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Industrial trucks — Lorry-mounted trucks —

Part 1: Safety requirements and verification

Chariots de manutention — Chariots embarqués sur porteur routier —

Partie 1: Exigences de sécurité et vérification

Reference number
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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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

This document was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 4, *Rough-terrain trucks*.

A list of all parts in the ISO 20297 series can be found on the ISO website.

Introduction

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

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

— machine manufacturers (small, medium and large enterprises);

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

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

— machine users/employers (small, medium and large enterprises);

— machine users/employees (e.g. trade unions, organizations for people with special needs);

— service providers, e.g. for maintenance (small, medium and large enterprises);

— consumers (in the case of machinery intended for use by consumers).

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

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

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

Lorry-mounted trucks are known by several terms, including “vehicle-mounted trucks” and “piggyback trucks”. They can also be equipped with a variety of attachments. The trucks covered by this document all have design features enabling them to be mounted for transport on a carrier vehicle.

Industrial trucks — Lorry-mounted trucks —

Part 1: Safety requirements and verification

1 Scope

This document specifies safety requirements and their verification for industrial and rough-terrain lorry-mounted trucks (hereafter referred to as "trucks").

It is applicable to those trucks capable of self-loading onto a carrier vehicle. It is not applicable to

— trucks that are driven onto the carrier vehicle, or

— trucks that are loaded onto the carrier vehicle with the assistance of external means, i.e. crane or other lifting device.

This document deals with all significant hazards, hazardous situations or hazardous events relevant to machinery, when it is used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer. The significant hazards covered by this document are listed in Annex A.

This document does not address hazards which can occur

— during manufacture,

— when handling suspended loads, which may swing freely,

— when using trucks on public roads,

— when operating in potentially explosive atmospheres,

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

It does not address the requirements of road safety when the truck is mounted on the carrier vehicle.

It is not applicable to trucks manufactured before the date of its publication.

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

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

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 3691-1:2011, *Industrial trucks — Safety requirements and verification — Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks*

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

ISO 5053-1, *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, *Graphical symbols for use on equipment — Registered symbols*

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

ISO 9247, *Earth-moving machinery — Electrical wires and cables — Principles of identification and marking*

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

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

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

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

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

ISO 13564-1, *Powered industrial trucks — Test methods for verification of visibility — Sit-on and stand-on operator trucks and variable-reach trucks up to and including 10 t capacity*

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

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

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

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

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

ISO 22915-3, *Industrial trucks — Verification of stability — Part 3: Reach and straddle trucks*

ISO 22915-7, *Industrial trucks — Verification of stability — Part 7: Bidirectional and multidirectional trucks*

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 22915-13, *Industrial trucks — Verification of stability — Part 13: Rough-terrain trucks with mast*

ISO 22915-14, *Industrial trucks — Verification of stability — Part 14: Rough-terrain variable-reach 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 12100, ISO 5053-1 and the following apply.

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

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

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

3.1
lorry-mounted truck
wheeled, operator-controlled vehicle with a powered driving mechanism, designed either to carry, stack or tier in racks any kind of load, and capable of self-loading to, and self-unloading from, a carrier vehicle using its load-lifting means

Note 1 to entry: This definition is different from the one given in ISO 5053-1.

3.1.1
industrial lorry-mounted truck
lorry-mounted truck designed for operation under normal operating conditions on substantially firm, smooth, level, prepared and consolidated surfaces

Note 1 to entry: Normal operating conditions are as described in 4.1.2.

3.1.2
rough-terrain lorry-mounted truck
lorry-mounted truck designed for operation under normal operating conditions on unimproved natural terrain as well as the disturbed terrain of work sites

Note 1 to entry: Normal operating conditions are as described in 4.1.2.

3.2
rated capacity
Q_1
<truck> maximum load permitted by the manufacturer at the *standard load centre distance* (3.7) that the truck is capable of lifting and transporting on *fork arms* (3.10) in normal conditions with the *boom* (3.11), *mast* (3.12) or forks fully retracted

Note 1 to entry: See Figure 1.

3.3
rated capacity
<attachment> maximum load that an *attachment* (3.14) is permitted by its manufacturer to handle in normal operation under specified conditions

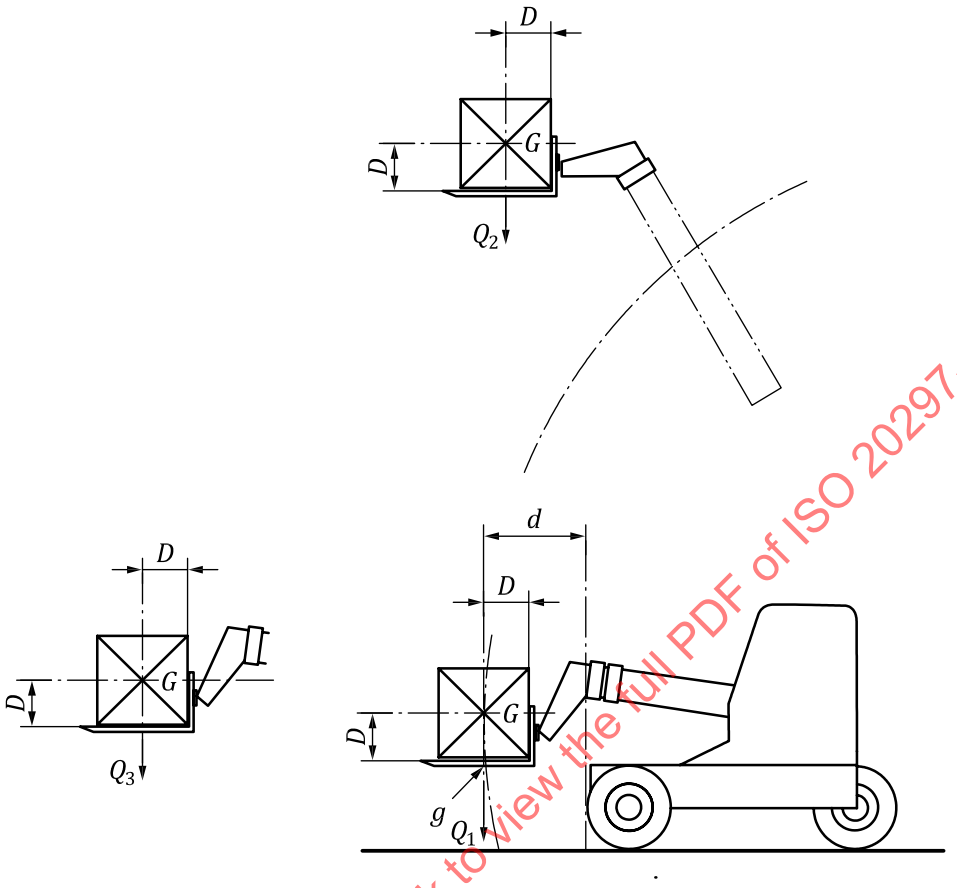
Note 1 to entry: The rated capacity of the attachment (3.14) can be associated with the load centre distance. See Table 1.

3.4
actual capacity
maximum load at a specified load centre distance, established by the manufacturer based on component strength and truck stability, that the truck can carry, lift and stack to a specified *lift height* (3.6) and *reach* (3.5), in normal operation

Note 1 to entry: See Figure 1.

Note 2 to entry: The actual capacity depends on the configuration of the truck in respect of variables including *lift height* (3.6), the *reach* (3.5) of the *boom* (3.11), the actual load centre, load-handling devices and *stabilizing devices* (3.9).

Note 3 to entry: It defines the load-handling ability of the particular truck as equipped. Additional actual capacity with removable *attachments* (3.14), where permitted, may also be established by the appropriate stability test or by calculation verified by empirical data.



Key

d	reach
D	standard load-centre distance
G	centre of gravity of the load
g	point corresponding to vertical projection of G
Q_1	rated capacity
Q_2	actual capacity at maximum lift height
Q_3	actual capacity at maximum reach

Figure 1 — Parameters for determining actual capacity of a truck with fork arms

3.5
reach
d
distance the load can be moved forward in the horizontal direction

Note 1 to entry: See Figure 1.

3.6
lift height
height from the ground to the upper face of the *fork arms* (3.10) or underside of the load, whichever is the lower

3.7
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* (3.10)

Note 1 to entry: See Figure 1.

Note 2 to entry: Table 1 gives standard load centre distances in relation to *rated capacity* (3.2).

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.

3.8
lost load centre
LL
effective thickness
ET
horizontal shift in the standard load centre that may occur when removable *attachments* (3.14) are added to a truck

3.9
stabilizing devices
extendable and/or pivoting mechanical supports used to improve the stability of a truck when stationary

3.10
fork arms
load-supporting structures, each consisting of a shank (vertical portion) and blade (horizontal portion) which are hook or shaft (pin)-mounted, fitted on the carriage and usually laterally adjusted manually

3.11
boom
pivoting support member that permits horizontal and vertical placement of the load or *attachment* (3.14)

[SOURCE: ISO 10896-1:2012, 3.14.]

3.12
mast
support member that permits vertical movement of the carriage

3.13
normal operating position
position specified by the manufacturer in which the operator is able to control the truck operations, including load-handling functions

3.14
attachment
component or assembly of components which can be mounted on the attachment bracket for a specific use

3.15
carrier vehicle
lorry or trailer that is suitable for transporting a *lorry-mounted truck* (3.1) by the fitting of a suitable *mounting kit* (3.16)

3.16
mounting kit
structure designed to fit a *lorry-mounted truck* (3.1) to a carrier vehicle

3.17
maximum working pressure
highest pressure at which a hydraulic circuit is intended to operate under normal operating conditions

Note 1 to entry: Normal operating conditions are as described in 4.1.2.

3.18
level ground
ground with a gradient of 0 ± 2 %

4 Safety requirements and/or protective/risk reduction measures

4.1 General

4.1.1 Management of risk

Trucks shall comply with the safety requirements and/or protective/risk reduction measures of this clause.

In addition, the truck shall be designed according to the principles of ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

4.1.2 Normal operating conditions

Normal operating conditions are considered to be the following:

— driving (travelling and manoeuvring) and load handling on surface conditions on which the truck is designed to operate; such surface conditions shall be specified in the instruction handbook;

— driving with the horizontal load centre of gravity approximately on the longitudinal centre plane of the truck;

— travelling with the load in the lowered (travel) position and with the load tilted backwards, where applicable.

If the above is not sufficient to allow the conditions for stability of a particular truck type to be specified, then the operating conditions shall be according to the International Standards referenced for stability in 4.16.

4.2 Sharp edges and acute angles

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

4.3 Stored energy components

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

4.4 Starting/moving

4.4.1 Unauthorized starting

The truck shall be provided with a device (e.g. key, code, magnetic card) which prevents starting without its use.

4.4.2 Unintended movement

The truck 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.

4.4.3 Uncontrolled motion

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

4.4.4 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.

4.4.5 Non-activation of the parking brake

If the operator leaves the operating position when the parking brake is not applied, means shall be provided to warn the operator.

4.4.6 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.

NOTE ISO 21281 can be used for guidance.

4.5 Brakes

Trucks shall be equipped with a service brake or brakes and parking brake, in accordance with ISO 6292.

Where electromechanical brake systems are fitted, they shall be applied mechanically and released electrically. Where hydro-mechanical parking brakes are fitted, they shall be applied mechanically and released hydraulically. When the operator manually releases the parking brake from the normal operating position, it shall not disable service brakes.

4.6 Failure of energy supply

Failure of the energy supply to a brake system shall not result in a total loss of braking.

The systems shall be able to bring the truck to a controlled stop and hold the truck in a parking position.

4.7 Electrical and electronic systems

4.7.1 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 as 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 or hoses containing fuel.

For safety-related parts of control systems, the principles given in ISO 13849-1 shall be followed, or methods providing similar protection applied.

4.7.2 Degree of protection

All components installed on the truck's exterior or directly exposed to the environment shall have at least the degree of protection corresponding to IP55 according to IEC 60529.

4.7.3 Electrical connections

Electric wires and cables used to connect components in electric circuits shall be marked and identified in accordance with ISO 9247.

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

4.7.4 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.

4.7.5 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.

4.7.6 Battery disconnection

It shall be possible to disconnect batteries quickly, e.g. by a quick coupling or an accessible isolator switch.

Symbol ISO 7000-2063 may be used for identification.

4.8 Controls

4.8.1 General

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

a) easy to access from the operator's position,

b) clearly identified, indelible and visible in the operator's station, with, if appropriate, graphical symbols in accordance with ISO 7000 being used and described in the operator's manual (see 6.2), and

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

For safety-related parts of control systems, the principles given in ISO 13849-1 shall be followed, or methods providing similar protection applied. See also 4.4.1.

Remote operator control systems fitted to the truck shall comply with the relevant provisions of ISO 15817, using ISO 6682 and ISO 10968 as guidance.

4.8.2 Controls of trucks accessible from ground level

Except when loading the truck on the carrier vehicle, mast, tilt, telescopic boom and carriage movement shall not be possible through operation of the primary load-handling control when the operator is not in the normal operating position.

4.8.3 Inadvertent activation

Controls that can cause a hazard due to inadvertent activation when the operator gets into or out of the normal operator position 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.

4.8.4 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 and disengaged positions shall be clearly marked.

4.8.5 Steering controls

4.8.5.1 Steering direction

On trucks with steering wheel control, clockwise rotation of the steering wheel shall direct the truck to the right when the truck is travelling in the forward direction.

4.8.5.2 Failure of power supply

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.

4.8.5.3 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.

4.8.5.4 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 strength requirements of 4.8.5.3.

4.8.6 Load-handling controls

4.8.6.1 General

Controls shall return to neutral when released and shall stop load movements, except where otherwise specified in this document.

The controls for the load-handling functions shall be separate from the driving controls, except for the travel direction control, which may or may not be separate. Annex C can be used as a guidance for consistency of direction of motion for load-handling controls.

4.8.6.2 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 operator's station 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.

4.8.6.3 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.

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.

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

4.8.6.4 Auxiliary hydraulic control

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

4.9 Power systems and accessories

4.9.1 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.

4.9.2 Cooling systems

Cooling systems shall be designed to prevent air flow through the system from being directed at the operator 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 shall not exceed 60 °C within reach of the operator while in the normal operating position and passenger while in the normal passenger's position(s).

4.9.3 Tanks and pressure vessels

4.9.3.1 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.).

4.9.3.2 Filler openings

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

— 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

— be located or guarded in such a way that the operator is protected.

4.9.3.3 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.

Fuel spillage shall not be possible during normal operating conditions (see 4.1.2), 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.

4.9.3.4 Liquefied petroleum gas (LPG)-powered trucks

For LPG fuelled trucks, the requirements of ISO 3691-1:2011, 4.5.4 apply.

4.10 Stabilizing devices

When stabilizing devices are provided,

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

— an indication (e.g. sensors, painted marks) shall be given to the operator when each horizontally extendable stabilizing device is extended to level and/or supports the truck in conformity with the load chart(s).

4.11 Design requirements for maintenance purposes

Trucks shall be designed such that routine lubrication and maintenance operations can be performed safely, with reference to ISO 20297-2[1)] for guidance on the safe maintenance of trucks and in accordance with ISO 2860 in reference to openings intended for maintenance purposes.

1) Under preparation.

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

4.12 Systems for lifting, tilting and reaching

4.12.1 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. The calculation of K_1 [see Formula (1)] shall be related to the maximum static load, Q, which would exist in one or more equally loaded chains when the truck and boom are stationary in the least favourable position, assuming no friction in the boom structure or lifting/reaching mechanism.

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

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.

The factor K_1 shall not be less than 5.

4.12.2 Hydraulic system

4.12.2.1 Hydraulic circuit

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 so 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.

4.12.2.2 Pressure control

Hydraulic systems shall include devices that prevent the pressures in the systems from exceeding pre-set 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.

4.12.2.3 Oil purification

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

4.12.3 Load holding

4.12.3.1 Variable-reach trucks

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

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 $0{,}5°min^{-1}$.

4.12.3.2 Masted trucks

The hydraulic lifting system shall be designed such that with the hydraulic fluid at normal operating temperature, the mast substantially vertical and carrying rated capacity load, the descent of the load caused by internal leakage in the first 10 min shall not exceed 100 mm.

The internal leakage rate of the complete hydraulic tilting system (e.g. cylinder, valve) with the oil at normal operating temperature shall allow no more than 5° forward movement of the mast in 10 min from the vertical mast position when the rated load is at a height of 2 500 mm or, in the case of trucks with lift heights of less than 2 500 mm, at their maximum lift height. The average tilting speed allowed by internal leaks shall not exceed $0{,}5°min^{-1}$ for trucks with a maximum forward tilt of less than 5°.

4.12.4 Maximum load-lowering speed

4.12.4.1 Variable-reach trucks

The maximum permissible lowering speed shall be such that in the event of a sudden stop of the lowering means, at the maximum reach for any load zone with the specified load, the rear wheels of the truck are only able to leave the ground momentarily and will return to the ground unassisted.

The test to be used for verifying this requirement is given in 5.4.

4.12.4.2 Masted trucks

A device shall be incorporated in the lift circuit which, in the event of a failure of the hydraulic circuit, excluding the hydraulic lift cylinder(s), shall restrict the rate of descent of the lifting mechanism with its rated load to $0{,}6 m \cdot s^{-1}$ maximum.

The device shall be fitted directly at the lifting cylinder(s).

4.12.5 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.

4.12.6 Fork arms, attachments and attachment brackets

Fork arms, attachments and attachment brackets shall be in accordance with Annex B.

4.13 Operator's station

4.13.1 General requirements

The normal operating position shall have space available for the operator, to minimize the potential for interior impact during normal operation. It is recommended that ISO 3411 be used as guidance.

4.13.2 Storage of operator's manual

A means shall be provided to store the operator's manual and other instructions. If the operator's station is not equipped with an enclosed cab, such means shall protect manuals and instructions from climatic conditions such as sunlight, rain or snow.

4.13.3 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.

4.13.4 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 may 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 this requirement.

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

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

4.13.5 Operator's station equipped with enclosed cab

4.13.5.1 Climatic conditions

Provisions shall be made to accommodate a ventilation system, an adjustable heating system and a system for defrosting windows.

4.13.5.2 Heating and ventilation system

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 2), 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; alternatively, the heating capacity may be determined by calculation.

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

Dimensions in millimetres

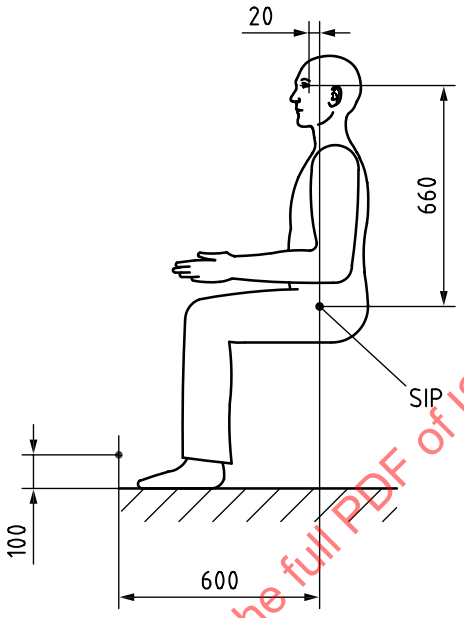


Figure 2 — Location of measuring points

4.13.5.3 Demisting and defrosting systems

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

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

4.13.5.4 Wipers and washers

Front and rear windows shall be fitted with motorized window wipers and washers.

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

Wipers shall clear a sufficient area to allow the operator to view the attachment or load through the entire lift zone. The window washer tank shall be easily accessible.

4.13.5.5 Pressurization system

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

4.13.5.6 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 operator's station.

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 if 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).

4.13.5.7 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 operator's station so that the operator's manual can be read.

4.13.6 Operator's seat

4.13.6.1 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.

For compact trucks only, the fore and aft adjustment (see ISO 11112:1995, Table 1, l2) shall be at least an adjustment of 70 mm in total, and the vertical adjustment (ISO 11112:1995, Table 1, h1) is not required.

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, and manual adjustment of the weight mechanism shall be possible without the use of tools;

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.

4.13.6.2 Operator restraint

Trucks shall have an operator restraint system according to ISO 6683.

4.13.7 Control panels and symbols on displays

4.13.7.1 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.

4.13.7.2 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.

4.14 Operator access

4.14.1 General requirements

An access system shall be provided for access to the operator's station 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.

4.14.2 Enclosed cab openings

4.14.2.1 Normal access opening

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

4.14.2.2 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.

4.15 Protective measures and devices

4.15.1 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.

4.15.2 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 3457.

If hazards still exist, they shall be identified on the truck in accordance with 4.15.4.

4.15.3 Guards

Guards, in accordance 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.

4.15.4 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.

4.15.5 Engine compartment

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

— locking,

— installation requiring the use of a tool or key, or

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

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

Trucks shall be equipped with

— FOPs 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, and

— for variable-reach trucks only, ROPs in accordance with ISO 3471:2008, Table 1, third list item.

4.15.7 Audible warning devices

Trucks shall be equipped with an audible warning device (horn), operable from the operator's station, and whose A-weighted sound pressure level shall be greater ≥ 93 dB. This value shall be measured 7 m from the foremost point of the truck with fork arms in their travel position, as defined by the manufacturer. The test procedure shall be in accordance with ISO 9533.

If a truck is equipped with a reverse audible alarm, it shall comply with ISO 9533.

4.16 Stability

The manufacturer shall verify stability according to the relevant requirements of ISO 22915-3 and ISO 22915-7, or according to those of ISO 22915-13 and ISO 22915-14 for masted and boom-type trucks.

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

NOTE An International Standard specific to lorry-mounted trucks, ISO 22915-23, is under preparation.

4.17 Visibility

Operator visibility during travel and manoeuvring shall be taken into consideration during the truck design. The requirements of ISO 13564-1 shall apply.

4.18 Fire protection

4.18.1 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.

4.18.2 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.

4.19 Lifting and towing

4.19.1 General

Attachment points for lifting 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.

4.19.2 Lifting

When provided, lifting attachment points shall be clearly identified on trucks and subassemblies that are to be lifted separately.

4.19.3 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.

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.

4.20 Noise

For examples of noise measurement methods, refer to Annex D.

4.21 Mounting kit

The truck manufacturer shall make available a mounting kit designed and tested to support the loading, unloading and transport of the lorry-mounted truck.

The mounting kit manufacturer shall

a) ensure that the appropriate kit is provided based on the truck and carrier vehicle combination,

b) provide guidelines and instructions, inspection and maintenance for installation of the mounting kit, and

c) provide the weight and centre of gravity of the mounting kit.

5 Verification of the safety requirements and/or protective/risk reduction measures

5.1 General

The manufacturer shall verify that each individual requirement of this document has been met by the design and manufacture of the truck by, for example,

— design, e.g. verification of drawings and documents, or calculation,

— measurement, e.g. tests of travelling and lowering speeds and lift and tilt leakage,

— visual examination, e.g. no permanent deformation after tests, verification of the marking of the truck, and/or

— 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, 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

— Q_1 the rated capacity of the truck,

— Q_2 the actual capacity at maximum lift height, and

— Q_3 the actual capacity at maximum reach.

See Figure 1.

Two different Q_2 and Q_3 values may be specified: one with the truck on tyres; the other with the truck on stabilizing devices.

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. The test 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 the fully retracted maximum lifted position and then to maximum height, and

c) bring Q_3 to maximum reach.

CAUTION — In order to perform this test safely, it is advisable to secure the truck to the ground.

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

5.4.1 General

Compliance with 4.9.3 shall be checked, on level ground, in respect of Q_1 and Q_2, as follows:

— Q_1 at the fully retracted and maximum lifted position;

— Q_2 at the maximum lift height.

5.4.2 Test procedure

With the engine at maximum speed, attain full lowering speed, then quickly release the control when the load reaches the maximum reach for the relevant load zone.

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.

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) climatic conditions for which the truck is designed;

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

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

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

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

6.2.2 Instructions for attaching the mounting kit to the carrier vehicle shall be provided.

6.2.3 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.

6.2.4 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.

6.2.5 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.

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

a) loading and unloading of trucks to or from the carrier vehicle;

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.

6.2.7 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 newtons (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.

6.4 Additional information for truck when mounted for transport

In addition to the marking requirements of Clause 6.3, the truck manufacturer shall provide the following information:

a) weight of the truck;

b) weight of the mounting kit (see 4.21);

c) overall dimension including length, width and height in transport position;

d) centre of gravity measured from fork face with mast or reach device retracted;

e) dimension from the fork face to the rearmost protrusion of the truck when mounted;

f) dimension from fork face to centre of front tire;

g) tire size;

h) fork dimensions including width, length and height.

6.5 Load charts

Where the manufacturer has authorized their use, trucks with load-carrying attachments shall be fitted with an appropriate load chart or charts related to the load-carrying attachment. Load charts shall be legible and durable, affixed in a prominent position, and easily readable by the operator in the normal operating position. See Figure 3 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) applicable limitations on the attachment use,

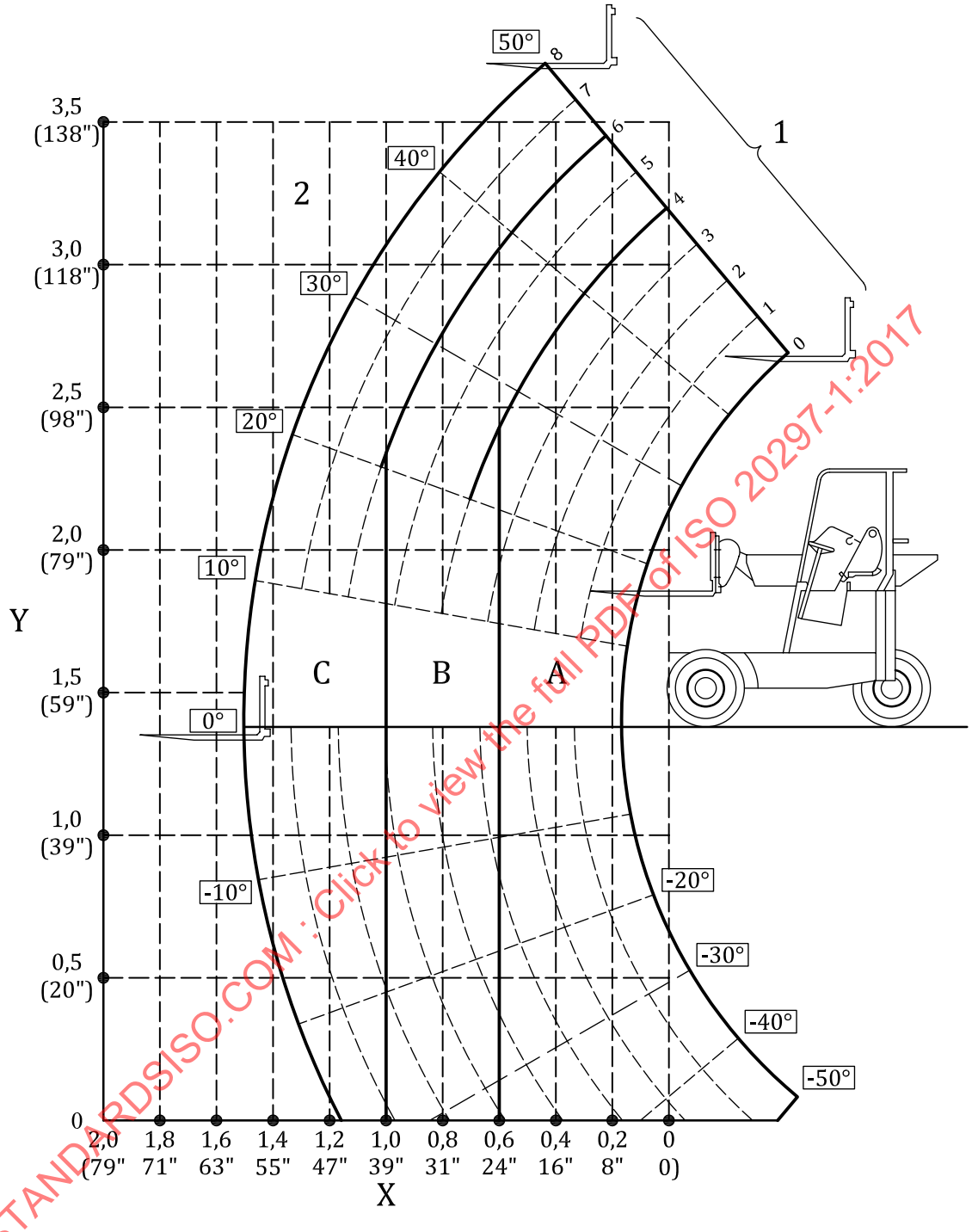
e) model of truck to which it applies,

f) type of tyres,

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

h) 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. Load charts may be combined with the nameplate.



Key

X	forward reach, m (in)	A	load zone A xxxx kg (xxxx lbs)
Y	lift height, m (in)	B	load zone B xxxx kg (xxxx lbs)
1	boom extension reference point	C	load zone C xxxx kg (xxxx lbs)
2	boom angle reference		

Figure 3 — Example load chart for variable-reach lorry-mounted truck

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:

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

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

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

— indicate whether any particular training is required;

— 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 hazards listed in Table A.1 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.

Table A.1 — List of significant hazards

Hazard		Relevant subclause of ISO 20297-1:2017	
1	**Mechanical hazards**		
1.1	**Crushing, shearing, cutting, severing, entanglement, drawing-in, trapping hazards**	4.5	Brakes
		4.8	Controls
		4.15.5	Access to engine compartment and other compartments
		4.15.2	Protection against crushing, shearing and trapping
		4.13.2	Operator restraint
		4.15.6	ROPS and FOPS
		4.15.7	Audible warning device
		4.17	Visibility
		4.13.5.6	Doors and windows
		4.19	Transportation
		4.19.3	Towing
		4.2	Sharp edges and acute angles
		4.11	Design requirements for maintenance purposes
1.2	**Impact hazards**		
	From mechanical failure	4.12.1	Chains
		4.12.2	Hydraulic system
		4.12.4	Fork arms, attachments and attachment brackets
		4.11	Design requirements for maintenance purposes
	From unstable load	4.12.3	Load holding
		4.15.6	ROPS and FOPS
	From lifting or transporting a truck	4.19	Transportation, lifting and towing
1.3	**Stabbing or puncture hazards**	4.2	Sharp edges and acute angles
		4.11	Design requirements for maintenance purposes
1.4	**High-pressure fluid ejection or ejection hazard**	4.3	Stored energy components
		4.12.2	Hydraulic system
		4.12.2.2	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	4.9.1	Exhaust systems
		4.13.3, 4.15.1	Hot parts
		4.18	Fire protection
	Damage to health by hot or cold working environment	4.13.5.1	Climatic conditions
3	**Hazards generated by noise**	4.20	Noise
4	**Hazards generated by materials**		
	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dust	4.9.1	Exhaust systems
		4.13.5.2	Heating and ventilation system
	Fire or explosion hazard	4.9.3.3	Fuel tanks
		4.18	Fire protection

Table A.1 *(continued)*

Hazard		Relevant subclause of ISO 20297-1:2017	
5	**Hazards generated by neglecting ergonomic principals in machinery design**		
	Unhealthy postures or excess effort	4.13.1	Operator station - General
		4.14	Operator access
		4.13.6	Operator's seat
		4.15.6	ROPS and FOPS
	Inadequate local lighting	4.13.5.7	Interior lighting system
	Human error, human behaviour	4.13.7	Marking of controls
		6.2	Operator's and maintenance manuals
6	**Unexpected start-up, unexpected overrun/overspeed**		
7	**Failure/disorder of the control system**	4.4.2	Unintended movement
		4.12.2	Hydraulic system
		4.12.3	Load holding
		4.11	Design requirements for maintenance purposes
8	**Failure of the power supply**	4.6	Failure of energy supply
9	**Errors of fitting**	4.3	Stored energy components
		4.11	Design requirements for maintenance purposes
		6.2.6	Transportation and storage of trucks
10	**Falling or ejected objects or fluids**	4.15	Protective measures and devices
		4.13.4	Pipes and hoses
11	**Loss of stability/overturning of machinery**		Tip over/overloading indicators
		4.16	Stability requirements
		6.5	Load chart
12	**Slips, trips and falls**	4.14.2.1	Operator access
	Additional hazards, hazardous situations and hazardous events due to mobility		
	Movement when starting the engine	4.4.2	Unintended movement
	— Layout of pedals	4.4.6	Pedal operated travel and braking controls
	— Additional operator positions		Multiple operating positions
	Movement without the driver at the driving position	4.4.4	Powered travel movement
13	**Linked to the work position on the truck**		
	Fall of persons during access to, at or from the work position	4.14.2.1	Operator access
	Exhaust gases/lack of oxygen at the work position	4.9.1	Exhaust system
	Mechanical hazards at the work position	4.13.5.2	Heating and ventilation system
	Fall of objects, penetration of objects	4.15.6	ROPS and FOPS
		4.13.4	Pipes and hoses
		4.12.6	Fork arms, attachments and attachment brackets
	Insufficient visibility from the work position	4.17	Visibility
		4.13.5.4	Wipers and washers
	Inadequate lighting	4.13.5.7	Interior lighting system

Table A.1 *(continued)*

Hazard		Relevant subclause of ISO 20297-1:2017	
	Inadequate seating	4.13.6	Operator's seat
	Noise at the work position	4.20	Noise reduction
	Vibration at the work position		Suspension seat vibrations
14	**Due to the control system**		
	Inadequate location of manual controls	4.8.1	Controls — General
	Inadequate design of manual controls and their mode of operation	4.8.1	Consistency with truck motions
15	**Due to the power source and the transmission of power**		
	Hazards from the engine and the batteries	4.9.1	Exhaust systems
		4.9.3.3	Fuel tanks
		4.7.5	Batteries
		6.2.4	Information covering the combustion-engine-driven trucks
	Hazards from coupling and towing	4.19.3	Towing
		6.2.3	Information covering the operational use of the truck
16	**From/to third persons**		
	Unauthorized start-ups	4.4.1	Unauthorized starting
		4.16	Stability requirements
		4.15.7	Audible warning device
		4.19.3	Towing
			Transportation
		5.2	Functional verification
		6.2.3	Information covering the operational use of the truck
Additional hazards due to lifting operation			
17	**Mechanical hazards and hazardous from load falls, collisions, machine tipping caused by**		
	Lack of stability	4.16	Stability requirements
	Uncontrolled loading, overloading, overturning moments exceeded		Tip-over/overloading indicators
		6.5	Load chart
		4.12.4	Maximum load-lowering speed
	Unexpected/unintended movement of loads	4.12.3	Load holding
			Multi-function controls
		4.12.2	Hydraulic system
		4.12.3	Load-handling controls
		4.12.6	Fork arms, attachments, and attachment brackets
	Insufficient mechanical strength of parts, from inadequate selection of chains, ropes, lifting and accessories, and their inadequate integration into the machine	4.12.1	Chains
		4.12.6	Fork-arm attachments and attachment brackets
		5.3	Structural verification
18	**Hazards generated by neglecting ergonomic principles/insufficient visibility when driving**	4.8.1	Controls — General
		4.17	Visibility