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Rough-terrain trucks — Safety requirements and verification —

Part 2: Slewing trucks

Chariots tout-terrain — Exigences de sécurité et vérifications —

Partie 2: Chariots rotatifs

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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).

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

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

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 110, *Industrial trucks*, Subcommittee SC 4, *Rough-terrain trucks*.

ISO 10896 consists of the following parts, under the general title *Rough-terrain trucks — Safety requirements and verification*:

— *Part 1: Variable-reach trucks*

— *Part 2: Slewing trucks*

— *Part 4: Additional requirements for variable-reach trucks handling freely suspended loads*

— *Part 5: Interface between rough-terrain truck and integrated personnel work platform*

— *Part 6: Tilting operator's cabs*

— *Part 7: Longitudinal load moment systems*

Safety requirements and verification of lorry-mounted trucks is addressed by ISO 20297-1.

Introduction

Variable-reach trucks are known by a variety of terms, including “telehandlers” and “multi-purpose handlers”.

The rough-terrain variable-reach trucks covered by this part of ISO 10896 are designed to transport loads to and place them on elevated work areas and can be driven on unimproved or disturbed terrain.

They can also be equipped with a variety of attachments (e.g. mowers, sweepers).

Rough-terrain trucks — Safety requirements and verification —

Part 2: Slewing trucks

1 Scope

This part of ISO 10896 specifies general safety requirements for slewing rough-terrain variable-reach trucks (hereafter known as "trucks"), consisting of a lower chassis with a slewing upper structure equipped with a telescopic lifting means (pivoted boom), on which a load handling device (e.g., carriage and fork arms) is typically fitted. Fork arms and other integrated attachments are considered to be parts of the truck.

Other standards, in addition to the relevant provisions of this part of ISO 10896, can apply to the attachments.

This part of ISO 10896 is not applicable to the following:

a) rough terrain variable-reach trucks covered by ISO 10896-1 (non-slewing);

b) industrial variable-reach trucks covered by ISO 3691-2;

c) mobile cranes;

d) machines designed primarily for earth-moving, such as loaders, even if their buckets are replaced by fork arms (see ISO 20474);

e) trucks designed primarily with variable-length load suspension elements (e.g. chain, ropes) from which the load may swing freely in all directions;

NOTE Additional requirements for trucks intended for freely swinging load applications, their lifting devices and attachments, and personnel/work platform applications on trucks, are being developed by ISO/TC 110/SC4.

f) trucks designed primarily for container handling.

The significant hazards covered by this part of ISO 10896 are listed in Annex A. This part of ISO 10896 does not address hazards that can occur

— during manufacture,

— when handling suspended loads, which may swing freely,

— when lifting personnel,

— when using trucks on public roads,

— when operating in potentially explosive atmospheres, or

— with a battery, LPG or hybrid as the primary power source.

2 Normative references

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

ISO 2328, *Fork-lift trucks — Hook-on type fork arms and fork arm carriages — Mounting dimensions*

ISO 2330, *Fork-lift trucks — Fork arms — Technical characteristics and testing*

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

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

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

ISO 3471:2008, *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 4413, *Hydraulic fluid power — General rules and safety requirements for systems and their components*

ISO 5053-1, *Powered industrial trucks — Terminology and classification — Part 1: Types of industrial trucks*

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

ISO 6292, *Powered industrial trucks and tractors — Brake performance and component strength*

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 7000[1)], *Graphical symbols for use on equipment — Registered symbols*

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

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

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

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

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

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

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

ISO 13284, *Fork-lift trucks — Fork-arm extensions and telescopic fork arms — Technical characteristics and strength requirements*

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

1) The database on Graphical Symbols for Use on Equipment contains the complete set of graphical symbols included in IEC 60417 and ISO 7000: http://www.graphical-symbols.info/.

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

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

ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs*

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

ISO 15870, *Powered industrial trucks — Safety signs and hazard pictorials — General principles*

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

ISO 22915-10, *Industrial trucks — Verification of stability — Part 10: Additional stability test for trucks operating in the special condition of stacking with load laterally displaced by powered devices*

ISO 22915-20, *Industrial trucks — Verification of stability — Part 20: Additional stability test for trucks operating in the special condition of offset load, offset by utilization*

ISO 22915-24, *Industrial trucks — Verification of stability — Part 24: Slewing variable-reach rough-terrain trucks*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5053-1 and the following apply.

3.1
rough-terrain variable-reach truck
variable-reach truck intended primarily for operation on unimproved natural terrain and on the disturbed terrain of, for example, construction sites

[SOURCE: ISO 5053-1:2015, 3.21]

3.2
slewing rough-terrain variable-reach truck
rough-terrain variable-reach truck (3.1) with an upper structure which can rotate around a vertical axis of the chassis in a circular motion greater than 5° either side of the longitudinal axis of the truck

[SOURCE: ISO 5053-1:2015, 3.22]

3.3
actual capacity
maximum load, established by the manufacturer based on component strength and truck stability, that the truck can carry, lift, and stack to a specified height, at a specified load centre distance and reach, in normal operating conditions

Note 1 to entry: The actual capacity depends on the configuration of the truck in terms of such variables as the following:

— lift height;

— reach of the boom (measured from the centre of slewing of the rotating upper structure);

— slewing position;

— actual load centre;

— load handling device (fork arms or attachment fitted);

— stabilizing devices.

Note 2 to entry: This actual capacity defines the load handling ability of the particular truck as equipped. Additional actual capacity ratings with removable attachments may also be established where permitted by the appropriate stability test or by calculation verified by empirical data.

3.4
reach
d
normal distance between the axis of rotation of the upper structure and the vertical plane including *G* perpendicular to the longitudinal axis of the upper structure

Note 1 to entry: See Figure 1.

Note 2 to entry: The centre-of-gravity of the load (*G*) is defined in Table 1.

3.5
rated capacity
Q_1
<truck> maximum load permitted by the manufacturer at the standard load centre distance that the truck is capable of lifting and transporting on *fork arms* (3.13) in normal conditions with the boom fully retracted

Note 1 to entry: See Figure 1.

3.6
rated capacity
<attachment> maximum load that the attachment is permitted by its manufacturer to handle in normal operation under specified conditions

Note 1 to entry: The rated capacity of the attachment can be associated with the load centre distance. See Table 1.

3.7
lift height
H
height from the ground to the upper face of the fork arms or underside of the load, whichever is the lower

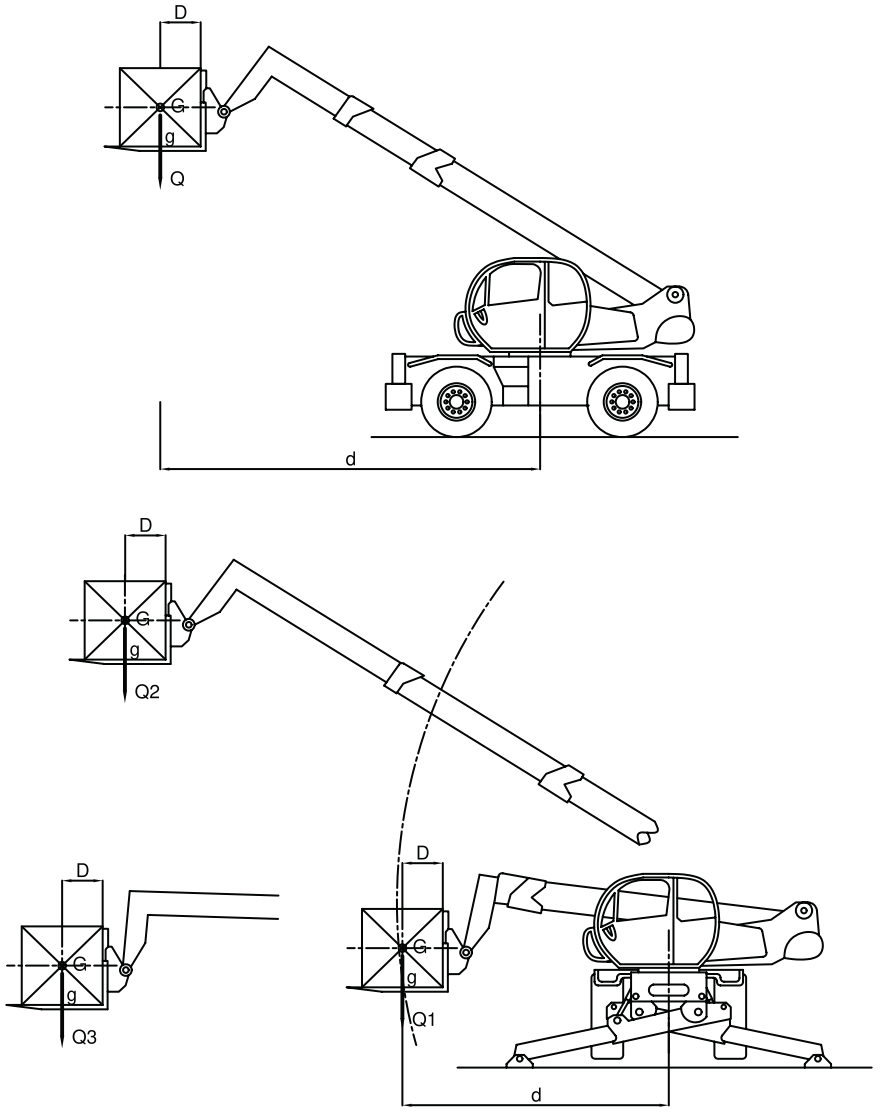
3.8
standard load centre distance
D
distance from the centre of gravity of the load, horizontally rearwards to the front of the fork shanks and vertically downwards to the upper faces of the *fork arms* (3.13)

Note 1 to entry: See Figure 1.

Note 2 to entry: Table 1 gives standard load centre distances in relation to their rated capacities.

3.9
effective thickness
ET
horizontal shift in the standard load centre that may occur when removable attachments are added to a truck

Note 1 to entry: Effective thickness is also known as lost load (LL) or lost load centre (LLC).



Key

d reach

D standard load centre distance

G centre of gravity of the load

g vertical projection of the centre-of-gravity (G) of the load onto the plane of the top surface of the fork arms

Q_1 rated capacity

Q_2 actual capacity at maximum height

Q_3 actual capacity at maximum reach

Figure 1 — Parameters for the designation of the actual capacity of the truck with fork arms

Table 1 — Standard load centre distances and rated capacities

Rated capacity Q_1 kg		Standard load centre distance D mm				
		400	**500**	**600**	**900**	**1 200**
0	<1 000	X		X[a]		
≥1 000	<5 000		X[c]	X[b]		
≥5 000	<10 000			X		
≥10 000	<20 000			X	X	X
≥20 000	<25 000				X	X
≥25 000						X

NOTE Trucks may be rated for special applications with load centres related to those applications.

[a] 600 mm is used in the USA.

[b] 600 mm is used in Asia, Australia, and the USA.

[c] 500 mm is typically used in Europe.

3.10
axle oscillation locking-mechanism
mechanism designed to lock oscillation of an axle to improve truck stability

3.11
stabilizing devices
extendable and/or pivoting mechanical supports used to improve the stability of a truck when stationary

3.12
adjustable levelling
setting the plane inclination angle between the chassis and the ground to ensure the boom operates in a vertical plane when the truck is positioned on a slope

3.13
fork arms
device comprising two or more solid fork arms, each consisting of a shank (vertical portion) and blade, which is hook- or shaft-mounted, fitted on the carriage

3.14
boom
pivoting support member that permits horizontal and vertical placement of the load or attachment

3.15
crab steering mode
steering mode where all wheels of the truck steer in the same direction

3.16
normal operating position
position specified by the manufacturer in which the operator is able to control the truck operations, including load-handling functions

Note 1 to entry: Other positions may be necessary if it is not possible to control all the functions of the truck from a single position.

3.17
attachment
component or assembly of components which can be mounted on the *quick coupler* (3.18) for a specific use

3.18
quick coupler
device fitted at the end of the boom to connect and lock interchangeable *attachments* (3.17) without the use of a tool to facilitate quick interchange of attachments

3.19
forward aligned position
configuration of the truck in which the longitudinal mid-axis of the slewing upper structure is aligned with the longitudinal mid-axis of the chassis and where the telescopic boom is oriented toward the front of the truck as defined by the manufacturer

Note 1 to entry: See Figure 2.

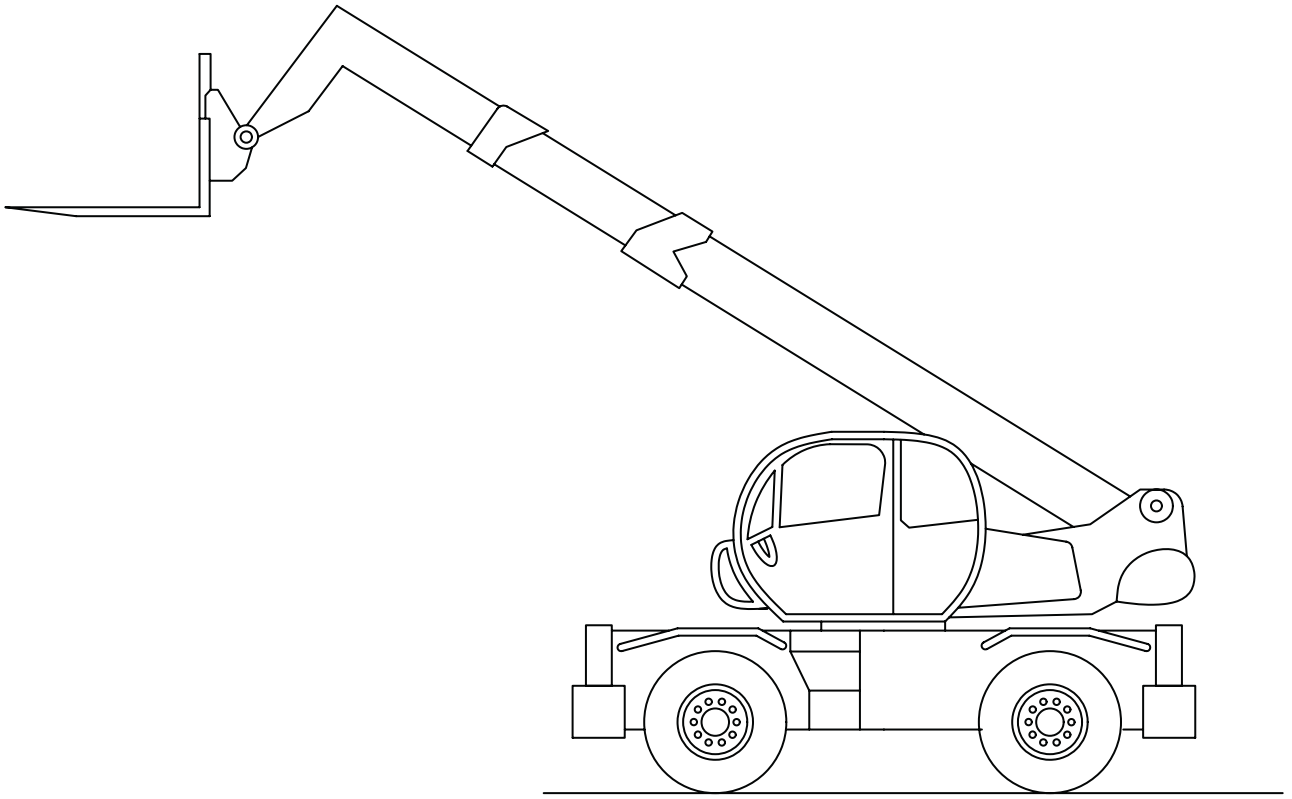


Figure 2 — Forward aligned position

3.20
rearward aligned position
configuration of the truck in which the longitudinal mid-axis of the slewing upper structure is aligned with the longitudinal mid-axis of the chassis and where the telescopic boom is oriented toward the back of the machine as defined by the manufacturer

3.21
forward position
configuration of the truck in which the longitudinal mid-axis of the slewing upper structure is rotated at an angle between −90° and +90° to the forward aligned position

3.22
load indicating device
LID
device that warns the operator when the truck load moment limits, pre-determined by the manufacturer, are approached/reached as a consequence of a change to the load handling geometry, and/or warns when overloading

3.23
load limiting device
LLD
device that prevents the operator changing the load handling geometry in direction(s) which would increase the load moment beyond the limits permitted by the manufacturer, and/or prevents overloading

3.24
load handling geometry
relationship of points, lines, and angles, described by the position of the load centre of gravity (the position of the boom, carriage and attachment, and slewing angle where applicable) and tipping line (on wheels or stabilizers)

3.25
boom float
control mode that uses gravity to allow an *attachment* (3.17) at the end of the boom to follow a contour (e.g. the ground)

3.26
maximum working pressure
highest pressure at which a hydraulic circuit is intended to operate under normal operating conditions

3.27
level ground
ground with a gradient of (0 ± 2) %

3.28
hybrid
truck powered using two or more distinct power sources

4 Requirements

4.1 General

4.1.1 Sharp edges and acute angles

Sharp edges and acute angles shall meet the requirements specified in ISO 12508 in areas to which the operator can be exposed during operation, access, egress, and daily maintenance.

4.1.2 Stored energy components

Components that store energy and can cause a risk of injury during removal or disassembly, e.g. hydraulic accumulators and spring-applied brakes, shall be provided with a means to release the energy before removal or disassembly and shall be clearly marked.

4.1.3 Boom extension and angle indicators

Visual indication shall be given to the operator on actual boom angle and extension.

4.2 Starting/moving

4.2.1 Unauthorized starting

All trucks shall be provided with a device (e.g. key, key pad, magnetic card) that prevents starting without the use of such device.

4.2.2 Unintended movement

Trucks shall be fitted with a device which prevents the engine being started while the drive system is engaged.

When the drive system direction control is in neutral, provisions shall be made to locate and maintain it in its neutral position.

4.2.3 Uncontrolled motion

The truck shall not move from rest, on level ground, until the drive system has been engaged.

4.2.4 Powered travel movement

Means shall be provided to prevent powered travel when the operator is not in the normal operating position.

Powered travel shall not occur automatically when the operator returns to the normal operating position without an additional operation, e.g. by reset of the direction control to neutral.

Application of the parking brake shall apply neutral travel control except on trucks with hydrostatic transmission.

NOTE On trucks with hydrostatic transmission, the transmission system achieves the same objective.

4.2.5 Non-activation of the parking brake

Means shall be provided to warn the operator, if he/she leaves the normal operating position when the parking brake is not applied.

4.2.6 Inching pedal

If an inching pedal is fitted, it shall be depressed to modulate the transmission and may apply the service brake. It shall be capable of being operated by the operator's left foot. If there is no separate means of applying the service brake, the inching pedal shall be a single pedal capable of being operated equally by either foot.

4.3 Brakes

4.3.1 General

Trucks shall be equipped with service brake(s), secondary brake(s), and parking brake systems, complying with the requirements in ISO 6292 and with the following requirements.

NOTE Local road regulations apply when trucks are used on roads.

— Where electromechanical parking brake systems are fitted, the braking device shall be applied mechanically and released electrically.

— Where hydromechanical parking brake systems are fitted, the braking device shall be applied mechanically and released hydraulically.

— When the operator manually releases the parking brake from the normal operating position, it shall not disable the service brakes.

4.3.2 Failure of energy supply

Failure of the energy supply shall not result in loss of braking for automatically applied brakes.

4.4 Electrical and electronic systems

4.4.1 General

Electrical components and conductors shall be installed in such a way as to minimize damage from exposure to environmental conditions (corresponding to the use of the truck intended by the manufacturer) that can cause deterioration.

Electrical component insulation shall have flame-retardant properties. Means to prevent abrasion of electrical component insulation shall be provided, e.g. when routed through frames and bulkheads.

Electrical wires/cables not protected by over-current devices shall not be routed such that they are in contact with pipes and hoses containing fuel.

4.4.2 Degree of protection

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

a) all components installed on the truck's exterior or directly exposed to the environment shall have a minimum degree of protection corresponding to IP55 (according to IEC 60529);

b) all components installed in the operator's enclosed cab or protected against the environment shall have a minimum degree of protection that corresponds to IP 43 (according to IEC 60529).

4.4.3 Electrical connections

Electric wires and cables used to connect components in electric circuits shall be marked and identified using IEC 60204-1as guidance.

This requirement does not apply to electrical circuits used for anti-theft systems when fitted.

4.4.4 Over-current protective devices

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

4.4.5 Batteries

Batteries shall be securely mounted in a ventilated location that provides access for maintenance.

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

Electrically energized wires and cables (not connected to the frame) and connectors shall be covered with insulation material.

4.4.6 Battery disconnection

Means shall be provided to disconnect batteries without the use of a tool, e.g. by a quick coupling or an accessible isolator switch.

ISO 7000:2014, symbol 2063 can be used for identification.

4.5 Controls

4.5.1 General

The controls (hand levers, joysticks, pedals, switches, etc.) and indicators of the truck and attachment shall be as follows:

a) designed, constructed, and so arranged to be accessed from the normal operating position in accordance with ISO 6682;

b) clearly identified, indelible, and visible in the normal operating position; if appropriate, graphical symbols in accordance with ISO 7000 may be used and shall be described in the operator's manual (see 6.2);

c) designed such that movement of the controls to activate the functions and indicators corresponds to the intended effect or common practice whenever possible.

Where controls are accessible from the ground, means shall be provided to minimize the possibility of actuating them from the ground or from the chassis (e.g. protection by door, guard, or by interlocking devices).

ISO 6682 and ISO 10968 may be used as guidance for the design of controls.

For safety-related functions of the control system(s), the principles outlined in ISO 13849-1 shall be followed, or methods providing similar protection shall be applied. See also 4.4.1.

Remote-operator-controlled systems fitted to the truck shall comply with the relevant provisions of ISO 15817.

4.5.1.1 Multiple operating positions

When more than one operator's position is provided

— each operating position shall be provided with an emergency stop complying with ISO 13850,

— the use of the controls at one operating position shall preclude the use of the controls at other operating positions, and

— the emergency stop shall be operable from all active operating positions.

4.5.1.2 Inadvertent activation

Controls that can cause a hazard due to inadvertent activation shall be so arranged, deactivated, or guarded as to minimize the risk. A deactivation device shall either be self-acting or acting by compulsory activation of the relevant device.

4.5.2 Differential locking

If the truck is equipped with a pedal-operated differential lock, depressing the pedal shall lock the differential.

If the truck is equipped with a differential lock that is engaged by other means (e.g. switch or hand lever), the engaged positions shall be clearly marked according to ISO 7000:2014, symbol 1662.

4.5.3 Steering controls

4.5.3.1 Steering direction

In the forward position, the following requirements shall be met:

a) for trucks with a steering wheel control, clockwise rotation of a steering wheel shall steer the truck to the right when the truck is travelling in the forward direction;

b) on trucks with a crab-steering mode, clockwise rotation of the steering wheel shall move the truck to the right when the truck is travelling in the forward direction and to the left when travelling in the reverse direction;

b) on trucks in which the steering is controlled by means of a single lever control, moving the lever to the right shall cause the truck to be steered to the right when the truck is travelling in the forward direction;

c) when the upper structure is slewed more than 90° to either side of the longitudinal axis of the chassis from the forward aligned position, a visual indicator shall warn the operator that steering controls are reversed compared to a) or b), if automatically reversing controls are not fitted;

d) two different means shall be provided to indicate to the operator in normal operating position when the truck is in forward or rearward aligned configuration.

4.5.3.2 Failure of power supply

For trucks with a maximum speed of less than or equal to 20 km/h, in the event of an interruption of the power supplied to the steering system (including a dead engine), it shall be possible to maintain the path being steered until the truck is brought to a stop.

Trucks with a maximum speed greater than 20 km/h shall be tested according to the following condition and shall meet the following requirements.

— The truck shall be tested with the load and operating condition which produces the greatest load on the steered axle(s).

— The truck shall travel in a spiral path at a speed of 10 km/h, starting from the straight ahead position, on a dry, flat road surface offering good tyre adhesion.

— The steering effort on the steering control shall be measured until it reaches the position corresponding to the truck entering a turning circle of 12 m radius (considering the outermost part of the steering wheels).

— The duration of the manoeuvre (time between the moment when the steering control is first operated and the moment when it reaches the position where the measurements are taken) shall not exceed 8 s.

— One manoeuvre shall be made to the left and one to the right.

— The emergency steering effort required to achieve a turning circle of 12 m radius, starting from the straight ahead position, shall not exceed 600 N.

Verification by type-test.

NOTE For the purpose of this Clause, ISO 5010 gives guidance.

4.5.3.3 Strength of components

The steering control and its support members shall be capable of withstanding a force of 900 N in any direction at the actuating means (e.g. steering wheel) without any functional damage or permanent deformation.

4.5.3.4 Steering knobs

Steering knobs (if installed) shall be capable of being reached by the operator's hand from the top, and shall be within the periphery of the steering wheel.

Steering knobs shall meet the requirements of 4.5.3.3.

4.5.4 Load-handling controls

4.5.4.1 General

Controls shall return to neutral when released and shall stop load movements, except where otherwise specified in this part of ISO 10896.

The controls for the load-handling functions shall be separate from the driving controls, except the travel direction control, which may or may not be separate.

4.5.4.2 Controls with detents or maintained engagement

4.5.4.2.1 General

The boom float control and the auxiliary hydraulic control(s) (e.g. for concrete mixers, brooms, augers) may be equipped with detents or other devices to maintain engagement of the function.

A visual indication that the detent is activated shall be provided to the operator.

The detent mode shall either

a) be automatically deactivated when the truck is switched off and not be automatically activated when the truck is switched on, or

b) prevent the truck from being restarted until the detent mode is deactivated.

4.5.4.2.2 Boom float control

On trucks equipped with boom float control, unintended lowering of the boom shall be protected against.

In addition to the provisions of 4.5.4.2.1, the boom float control mode shall be automatically deactivated when the boom-raising/-lowering control is operated.

4.5.5 Multi-function controls

If a control is designed to perform more than one function, each separate function shall be clearly identified in accordance with ISO 7000 in the normal operating position and explained in the operator's manual (see 6.2).

Visual indication shall be provided to inform the operator of the selected mode(s) of operation.

4.5.6 Stabilizing device control

On trucks equipped with stabilizing devices, controls for deployment and retraction of such devices shall be clearly marked in accordance with ISO 7000.

Means shall be provided to unequivocally identify at all time (day and night) the stabilizing device operated by each control, regardless of the truck slewing angle.

Where independent or selectable controls for stabilizing devices are provided, the left control shall operate the left stabilizing device, and the right control shall operate the right stabilizing device with the truck in forward aligned position.

If selectable controls are provided, a centre position may operate both stabilizing devices.

4.5.7 Sway/levelling control

On trucks equipped with operator-controlled lateral levelling, operating the control to the left shall cause the truck to sway to the left, and operating the control to the right shall cause the truck to sway to the right with the truck in forward aligned position.

Means shall be provided to unequivocally identify at all time (day and night) the levelling direction operated by each levelling control, regardless of the truck slewing angle.

4.5.8 Axle oscillation locking

When operating on wheels, means shall be provided to automatically lock the oscillating axle when the slewing upper structure is not in the forward aligned position and when the boom is lifted at height greater than the one corresponding to the travel position as defined by the manufacturer.

On trucks equipped with manual axle oscillation locking, the lock/unlock control(s) shall be clearly marked in accordance with ISO 7000, i.e. ISO 7000:2014, symbols 2872 and 2873.

A visual indication that the axle oscillation lock has occurred shall be provided at the normal operating position.

4.5.9 Auxiliary hydraulic control

On trucks equipped with auxiliary hydraulic control, this control shall be clearly marked in accordance with ISO 7000.

The control may be equipped with a detent or other device to maintain engagement of the function. See 4.5.4.2.

4.6 Power systems and accessories

4.6.1 Exhaust systems

Exhaust systems shall be designed to direct engine exhaust emissions away from the normal operating position(s) and any passenger position(s). Materials used in the vicinity of an exhaust system shall be non-flammable and shall be chosen and protected so that they are not adversely affected by heat from the exhaust system.

4.6.2 Cooling systems

Cooling systems shall be designed to prevent air flow through the system from being directed at the normal operating position(s) and any passenger position(s), or so that the operator and passenger(s) are shielded from airflow through the system. The surface temperature of any shielding within reach of the operator or passenger(s) in their normal position(s) shall not exceed 60 °C adjacent to the operator and passenger position(s).

4.6.3 Tanks and pressure vessels

4.6.3.1 General

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

4.6.3.2 Filler openings

Filler openings of tanks (except window washer and brake fluid reservoirs) shall

a) have provisions for lockable filler caps (filler caps located inside lockable compartments, e.g. the engine compartment, or those caps that can only be opened with a special tool, do not require a lockable provision), and

b) be located outside the operator's station.

4.6.3.3 Fuel tanks

Fuel tanks shall be securely mounted. The installation arrangement and construction shall ensure that any fuel leaking from the tank, its filler, or its connections shall not collect in pools without a passive means for drainage and shall not drain onto unprotected electrical or hot parts.

If the tank is to contain gasoline, the tank installation shall be designed and installed in the truck such that any ignition hazard due to static electricity is avoided.

If the filler is located on the side of the truck, the filler cap shall not, when closed, project beyond the external envelope of the truck.

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

NOTE 1 bar = 0,1 MPa = 0,1 N/mm^2 = 105 N/m^2.

Fuel spillage shall not be possible during normal operating conditions, as specified by the manufacturer, excluding refuelling and fuel filter replacement.

If constructed with non-metallic materials, the fuel tank shall comply with ISO 21507.

4.6.3.4 Air pressure vessels

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

4.7 Stabilizing devices

When stabilizing devices are provided,

a) they shall be fitted with means, e.g. locking valves, to keep them in position in case of hose failure or oil leakage,

b) means shall be provided to the operator to indicate that the stabilizing devices are positioned in a safe travelling position when moving the truck,

c) each stabilizing device shall be equipped with a footplate that is self-aligning in at least one plane, and

d) a visual indication (e.g. painted marks or other suitable means) shall be given to the operator when each stabilizing device is deployed to level and/or support the truck in conformity with the load chart(s).

4.8 Design requirements for maintenance purposes

4.8.1 General

Trucks shall be designed such that routine lubrication and maintenance operations can be performed safely, using ISO 11525-2 as guidance on the safe maintenance of trucks and ISO 2860 for openings intended for maintenance purposes.

Where the maintenance procedures described in the operator's manual can only be performed with a component (e.g. boom, tiltable cab) in a position that could cause injury, the component shall be mechanically secured with a device(s) provided with, and permanently affixed to, the truck, or stored in a secure place on the truck.

The mechanical boom support device shall be designed to withstand at least 1,5 times the mass of the boom and the carriage with forks.

4.8.2 Tiltable cab support device

When a cab is designed to be tilted for maintenance, servicing, or other non-operational purpose, a means of locking the controls shall be provided. If daily maintenance is required below a tilted cab, an automatically acting support device shall be provided.

4.9 Systems for lifting, tilting and reaching

4.9.1 Chains and wire ropes

4.9.1.1 Chains

When the lifting or reaching mechanism includes one or more chains, the truck manufacturer shall use only leaf or roller chains. These chains shall provide a factor, K_1, with the minimum values specified in Table 2. The calculation of K_1 shall be related to the maximum static load Q (Q calculated assuming no friction in the boom structure or lifting/reaching mechanism), that would exist in a single or more than one equally loaded chain when the truck and boom are stationary in the least favourable position.

$$K_1 = \frac{L_c \times n}{Q + w} \tag{1}$$

where

- L_c is the minimum breaking load for new chain;
- n is the number of chains;
- Q is the maximum static load in chains;
- w is the friction load in lifting/telescoping mechanism carried by the chains, and where L_c, Q and w are expressed using the same unit.

Pulley diameters shall follow the chain manufacturer's recommendations.

Table 2 — Factor K_1

Trucks <10 000 kg rated capacity	$K_1 \geq 5$
Trucks >10 000 kg rated capacity	$K_1 \geq 5 - 0{,}2\ (Q_1 - 10)$
K_1 shall never be less than 4.	
Q_1 is expressed in tonnes (t).	

4.9.1.2 Wire ropes

When the lifting or reaching mechanism includes one or more wire ropes, the truck manufacturer shall use only wire ropes with a factor, K_2, of at least 6. The calculation of K_2 shall be related to the maximum static load Q (Q calculated assuming no friction in the boom structure and in the lifting/reaching

mechanism), that would exist in a single or in equally loaded wire ropes when the truck and boom are stationary in the least favourable position.

$$K_2 = \frac{L_{\text{wr}} \times n}{Q + w} \tag{2}$$

where

L_{wr} is the minimum breaking load for new wire rope;

n is the number of wire ropes;

Q is the maximum static load in wire ropes;

w is the friction load in lifting/telescoping mechanism carried by the wire ropes, and where L_{wr}, Q and w are expressed using the same unit.

Pulley diameters shall follow the wire rope manufacturer's recommendations.

4.9.2 Hydraulic system

4.9.2.1 Hydraulic circuit

Hydraulic circuit shall comply with ISO 4413.

Hoses, piping, and connections subject to internal pressure shall be capable of withstanding, without bursting or permanent deformation, a pressure equal to at least three times the maximum working pressure. Pipes and hoses shall be so located and restrained as to minimize deterioration, sharp edges, and other damage-causing sources. The hydraulic system shall be designed and installed such that its performance and reliability are not reduced or its components damaged as a result of external stresses, vibration, or movements of the truck or its components.

4.9.2.2 Pressure control

Hydraulic systems shall include devices that prevent the pressures in the systems from exceeding preset levels. The devices shall be designed and fitted so that unintentional loosening or adjustment is avoided and a tool or key is required to alter the pressure setting.

4.9.2.3 Oil purification

The hydraulic system(s) shall be continuously protected against the risk of contamination of the hydraulic oil, e.g. by means of magnet(s), filter(s), etc.

4.9.3 Maximum load-lowering speed

The maximum permissible lowering speed shall be such that in the event of a sudden stop of the lowering means (e.g. a hose burst or trigger of LLD), at the maximum reach for any load zone with the specified load, the wheels, or stabilizers of the truck are only able to leave the ground momentarily and shall return to the ground unassisted.

The test to verify this requirement is defined in 5.4.

4.9.4 Limitation of stroke

Any mechanism on the truck with movement requiring limits to prevent over-travel shall be provided with means for positive stops. Hydraulic cylinders can fulfil this requirement if designed for that purpose.

4.9.5 Fork arms, attachments, and quick couplers

Fork arms, attachments, and quick couplers shall be in accordance with Annex B.

4.9.6 Slewing brake

Slewing mechanisms shall be provided with an automatic holding brake or a locking mechanism to hold the superstructure during operation with load and during out-of-service condition in a safe position. The holding brake/locking mechanism shall withstand a torque moment at least 25 % above the torque required for holding the acting torque derived from wind loads combined with the inclination permitted by the manufacturer. The slewing brake/ locking mechanism shall operate in all permissible slewing positions and on both stabilizers and wheels positions.

4.10 Normal operating position

4.10.1 General requirements

The normal operating position shall have space available for the operator to minimize the potential for interior impact during normal operation, using ISO 3411 as guidance.

4.10.2 Storage of operator's manual

A means shall be provided within the cab to store the operator's manual and it shall be accessible from the normal operating position. If the truck is not fitted with an enclosed cab, such means shall protect the manual(s) from climatic conditions (e.g. sunlight, rain, snow).

4.10.3 Hot parts

All parts of the truck within the zones of comfort and reach of controls, as defined in ISO 6682, or within the reach of the operator when entering or exiting the operating position, shall be designed in accordance with ISO 13732-1.

The temperature of the air at the heater outlet, where fitted, shall not exceed 60 °C.

4.10.4 Pipes and hoses

Pipes and hoses located within 1 m of the DLV (deflection limiting volume, see ISO 3164) and having a pressure exceeding 5 MPa or a temperature of 60 °C shall be guarded.

Guards (including flexible hose coverings) shall be sufficiently sturdy to stop, disperse or divert a fluid stream in case of hose, pipe or component failure.

Any part or component that diverts a fluid stream can be regarded as a sufficient protection device.

An enclosed cab may be considered as a guard when hoses are located outside the enclosed cab, provided it meets the above requirement.

NOTE Enclosed cab doors or windows able to be opened during truck operations do not satisfy this requirement.

If possible, pipes and hoses should be placed outside the enclosed cab.

4.10.5 Normal operating position equipped with enclosed cab

4.10.5.1 Heating and ventilation system

Ventilation system shall comply with ISO 10263-4.

If a heating system is fitted, it shall either

a) comply with ISO 10263-4, or

b) have the capability of increasing the temperature of the air inside the enclosed cab and of maintaining a temperature of 18 °C at the minimum ambient temperature in which the truck is intended to operate, with the minimum capacity of the heating system having a temperature variation of ΔT of 25 °C within 30 min.

The test shall be run starting with the engine at working temperature, as specified by the manufacturer. Measurement of the system capacity shall be made at three points located in a vertical plane through the seat index point (SIP) and parallel to the longitudinal axis of the truck (see Figure 3) as follows:

— 660 mm above the SIP and 20 mm in front of it;

— at the SIP, as defined by ISO 5353;

— 100 mm above the floor plate and 600 mm in front of the SIP.

Dimensions in millimetres

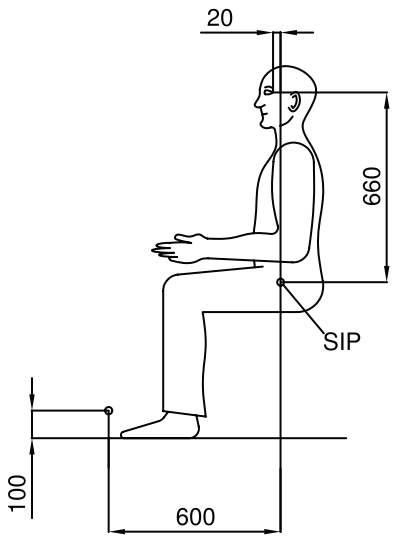


Figure 3 — Location of measuring points

Alternatively, the heating capacity may be determined by calculation.

NOTE Filter element selection depends on the intended operating environmental conditions.

4.10.5.2 Demisting and defrosting systems

Trucks shall be provided with facilities for demisting and defrosting internally the front, rear, side, and top window(s), for example, by means of a heating system or particular defrosting device.

NOTE A method for testing windscreen defrosting system is given in ISO 10263-5.

4.10.5.3 Wipers and washers

The front and rear window(s) shall be fitted with motorized window wiper(s) and washer(s).

Wiper(s) and washer(s) shall be provided for the roof window if it is necessary for the operator to view the attachment or load through the roof window.

Wiper(s) shall clear a sufficient area to allow the operator to view the attachment or load through the entire lift zone.

The tank of the window washer(s) shall be easily accessible.

4.10.5.4 Pressurization system

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

4.10.5.5 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 in their intended operating position(s) by a positive engagement device. The door-open locking device for the normal opening shall be releasable from the normal operating position.

It shall only be possible to open the boom side window if additional protection is provided to prevent the operator being injured by the boom and/or the opening is small enough to prevent the operator accessing this area from the cab.

If such protection depends solely upon the glass, the truck shall be so designed that, in the event of a missing or broken boom side window, the operator is not at risk of injury.

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

4.10.5.6 Interior lighting system

When the truck is intended and equipped to operate in darkness, the enclosed cab shall be fitted with a fixed inner lighting system. This system shall be able to function with the engine stopped, making it possible to illuminate the normal operating position so that the operator's manual can be read.

4.10.6 Operator's seat

4.10.6.1 General

Trucks shall be fitted with an adjustable seat that supports the operator in a position that allows the operator to control the truck under the intended operating conditions.

All seat adjustments shall be possible without the use of tools and shall be clearly described in the operator's manual.

The seat dimensions and adjustments shall comply with ISO 11112. The operator's seat shall meet the following requirements:

a) if a weight-adjustable seat is fitted, the adjustment shall accommodate a minimum range of operator weights, from 55 kg to 110 kg;

b) swivelling seats shall be provided with a mechanism (e.g. spring or latch) to lock the seat in position, and the swivel shall be possible in all positions of adjustment;

c) the seat mounting shall be able to withstand the forces that can occur during operation, e.g. braking.

4.10.6.2 Suspension seat vibration

An operator's seat fitted with suspension shall meet the requirements of the following input spectral classes, according to ISO 7096, with regard to its ability to reduce the vibration transmitted to the operator:

— for trucks with an operating mass greater than 4 500 kg, EM 3;

— for trucks with an operating mass less than or equal to 4 500 kg, EM 8.

4.10.6.3 Operator restraint

Trucks shall have an operator restraint system that is in accordance with ISO 6683.

4.10.7 Control panels and symbols on displays

4.10.7.1 Control panels

The operator shall be able to see, from the normal operating position, in daylight and, if need be, in darkness, the indicators necessary in order to be able to check the proper functioning of the truck. Glare shall be minimized.

4.10.7.2 Symbols on displays

Symbols for use on displays shall be in accordance with ISO 7000.

NOTE Other International Standards dealing with symbols on machines are ISO 3287, ISO 3767-1, ISO 6405-1 and ISO 6405-2.

4.10.7.3 Load limiting devices (LLD)

4.10.7.3.1 General

Trucks shall be fitted with a load limiting device, in order to prevent instability and/or overloading whichever is the attachment fitted.

The load limiting device shall stop movements of the load handling geometry which would either

a) increase the load moment beyond the limits determined by the stability verification (see 5.4), or

b) exceed the structural limits determined according to 4.19 and structural tests (see 5.3).

Arresting the movement shall not in itself give rise to instability.

The LLD shall operate automatically and without the need for resetting when triggered. The LLD, once triggered, shall remain triggered until the overload condition has been removed or the overturning moment has been lessened within the limits permitted by the manufacturer.

Where a truck can be operated in different configurations of wheels, stabilizing devices, or slewing angle range, the proper selection of correct LLD settings for the actual configuration shall be automatic and their modification by the operator shall not be possible. This requirement does not cover the interchange of attachment fitted on the load carriage.

When the truck is intended to be used with a range of attachments, an attachment selector may allow the operator to set the LLD with reference to the attachment used.

4.10.7.3.2 Override of the LLD

It shall not be possible to override the LLD other than with a 2-action operated hold to run control.

The overriding function shall be automatically cancelled after not more than 30 s or at engine stop.

The design and installation of LLD shall be able to withstand overloads during test and verification without affecting their performance.

4.10.7.4 Load indicating device (LID)

Trucks shall be fitted with a load indicating device, in order to warn the operator of instability and/or overloading whichever is the attachment fitted.

The LID shall warn the operator

a) both visually and audibly when the truck is approaching the stability and/or load limits permitted by the manufacturer,

b) both visually and audibly when the truck has reached the stability and/or load limits permitted by the manufacturer, and

c) visually when the override function of the LLD has been activated.

Warnings for a) and b) shall be different from each other both visually and audibly. Warnings for a), b), and c) shall be visually different from each other.

There shall be no provisions for the operator to cancel a warning.

The LID shall not be deactivated when the LLD has been overridden.

The design and installation of the LID shall be able to withstand overloads during test and verification without affecting their performance.

4.11 Operator access

4.11.1 General requirements

An access system shall be provided for access to the normal operating position and areas where routine maintenance has to be performed. This shall be in in accordance with ISO 2867, except that the first step shall not be more than 550 mm above the ground (measured with the truck on tyres) and successive steps shall not be more than 350 mm apart. The values specified in ISO 2867 are to be considered with the wheels on the ground and in forward aligned position.

4.11.2 Enclosed cab openings

4.11.2.1 Normal access opening

A normal access opening shall be provided. The dimensions shall be in accordance with ISO 2867:2011, Table 1.

4.11.2.2 Alternative opening (emergency exit)

An alternative opening shall be provided on a side other than that of the normal opening. The dimensions shall comply with ISO 2867:2011, 5.3.2.

In order to be acceptable for use as an alternative opening, a window panel or another door shall be 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 suitably sized window panel is considered equivalent to an alternative opening, if the necessary pane hammer, immediately accessible to the operator in the enclosed cab, is provided.

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

4.12 Protective measures and devices

4.12.1 Hot parts

Parts that are hot in operation shall be designed, positioned, or provided with a thermal guard to minimize the risk of contact with such parts and surfaces in close proximity to the normal opening, normal operating position, or daily routine maintenance areas, according to ISO 13732-1.

4.12.2 Protection against crushing, shearing, and trapping

Parts that move relative to one another and are within reach of the operator in the normal operating position shall be designed, positioned, or provided with protective devices, thereby minimizing the risk of crushing, shearing, and trapping.

Distances shall be in accordance with ISO 13857.

If hazards still exist, they shall be identified on the truck in accordance with 4.12.4.

4.12.3 Guards

Guards, which shall comply with ISO 3457, shall be designed to be securely held in place, restricting access to dangerous areas and parts where a hazard exists.

Movable guards shall, if possible, remain attached to the truck when open. When unintentional closure could cause injury, movable guards and engine panels shall be fitted with a support system (e.g. springs, gas strut) to secure them in an open position for a wind speed up to 8 m/s.

4.12.4 Safety signs

Safety signs shall be affixed to the truck and attachments in accordance with ISO 15870 or ISO 9244.

Trucks intended for lifting material only shall bear clear and indelible safety sign(s) prohibiting the lifting of personnel.

4.12.5 Engine compartment

The engine compartment shall be protected against unauthorized access by means including either

a) locking,

b) installation requiring the use of a tool or key, or

c) a latch inside a lockable compartment (e.g. enclosed cab).

4.12.6 Fenders

The operator in the normal operating position and the critical information displays shall be protected from debris ejected by the tyres or tracks, if the risk exists, in any steered position.

4.12.7 Roll-over protective structures (ROPS) and falling object protective structures (FOPS)

Trucks other than fitted with a tiltable cab shall be equipped with the following:

— ROPS in accordance with ISO 3471:2008, Table 1, third list item;

— FOPS level II in accordance with ISO 3449, and with openings in the top of the overhead guard not exceeding 150 mm in one of the two dimensions, i.e. width or length.

4.12.8 Tiltable cab

Trucks fitted with a tiltable cab shall comply with ISO 10896-6.

4.12.9 Audible warning devices

Trucks shall be equipped with an audible warning device (e.g. a horn) operable from the operator's station and an audible reversing alarm, both complying with ISO 9533.

4.13 Stability

Trucks shall meet the requirements of ISO 22915-20 and ISO 22915-24.

Additionally, for trucks fitted with power devices having the capability of stacking laterally displaced loads, the stability test of ISO 22915-10 shall also apply.

4.14 Visibility

Operator visibility during travel and manoeuvring shall be taken into consideration during the truck design.

4.15 External lighting devices

ISO 12509 may be used as guidance for trucks fitted with external lighting devices.

4.16 Fire protection

4.16.1 Fire resistance

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

4.16.2 Fire extinguisher

Trucks shall have space for installation of fire extinguisher(s), easily accessible to the operator, or a built-in extinguishing system to permit the operator safe exit from the truck.

4.17 Retrieval, transportation, lifting, and towing

4.17.1 General

Attachment points for tying-down, lifting, retrieval and towing of the truck, and their correct use shall be described in the operator's manual.

These attachment points may be the same if allowed by the manufacturer.

If a pin is part of the retrieval, tie-down, lifting, or towing device, provision shall be made to retain the pin in place during use and to prevent it from being lost when not in use.

4.17.2 Retrieval

Retrieval points shall be provided at the front and/or rear of the truck.

The capacity of the retrieval point, expressed in N, shall be equal to 1,5 times the machine mass multiplied by the acceleration due to gravity.

The retrieval point shall withstand the above capacity at the maximum pull angle.

4.17.3 Tie-down

Tie-down points shall be provided and shall be clearly identified on the truck, according to ISO 7000:2014, symbol 2069.

4.17.4 Lifting

When provided, lifting attachment points shall be clearly identified on trucks and subassemblies that are to be lifted separately, according to ISO 7000:2014, symbol 1368.

4.17.5 Towing

Trucks with provision for towing shall be fitted with towing or coupling devices designed and arranged to ensure easy and safe connection and disconnection, and to prevent accidental disconnection during use. They shall be identified according to ISO 7000-2014, symbol 2686.

If a pin is part of the retrieval, tie-down, lifting, or towing device, it shall be securely attached to the device. The securing device for the pin (if needed) shall not be detachable.

Specific road and agricultural requirements may apply. See, for example, ISO 6489.

4.17.6 Transportation

A pin securely attached to the truck, designed and arranged to prevent accidental disengagement during use, shall be provided to lock the slewing upper structure to the chassis in forward aligned position.

4.18 Noise

Noise reduction shall be an integral part of the design process for trucks, specifically taking into account technical progress and measurements at source.

Some major sound sources of trucks are power generation and transmission equipment such as combustion engines, cooling, electric-drive and hydraulic systems.

Measures for noise reduction include enclosing power generation, transmission and hydraulic equipment, capsulated cooling systems, and exhaust silencers.

NOTE ISO/TR 11688-1 and ISO/TR 11688-2 give further information on noise generation mechanisms in machinery.

4.19 Structural calculations

4.19.1 General

Verification shall be provided for loads and load combinations according to 4.19.2 and 4.19.3 acting simultaneously on the truck to ensure that limit states of materials are not exceeded.

NOTE Alternatively, advanced methods (e.g. FEM analysis) or experimental methods (e.g. measurement by strain gauge) can be used.

4.19.2 Loads and forces

4.19.2.1 General

The following loads and forces shall be taken into account:

a) actual load (see 4.19.2.2);

b) structural loads (see 4.19.2.3);

c) wind load (see 4.19.2.4);

d) dynamic loads (see 4.19.2.6);

e) additional loads (see 4.19.2.7).

Load effects shall be determined based on an elastostatic/rigid body kinetic model of the truck and load models.

Loads acting on the truck at the same time shall be combined as given in 4.19.3.2.

4.19.2.2 Actual load

The actual load shall be considered as a solid cube of 2 × D side, D given in Table 1.

4.19.2.3 Structural loads

The masses of the components of the truck when they are not moving shall be taken to be static structural loads.

The masses of the components of the truck when they are moving shall be taken to be dynamic structural loads.

4.19.2.4 Wind load

To calculate the wind loads, it is assumed that the wind blows horizontally from the most unfavourable direction, but at an elevation-related speed.

The speed of a 3 s wind gust $v(z)$ [m/s] acting on an elevated point z [m] and decisive for calculations is based on a mean wind speed determined over 10 min v [m/s] at 10 m above ground or sea level. If not otherwise specified, trucks are regarded as being affected by wind at a wind speed v of 14,3 m/s (Beaufort Scale 7 - normal in-service wind).

$$v(z)=[(z/10)^0{,}14 + 0{,}4] * v \quad (3)$$

The quasi-static impact pressure q [$N/m2$] is as a result of:

$$q(z)=0{,}625 * v(z)^2 \quad (4)$$

To calculate the wind load conservatively, the wind gust speed determined at the highest elevated point vi (max. z) can be assumed to act all over the boom structure and load.

4.19.2.5 Shape factors

Shape factors applied to areas exposed to wind are as follows:

a) L-, U-, T-, I- sections 1,6;

b) box sections 1,4;

c) large flat areas 1,2;

d) circular sections, according to size 0,8/1,2.

If additional information is needed, especially concerning shielded structural areas, see ISO 4302.

4.19.2.6 Dynamic loads

Additional loads due to abrupt decelerations in sudden stopping of movements of the truck (travelling forward/rearward) or the load (lifting/lowering, slewing) shall be considered (kinetic energy).

These dynamic effects shall be covered by calculation considering an additional dynamic force component calculated by multiplying the related mass weight by a dynamic factor ϕi of 0,1 for lowering, telescoping and travelling or 0,5 for slewing and taken to be acting in the direction of movement.

4.19.2.7 Additional loads

Additional effects due to elastic deformation of tyres or raised by the use with particular attachments shall be considered to determine adequate stability of the truck.

Where relevant, local temperature variation shall be specified and taken into account.

4.19.3 Calculations

4.19.3.1 General

The following structural analyses shall be carried out on all load bearing components and joint of the truck according to relevant clauses of this part of ISO 10896:

— general stress;

— fatigue stress;

— elastic stability.

The limit states method shall be used for the load combinations given in Table 3.

4.19.3.2 Load combinations

Forces to be used in structural calculations shall be derived by multiplying each load for its relevant factor ϕi and combined according to the load combinations given in Table 3 using the relevant partial safety factors γpi.

Table 3 — Load combinations

Loads		Load combinations			
		A		B	
		γpi	ϕi	γpi	ϕi
Mass of the structures, actual load and dynamics	Lifting/Lowering	1,34	1 + 0,1	1,22	1 + 0,1
	Slewing		1 + 0,5		1 + 0,5
Wind		—	—	1,16	1
Temperature variations		—	—	1,16	1

NOTE In general, the loads are combined to reflect the events during acceleration, deceleration, and positioning of the load and/or the truck. Load combination A covers regular loads under normal operation. Load combination B covers regular loads combined with occasional loads. List of regular and occasional loads is given in Annex C.

4.19.3.3 General stress analysis

The general stress analysis is the proof of safety against attaining the yield point. EN 13001-3-1 may be used as a guidance.

4.19.3.4 Fatigue stress analysis

The fatigue stress analysis is the proof against failure by fatigue due to stress fluctuations. EN 13001-3-1 may be used as a guidance for analysis of all load bearing components and joints which are critical to fatigue taking into account the constructional details and a class S3.

NOTE 1 Class S3 is an intermediate value between classes S2 and S5 which are provided in EN 13001-3-1, Appendix B.

NOTE 2 A Class S3 is given because a reference distribution of stress fluctuations during operations cannot be calculated with any degree of accuracy due to the versatility of these trucks. If the manufacturer is able to provide more detailed information about stress fluctuations, these can be used in fatigue stress analysis.

EN 13001-3-2 for a class SR3 may be used as a guidance for the fatigue stress analysis of wire rope drive systems.

4.19.3.5 Elastic stability

The elastic stability analysis is the proof against buckling of linear members. The principles in EN 13001-3-1 may be used as a guidance.

NOTE ISO/TS 13725 providing a method for evaluating cylinder buckling load is under preparation.

5 Verification of requirements and safety measures

5.1 General

The manufacturer shall verify that each individual requirement of this part of ISO 10896 has been met by the design and manufacture of the truck, for example, by the following:

a) design, e.g. verification of drawings and documents, or calculation;

b) measurement, e.g. tests of travelling and lowering speeds and lift and tilt leakage;

c) visual examination, e.g. no permanent deformation after tests, verification of the marking of the truck;

d) specific tests, e.g. type tests.

5.2 Functional verification

Functional verification shall be performed on each truck to verify that it is able to perform the tasks for which it was designed, e.g. travelling, braking, steering, slewing, load-handling, warning, safety, lighting (if any), and remote control (if fitted).

5.3 Structural verification

5.3.1 Test loads

The test loads are as follows:

— Q_1 the rated capacity of the truck;

— Q_2 the actual capacity at maximum lift height;

— Q_3 the actual capacity at maximum reach.

See Figure 1.

Four different Q_2 and Q_3 values may be specified as follows:

a) with truck on tyres and the boom in aligned position;

b) with truck on stabilising devices (if fitted) and the boom in aligned position;

c) with truck on tyres and the boom slewed in the less stable position;

d) with truck on stabilising devices (if fitted) and the boom slewed in the less stable position.

5.3.2 Static test

5.3.2.1 Purpose

The purpose of this test is to demonstrate the overall structural integrity of the loaded truck in static conditions. It shall be applied to each representative type of truck.

5.3.2.2 Test procedure

WARNING — For this test, it is advisable to secure the truck to the ground to avoid the risk of overturning.

Trucks shall be type-tested on firm, level ground at 125 % of Q_1, Q_2, and Q_3 at the corresponding positions.

5.3.2.3 Acceptance criteria

The truck shall be considered as complying with this test if the test load is safely supported for 10 min without permanent deformation or component failure.

5.3.3 Dynamic testing

5.3.3.1 Purpose

The purpose of this test is to demonstrate the overall structural integrity of the loaded truck in dynamic conditions. It shall be applied to each representative type of truck.

5.3.3.2 Test procedure

WARNING — For this test, it is advisable to secure the truck to the ground to avoid the risk of overturning.

Trucks shall be tested at 100 % of each of the three capacities, Q_1, Q_2, and Q_3, in a complete operating cycle, at the maximum engine speed specified by the manufacturer, and from a stationary, fully retracted and lowered boom position to each of the positions specified below, and back again.

At the maximum engine speed specified by the manufacturer,

a) bring Q_1 to the fully retracted and maximum lifted position,

b) bring Q_2 to maximum height (first lifting and then telescoping), and

c) bring Q_3 to maximum reach.

5.3.3.3 Acceptance criteria

The truck shall be considered as complying with this test if the test is completed without permanent deformation or component failure.

5.4 Maximum load-lowering speed verification

WARNING — In order to perform this test safely, it is advisable to secure the truck to prevent overturn whilst permitting the rear wheels to leave the ground.

Compliance with the requirements in 4.9.3 shall be checked starting with Q_1 and Q_2 from the following positions, with the truck on tyres and slewed in the least stable position:

— with Q_1 at the fully retracted and maximum lifted position;

— with Q_2 at the maximum boom extension and maximum height.

The lowering control shall be fully actuated and the engine accelerated to the maximum recommended rpm. When the position of the maximum forward reach for the relevant load zone is reached, the lowering control shall be suddenly released or the LLD shall be triggered whichever is the most unfavourable.

5.5 Load holding

Means shall be provided to maintain the load in the event of leakage, a fault or interruption of the power supply, failure in the hydraulic circuit of the load lifting, tilting, reaching, stabilizing, or lateral levelling systems.

The descent of the rated load in its least favourable position shall not exceed 150 mm in 10 min with the oil in the hydraulic system at normal working temperature.

The average forward tilting of fork carriage speed with the rated load shall not exceed 0,5° per min.

6 Information for use

6.1 General

Manual(s) shall be supplied with each truck and include information for use and information for routine maintenance.

Information for use and routine maintenance shall comply with ISO 12100:2010, 6.4.5.2.

6.2 Operator's and maintenance manuals

6.2.1 The following information covering use of the truck shall be provided:

a) intended and prohibited uses of the truck;

b) list of approved attachments;

c) climatic conditions for which the truck is designed;

d) instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment (PPE) to be provided;

e) conditions in which the truck meets the requirement for stability during use and transportation;

f) operating method to be followed in the event of breakdown;

g) prohibition of operation in hazardous atmospheres for which the truck is not designed.

6.2.2 The following information covering the truck shall be provided:

a) business name and full address of the manufacturer or authorized representative;

b) description of the truck and approved attachments for use with the truck;

c) description of the safety systems and warning signs;

d) description of authorized tyres (including solid, foam, and water-filled), information on their required size, design, and inflation pressures;

e) capacity of, and performance data on, the truck and the combination of truck and related attachments;

f) truck weight, dimensions, and turning radii;

g) adjustment of the operator's seat and use of the seat belt.

6.2.3 The following information covering operational use of the truck shall be provided:

a) required competencies of the operator;

b) measures necessary to control residual risks;

c) ground-bearing pressure (wheels and stabilizing devices) unloaded and loaded in static position;

d) daily checks before operating the truck;

e) instructions for access and egress;

f) operating controls and operating displays;

g) starting, driving, and braking of the truck;

h) handling of loads and use of the different attachments and warning about the hazards due to the action of wind forces;

i) information on possible displacement of the centre of gravity;

j) lift height for travelling;

k) travelling on gradients;

l) safe parking of the truck;

m) instructions for de-energizing stored energy components;

n) use when the operator's direct visibility is limited;

o) instructions for towing with the truck.

6.2.4 The following information relating to internal combustion (IC) engine trucks shall be provided:

a) approved fuels;

b) safe handling of fuels;

c) refuelling operations;

d) warning of the effect of exhaust emissions in confined spaces;

e) warning of the effect of exhaust emissions on the operator.

6.2.5 The following information on transportation and storage of trucks shall be provided:

a) loading and unloading of trucks;

b) restraint of the truck during transport using tie-down points;

c) towing the truck and moving inoperative trucks;

d) storage of trucks for extended periods of time;

e) instructions for transport in the operator's manual.

6.2.6 The following information covering inspection and routine maintenance:

a) training and competencies required for inspection and routine maintenance operations;

b) information covering routine maintenance that can be performed by the truck operator;

c) information covering operations to be performed by a competent person;

d) type and frequency of inspections and maintenance operations, with particular attention to the replacement and durability of wear parts;

e) specifications of consumables and quantity required;

f) information covering approved spare parts;

g) filling and handling of battery, oil, diesel, or other fuels, as applicable;

h) instructions for the verification of marking;

i) warnings of particular hazards and the correct procedure to be followed during maintenance;

j) instructions for de-energizing stored energy components;

k) access to inspection, service and maintenance at height, and under or in the boom;

l) drawings, diagrams, descriptions, and explanations necessary for use and routine maintenance of the truck;

m) instructions for disposing of waste material (e.g. oils and battery);

n) information for checking the proper functioning of any additional protective devices, e.g. overload indicators, and the frequency of these checks, if fitted by the manufacturer or authorized representative;

o) instructions for changing wheels.

6.3 Marking

Trucks shall be marked legibly and indelibly with the following minimum details. This information can be provided on one or more labels:

a) business name and full address of the manufacturer or authorized representative;

b) designation of series or type;

c) serial number;

d) year of construction;

e) rated capacity;

f) net power of engine expressed in kilowatts (kW);

g) mass of the unladen truck, fully fuelled and serviced, without the operator and without the mass of any removable attachment;

h) if necessary, the maximum vertical force and the drawbar pull on the tow-hook in *N*.

i) a warning, visible to the operator in the normal operating position, stating that the truck is to be level before lifting or extending the boom.

Information from a) to h) may be provided in a language different form the one of the country in which the truck will be used for the first time.

6.4 Load charts

6.4.1 Trucks with load-carrying attachments

Where the manufacturer has authorized their use, trucks with load-carrying attachments shall be fitted with appropriate load charts related to the load-carrying attachment. The load chart shall be legible and durable, affixed in a prominent position, and easily readable by the operator in the normal operating position.

See Figure 4 for an example.

The load chart shall provide information on

a) the type of attachment to which it applies,

b) applicable load centre distances,

c) actual capacities at lift heights and reach,

d) slewing angle range applicability,

e) applicable limitations on the attachment use,

f) model of truck to which it applies,

g) type of tyres,

h) use with and without stabilizing device, if applicable, and

i) use with and without ballasted tyres and optional counterweights, if applicable.

For trucks equipped with stabilizing devices, load charts shall be provided showing capacities when the stabilizing devices are deployed and when not deployed.

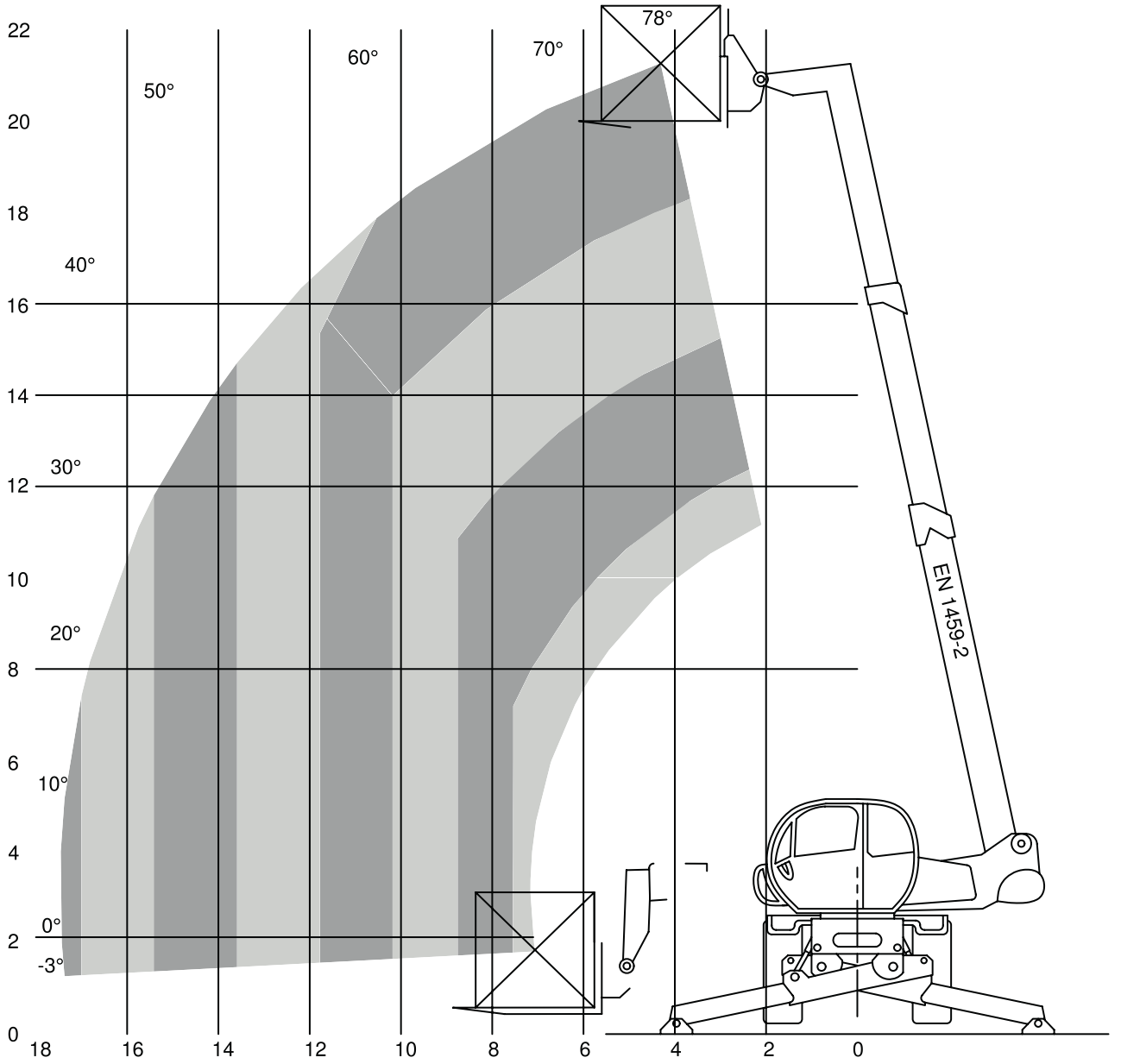


Figure 4 — Load chart

6.4.2 Trucks with non-load-carrying attachments

Non-load-carrying attachments, e.g. hydraulic-breakers and brooms, which normally operate near the ground and comply with the stability criteria given in ISO 22915-24, do not require a load chart to be installed on the truck. If necessary, specific operating instructions for the limits on the attachment position, i.e. lift height or reach, shall be provided.

Annex A
(informative)

List of significant hazards

The product should be designed such that it is fit for its purpose or function and can be adjusted and maintained without putting persons at risk when it is used under conditions foreseen by the manufacturer.

To properly design a product and cover all specific safety requirements, the manufacturer should

— identify the hazards that apply to the product and perform risk assessments, and

— design and construct the product taking into account these assessments.

The aim of this procedure is to eliminate or reduce the risk of accidents throughout the foreseeable lifetime of the machinery, including the phases of assembling and dismantling, in which the risk of accidents can also arise from foreseeable abnormal situations.

In selecting the most appropriate methods, the manufacturer should apply the following principles in the following order given:

a) eliminate or reduce risks as much as possible by design (inherently safe machinery design and construction);

b) take the necessary protection measures in relation to risks that cannot be eliminated by design;

c) inform users of the residual risks due to any shortcomings of the protection measures adopted;

d) indicate whether any particular training is required;

e) specify any need to provide personal protection equipment (PPE).

The truck should be designed to prevent abnormal use, wherever possible, if such use would engender risk. In other cases, the instructions should draw the user's attention to ways in which experience has shown the truck should not be used.

The following hazards may be applicable and could involve risks to persons if not addressed. The corresponding requirements offer guidance to limit the risk or reduce these hazards.

See Table A.1.

Table A.1 — List of significant hazards

Hazard		Related subclause of this part of ISO 10896/aspect of machine	
1	**Mechanical hazards**		
1.1	**Crushing, shearing, cutting, severing, entanglement, drawing-in, trapping hazards**	4.3	Brakes
		4.5	Controls
		4.12.5	Access to engine compartment and other compartments
		4.12.6	Fenders
		4.12.2	Protection against crushing, shearing, and trapping
		4.10.6.3	Operator restraint
		4.12.7	ROPS and FOPS
		4.12.9	Audible warning device
		4.14	Visibility
		4.10.5.5	Doors and windows
		4.17.6	Transportation
		4.17.5	Towing
		4.1.1	Sharp edges and acute angles
		4.8	Design requirements for maintenance purposes
1.2	**Impact hazards**		
	From mechanical failure	4.9.1.1	Chains
		4.9.2	Hydraulic system
		4.9.5	Fork arms , attachments, and quick couplers
		4.8	Design requirements for maintenance purposes
	From unstable load	5.5	Load holding
		4.12.7	ROPS and FOPS
	From road debris	4.12.6	Fenders
	From lifting or transporting a truck	4.17	Retrieval, transportation, lifting, and towing
1.3	**Stabbing or puncture hazards**	4.1.1	Sharp edges and acute angles
		4.8	Design requirements for maintenance purposes
1.4	**High-pressure fluid ejection or ejection hazard**	4.1.2	Stored energy components
		4.9.2	Hydraulic system
		4.9.2.2	Pressure control
2	**Thermal hazards**		
	Burns, scalds, and other injuries by a possible contact of persons with an extreme high or low temperature, by flames or explosions, and by radiation from heat sources	4.6.1	Exhaust systems
		4.10.3, 4.12.1	Hot parts
		4.16	Fire protection
	Damage to health by hot or cold working environment	4.10.5.1	Climatic conditions
3	**Hazards generated by noise**	4.18	Noise

Table A.1 *(continued)*

Hazard		Related subclause of this part of ISO 10896/aspect of machine	
4	**Hazards generated by materials**		
	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes, and dust	4.6.1	Exhaust systems
		4.10.5.1	Heating and ventilation system
	Fire or explosion hazard	4.6.3.3	Fuel tanks
		4.16	Fire protection
5	**Hazards generated by neglecting ergonomic principals in machinery design**		
	Unhealthy postures or excess effort	4.10.1	Operator station — General
		4.11	Operator access
		4.10.6	Operator's seat
		4.12.7	ROPS and FOPS
	Inadequate local lighting	4.10.5.6	Interior lighting system
	Human error, human behaviour	4.5.1	Marking of controls
		6.2	Operator's and maintenance manuals
6	**Unexpected start-up, unexpected overrun/overspeed**		
7	**Failure/disorder of the control system**	4.2.2	Unintended movement
		4.9.2	Hydraulic system
		5.5	Load holding
		4.8	Design requirements for maintenance purposes
8	**Failure of the power supply**	4.3.2	Failure of energy supply
9	**Errors of fitting**	4.1.2	Stored energy components
		4.8	Design requirements for maintenance purposes
		6.2.5	Transportation and storage of trucks
10	**Falling or ejected objects or fluids**	4.12	Protective measures and devices
		4.10.4	Pipes and hoses
11	**Loss of stability/overturning of machinery**	4.10.7.3	Tip over/overloading indicators
		4.13	Stability requirements
		6.4	Load chart
12	**Slips, trips and falls**	4.11	Operator access
	Additional hazards, hazardous situations and hazardous events due to mobility		
	Movement when starting the engine	4.2.2	Unintended movement
	— Layout of pedals	4.5.1	Pedal operated travel and braking controls
	— Additional operator positions	4.5.1.1	Multiple operating positions
	Movement without the driver at the driving position	4.2.4	Powered travel movement

Table A.1 *(continued)*

Hazard		Related subclause of this part of ISO 10896/aspect of machine	
13	**Linked to the work position on the truck**		
	Fall of persons during access to, at or from the work position	4.11	Operator access
	Exhaust gases/lack of oxygen at the work position	4.6.1	Exhaust system
		4.10.5.1	Heating and ventilation system
	Mechanical hazards at the work position		
	Fall of objects, penetration of objects	4.12.7	ROPS and FOPS
		4.10.4	Pipes and hoses
		4.9.5	Fork arms, attachments and quick couplers
	Insufficient visibility from the work position	4.14	Visibility
		4.10.5.3	Wipers and washers
	Inadequate lighting	4.15	Lighting
	Inadequate seating	4.10.6	Operator's seat
	Noise at the work position	4.18	Noise reduction
	Vibration at the work position	4.10.6.2	Suspension seat vibrations
14	**Due to the control system**		
	Inadequate location of manual controls	4.5.1	Controls — General
	Inadequate design of manual controls and their mode of operation	4.5.1	Consistency with truck motions
15	**Due to the power source and the transmission of power**		
	Hazards from the engine and the batteries	4.6.1	Exhaust systems
		4.6.3.3	Fuel tanks
		4.4.5	Batteries
		6.2.4	Information covering the combustion-engine-driven trucks
	Hazards from coupling and towing	4.17.5	Towing
		6.2.3	Information covering the operational use of the truck
16	**From/to third persons**		
	Unauthorized start-ups	4.2.1	Unauthorized starting
		4.13	Stability requirements
		4.12.9	Audible warning device
		4.17.5	Towing
		4.17.6	Transportation
		5.2	Functional verification
		6.2.3	Information covering the operational use of the truck

Table A.1 *(continued)*

Hazard		Related subclause of this part of ISO 10896/aspect of machine	
Additional hazards due to lifting operation			
17	**Mechanical hazards and hazardous from load falls, collisions, machine tipping caused by**		
	Lack of stability	4.13	Stability requirements
	Uncontrolled loading, overloading, overturning moments exceeded	4.10.7.3	Tip-over/overloading indicators
		6.4	Load chart
		4.9.3	Maximum load-lowering speed
	Unexpected/unintended movement of loads	5.5	Load holding
		4.5.5	Multi-function controls
		4.9.2	Hydraulic system
		4.5.4	Load-handling controls
		4.9.5	Fork arms, attachments, and quick couplers
	Insufficient mechanical strength of parts, from inadequate selection of chains, ropes, lifting and accessories, and their inadequate integration into the machine	4.9.1.1	Chains
		4.9.5	Fork-arm attachments and quick couplers
		5.3	Structural verification
18	**Hazards generated by neglecting ergonomic principles/insufficient visibility when driving**	4.5.1	Controls — General
		4.14	Visibility
Additional hazards			
19	**Travelling of self-propelled machinery**		
	Direction of movement	4.5.2	Differential locking
		4.5.3.1	Steering direction
		4.5.5	Multi-function controls

Annex B
(normative)

Attachments and quick couplers

B.1 Attachment

B.1.1 General

The truck manufacturer shall define the range of attachments intended to be used with the truck and establish the criteria for their safe fitting and use. Specific load chart(s) for the combination of the truck and the attachment are required, according to 6.4.

The truck manufacturer shall ensure that the attachment complies with the following:

a) the attachment (e.g. clamps, side shift carriage, bucket, sweeper) is designed and manufactured such that unintentional displacement and detachment from the truck are prevented;

b) clamping devices are designed such that clamping pressure is sustained for at least 10 min after the engine has been shut down, by means of check valves or any other effective system when the truck control mechanisms are in the neutral position;

c) in the event of a malfunction in the power supply system for the attachment, means are provided to prevent the load loosening or unintentional shifting;

d) when the truck is equipped with a load-bearing clamp (e.g. paper clamp), it features control(s) with a secondary action to prevent unintentional release of the load;

e) if the truck is equipped with quick-fastening devices for attachments, as defined in B.2, it is designed and manufactured such that the locking devices can be seen by the operator to be correctly engaged with the attachment from the normal operating position, and means are provided to prevent disengagement of the attachment in the event of system failure;

f) if the attachment has its own separate hydraulic system, the system complies with 4.9.2;

g) if the attachment has a hydraulic system connected to the truck hydraulic system, the two systems are compatible, and the combined system complies with 4.9.2.

B.1.2 Identification

The truck manufacturer shall ensure that approved attachments, excluding fork arms, fork-arm extensions (see B.3), or other interchangeable attachment components, are permanently marked with the following information:

a) manufacturer's name and address;

b) type denomination (e.g. part no., model no.);

c) serial number (if any);

d) year of construction;

e) mass, in kilograms (kg), with those attachments having interchangeable components (such as carriages that accept different types of fork arms) specifying the mass of the attachment with the heaviest interchangeable component;

f) distance of the centre of gravity of the unladen attachment from its mounting, which may be

   1) for fork arms mounted attachments, the heel of the fork arms, or

   2) for attachments that fit on a quick interchange device, the horizontal axis about which the quick fastening device pivots and for which the centre distance shall be the maximum possible;

g) if applicable, lost load centre (LL), also known as effective thickness (ET);

h) if applicable, the maximum hydraulic operating pressure, in megapascals (MPa), as recommended by the attachment manufacturer;

i) volumetric capacity of attachment in cubic metres (m^3), if relevant;

j) rated capacity and load-centre distance of the attachment and, for those attachments such as carriages that accept different types of fork arms whose capacity can vary depending on the capacity of interchangeable components (e.g. carriages that accept different types of fork arms), the maximum capacity of the attachment with interchangeable components;

k) a warning or equivalent pictorial noting that the rated capacity of this attachment may be reduced and to refer to the load chart for truck/attachment combination.

Information from a) to j) may be provided in a language different form the one of the country in which the truck will be used for the first time.

B.1.3 Instructions

The truck manufacturer shall ensure that instructions for the mounting, use and maintenance of the attachment are provided.

Information for use and routine maintenance shall comply with ISO 12100:2010, 6.4.5.2.

NOTE If attachment instructions can be provided in the form of a label on the attachment, then a dedicated operator's manual is not needed.

B.2 Quick coupler (quick-fastening)

B.2.1 Locking

The truck manufacturer shall ensure that the quick coupler has a locking system that meets the following requirements:

a) the locking system keeps the quick coupler in the locked position by a positive engagement system and keeps it locked under all intended/normal operating conditions;

b) it is possible to verify the locked position of the quick coupler from the operator's position, or from the location where the locking control is operated;

c) it is not possible that the bracket be released by malfunction or loss of engagement forces;

d) wedge-shape locking systems provide a continuous force (e.g. continuous pressure with open return, hydraulic accumulator, compressed spring) to hold the attachment in the locked position.

B.2.2 Control

The truck manufacturer shall ensure that

a) for actuation of a hydraulically operated locking and unlocking system of a quick coupler, a separate control is provided,

b) the control is secured against inadvertent activation (see 4.5.1.2), and

c) if the actuation is integrated into a control used for functions other than locking/unlocking the quick coupler, activation of the unlocking function is only possible by simultaneous actuation of two independent controls, both of the hold-to-run type.

B.3 Identification

The truck manufacturer shall ensure that if the bracket is not permanently integrated into the truck, markings for the quick coupler are provided in accordance with B.1.2.

B.4 Instructions

The truck manufacturer shall ensure that the instructions for mounting, locking, inspection, and the effect on the rated capacity are provided by the quick coupler manufacturer and that the inspection procedure for locking is described in detail.

B.5 Fork arms

B.5.1 General

The truck manufacturer shall ensure that

a) fork arms are manufactured and tested in accordance with ISO 2330,

b) the total capacity of the fork arms fitted to a truck is not less than the rated capacity of the truck, and

c) all fork arms fitted to a truck at a given time shall have the same capacity.

B.5.2 Fork arm extensions

The truck manufacturer shall ensure that fork arm extensions are designed to prevent accidental disengagement from the fork arms, and that they are in accordance with ISO 13284.

B.5.3 Fork carriers

The truck manufacturer shall ensure that

a) means conforming to ISO 2328 are provided on the fork carrier to prevent lateral disengagement of the fork arms at the extremities, and

b) if a fork arm removal slot is provided at the bottom of the fork carrier, it is not positioned opposite a slot at the top of the fork carrier, unless means are provided to prevent the fork arms being inadvertently displaced.

B.5.4 Load retention device

The truck manufacturer shall ensure that

a) if the truck is fitted with fork arms, it is designed such that they can be equipped with load retention device(s), such as load backrest extensions,

b) if fitted with a load backrest extension, it has a height, width and strength sufficient to minimize the possibility of the load falling toward the operator when the fork arms are in a position of maximum rearward tilt, and

c) the size of the openings in the load backrest extension do not exceed 150 mm in one of the two dimensions.

Annex C
(informative)

Consistency of direction of motion for load-handling controls

Table C.1 is applicable to the truck in forward aligned position.

Table C.1

Control	Direction of motion of load/equipment	Predominant motion/direction of operator's hand
Functions		
Reach	Retract	Rearward or to left
	Extend	Forward or to right
Lift	Up	Rearward
	Down	Forward
Tilt (mast/fork)	Rearward	Rearward or to left
	Forward	Forward or to right
Frame level	Clockwise	Right
	Counter-clockwise	Left
Stabilizer	Raise	Rearward or up
	Lower	Forward or down
Side shift	Right	Rearward or to right
	Left	Forward or to left
Slewing	Clockwise	Right
	Counterclockwise	Left
Auxiliary functions		
Push-pull	Rearward	Rearward
	Forward	Forward
Rotate laterally	Clockwise	Rearward, up or to right
	Anticlockwise	Forward, down or to left
Rotate longitu-dinally	Rearward	Rearward or up
	Forward	Forward or down
Load stabilizer	Down	Rearward or up
	Up	Forward or down
Swing	Right	Rearward, up or to right
	Left	Forward, down or to left
Slope	Clockwise	Rearward, up or to right
	Anticlockwise	Forward, down or to left
Fork position	Together	Rearward or up
	Apart	Forward or down
Trip	Engage	Rearward or up
	Release	Forward or down
Grip	Engage	Rearward or up

Table C.1 *(continued)*

Control	Direction of motion of load/equipment	Predominant motion/direction of operator's hand
	Release	Forward or down
Clamp	Clamp	Rearward or up
	Release	Forward or down

Annex D
(informative)

Examples of regular and occasional loads

D.1 Regular loads

a) Hoisting and gravity effects acting on the mass of the truck

b) Inertial and gravity effects acting vertically on the hoist load

c) Loads caused by travelling on uneven surface

d) Loads caused by acceleration of all truck drives

e) Loads induced by displacements

NOTE Regular loads occur frequently under normal operation.

D.2 Occasional loads

a) Loads due to in-service wind

b) Snow and ice loads

c) Loads due to temperature variation

NOTE Occasional loads occur infrequently. They are usually neglected in fatigue assessment.

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