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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 20770-1

Drilling and foundation equipment — Safety —

Part 1: Common requirements

Machines de forage et de fondation — Sécurité —

Partie 1: Prescriptions commun

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ISO/TC 195/SC 3

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2025-02-13

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This document is circulated as received from the committee secretariat.

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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).

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This document was prepared by Technical Committee ISO/TC 195, *Building construction machinery and equipment*, Subcommittee SC 3, *Drilling and foundation machinery and equipment*.

A list of all parts in the ISO 20770 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 12100:2010.

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

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organisations, market surveillance etc.)

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

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e. g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

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 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 drilling and foundation machines that have been designed and built according to the requirements of this type C standard.

Drilling and foundation equipment — Safety —

Part 1: Common requirements

1 Scope

This document specifies the common safety requirements for drilling and foundation equipment.

This document deals with the significant hazards (see [Annex F](#)) common to drilling and foundation equipment (see ISO 11886:____)¹⁾, , when they are used as intended and under the conditions of misuse which are reasonably foreseeable by the manufacturer associated with the whole life time of the machine (transport, assembly, dismantling, equipment in service and out of service, maintenance, moving on site, storage, disabling and scrapping).

NOTE 1 The requirements specified in this part of the standard are common to two or more families of drilling and foundation equipment.

This document gives common safety requirements for drilling and foundation equipment and is intended to be used in conjunction with relevant parts of this series (Part 2 thru Part 6). These machine specific parts do not repeat the requirements from part 1 but supplement or modify the requirements for the type of drilling and foundation equipment in question.

For multipurpose machinery, the parts of the standard that cover the specific functions and applications are used, e.g. a drilling machine also used as a piling machine will use the relevant requirements of ISO 20770-1 to -6.

The following machines are excluded from the scope of this standard:

- autonomous or semi-autonomous (as defined in ISO 17757:2019) drilling and foundation equipment;
- tunnelling machines, unshielded tunnel boring machines and rodless shaft boring machines for rock according to EN 16191;
- raise boring machines;
- drill rigs used in oil and gas industry ;
- specialized mining machinery and equipment for opencast mining (e.g. rock drill rigs, blast hole drills) (under the scope of ISO/TC 82);
- all underground mining machinery and equipment for the extraction of solid mineral substances (e.g. rock drill rigs, raise boring machines, shaft boring machines, mining auger boring machines, jumbos) as well as machinery and equipment for underground mine development (under the scope of ISO/TC 82);
- core drilling machines on stand (covered by EN 12348);
- hand-held machines (in particular machines covered by ISO 11148-5);
- horizontal directional drilling machines (HDD) as defined in ISO 21467).

NOTE 2 ISO 23224 (*in preparation*) deals with the significant hazards for horizontal directional drilling (HDD) machines.

NOTE 3 Specific requirements for offshore applications are not covered by this document.

1) Under preparation (stage DIS)

Where a drilling and foundation machine of fixed configuration that is not intended to be separated is assembled using a carrier machine based on earth-moving equipment, agricultural equipment, or crane, then the completed assembly is covered by this document.

Drilling and foundation machinery within the scope of ISO 20770 parts 1 to 5 may include interchangeable auxiliary equipment within the scope of ISO 20770-6, either as an integral part of its construction or as interchangeably fitted equipment.

Hazards due to:

- self-learning systems;
- cybersecurity;
- corruption due to machines which are connected to the internet or an external network;
- potentially explosive atmosphere, or lightning;
- high-voltage batteries integrated in the power source system

are not covered by this document.

This document is not applicable to drilling and foundation equipment 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.

EN 474-1:2022, *Earth-moving machinery — Safety — Part 1: General requirements*

EN 474-5:2022, *Earth-moving machinery — Safety — Part 5: Requirements for hydraulic excavators*

NOTE Although the ISO 20474 series has the same scope as the EN 474 series, the European standards are more recent and therefore more representative of the state of the art.

EN 614-1:2006+A1:2009, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*

EN 614-2:2000+A1:2008, *Safety of machinery — Ergonomic design principles — Part 2 : interactions between the design of machinery and work tasks*

EN 795:2012, *Personal fall protection equipment — Anchor devices*

EN 12254:2010, *Screens for laser working places - Safety requirements and testing*

EN 60825-4:2006, *Safety of laser products - Part 4 : Laser guards*

EN ISO 14118:2018, *Safety of machinery — Prevention of unexpected start-up*

EN 13411-6:2004+A1:2008, *Terminations for steel wire ropes — Safety — Part 6: Asymmetric wedge socket*

EN 13411-7:2006+A1:2008, *Terminations for steel wire ropes — Safety — Part 7: Symmetric wedge socket*

ISO 12117:2008, *Earth-moving machinery — Tip-over protection structure (TOPS) for compact excavators — Laboratory tests and performance requirements*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

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

ISO 2867:2011, *Earth-moving machinery — Access systems*

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

ISO 3449:2005, *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 3471:2008, *Earth-moving machinery — Roll-over protective structures — Laboratory tests and performance requirements*

ISO 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane*

ISO 3747:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering/survey methods for use in situ in a reverberant environment*

ISO 4413:2010, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 4414:2010, *Pneumatic fluid power — General rules and safety requirements for systems and their components*

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

ISO 6682:2008²⁾, *Earth-moving machinery — Zones of comfort and reach for controls*

ISO 7096:2020, *Earth-moving machinery — Laboratory evaluation of operator seat vibration*

ISO 9614-2:1996, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*

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 11203:1995, *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 13732-1:2006, *Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces*

ISO 13766-1:2018, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 1: General EMC requirements under typical electromagnetic environmental conditions*

ISO 13766-2:2018, *Earth-moving and building construction machinery — Electromagnetic compatibility (EMC) of machines with internal electrical power supply — Part 2: Additional EMC requirements for functional safety*

ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13850:2015, *Safety of machinery — Emergency stop function — Principles for design*

ISO 13855:2010, *Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body*

2) As impacted by ISO 6682:2008/Amd 1:1989, *Earth-moving machinery — Zones of comfort and reach for controls*

ISO 13856-1:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 1: General principles for design and testing of pressure-sensitive mats and pressure-sensitive floors*

ISO 13856-2:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 2: General principles for design and testing of pressure-sensitive edges and pressure-sensitive bars*

ISO 13856-3:2013, *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 13857:2019, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

ISO 14120:2015, *Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards*

ISO 14122-4:2004, *Safety of machinery — Permanent means of access to machinery — Part 4: Fixed ladders*³⁾

IEC 61000-6-2:2016, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments*

IEC 61000-6-4:2018, *Electromagnetic compatibility (EMC) — Part 6-4: Generic standards — Immunity standard for industrial environments*

IEC 61496-1:2020, *Safety of machinery — Electro-sensitive protective equipment — Part 1: General requirements and tests*

ISO 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*⁴⁾

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

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

ISO 4309:2010, *Cranes — Wire ropes — Care and maintenance, inspection and discard*

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

ISO 6405-1:2017, *Earth-moving machinery — Symbols for operator controls and other displays — Part 1: Common symbols*

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

ISO 7000:2012, *Graphical symbols for use on equipment — Registered symbols*

ISO 9533:2010, *Earth-moving machinery — Machine-mounted audible travel alarms and forward horns — Test methods and performance criteria*

ISO 10265:2008, *Earth-moving machinery — Crawler machines — Performance requirements and test procedures for braking systems*

ISO 10532:1995, *Earth-moving machinery — Machine-mounted retrieval device — Performance requirements*

ISO 10567:2007, *Earth-moving machinery — Hydraulic excavators — Lift capacity*

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

ISO 10968:2020, *Earth-moving machinery — Operator's controls*

3) This document is impacted by stand-alone Amendment 1 published in 2010.

4) This document is impacted by stand-alone Amendment 1 published in 2010.

ISO 12117-2:2008, *Earth-moving machinery — Laboratory tests and performance requirements for protective structures of excavators — Part 2: Roll-over protective structures (ROPS) for excavators of over 6 t*

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

ISO 15817:2012, *Earth-moving machinery — Safety requirements for remote operator control systems*

ISO 15818:2017, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements*

ISO 11886, ____⁵⁾, , *Drilling and foundation machinery — Soil drilling machines, and soil/rock drilling machines, and foundation machines — Commercial specifications*

ISO 16625:2013, *Cranes and hoists — Selection of wire ropes, drums and sheaves*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 11886:____⁵⁾, ISO 12100:2010 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

working platform for lifting personnel

platform used for raising or lowering personnel and materials, independently guided by the *leader* (3.7), to enable operational work or maintenance to be carried out

3.2

movable platform

level surface attached to leader guided parts of drilling and foundation equipment, e.g. drill head, to enable operational work or maintenance to be carried out

Note 1 to entry: The movable platform can be a temporary or permanent attachment.

Note 2 to entry: Persons may enter and stay on the movable platform only when it is stationary.

3.3

assistant

person who assists with the drilling and foundation equipment operation but is not responsible for control of the drilling and foundation equipment

Note 1 to entry: The assistant could be exposed to moving parts involved in the drilling process without having the control on the said moving parts.

3.4

driver (for transport movement)

person controlling and moving drilling and foundation equipment while driving

3.5

operator

person controlling the drilling and foundation equipment while operating

Note 1 to entry: The operator may also be the driver of the rig.

Note 2 to entry: The operator can also be the maintenance technician of the rig.

5) At the stage of preparation : ISO/DIS 11886:2023

3.6

user

person or entity having direct control over the use of the the drilling and foundation equipment

3.7

working area

area near a machine in which its tools are moved in order to carry out work

[SOURCE: ISO 18758-1:2018, 17.3]

3.8

danger zone

any zone within and/or around drilling and foundation equipment in which a person is exposed to risk of injury or damage to health

Note 1 to entry: For drilling and foundation equipment this means the area in which a person can be reached by an operational movement of the drilling and foundation equipment, by any part involved in the process by swinging or falling parts, pile elements and evacuated spoil or by ejected material.

3.9

hook load

actual load carried by the hook of the bottom block, including the weight of the bottom block and of the running ropes

3.10

rope safety factor

chain safety factor

ratio between the guaranteed minimum breaking and maximum pulling load

3.11

required stability angle

minimum required value for stability angle (α_{sr})

Note 1 to entry: Different values can be required for different load cases (e.g. travelling, working) and types of machine.

3.12

tilt angle

angle between the ground contact plane of the carrier and the operating slope in a tilted position used for the determination of the stability angle

Note 1 to entry: Tilt angle is increased from zero to the tipping angle in the stability calculation process

3.13

balance point

point where the moment acting to overturn the drilling and foundation equipment at a specific load overhang is equal to the stabilizing moment

3.14

tramming

moving of drilling and foundation equipment in operating condition on site

3.15

travelling

moving of drilling and foundation equipment in non-operating condition specified by the manufacturer

3.16

line pull

pulling force to the rope by the winch at the outer diameter of the drum/outer layer of the rope

3.17**geometric protection zone**

volume within which, in case of a rolling-over or tilting-over of the rig, the cabin is located to be safe from major deformations

Note 1 to entry: [Figure 5](#) ([subclause 4.14.1](#)) illustrates a geometric protection zone.

3.18**supplementary trip device**

sensitive protective equipment intended to detect the touch of a person or body part of a person (mechanically or electro sensitive activated trip) and which can also act as impeding device

Note 1 to entry: This device is aimed at reducing severity of the accident, in addition to the other protective devices intended to reduce the occurrences of accidents.

4 Safety requirements and/or protective/risk reduction measures**4.1 General**

Drilling and foundation equipment shall comply with the safety requirements and/or protective/risk reduction measures of this clause. In addition, the drilling and foundation equipment shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document.

4.2 Requirements for strength and stability**4.2.1 Loads****4.2.1.1 General**

The loads acting on drilling and foundation equipment are divided into the categories of regular, occasional and exceptional as given in [4.2.1.2](#), [4.2.1.3](#) and [4.2.1.4](#). For the calculation of means of access, loads only acting locally are given in ISO 2867:2011.

These loads shall be considered in proof against failure by uncontrolled movement, yielding, elastic instability and, where applicable, against fatigue.

4.2.1.2 Regular loads

Regular loads comprise for example the following:

- a) lifting and gravity effects acting on the mass of the drilling and foundation equipment;
- b) inertial and gravity effects acting on the lifted load;
- c) loads caused by travelling on uneven surface;
- d) loads caused by acceleration of all drives;
- e) loads induced by displacements;
- f) loads induced by drilling and foundation operation.

Regular loads occur frequently under normal operation.

4.2.1.3 Occasional loads

Occasional loads comprise for example the following:

- a) loads due to in-service wind;

- b) snow and ice loads;
- c) loads due to temperature variation;
- d) loads caused by erection and dismantling.

Occasional loads occur infrequently; therefore fatigue assessment is not mandatory.

4.2.1.4 Exceptional loads

Exception loads comprise for example the following:

- a) loads caused by rescue lifting or pulling under exceptional circumstances;
- b) loads due to out-of-service wind;
- c) test loads;
- d) loads caused by emergency cut-out.

Exceptional loads occur infrequently; therefore fatigue assessment is not mandatory.

4.2.2 Structural calculations

4.2.2.1 General

The calculations shall conform to the laws and principles of applied mechanics and strength of materials. If special formulae are used, the sources shall be given, if they are generally available. Otherwise the formulae shall be developed from first principles, so that their validity can be checked.

The individual loads shall be taken to act in the positions, directions and combinations which produce the most unfavourable conditions under all intended operating conditions.

For all critical load-bearing components and joints, the required information on stresses or safety factors shall be included in calculations in a clear and easily verifiable form. If necessary for checking the calculations, details of the main dimensions, cross-sections and materials for the individual components and joints shall be given.

4.2.2.2 Calculation methods

The method of calculation shall follow any one of the recognised international or national design standards, which includes fatigue-stress calculation methods.

For example the EN 13001 series may be used.

The elastic deformations of slender components and geometrical non-linear effects shall be taken into account when necessary for accomplishing a safe and suitable structure.

EN 1993-1-1:2005, 5.2, may be used.

The analysis shall be made for the worst-case load combinations. The calculated stresses shall not exceed the permissible values. The calculated safety factors shall not fall below the required values. The permissible values of stresses and the required values of safety factors depend on the material, the load combination and the calculation method.

4.2.2.3 Analysis

4.2.2.3.1 General stress analysis

The general stress analysis is the proof against failure by yielding or fracturing. This analysis shall be made for all load-bearing components and joints which are critical to failure. Finite element analysis

(FEA) modelling may be used to meet this requirement. The FEA model shall be specified and include an explanation of the loading areas, load types, constraint areas and constraint types.

4.2.2.3.2 Elastic stability analysis

Elastic stability analysis is the proof against failure by elastic instability (e.g. buckling). This analysis shall be made for all critical load-bearing components subjected to compressive loads and defined as those whose failure represents a hazard to the entire structure. Any initial residual stresses and geometrical imperfections of those components shall be taken into account for analysis.

EN 1993-1-1:2005, 5.3, may be used.

4.2.2.3.3 Fatigue-stress analysis

Fatigue-stress analysis is the proof against failure by fatigue due to stress fluctuations. This analysis shall be made for all load-bearing components and joints which are critical to fatigue, taking into account the construction details, the degree of stress fluctuation and the number of stress cycles.

4.2.3 Rigid body stability

4.2.3.1 General

This subclause contains requirements for the calculation of stability of drilling and foundation equipment.

Drilling and foundation equipment shall be so designed and constructed that it is sufficiently stable under the intended operating conditions, e.g. transport, rigging, tramping, parking and working, and that there is no risk of overturning.

The above mentioned operating conditions shall be the same described as intended use in the operator's manual.

Foreseeable misuse shall also be taken into consideration.

The rigid body stability shall be verified by calculation.

4.2.3.2 Stability criteria

The following stability criteria and calculations refer to mobile and stationary equipment:

- a) The calculation shall assume that the equipment is standing on firm ground. The maximum allowed operating slope, if any, shall be considered in the calculation.
- b) The calculation is based on the algebraic sum of all moments which simultaneously occur (see [4.2.3.4](#)).
- c) The parameter assumed for assessing stability is the stability angle, representing the residual angle by which the equipment, subjected to a system of loads including dynamic ones, can be tilted before tipping over.
- d) The stability shall be proven according to [4.2.3.5](#). The stability criterion is: the stability angle shall not be less than the required stability angle.
- e) As an alternative to indent c) and d): for rigging and de-rigging calculations, the stabilising moments of parts behind the tipping line shall exceed the tipping moments of parts in front of the tipping line by at least 10 %.
- f) Calculation of ground pressure shall be in accordance with [4.2.3.7](#).

These criteria are not applicable to equipment fixed to the ground, floating pontoons or a foundation. For those rigs, the moments from weights and loads shall be taken into account when calculating and designing the anchoring of the rig.

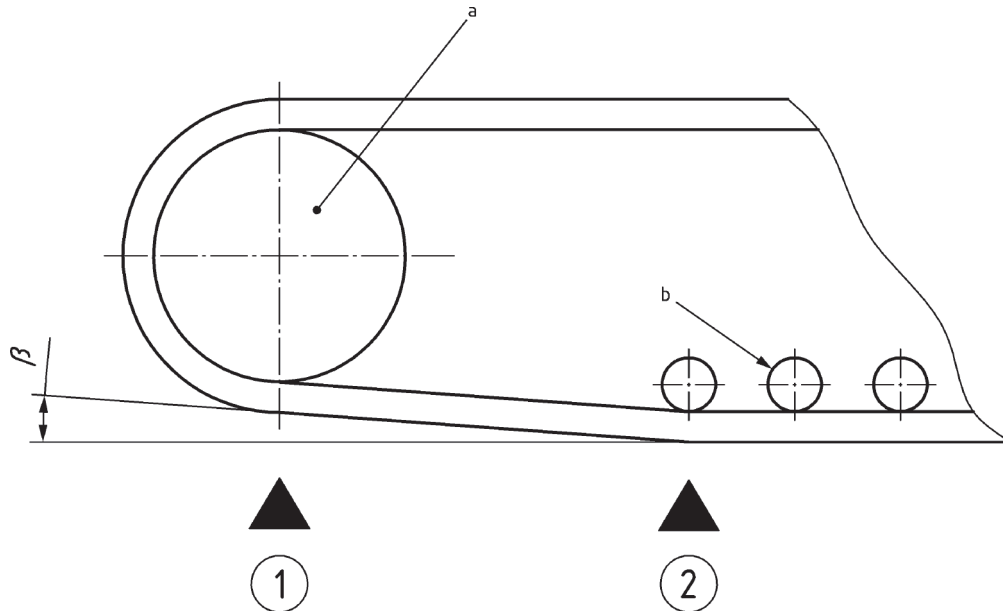
4.2.3.3 Tipping lines

4.2.3.3.1 General

Tipping lines shall be taken from ISO 10567:2007, 4.1.3 and 4.1.4.

4.2.3.3.2 Tipping lines for crawler machines

For crawler machines the tipping line definition given in [Figure 1](#) shall be used.



Key

a Drive or idler.

b Roller.

Choose 1 if β is lower than or equal to 2°

Choose 2 if β is more than 2°

Figure 1 — Tipping line for tipping in direction of travel

4.2.3.3.3 Additional support

Examples of tipping lines in case of additional support by outrigger or leader are given in [Figure 2](#):

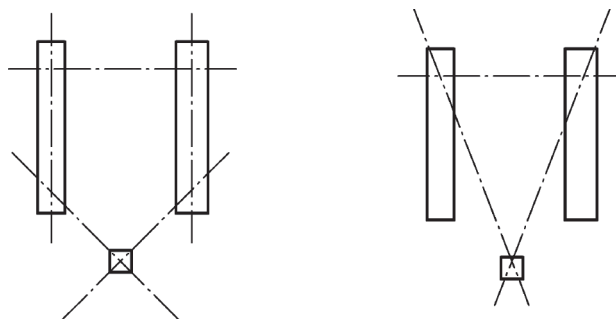


Figure 2 — Tipping lines

4.2.3.4 System of loads

4.2.3.4.1 General

Loads acting on the equipment are external loads (pulling-pushing working loads or lifting loads), mass loads (due to gravitational, centrifugal, inertial accelerations), and surface loads (mainly due to wind).

4.2.3.4.2 Weights and moments of inertia

Weights, positions of centres of gravity and moments of inertia of single parts of the equipment, including the base machine, which have a significant effect on the stability and which are input data for the stability calculation, shall be verified by weighing as far as possible and/or by calculation.

The position of the total centre of gravity and the total weight shall be measured by testing or calculated using the centres of gravity and weights of all parts of the equipment.

This calculation shall be made to search the most unfavourable combination of masses, their positions and configuration of the equipment.

4.2.3.4.3 Centrifugal load

For equipment with a slewing superstructure, the calculation shall consider the effect of centrifugal load which acts at the centre of gravity of the rotating masses, including the mass of superstructure and working loads.

For any working loads (e.g. swinging leader, lifted load) whose radial position is not fixed relative to the axis of rotation, its centrifugal load is considered to be applied to its suspension point on the structure.

An overspeed limiting device shall be used to limit the slewing speed to the value used for calculation.

4.2.3.4.4 Wind load

The calculation shall be made according to ISO 4302:2016 for a wind pressure

- for in-service load cases:
 - $p = 0,25 \text{ kPa (250 N/m}^2\text{)}$;
- for erected out-of-service:
 - $p = 0,8 \text{ kPa (800 N/m}^2\text{)}$, surfaces lower than 20 m from the ground;
 - $p = 1,1 \text{ kPa (1 100 N/m}^2\text{)}$, surfaces higher than 20 m from the ground;
 - $p = 1,65 \text{ kPa (1 650 N/m}^2\text{)}$ for offshore applications.
- for all other operating conditions:
 - $p = 0,25 \text{ kPa (250 N / m}^2\text{)}$

The direction of the wind , if any, load shall be considered as acting in the most unfavourable combination with other loads.

4.2.3.4.5 Dynamic loads

The effect of dynamic loads which are caused by movement of the equipment or suddenly released loads shall also be considered.

Examples are: accelerations of lifted load, travel accelerations, slewing accelerations, adjustment of leader position, etc.

For working loads (e.g. swinging leader, lifted load) whose radial position is not fixed relative to the axis of rotation, the mass shall be applied to its suspension point on the structure.

The dynamic effect of sudden release of suspended load is an upward load that shall be calculated considering the application and the structure of the equipment such as drop hammer, diesel hammer ram, chisel, hammer grab, rope grab, etc. or on the basis of a default value of 30 % of the released mass.

When available, measured accelerations/deceleration values shall be used for the calculation.

Such measurement shall be made by operating the controls in the most abrupt way in order to define the highest real acceleration/deceleration, both when starting and when stopping the movement to/from the maximum speed.

In the absence of measured values of acceleration/deceleration, approximate values (a_{appr} , $\dot{\omega}_{\text{appr}}$) may be used in the calculations.

a_{appr} and $\dot{\omega}_{\text{appr}}$ are obtained as follows:

$$a_{\text{appr}} = \frac{k \cdot v_{\text{max}}^2}{(2 \cdot \Delta s)} = \frac{k \cdot v_{\text{max}}}{\Delta t}$$

where

v_{max} is the max speed of the movement;

Δs is the measured distance (starting/braking distance) required for acceleration to/deceleration from v_{max} ;

Δt is the minimum between starting and stopping time;

k is an amplification factor.

$$\dot{\omega}_{\text{appr}} = \frac{k \cdot \omega_{\text{max}}^2}{(2 \cdot \Delta \theta)} = \frac{k \cdot \omega_{\text{max}}}{\Delta t}$$

where

ω_{max} is the max speed of the angular movement;

$\Delta \theta$ is the measured angle in radians required for acceleration to / deceleration from ω_{max} ;

Δt is the minimum between starting and stopping time;

k is an amplification factor.

The following values of k shall be applied:

- $k = 1$ for centrifugal forces;
- $1 \leq k \leq 1,5$ for movements with no backlash or in cases where existing backlash does not affect the dynamic forces and with smooth change of forces;
- $1,5 \leq k \leq 2$ for movements with no backlash or in cases where existing backlash does not affect the dynamic forces and with sudden change of forces;
- $k = 3$ for movements with considerable backlash, if not estimated more accurate by using a spring-mass-model.

Finally, in the absence of both direct (a_{test} , $\dot{\omega}_{\text{test}}$) and indirect (Δs , $\Delta \theta$, Δt) measurements, default acceleration/deceleration values may be used. These values are listed in [Table 1](#) hereafter.

The manufacturer ensures that these values are not exceeded.

[Table 1](#) also provides a summary of the methods explained above.

Table 1 — Values for acceleration/deceleration

MOVEMENT		ACCELERATION/DECELERATION		
		Method 1 by direct measurement	Method 2 by approximation	Method 3 by default values
Load lifting		a_{test}	a_{appr}	1 m/s ²
Travel	crawler mounted – hydraulic traction drive	a_{test}	a_{appr}	0,4 m/s ²
	crawler mounted – mechanical traction drive	a_{test}	a_{appr}	0,6 m/s ²
	wheel mounted	a_{test}	a_{appr}	2,5 m/s ²
Slewing	hydraulic drive	$\dot{\omega}_{\text{test}}$	$\dot{\omega}_{\text{appr}}$	0,25 rad/s ²
	mechanical drive	$\dot{\omega}_{\text{test}}$	$\dot{\omega}_{\text{appr}}$	0,35 rad/s ²
Adjustment of leader		a_{test}	a_{appr}	0,6 m/s ² at the outermost part of the leader

4.2.3.4.6 Horizontal load from unguided lifted load

The design shall take account of horizontal loads arising from the lifting of items on the hoist in a non-vertical manner. The manufacturer shall give in the operator's manual the limit admitted in the pulling of the rope in inclined direction for lifting unguided parts involved in the working process.

Although lifting may be foreseen vertically only, in practice it cannot be prevented that under normal operating circumstances some rope pulling on the slant occurs. In this case the effect of this slanting rope pull is taken into account by a horizontal load as follows.

for $L \leq 10$ t: $0,1 \cdot L \cdot g$ kN

for $L > 10$ t: $(5 + 0,05 \cdot L \cdot g)$ kN

with a maximum of 50 kN,

where

L is the hoisted load, in t

g is the gravitational acceleration, to be put at 10 m/s²

The direction of this load shall be chosen in such a way that the overturning moments are as unfavourable as possible.

It is not necessary to consider a combination of this horizontal load and slewing.

NOTE Already at an angle between the hoisting cable and the vertical axis of only 6°, the horizontal component of the rope pull is equal to 0,1 of the vertical component.

The horizontal load is considered to be applied to its suspension point on the structure.

4.2.3.4.7 Working loads

Other working loads that can influence the stability shall be taken into account when calculating the stability:

- the winch force between leader and drilling tool in the bore hole. The drill string and drilling tool shall not be regarded as a support when only a rope is being used for pulling up the drilling tool;
- pulling or extraction load;
- pushing or feed load that may cause a backward overturning. The maximum permissible values shall be given in the operator's manual, see [6.3.2.2.3](#).

In the case of drilling down, the drill string shall not be considered as a support.

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

The manufacturer shall give in the operator's manual the limit angle admitted for the use of service rope in inclined direction for lifting unguided parts involved in the working process. The stability calculation shall give consideration to this inclined load in the most unfavourable combination.

4.2.3.5 Stability calculation – Tipping angle

For each tipping line the algebraic sum of moments which simultaneously occur shall be calculated, considering the most unfavourable combination of loads, their position and equipment geometry.

The moment calculation shall be repeated for a tilted position of the equipment around the tipping line, taking into account that some loads (e.g. feed load, centrifugal and inertial loads) rotate together with the equipment, while other loads are fixed in direction (e.g. weight and wind loads, swinging loads).

The tilt angle will be increased until the sum of moments results to be nil. The final tilt angle is assumed as tipping angle relative to this tipping line.

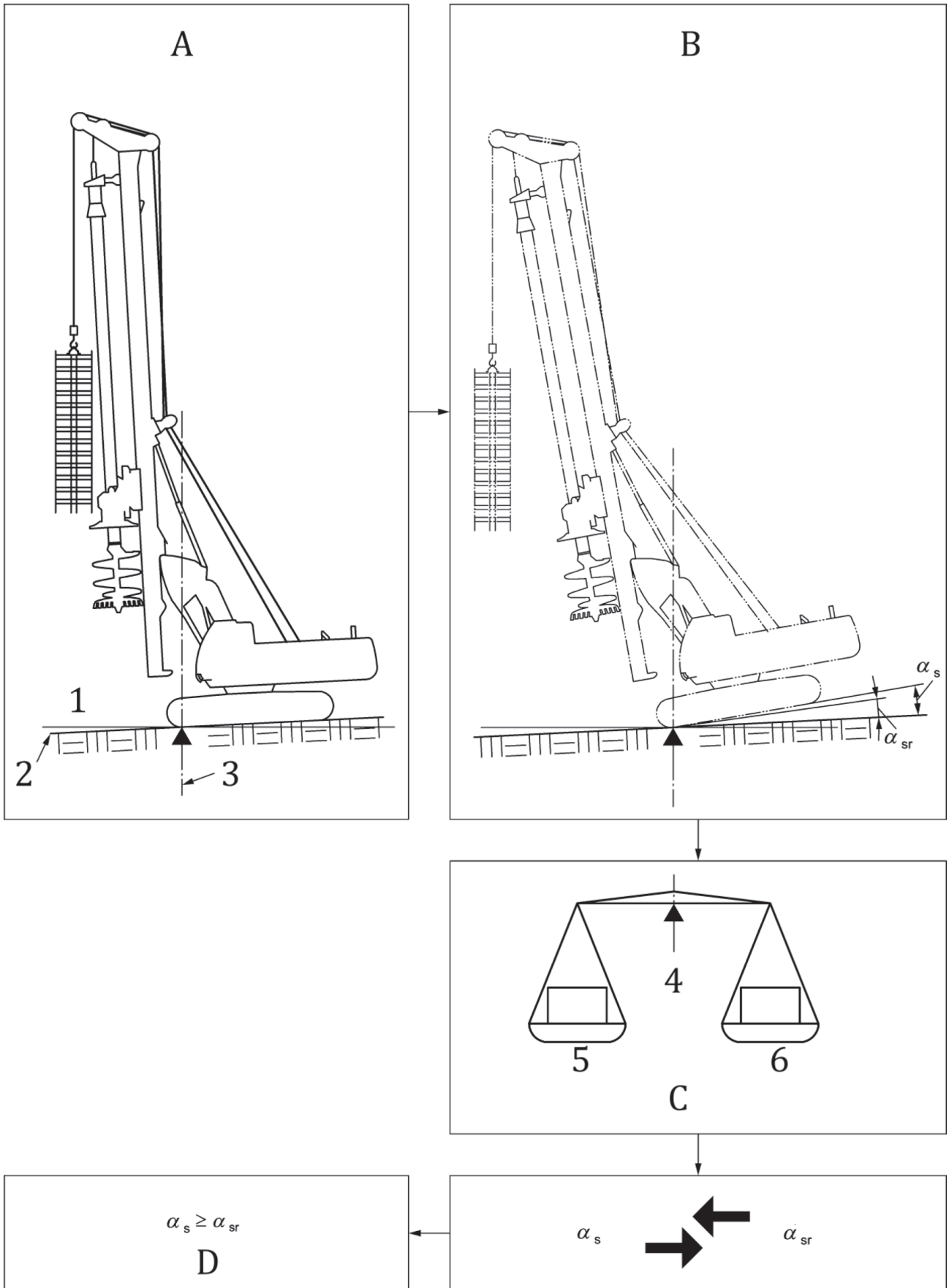
The minimum among the tipping angles relative to all the tipping lines is the stability angle of the equipment in the considered load case and position.

All operating, travelling and erection/dismantling conditions shall be examined, according to the relevant instructions given in the operator's manual. The stability angle for all above load cases shall be determined.

Stability angle shall be not less than the required value as specified in ISO 20770 parts 2 to 6. These parts may prescribe calculations relating to specific situations.

Deformations and displacements under load shall be taken into account where the design calculation or the practice show that they may significantly affect the stability of the equipment.

See [Figure 3](#) for a schematic explanation of method used for the stability calculation (see also [4.2.3.6.6](#)).



Key

α_s stability angle

5 overturning

α_{sr}	required stability angle	6	stabilizing
1	horizontal	A	load case, to be checked by stability calculation
2	operating slope	B	virtual variation of load case to find balance point between overturning and stabilizing moments
3	tipping line	C	balance point is found at stability angle α_s
4	balance point	D	load case fulfils requirements

Figure 3 — Schematic explanation of stability calculation

4.2.3.6 Operating conditions

4.2.3.6.1 General

The calculation shall consider the most unfavourable conditions which may occur at the same time, including the following conditions, as specified in the operator's manual.

Examples are given in following subclauses.

4.2.3.6.2 In service – during operation

Examples of generally critical conditions are listed below.

- the most unfavourable position and maximum forward, backward or sideways inclination of the leader;
- moveable loads in the most unfavourable position;
- most unfavourable tipping line;
- for a slewing superstructure, centrifugal load due to maximum slewing speed and loads due to relevant accelerations;
- loads caused by adjustment to leader position;
- dynamic effects of raising or suddenly releasing loads;
- maximum extracting or pull-down load;
- inclined rope pull of unguided loads;
- wind in the most unfavourable direction.

4.2.3.6.3 Trimming

For trimming between working positions, parameters listed in 4.2.3.6.2 shall be considered where appropriate.

In addition, the acceleration loads caused by the tractive functions of the carrier machine shall be considered.

Possible restrictions to geometry and loads when trimming shall be defined in the operator's manual.

4.2.3.6.4 Out of service – erected leader

The calculation shall be based on the drilling and foundation equipment weights and wind pressure in the foreseen configuration.

4.2.3.6.5 Out of service – lowered leader, during rigging and stowed condition during transport

The calculation shall be based on the drilling and foundation equipment weights and wind pressure in the foreseen configuration.

4.2.3.6.6 Travelling and operating on slopes

The calculation of the stability angle shall start from an initial position of parts of the machine and equipment suitable for the relevant slope angle, as allowed and prescribed in the operator's manual. For example, when working on a slope with leader rendered vertical, the angle between the machine and the leader feature a different configuration of geometry and loads position in respect to the work on horizontal ground. This initial configuration is the one that shall be tilted to search the stability angle.

4.2.3.6.7 Equipment mounted on truck or trailer

In addition to the above mentioned criteria, the following shall be considered:

When 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 elastic effect of vehicle suspensions.

4.2.3.6.8 Leader support foot

Special consideration shall be given to equipment provided with a support foot at the base of leader (telescopic leader foot, sliding leader or similar), see [Figure 2](#).

NOTE If the foot is capable of lifting the front side of crawlers, thus excluding some previous support point and limiting the area surrounded by the tipping lines, an additional risk is generated. On the contrary, if the foot is not in contact with the ground (e.g. due to ground collapse), some tilt angle is allowed before the efficiency of the foot is restored. Consideration shall be given to the fact that both cases may drastically reduce the intended effect of such device.

When the foot is in working position it shall be designed to withstand the foreseen support reaction.

4.2.3.7 Ground pressure

The ground pressure of crawler mounted drilling and foundation equipment shall be calculated in accordance with [Annex D](#).

4.2.4 Floating ship, barge or pontoon

When calculating strength and stability of drilling and foundation equipment that is operating on a floating ship, barge or pontoon, the expected deviations by trim and list shall be considered. The resulting angle due to trim and list during handling and drilling or piling shall be maximum 2,5°. When lifting pile elements and/or changing position of the equipment on the pontoon, the maximum allowed angle due to trim and list is 5°.

4.3 Electrotechnical systems

4.3.1 General

Electrical components and conductors shall be installed in such a way as to avoid 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 not protected by over-current devices shall not be strapped in direct contact with pipes and hoses containing fuel.

The electric installation of drilling and foundation equipment shall comply with the requirements of EN 60204-1:2018.

When the ambient temperature limits set in EN 60204-1:2018 are exceeded, the appropriate means, such as heating or cooling, shall be used.

4.3.2 Battery installation

Batteries shall be firmly attached in a ventilated space. The batteries shall be provided with handles and/or grips to allow their easy removal in order to avoid hazardous concentration of gases, e.g. hydrogen, acid vapours.

Batteries and/or battery locations shall be designed and built or covered to minimise any hazard to the operator and maintenance personnel caused by battery acid or acid vapours in the event of overturning of the machine, recharging the batteries and during maintenance activities.

Live parts (not connected to the frame) and/or connectors shall be covered with insulation material.

The location should have an easy access. Batteries should be easily removable.

It shall be possible to disconnect batteries easily, e.g. by a quick coupling or an accessible isolator switch. The symbol according to ISO 7000:2012, symbol 2063, shall be used for identification.

4.3.3 Electromagnetic compatibility (EMC)

The electrical equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment. In addition, the electrical equipment shall have a sufficient level of immunity to electromagnetic disturbances so that it can function in its intended environment.

Machines shall meet the EMC requirements of:

- ISO 13766-1:2018 and ISO 13766-2:2018;
- or
- IEC 61000-6-2:2016 and IEC 61000-6-4:2018.

See also IEC 61000-6-7:2014.

NOTE Tests are carried out either on the complete machines or on the safety-relevant ESA (Electrical/electronic subassemblies) as specified in ISO 13766 series.

4.4 Hydraulic and pneumatic systems

4.4.1 Hydraulic systems

The hydraulic systems shall comply with the requirements of ISO 12100:2010, 6.2.10 and ISO 4413:2010.

Hydraulic cylinders used for erection and lifting shall be fitted with load-sustaining devices which shall be self-bleeding or fitted with an air bleed point at the highest point.

Alternatively, bleeding can also be obtained by moving the piston between full stroke movements.

Load holding cylinders (e.g. leader lifting cylinders, feed cylinders) shall be fitted with a load holding device to prevent unintended movement caused by failure of an external pipe or hose [excluding those pipes indicated in c)]. The load holding device shall only release the overpressure caused by an external force or by an internal force due to, e.g. thermal expansion inside the cylinder. The setting of the internal relief-valve shall be at a pressure which does not allow movements causing unsafe conditions. 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, having welded or flanged connections and being calculated in the same way as the cylinder.

Flexible hydraulic hoses intended for pressures higher than 15 MPa shall be fitted with swaged fittings.

Hydraulic hoses and pipes shall be separated from electric power wiring (except signal cables) and be guarded against hot surfaces and sharp edges, in accordance with EN 60204-1:2018, 13.5.1 and 13.5.7.

Pipes and hoses, which have to be disconnected frequently, shall be fitted with self-sealing couplings with built-in check valves. Couplings shall be marked to ensure correct reconnection.

The tanks for hydraulic fluid shall be fitted with level indicators and a low level sensor or cut out switch to prevent damage to the hydraulic system and loss of hydraulic power, which gives a warning signal. The filling point of the tank shall be so designed that overflow is prevented when working on any gradient for which the drilling and foundation equipment is designed.

A temperature gauge or a monitor, which gives a warning signal (at least visual) shall be fitted in order to detect an excess of the allowed temperature.

4.4.2 Pneumatic systems

Pneumatic installations shall comply with the requirements of ISO 12100:2010, 6.2.10 and ISO 4414:2010.

4.4.3 Hoses, pipes and fittings under pressure

Pipes, hoses and fittings shall be able to withstand the stresses from the pressure. The requirements of ISO 4413:2010 and ISO 4414:2010 shall be complied with.

Hoses and pipes at the operator's position shall be shielded to prevent a hazard due to a rupture of hose or pipe or a high velocity jet or pressurized release of oil from a hose or pipe, e.g. as shown in [Figure 4](#).

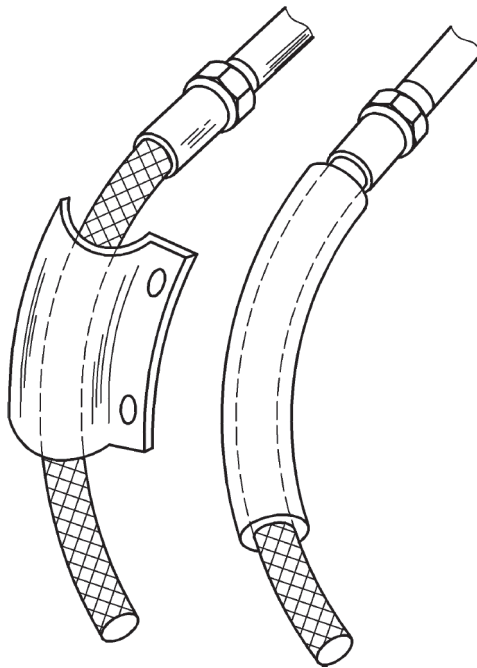


Figure 4 — Example of shielding

Hoses and pipes for materials such as air, water, mud, concrete, grout etc., shall be secured in case of disconnection or breakage, by means of adequate restraints.

4.5 Failure of the power supply

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

- it shall only be possible to restart drilling and foundation equipment as described in [4.15.3](#);

- the drilling and foundation equipment shall not be prevented from stopping if the stop command has been given;
- no part of the machine or a tool shall fall or be ejected;
- stopping, automatic or manual, of moving parts shall be unimpeded;
- guards and other protective devices shall remain effective.

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

4.6 Uncontrolled motion

Machine and equipment or attachment movement from the holding position, other than by actuation of the controls by the operator, due to drift or creep (e.g. by leaking) or when power supply stops, shall be limited to the extent that it cannot create a risk to exposed persons.

4.7 Brakes of the carrier machine

4.7.1 Brakes for travelling

Brakes for travelling of the carrier machine shall comply with the requirements of ISO 3450:2011 (wheeled machines) or ISO 10265 (crawler machines).

4.7.2 Brakes for slewing

Drilling and foundation equipment capable of slewing shall meet the requirements of EN 474-5:2022, Annex C.

4.8 Winches, draw-works and ropes

4.8.1 General

Winches, ropes and pulleys not directly involved in the drilling or foundation process shall comply with EN 14492-1:2006+A1:2009 or ISO 16625:2013.

For drilling and foundation equipment equipped with winches, ropes and pulleys that are directly involved in the drilling or foundation process, [4.8.2](#) to [4.8.4](#) shall be fulfilled.

NOTE Such systems are:

- systems running drill rods, chisels, kelly bars, hammer grabs, free fall hammers, piling hammers and other impact tools, by free fall, controlled free fall or powered lowering;
- systems running drill rods, casings, tools, tremie pipes and other accessories in and out of the bore hole;
- systems handling vibrators, pile elements, sheet piles, reinforcement elements, to and from the drilling and foundation equipment;
- systems assisting assembling, replacing and dismantling of equipment and tools;
- cable feed systems;
- any other system using winches, ropes and sheaves for any purpose other than lifting goods and personnel.

For requirements on winches, ropes and pulleys for working platforms for lifting personnel and movable platforms, see [4.13.2](#) and [4.13.3](#).