shall be carried out.

The measurement time shall not be less than 15 s.

The operating conditions during noise tests shall be identical for the determination of both the sound power level and emission sound pressure levels at operator's positions.

C.2.2 Multiple power units

Separate tramming engines on the rig shall not be in operation during the test.

When providing a power unit which is different from the engine of the carrier, this power unit shall be measured and declared separately. An exception is when the power unit is dedicated to a specific interchangeable equipment, in which case the measurement shall be carried out with the power unit in operation.

1) Under preparation. Stage at the time of publication: ISO/DIS 3740:2017.

C.2.3 Fan speed

If the engine of the machine or its hydraulic systems are fitted with one or more fans, all fans shall operate during the test. The fan speed shall be in accordance with one of the following conditions, stated and set by the manufacturer of the machine.

a) **Fan drive directly connected to the engine**

If the fan drive is directly connected to the engine or hydraulic equipment (e.g. by belt drive), it shall operate during the test.

b) **Fan drive with several distinct speeds**

If the fan can work at several distinct speeds, the test shall be carried out:

1) either at the maximum working speed of the fan; or

2) in a first test, with the fan set at zero speed and, in a second test, with the fan set at maximum working speed. The resulting sound pressure level, L_{pA}, shall then be calculated by combining both test results using the following formula:

$$L_{pA} = 10 \log\left\{0{,}3\times10^{0{,}1L_{pA,0}} + 0{,}7\times10^{0{,}1L_{pA,100}}\right\} \text{ dB}$$

where

$L_{pA,0}$ is the sound pressure level determined with the fan set at zero speed;

$L_{pA,100}$ is the sound pressure level determined with the fan set at maximum speed.

NOTE The formula applies to the determination of the sound power level with L_{pA} replaced by L_{WA}.

c) **Fan drive with continuously variable speed**

If the fan can work at continuous variable speed, the test shall be carried out either according to C.2.3 b) or with the fan speed set by the manufacturer at no less than 70 % of the maximum working speed.

If the machine is equipped with more than one fan, all fans shall run at either the conditions specified in a) or b) or c).

This is valid for both the sound power and the emission sound pressure levels at operator's positions.

C.2.4 Different types of rigs

C.2.4.1 General

Rigs shall be operated with all motors and engines running at rated speed. Auxiliary equipment (except cooling fans), which forms an integral part of the machine, shall be running at normal operating speed as specified by the manufacturer.

C.2.4.2 Non-percussive mobile rigs (rotary drilling and raise boring)

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

During the noise emission tests, the rotary rig shall be operated under no load.