INTERNATIONAL STANDARD

ISO 20474-1

First edition
2008-12-15

Earth-moving machinery — Safety —

Part 1: General requirements

Engins de terrassement — Sécurité —

Partie 1: Exigences générales

Reference number
ISO 20474-1:2008(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 20474-1 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 2, *Safety, ergonomics and general requirements*.

ISO 20474 consists of the following parts, under the general title *Earth-moving machinery — Safety*:

— *Part 1: General requirements*
— *Part 2: Requirements for tractor-dozers*
— *Part 3: Requirements for loaders*
— *Part 4: Requirements for backhoe-loaders*
— *Part 5: Requirements for hydraulic excavators*
— *Part 6: Requirements for dumpers*
— *Part 7: Requirements for scrapers*
— *Part 8: Requirements for graders*
— *Part 9: Requirements for pipelayers*
— *Part 10: Requirements for trenchers*
— *Part 11: Requirements for earth and landfill compactors*
— *Part 12: Requirements for cable excavators*
— *Part 13: Requirements for rollers*
— *Part 14: Information on national and regional provisions* [Technical Specification]

Introduction

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

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

Provisions that are applicable for Australia, EU, Japan or the USA, and which are mandatory for compliance with specific governmental laws, directives or regulations in force in the particular country or region, are given in ISO/TS 20474-14.

NOTE Other countries or regions may also have regional requirements.

Earth-moving machinery — Safety —

Part 1: General requirements

1 Scope

This part of ISO 20474 specifies the general safety requirements for earth-moving machinery as defined in ISO 6165, each of these requirements being common to two or more earth-moving machine families. It is also applicable to machine attachments, and to derivated machinery designed primarily for equipment used to loosen, pick-up, move, transport and/or distribute earth, or to grade earth and rock.

It is intended to be used in conjunction with the other parts of ISO 20474, which give the provisions that are specific to particular machine families, and with ISO/TS 20474-14, which gives information on provisions that are mandatory in particular countries or regions. Those specific requirements take precedence over the requirements of this part of ISO 20474 for the machines concerned. For multipurpose machinery, all of those parts of ISO 20474 whose requirements cover the functions and applications of such machines are applicable.

EXAMPLE For a compact loader also used as a trencher, the relevant requirements of ISO 20474-1, ISO 20474-3 and ISO 20474-10 are applicable.

This part of ISO 20474 deals with all significant hazards, hazardous situations and events relevant to the earth-moving machinery within its Scope when used as intended or under conditions of misuse reasonably foreseeable by the manufacturer (see also ISO/TS 20474-14). It specifies the appropriate technical measures for eliminating or reducing risks arising from significant hazards, hazardous situations or events during commissioning, operation and maintenance. It does not deal with the electrical hazards related to the main circuits and drives of machines when the principal source of energy is electrical. It is not applicable to machines manufactured before the date of its publication.

2 Normative references

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

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

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

ISO 3164, *Earth-moving machinery — Laboratory evaluations of protective structures — Specifications for deflection-limiting volume*

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

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

ISO 3450, *Earth-moving machinery — Braking systems of rubber-tyred machines — System and performance requirements and test procedures*

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

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

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

ISO 4250-3, *Earth-mover tyres and rims — Part 3: Rims*

ISO 4413, *Hydraulic fluid power — General rules relating to systems*

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

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

ISO 6011, *Earth-moving machinery — Visual display of machine operation*

ISO 6014, *Earth-moving machinery — Determination of ground speed*

ISO 6016, *Earth-moving machinery — Methods of measuring the masses of whole machines, their equipment and components*

ISO 6165, *Earth-moving machinery — Basic types — Identification and terms and definitions*

ISO 6395, *Earth-moving machinery — Determination of sound power level — Dynamic test conditions*

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

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

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

ISO 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, *Earth-moving machinery — Operator's manual – Content and format*

ISO 8643, *Earth-moving machinery — Hydraulic excavator and backhoe loader boom-lowering control device — Requirements and tests*

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

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

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

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

ISO 10263-4, *Earth-moving machinery — Operator enclosure environment — Part 4: Operator enclosure ventilation, heating and/or air-conditioning test method*

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

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

ISO 10968:2004, *Earth-moving machinery — Operator's controls*

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

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

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

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

ISO 12117-2, *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* [1)]

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

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

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

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 14401-1, *Earth-moving machinery — Field of vision of surveillance and rear-view mirrors — Part 1: Test methods*

ISO 14401-2, *Earth-moving machinery — Field of vision of surveillance and rear-view mirrors — Part 2: Performance criteria*

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

ISO 15818, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements* [2)]

ISO 15998, *Earth-moving machinery — Machine-control systems (MCS) using electronic components — Performance criteria and tests for functional safety*

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 17063, *Earth-moving machinery — Braking systems of pedestrian-controlled machines — Performance requirements and test procedures*

ISO 21507, *Earth-moving machinery — Performance requirements for non-metallic fuel tanks*

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

---

1) To be published.

2) To be published.

3 Terms and definitions

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

3.1
earth-moving machinery
self-propelled or towed machine on wheels, crawlers or legs, having equipment or attachment (working tool), or both, primarily designed to perform excavation, loading, transportation, drilling, spreading, compacting or trenching of earth, rock and other materials

[ISO 6165:2006, definition 3.1]

3.1.1
compact machine
earth-moving machinery having an operating mass as defined in ISO 6016 of 4 500 kg or less, or, in the case of compact excavators, having an operating mass as defined in ISO 6016 of 6 000 kg or less

3.1.2
derivated machinery
earth-moving machinery fitted with equipment and/or attachment that modifies its function

NOTE In the European Economic Area (EEA), the equipment and/attachment, as defined in ISO 6016, that modifies the function of a machine and that is intended to be assembled by the operator can be *interchangeable equipment* in the sense of the Machinery Directive.

3.2
attachment
working tool
component or assembly of components that can be mounted onto the base machine or equipment for a specific use

NOTE See ISO 6746-1, ISO 6746-2 and ISO 6016.

3.3
attachment bracket
device to facilitate quick interchange of attachments

3.4
object handling
application of earth-moving machinery comprising lifting, lowering and transporting of a load by use of lifting accessories, whereby the assistance of a person or the operator of the machine is required for hooking, unhooking or stabilizing (while transporting) the load

NOTE 1 If the load is picked up by a self-acting device and no assistance of a person is required for hooking, unhooking and stabilising the load, this work is considered as a usual earth-moving application.

NOTE 2 Examples of lifting accessories are wire ropes, chains or textile straps; loads in object handling applications include pipes and vessels; examples of self-acting devices are grabs, clamshell buckets, log clamps, vacuum lifting device, magnetic plate and fork.

3.5
maximum rated operating [lift] capacity
〈object handling〉 maximum load which can be lifted in at least one position of the working range as specified by the manufacturer (e.g. on the rated object handling capacity table) in the most stable configuration (such as with outriggers down)

NOTE 1 A definition of *rated operating capacity* for loaders given in ISO 14397-1 is used in ISO 20474-3 and ISO 20474-4.

NOTE 2 *Rated lift capacity* forms the subject of ISO 10567 and is the term used in ISO 20474-5.

4 Safety requirements and/or protective measures

4.1 General

Machinery shall comply with the safety requirements and/or protective measures of this clause, in as far as those are not modified by the specific requirements of another part of ISO 20474.

In addition, the machine shall be designed according to the principles of ISO 12100 for relevant but not significant hazards which are not dealt with by this part of ISO 20474.

4.2 Access

4.2.1 General requirements

Adequate access systems shall be provided to the operator's station and areas where routine maintenance (as defined in ISO 3457) has to be performed by the operator as described in the operator's manual. The access system shall comply with ISO 2867.

Effect of mud on the means of access shall be minimized by adequate design.

For mandatory national and/or regional provisions, see ISO/TS 20474-14.

4.2.2 Access to articulated machines

On machines with articulated frames and in the fully articulated steering position, a minimum clearance of 150 mm for the lower limbs shall be provided between firm structures and components with relative movement in the path of the access systems to the operator's station, as illustrated in Figure 1.

Dimension in millimetres

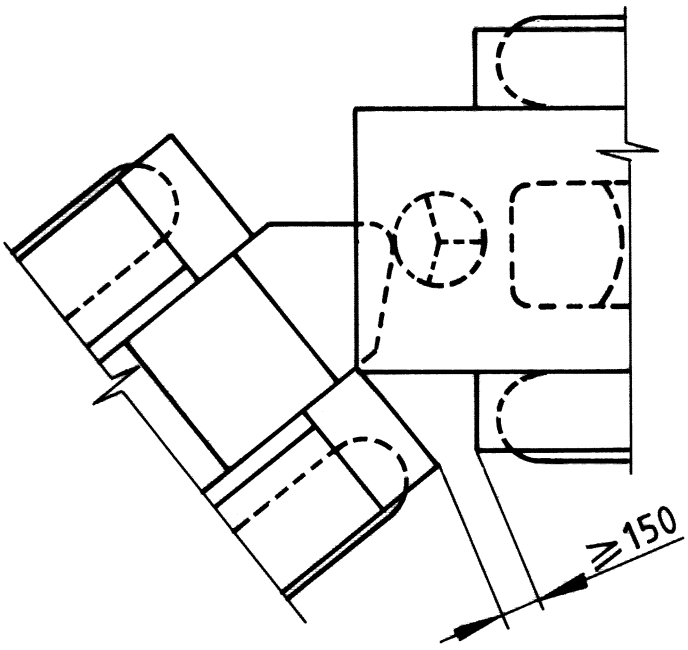

Figure 1 — Minimum clearance of lower limbs at access to operator's station on machines with articulated steering

4.3 Operator's station

4.3.1 General requirements

4.3.1.1 Machinery equipment

Machines with an operating mass of less than 1 500 kg are not required to have a cab.

Machines with an operating mass greater than or equal to 1 500 kg (see ISO 6016) shall be equipped with a cab, unless the foreseeable adverse weather conditions allow all-year operation without a cab (negotiated between manufacturer and user).

Machines shall be equipped with a cab and a contamination protective system if the machine is intended for use in unhealthy environments, e.g. contaminated areas (negotiated between manufacturer and user). See 4.14.1.

If a hazard due to projection of fractured material exists, e.g. operation with a hydraulic- or demolition-hammer, protection such as impact-resistant material, a mesh guard or an equivalent protection may be required for the application. Instructions shall be included in the operator's manual concerning the need for additional protection for such applications, based upon a risk assessment.

For mandatory national and regional requirements, see ISO/TS 20474-14.

4.3.1.2 Minimum space

The minimum space available to the operator shall be as defined in ISO 3411, modified by the provisions of 4.3.2.5.

The minimum space and location of the controls at the operator's station shall be in accordance with ISO 6682.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.3.1.3 Moving parts

Measures shall be taken to avoid accidental contact from the operating position with moving parts, e.g. wheels, tracks or working equipment and/or attachments, in accordance with the relevant subclauses of 4.14.

4.3.1.4 Engine exhaust

The engine exhaust system shall release the exhaust gas away from the operator and the air inlet of the cab.

4.3.1.5 Instruction storage

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.3.1.6 Sharp edges

The operator's working space within the operator's station, e.g. ceiling, inner walls, instrument panels and access to the operator's station, shall not present any sharp exposed edges or acute angles/corners. The radius of corners and the bluntness of edges shall comply with ISO 12508, in order to avoid sharp edges (see also 4.14.6).

4.3.1.7 Pipes and hoses

Pipes and hoses located inside the cab which contain fluids that are hazardous, for example, because of their pressure (greater than 5 MPa) or temperature (greater than 50 °C) shall be guarded in accordance with ISO 3457:2003, Clause 9.

As far as possible pipes and hoses should be placed outside the cab.

Parts or components placed between pipes or hoses and the operator that divert, for example, a hazardous spray of fluid, may be considered as providing sufficient protection.

4.3.2 Operator's station equipped with a cab

4.3.2.1 Climatic conditions

The cab shall protect the operator against foreseeable adverse climatic conditions. Provisions shall be made to install a ventilation system, an adjustable heating system and a system for defrosting windows. For details, see 4.3.2.6 to 4.3.2.8.

4.3.2.2 Pipes and hoses

See 4.3.1.7.

4.3.2.3 Primary opening

A primary access opening shall be provided. The dimensions shall be in accordance with ISO 2867.

4.3.2.4 Alternative opening (emergency exit)

An alternative opening shall be provided on a side other than that of the primary opening. The dimensions shall be in accordance with ISO 2867. A window panel or another door are acceptable if they are easy to open or remove without the use of keys or tools. Latches may be used if they can be opened from the inside without the use of keys or tools. The breaking of a suitable size of glass pane is considered to represent a suitable alternative opening, provided that the necessary pane hammer, immediately accessible to the operator, is provided and stored in the cab.

When the window panel is used as an emergency exit, it shall bear an appropriate marking (see, for example, IEC 61310-1:1995, Figure 8).

4.3.2.5 Space envelope height

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.3.2.6 Heating and ventilation system

If a heating system is fitted it shall either

a) comply with ISO 10263-4, or

b) have a heating capacity that can be determined by calculation.

The ventilation system shall be capable of providing the cab with filtered fresh air at a minimum of 43 m^3/h. The filter shall be tested according to ISO 10263-2.

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

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.3.2.7 Defrosting system

Machines with cab shall provide facilities for defrosting the front and rear window(s), for example, by means of a heating system or a particular defrosting device.

NOTE A test method for windscreen defrosting systems is given in ISO 10263-5.

4.3.2.8 Pressurization system

Where a cab is provided with a pressurization system, it shall be tested according to ISO 10263-3 and shall provide an interior relative pressure of at least 50 Pa.

4.3.2.9 Doors and windows

Doors, windows and flaps shall be securely held in their functional positions; measures shall be taken for preventing inadvertent opening. Doors shall be retained at their intended operating position(s) by a positive engagement device. A primary opening that is designed to be held securely open as an intended operating position shall be releasable from the operator's station or the entry platform to the operator's station.

Windows shall be made of safety glass or other material that provides similar safety performance (see, for example, ECE R43).

Roof windows do not require additional mechanical safeguarding.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.3.2.10 Inner lighting

The cab shall be fitted with a fixed inner lighting system and 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.

4.3.3 Operator-protective structures

4.3.3.1 General

Earth-moving machinery with a seated operator position shall be equipped with a roll-over protective structure (ROPS). The ROPS shall be in accordance with ISO 3471 or ISO 12117-2, whichever is applicable. Where another part or parts of ISO 20474 state that a ROPS is not required for a particular family of covered machines, anchorage points for the ROPS are permitted.

4.3.3.2 ROPS for derivated machinery

For derivated machinery, the ROPS shall be designed taking into account the operating mass according to ISO 6016 of the derivated machinery in the heaviest configuration as specified by the manufacturer.

4.3.4 Falling-object protective structures (FOPS)

Earth-moving machinery, apart from exceptions as specified in ISO 3449, shall be so designed that a FOPS can be fitted, when they are intended for applications where there is a risk of falling objects.

The fitted FOPS shall be in accordance with ISO 3449.

If a provision for a FOPS is required by another part of ISO 20474, the manufacturer shall provide the corresponding FOPS on demand.

4.3.5 Elevating operator's station

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.3.6 Replacement of operator protective structure

In case any part of the protective structure, including ROPS, FOPS and TOPS (tip-over protective structures), is affected by plastic deformation or rupture (e.g. as a consequence of roll-over, falling-object impact or tipping over), the protective structure shall be replaced according to manufacturer's specifications. See also 6.2.

4.4 Seats

4.4.1 Operator's seat

4.4.1.1 General requirements

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

4.4.1.2 Dimensions

The seat dimensions shall be in accordance with ISO 11112.

4.4.1.3 Adjustment

All adjustments to accommodate the operator's size shall be in accordance with ISO 11112 and shall be adjustable without the use of any tool.

For the seats of compact machines, the following applies:

a) either the fore and aft adjustment (see ISO 11112:1995, Table 1, l_2) shall be at least $\pm$ 35 mm or the corresponding adjustment of frequently used operator controls shall be provided;

b) vertical adjustment (ISO 11112:1995, Table 1, h_1) is not required.

4.4.1.4 Vibration

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.4.1.5 Restraint system

Machines fitted with ROPS or TOPS shall have an operator restraint system that meets the requirements specified in ISO 6683.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.4.2 Additional seat

4.4.2.1 Instructor's seat

If an additional seat for an instructor is installed in the operator's station, it shall be padded and shall provide adequate space for the instructor. The instructor shall also have available a conveniently placed handhold.

4.4.2.2 Second operator's seat

If, for a particular machine, a second operator's seat is required, which can be frequently or alternatively used by the operator to perform the application of the machine, this seat shall fulfil all the requirements for seats given in this clause, as well as those for safety structures in 4.3.3 for ROPS and 4.3.4 for FOPS.

4.5 Operator's controls and indicators

4.5.1 General

The controls (hand levers, joysticks, pedals, switches, etc.) and indicators of the machine and/or equipment/attachment, shall be chosen, designed, constructed and arranged in accordance with ISO 10968, and such that

a) they are of easy access, in accordance with ISO 6682 and ISO 10968,

b) the neutral positions of the controls are in accordance with ISO 10968:2004, 5.1.3,

c) they are clearly identified in accordance with ISO 6405-1and ISO 6405-2 in the operator's station and explained in the operation manual (see 6.2),

d) the movement of their controls for activating functions and indicators shall correspond to the intended effect or common practice whenever possible,

e) the normal engine stop device is within the zone of reach as defined by ISO 6682,

f) when a control such as a keyboard or joystick control (see the requirements for joysticks given in ISO 10968) is designed and constructed to carry out several of the machine's functions, the activated function(s) are clearly identified,

g) for the safety-related functions of control system(s) having no electronic components, the principles outlined in ISO 13849-1 are followed, or methods giving similar protection are applied.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.5.2 Starting system

The starting system of an earth-moving machinery shall be provided with a starting device (e.g. key) and shall comply with ISO 10264 or have similar protection.

Earth-moving machines shall be so designed that hazardous movement of the machine or its working equipment and/or attachment shall not occur by starting the engine.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.5.3 Inadvertent activation

Controls that can cause a hazard due to inadvertent activation shall be so arranged, deactivated or guarded as to minimize the risk — particularly while the operator is getting into or out of the operator's station. The deactivation device shall either be self-acting or shall act by compulsory actuation of the relevant device.

4.5.4 Pedals

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

If the pedals of an earth-moving machine have the same function (clutch, brake and accelerator) as those of vehicle, they shall be arranged in the same manner in order to avoid the risk of confusion.

4.5.5 Emergency attachment lowering

If the engine is stopped it shall be possible to

a) lower the equipment/attachment to the ground/frame,

b) see the equipment/attachment lowering from the operator actuating position of the lowering control,

c) release the residual pressure in each hydraulic and pneumatic circuits causing a risk.

The means to lower the attachment and the device to release the residual pressure may be located outside the operator's station and shall be described in the operation manual.

4.5.6 Uncontrolled motion

Machine and equipment/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.

4.5.7 Remote control

Remote operator controlled earth-moving machinery shall be in accordance with ISO 15817.

4.5.8 Control panels, indicators and symbols

4.5.8.1 Control panels

The operator shall be able to see from the operator's station, in either daylight or darkness, the necessary indicators allowing a check of the proper function of the machine. Glare shall be minimized.

4.5.8.2 Operating instrumentation

Control indicators for the safe and proper operation of the machine shall be in accordance with ISO 6011 in respect of the use of safety colours and related aspects.

4.5.8.3 Symbols

For symbols used on operator controls and other displays on earth-moving machinery, see, for example, ISO 6405-1 or ISO 6405-2.

4.5.9 Controls of ride-on machinery accessible from ground level

On ride-on machinery where controls are accessible from the ground, means shall be provided to minimize the possibility of actuating the controls from the ground.

EXAMPLE Protection by door, guard locking or interlocking systems.

4.6 Steering system

4.6.1 General

The steering system shall be such that the movement of the steering control corresponds to the intended direction of steering according to ISO 10968.

4.6.2 Rubber-tyred machines

The steering system of wheeled machines with rubber tyres and having a forward/reverse travel speed greater than 20 km/h shall be in accordance with ISO 5010.

4.6.3 Crawler machines

The steering system of crawler machines with a forward/reverse travel speed greater than 20 km/h shall be gradual.

4.7 Brake systems

The earth-moving machines shall be equipped with a service brake system, a secondary brake system and a parking brake system, with all three systems being efficient under all conditions of service, load, speed, terrain and slope, according to the intended use of the machine.

Brake systems shall be in accordance with the following International Standards:

a) for wheeled machines, ISO 3450;

b) for crawler machines, ISO 10265;

c) for pedestrian-controlled machines, ISO 17063.

4.8 Visibility

4.8.1 Operator's field of view

Earth-moving machines shall be designed so that the operator has sufficient visibility from the operator's station in relation to the travel and work areas of the machine necessary for its intended use. The performance criteria shall be in accordance with ISO 5006.

NOTE 1 The travel mode according to ISO 5006 is considered to be representative for testing visibility in both travel and operating modes.

Earth-moving machines shall be equipped with rear view mirrors compliant with ISO 14401-1 and ISO 14401-2.

NOTE 2 It is sufficient to measure the machine with the most challenging standard attachment within the limits of the intended use.

For mandatory national and regional provisions, see ISO/TS 20474-14.

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

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

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.9 Warning devices and safety signs

The earth-moving machinery shall be equipped with

a) an audible warning device (horn) controlled from the operator's station and tested to compliance with ISO 9533, and

b) safety signs and hazard pictorials in accordance with ISO 9244.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.10 Tyres and rims

Wheeled earth-moving machinery with rubber tyres shall have tyre and rim load performance adapted to the machine's purpose and application.

Rims shall have clear identification in accordance with ISO 4250-3.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.11 Stability

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.12 Object handling

4.12.1 Lifting device(s) for object handling

The lifting device(s) may be either fixed or removable. This device may be located on a bucket, an arm or on any other part of the machine, or may be a separate device. It shall be

a) so located and designed that the risk of its damage during normal earth moving operations is minimized, and

b) designed so that the hooking device prevents unintentional unhooking of the load.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.12.2 Lowering control device

Machines used in object handling applications (see the other, machine-specific, parts of ISO 20474), which require a boom lowering control device, shall conform to ISO 8643.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.13 Noise

4.13.1 Requirements for noise reduction

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.13.2 Noise emission measurement

4.13.2.1 Sound power level

The sound power level for the different types of earth-moving machinery shall be measured according to ISO 6395 unless otherwise stated in the machine-specific parts of ISO 20474.

NOTE Noise emission values obtained from measurements are the accepted means of verifying the result of the noise-reduction measures taken at the design stage (see 4.13.1).

4.13.2.2 Emission sound pressure level at the operator's station

The emission sound pressure level at the operator's station for the different types of earth-moving machinery shall be measured according to ISO 6396 unless otherwise stated in the machine-specific parts of ISO 20474.

On machines fitted with a cab, the A-weighted emission sound pressure level at the operator's position should not exceed 85 dB.

NOTE Noise emission values obtained from measurements are the accepted means of verifying the result of the noise-reduction measures taken at the design stage (see 4.13.1).

4.14 Protective measures and devices

4.14.1 Contaminated area

If an earth-moving machine is intended to be used in a contaminated environment, and if a hazard exists, special precautions to protect the operator shall be provided (see also 4.3.1.1).

EXAMPLE Fresh air filter systems or a system providing breathing air to the operator.

4.14.2 Hot parts

Parts which become hot in operation shall be designed, constructed, positioned or provided with a thermal guard to minimize the risk of contact with hot parts and/or surfaces in close proximity to the primary opening, operating position and maintenance area, in accordance with ISO 3457.

For ergonomic data that can be used to establish temperature limit values for hot surfaces, see ISO 13732-1.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.14.3 Moving parts

All moving parts that create a hazard shall be designed, constructed, positioned or provided with protection devices that minimize the risk of crushing, shearing and cutting.

4.14.4 Guards

Guards shall comply with ISO 3457.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.14.5 Articulated frame lock

Articulated machines shall be equipped with an articulated frame lock according to ISO 10570.

4.14.6 Sharp edges and acute angles

Sharp edges and acute angles shall be in accordance with ISO 12508 in those areas that can be accessed during operation and daily maintenance, except for the area of the attachment. See also 4.3.1.6.

4.14.7 Fenders

Earth-moving machinery with a design speed as specified in ISO 6014 greater than 25 km/h shall be equipped with fenders in accordance with ISO 3457 that protect the operator's station from debris ejected by the tyres or tracks, where this risk exists.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.15 Retrieval, transportation, lifting and towing

4.15.1 Common use

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

NOTE See ISO 15818[3)] .

4.15.2 Retrieval

If retrieval points are fitted, they shall comply with ISO 10532.

4.15.3 Tie-down

Tying-down devices shall be in accordance with ISO 15818.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.15.4 Lifting

Lifting devices shall be in accordance with ISO 15818.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.15.5 Towing

If towing devices or location points are fitted, they shall comply with ISO 10532.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.15.6 Transportation

Stabilizers, outriggers or other moveable devices that can cause a hazard during transportation or travelling shall be secured in their transport position.

Instructions for secure locking shall be provided in the operator's manual.

4.16 Electro-magnetic compatibility (EMC)

Earth-moving machines shall comply with EMC requirements as specified in ISO 13766.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.17 Electrical and electronic systems

4.17.1 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) that can cause deterioration. Electrical component insulation shall have flame-retardant properties. Lead-through, e.g. through frames and bulkheads, shall be protected from abrasion.

---

3) To be published.

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

Safety-related machine control systems using electronic components shall comply with ISO 15998 or other standards providing equivalent integrity.

4.17.2 Degree of protection

Depending on the location/installation of electrical and electronic components, the following degrees of protection are required:

a) all components installed exterior to the machine or directly exposed to the environment shall have a minimum degree of protection corresponding to according IEC 60529, IP 55;

b) for all components installed in the operator's cab or protected against the environment, the protection shall be designed and executed to safeguard a correct function under expected and intended conditions.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.17.3 Electrical connections

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 as guidance.

This requirement does not apply to the electrical circuits of anti-theft systems.

4.17.4 Over-current protective devices

Electrical equipment, except for the starter motor, alternator and pre-heater, shall be protected with an over-current device (e.g. fuse) or other device giving the same protection.

4.17.5 Batteries

Batteries shall be firmly attached in a ventilated space. The location should be easy to access and batteries be easily able to be removed. The batteries shall be provided with handles and/or grips.

Batteries and/or battery locations shall be designed and built or covered so as to minimize any hazard to the operator caused by battery acid or acid vapours in the event of the machine overturning.

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

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.17.6 Battery disconnection

It shall be possible to disconnect batteries easily, e.g. by a quick coupling or an accessible isolator switch. The symbol ISO 7000-2063 (see ISO 6405-1) shall be used for identification.

4.17.7 Electrical connectors for auxiliary starting aids

If electrical connectors for auxiliary starting aids or power supply are mounted on the machine, the connectors shall be in accordance with ISO 11862.

4.17.8 Electric sockets for lighting

An electric socket intended for the connection of a lighting device for service and maintenance use shall be provided on the machine and shall be easily accessible.

The design of the sockets shall be such as to prevent incorrect connection.

4.18 Pressurized systems

4.18.1 General

Pressurized equipment shall be designed in accordance with ISO 4413 and shall be designed and constructed so as to withstand loading to the pressure to which they are subjected.

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.18.2 Hydraulic lines

Pipes and hoses shall be located and, if necessary, restrained so as to minimize deterioration, e.g. through contact with hot surfaces, sharp edges and other damage-causing sources. Visual inspection of hoses and fittings shall be possible. Pipes and hoses located inside frames are exempt from this requirement.

4.18.3 Hydraulic hoses

Hydraulic hoses containing fluid at a pressure of more than 5 MPa (50 bar)[4)] and/or at a temperature of more than 50°C, and which are located within 1,0 m from any surface of DLV (deflection limiting volume, as defined in ISO 3164), shall be guarded in accordance with ISO 3457 (see also 4.3.2.2).

Any part or component that diverts a possible jet of fluid may be regarded as providing sufficient protection.

Hoses intended to withstand a pressure of more than 15 MPa (150 bar) shall not be fitted with reusable fittings, unless they require the use of dedicated tooling (such as a press) and are parts authorized by the manufacturer of the earth-moving machine.

4.19 Fuel tanks, hydraulic tanks and pressure vessels

4.19.1 General

Fuel and hydraulic tanks shall be provided with a fluid level indicator. Pressure in the tanks exceeding the specified pressure shall be automatically compensated by a suitable device (vent, safety valve, etc.).

4.19.2 Filler openings

Filler openings of tanks (except window washer tanks) shall

a) be easily accessible for filling,

b) have provisions for lockable filler caps, except for filler caps located inside lockable compartments (such as the engine compartment) or caps that can only be opened with a special tool, and

c) be located outside the cab, with the exception of the hydraulic oil tank on compact machines.

4.19.3 Fuel tanks

Fuel tanks shall withstand an internal pressure of 0,03 MPa (0,3 bar) without permanent deformation or leakage.

Non-metallic fuel tanks shall comply with ISO 21507.

---

4) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.19.4 Air pressure vessels

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

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.20 Fire protection

4.20.1 Fire resistance

The interior, upholstery and insulation of the cab and other parts of the machine where insulation materials are used shall be made of flame-retardant materials. The burning rate shall not exceed 200 mm/min, tested in accordance with ISO 3795.

4.20.2 Fire extinguisher

Earth-moving machinery with an operating mass of more than 1 500 kg (see ISO 6016) shall have space for the installation of a fire extinguisher or extinguishers, easily accessible to the operator, or shall have a built-in extinguishing system to permit the operator safe exit from the machine.

4.21 Attachments and attachment bracket

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.22 Maintenance

4.22.1 General

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

Openings intended for maintenance purposes shall comply with ISO 2860.

If possible, the design of the machine shall permit lubrication and filling of tanks from the ground.

4.22.2 Frequent maintenance

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

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

4.22.3 Support devices

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

If the support device or devices are required for daily maintenance, they shall be permanently affixed to the machine or shall be stored in a secure place on the machine.

Engine access panels shall be provided with a device to hold them in the open position.

4.22.4 Access to the engine compartment

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.22.5 Tiltable cab support device

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

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

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.23 Underground operation in non-explosive atmosphere

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.24 Rear-mounted winch

4.24.1 General

For mandatory national and regional provisions, see ISO/TS 20474-14.

4.24.2 Mounting

The means for securing a winch to the machine structure shall be designed to withstand a force of twice the maximum line-pull that can be exerted by the rope without permanent deformation.

ISO 19472 should be used as guidance for design of the mounting system.

4.24.3 Controls

The winch controls shall be located at the operator's station and shall be in accordance with ISO 10968.

4.24.4 Protection

Where a rear-mounted winch is fitted, provision shall be made to allow for protection.

Earth-moving machinery equipped with a rear winch shall be equipped with an adequately sized protective screen or screens of a steel wire of minimum diameter 6 mm woven wire mesh and maximum opening of 45 mm $\times$ 45 mm, or equivalent protection, between the operator and the winch.

ISO 8084 should be used as guidance for design.

The screen width and height shall cover at least

— the rear window, for machines fitted with a cab;

— the rear of the minimum space envelope as specified in ISO 3411:2007, Figure 4, for machines without a cab.

5 Verification of safety requirements and/or protective measures

Either one or a combination of the following shall be used to verify that the requirements of this part of ISO 20474 have been incorporated in the design and manufacture of the earth-moving machinery:

a) measurement;

b) visual examination;

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

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

6 Information for use

6.1 Safety labels

Safety labels shall meet the requirements of ISO 9244.

For mandatory national and regional provisions, see ISO/TS 20474-14.

6.2 Operator's manual

The operator's manual shall be in accordance with ISO 6750.

The manufacturer shall provide information on

— operation and safe use of winches, if fitted, and

— marking of the maximum pull force of the winch, if fitted.

For mandatory national and regional provisions, see ISO/TS 20474-14.

6.3 Machine marking

Each machine shall, as a minimum, bear the following minimal information in a legible and indelible condition:

a) name and address of the manufacturer;

b) mandatory marking;

c) designation of series or type;

d) the serial number, e.g. PIN according to ISO 10261.

For mandatory national and regional provisions, see ISO/TS 20474-14.

Bibliography

[1] ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs in workplaces and public areas*

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

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

[4] ISO 5353, *Earth-moving machinery, and tractors and machinery for agriculture and forestry — Seat index point*

[5] ISO 6746-1, *Earth-moving machinery — Definitions of dimensions and codes — Part 1: Base machine*

[6] ISO 6746-2, *Earth-moving machinery — Definitions of dimensions and codes — Part 2: Equipment and attachments*

[7] ISO 6749, *Earth-moving machinery — Preservation and storage*

[8] ISO 7000, *Graphical symbols for use on equipment — Index and synopsis*

[9] ISO 7096, *Earth-moving machinery — Laboratory evaluation of operator seat vibration*

[10] ISO 7597, *Forged steel lifting hooks with point and eye for use with steel chains of grade T(8)*

[11] ISO 8084, *Machinery for forestry — Operator protective structures — Laboratory tests and performance requirements*

[12] ISO 9247, *Earth-moving machinery — Electrical wires and cables — Principles of identification and marking,* ISO 9247:1990/Amd 1:1998

[13] ISO 10261, *Earth-moving machinery — Product identification numbering system*

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

[15] ISO 10567, *Earth-moving machinery — Hydraulic excavators — Lift capacity*

[16] ISO/TR 11688-1, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning*

[17] ISO/TR 11688-2, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 2: Introduction to the physics of low-noise design*

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

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

[20] ISO 14397-1, *Earth-moving machinery — Loaders and backhoe loaders — Part 1: Calculation of rated operating capacity and test method for verifying calculated tipping load*

[21] ISO 15667, *Acoustics — Guidelines for noise control by enclosures and cabins*

[22] ISO 15818, *Earth-moving machinery — Lifting and tying-down attachment points — Performance requirements*[5)]

[23] ISO 19472, *Machinery for forestry — Winches — Dimensions, performance and safety*

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

[25] FMVSS 205, *Glazing material*

[26] ANSI Z26.1, *Review task force*

[27] EN 791, *Drillrigs — Safety*

[28] JIS R3211, *Safety glazing materials for road vehicles*

[29] UNECE, *Agreement concerning the adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicle equipment and parts* (United Nations Economic Commission for Europe)

[30] ECE R34, *Uniform provisions concerning the approval of vehicles with regard to the prevention of fire risks*

[31] ECE R43, Annex 5, *Uniform provisions concerning the approval of safety glazing and glazing material. Uniformly-Toughened Glass Panes*

[32] ECE R43 (rev. 2), *Uniform provisions concerning the approval of safety glazing and glazing materials and their installation on vehicles* (see http://www.unece.org/trans/main/wp29/wp29regs/43rv2e.pdf)

[33] ECE R46, *Uniform provisions concerning the approval of rear-view mirrors, and of motor vehicles with regard to the installation of rear-view mirrors*

5) To be published.

ICS 53.100

Price based on 22 pages