INTERNATIONAL STANDARD

ISO 3691-4

Second edition
2023-06

Industrial trucks — Safety requirements and verification —

Part 4: Driverless industrial trucks and their systems

Chariots de manutention — Exigences de sécurité et vérification —
Partie 4: Chariots sans conducteur et leurs systèmes

Reference number
ISO 3691-4:2023(E)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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Foreword

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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 document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

This document was prepared by Technical Committee ISO/TC 110, *Industrial trucks*, Subcommittee SC 2, *Safety of powered industrial trucks,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 150, *Industrial Trucks - Safety,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 3691-4:2020), which has been technically revised.

The main changes are as follows:

— the Scope has been updated to include a list of significant hazards not covered;

— the list of normative references has been updated to include the most recent editions of documents;

— the term entries "active detection field" and "operational stop" have been added to Clause 3;

— Clause 4, Clause 5, Clause 6, Annex A, Annex B and Annex C have been updated, with new requirements added in subclauses 4.1.16 to 4.1.27;

— the verification of the safety requirements lists in Annex E have been reworded.

A list of all parts in the ISO 3691 series can be found on the ISO website.

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

Introduction

This document is a type-C standard as stated in ISO 12100:2010.

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

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

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

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

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

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

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

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

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

The machinery concerned and the extent to which hazards, 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 type-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.

This document takes into consideration the current state of the art and especially:

— virtual bumper technology;

— hybrid (i.e. manual and automatic) mode trucks;

— performance level versus category;

— further specified clearances;

— guarding for specific zones.

Industrial trucks — Safety requirements and verification —

Part 4: Driverless industrial trucks and their systems

1 Scope

This document specifies safety requirements and the means for their verification for driverless industrial trucks (hereafter referred to as trucks) and their systems.

Examples of driverless industrial trucks (trucks as defined in ISO 5053-1:2020) include: “automated guided vehicle”, “autonomous mobile robot”, “bots”, “automated guided cart”, “tunnel tugger”, “under cart”, etc.

This document is also applicable to driverless industrial trucks which are provided with:

— automatic modes which either require operators’ action(s) to initiate or enable such automatic operations;

— the capability to transport one or more riders (which are neither considered as drivers nor as operators);

— additional manual modes which allow operators to operate the truck manually; or

— a maintenance mode which allows manual operation of truck functions for maintenance reasons.

This document is not applicable to trucks solely guided by mechanical means (rails, guides, etc.) or to remotely-controlled trucks, which are not considered to be driverless trucks.

For the purposes of this document, a driverless industrial truck is a powered truck, which is designed to operate automatically. A driverless truck system comprises the control system, which can be part of the truck and/or separate from it, guidance means and power system. Requirements for power sources are not covered in this document.

The condition of the operating zone has a significant effect on the safe operation of the driverless industrial truck. The preparations of the operating zone to eliminate the associated hazards are specified in Annex A.

This document is applicable to all significant hazards, hazardous situations or hazardous events during all phases of the life of the truck (ISO 12100:2010, 5.4), as listed in Annex B, relevant to the applicable machines when it is used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer.

In particular, this document does not apply to significant hazards related to:

— noise;

— vibrations;

— ionising and non-ionising radiation;

— laser radiation;

— sales literature (commercial documents);

— declaration of vibrations transmitted by mobile machinery.

It does not apply to additional hazards that can occur:

— during operation in severe conditions (e.g. extreme climates, freezer applications, strong magnetic fields);

— during operation in nuclear environments;

— from trucks intended to operate in public zones (see in particular ISO 13482:2014);

— during operation on a public road;

— during operation in potentially explosive environments;

— during operation in military applications;

— during operation with specific hygienic requirements;

— during operation in ionizing radiation environments;

— during the transportation of (a) person(s) other than (the) intended rider(s);

— when handling loads the nature of which can lead to dangerous situations (e.g. molten metals, acids/bases, radiating materials);

— for rider positions with elevation function higher than 1 200 mm from the floor/ground to the platform floor.

This document does not contain safety requirements for trailer(s) being towed behind a truck.

This document does not contain safety requirements for elevated operator trucks.

This document does not apply to trucks manufactured before the date of its publication.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 3691-1:2011 ISO 3691-1:2011/Amd 1:2020, *Industrial trucks — Safety requirements and verification — Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks*

ISO 3691-2:2023, *Industrial trucks — Safety requirements and verification — Part 2: Self-propelled variable-reach trucks*

ISO 3691-6:2021, *Industrial trucks — Safety requirements and verification — Part 6: Burden and personnel carriers*

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

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

ISO 5053-1:2020, *Industrial trucks — Vocabulary — Part 1: Types of industrial trucks*

ISO 7010:2019, ISO 7010:2019/Amd 1:2020, ISO 7010:2019/Amd 2:2020, ISO 7010:2019/Amd 3:2021, ISO 7010:2019/Amd 4:2021, ISO 7010:2019/Amd 5:2022 and ISO 7010:2019/Amd 6:2022, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 10896-1:2020, *Rough-terrain trucks — Safety requirements and verification — Part 1: Variable-reach trucks*

ISO 10896-2:2016, *Rough-terrain trucks — Safety requirements and verification — Part 2: Slewing trucks*

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

ISO 13849-1:2023, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design*

ISO 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation*

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

ISO 13851:2019, *Safety of machinery — Two-hand control devices — Principles for design and selection*

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

ISO 13856-3:2013, *Safety of machinery — Pressure-sensitive protective devices — Part 3: General principles for design and testing of pressure-sensitive bumpers, plates, wires and similar devices*

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

ISO 14119:2013, *Safety of machinery — Interlocking devices associated with guards — Principles for design and selection*

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

ISO 14122-2:2016, *Safety of machinery — Permanent means of access to machinery — Part 2: Working platforms and walkways*

ISO 15870:2000, *Powered industrial trucks — Safety signs and hazard pictorials — General principles*

ISO 22915-2:2018, *Industrial trucks — Verification of stability — Part 2: Counterbalanced trucks with mast*

ISO 22915-3:2021, *Industrial trucks — Verification of stability — Part 3: Reach and straddle trucks*

ISO 22915-4:2018, *Industrial trucks — Verification of stability — Part 4: Pallet stackers, double stackers and order-picking trucks with operator position elevating up to and including 1 200 mm lift height*

ISO 22915-5:2020, *Industrial trucks — Verification of stability — Part 5: Single-side-loading trucks*

ISO 22915-7:2016, *Industrial trucks — Verification of stability — Part 7: Bidirectional and multidirectional trucks*

ISO 22915-8:2018, *Industrial trucks — Verification of stability — Part 8: Additional stability test for trucks operating in the special condition of stacking with mast tilted forward and load elevated*

ISO 22915-9:2014, *Industrial trucks — Verification of stability — Part 9: Counterbalanced trucks with mast handling freight containers of 6 m (20 ft) length and longer*

ISO 22915-10:2023, *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 22915-11:2011, *Industrial trucks — Verification of stability — Part 11: Industrial variable-reach trucks*

ISO 22915-12:2015, *Industrial trucks — Verification of stability — Part 12: Industrial variable-reach trucks handling freight containers of 6 m (20 ft) length and longer*

ISO 22915-13:2012, *Industrial trucks — Verification of stability — Part 13: Rough-terrain trucks with mast*

ISO 22915-14:2010, *Industrial trucks — Verification of stability — Part 14: Rough-terrain variable-reach trucks*

ISO 22915-15:2020, *Industrial trucks — Verification of stability — Part 15: Counterbalanced trucks with articulated steering*

ISO 22915-17:2020, *Industrial trucks — Verification of stability — Part 17: Towing tractors, burden and personnel carriers*

ISO 22915-20:2023, *Industrial trucks — Verification of stability — Part 20: Additional stability test for trucks operating in the special condition of offset load, offset by utilization*

ISO 22915-22:2014, *Industrial trucks — Verification of stability — Part 22: Lateral- and front-stacking trucks with and without elevating operator position*

IEC 61496-2:2020, *Safety of Machinery — Electro-sensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)*

IEC 61496-3:2018, *Safety of machinery —Electro-sensitive protective equipment — Part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR)*

IEC 60204-1:2016+AMD1:2021, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC 61558-1:2017, *Safety of power transformers, power supply units, reactors and similar — Part 1: General requirements and tests*

IEC 62046:2018, *Safety of machinery - Application of protective equipment to detect the presence of persons*

EN 1175:2020, *Safety of industrial trucks — Electrical/electronic requirements*

EN 12895:2015+A1:2019, *Industrial trucks — Electromagnetic compatibility*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5053-1:2020 and ISO 12100:2010 and the following apply.

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

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

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

3.1
actuating force
force applied on the bumper that initiates a stop signal

3.2
authorized person
authorized personnel
authorized individual
person designated by the user, trained on specific hazards and if required, trained to operate or maintain the truck or system

3.3
automatic mode
operating mode where no operator intervention is required for the operation

3.4
bumper
pressure-sensitive protective device (PSPD) fitted to the truck that generates a signal to stop the truck upon physical contact

3.5
virtual bumper
electro sensitive (non-contact) protective equipment (ESPE) fitted to the truck, having one or more detection zones that generates a signal for the truck to take further actions when actuated

Note 1 to entry: Further action can include stopping the truck or changing its path or speed.

EXAMPLE Active opto-electronic protective devices responsive to diffuse reflection (AOPDDRs).

3.6
driverless truck system
combination of one (or more) driverless truck(s) and ancillary components to control and manage the automatic operation of the truck(s)

Note 1 to entry: Ancillary components can be integrated or external (e.g. guidance, traffic control, power system, communication system, guarding, signs, warnings, floor marking).

3.7
driverless industrial truck
powered truck, designed to operate automatically to transport loads

3.8
escape route
space provided for a person to exit away from the hazard(s)

3.9
path
area swept by the truck with its load including trailer(s)

3.10
load
item intended to be handled by the truck

3.11
load handling
load lifting, lowering, conveying and manipulating

EXAMPLE Rotation, reach, tilting, clamping and towing.

3.12
manual mode
operating condition where all operations are under the control of an operator

3.13
static force
force applied by the bumper when an automatic stop is completed

3.14
rider
intended rider
person on the truck in automatic mode with a rider who can enable or disable functions of the truck

3.15
stopping device
control device that when actuated, generates a signal to stop all movements of the truck

3.16
emergency stop device
manually actuated control device used to initiate an emergency stop function

[SOURCE: ISO 13850:2015, 3.3]

3.17
direction of travel
one or more directions of travel based upon the operating conditions of the truck as specified by the manufacturer

3.18
personnel detection means
system to detect persons in the path of a truck

3.19
rated speed
travel speed of the truck as specified by the manufacturer

3.20
automatic restart
resumption of the truck operation without outside input

Note 1 to entry: The truck starts only after the conditions which have stopped the truck have been cleared.

3.21
automatic mode with a rider
operating condition where (a) rider(s) is (are) present on the truck during automatic movement

3.22
confined zone
enclosed truck operating space that is intended to prevent access of persons

3.23
operating hazard zone
area of the operating zone in which a person can be exposed to a hazard

Note 1 to entry: This can be found in load transfer areas or low clearances.

Note 2 to entry: The operating hazard zone is considered a hazard zone according to ISO 12100:2010, 3.11.

3.24
operating zone
defined area in which a truck operates

Note 1 to entry: Examples of defined areas: areas signalled by navigation systems, signs, floor markings, fencings, guarding.

3.25
public zone
space opened to all persons without specific training, instruction or awareness

3.26
restricted zone
enclosed truck operating space that is intended to prevent access of unauthorized persons

3.27
method statement
safe system of work
document that details the way a work task or process is to be completed and outlines the hazards involved

Note 1 to entry: This can include a step by step guide on how to do the job safely and detail which control measures have been introduced to ensure the safety of anyone who is affected by the task or process.

3.28
load transfer area
location where a load can be picked up or deposited by the truck

Note 1 to entry: The location can be on the floor/ground (e.g. rack, machines and conveyors).

3.29
operator
designated person, appropriately trained and authorized to operate the truck

[SOURCE: ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 3.7, modified — In the definition, “who is responsible for the movement and load handling of an industrial truck” has been replaced with "to operate the truck”. Notes 1 and 2 have been removed.]

3.30
rider designated position
position on the truck that is specified by the manufacturer for (a) person(s) to safely ride on the truck

3.31
belt conveyor
conveyor with one or more endless belt(s) acting as a carrying and traction element

Note 1 to entry: The belt is supported by rollers or slides on a surface.

Note 2 to entry: The carrying belt may also be made of flexible elements.

[SOURCE: EN 619:2022, 3.7, modified — The reference to the figure has been removed.]

3.32
roller conveyor
conveyor with rollers as carrying elements

[SOURCE: EN 619:2022, 3.8]

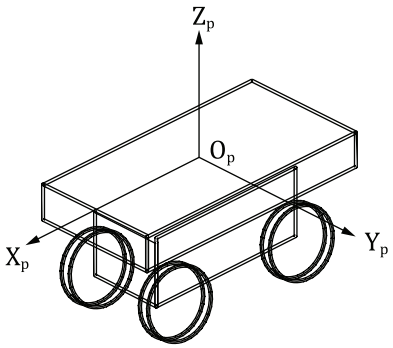
3.33
carrying-chain conveyor
conveyor with chains as traction and carrying elements, with or without tappets attached to the chains

[SOURCE: EN 619:2022, 3.9, modified — The reference to the figure has been removed.]

3.34
coordinate system of the truck
coordinate system (O_p – X_p – Y_p – Z_p) referenced to one of the components which enables the locomotion of the truck

Note 1 to entry: ISO 9787:2013, 5.5, specifies a mobile platform coordinate system, (O_p – X_p – Y_p – Z_p). The origin of the mobile platform coordinate system, O_p, is the mobile platform origin. The $+X_p$ axis is normally taken in the forward direction of the mobile platform. The $+Z_p$ axis is normally taken in the upward direction of the mobile platform.

Note 2 to entry: See Figure 1.



Key

O_p origin of the referential

NOTE This figure is adapted from ISO 9787:2013, Figure 6.

Figure 1 — Coordinate system of the truck

3.35
forward direction
movement of the truck following $+X_p$ axis

Note 1 to entry: See *coordinate system of the truck* (3.34).

Note 2 to entry: See Figure 1.

3.36
backward direction
movement of the truck following $-X_p$ axis

Note 1 to entry: See *coordinate system of the truck* (3.34).

Note 2 to entry: See Figure 1.

3.37
lateral direction
movement of the truck following the Y_p axis

Note 1 to entry: See *coordinate system of the truck* (3.34).

Note 2 to entry: See Figure 1.

3.38
crabbing direction
combined movement of the truck following the X_p and Y_p axes without changing the orientation

Note 1 to entry: See *coordinate system of the truck* (3.34).

Note 2 to entry: See Figure 1.

3.39
turning direction
movement that generates a change of the orientation of the truck coordinate system around the Z_p axis combined with a movement of the truck following the X_p and/or Y_p axis

Note 1 to entry: See *coordinate system of the truck* (3.34).

Note 2 to entry: See Figure 1.

3.40
pivoting direction
movement that generates a change of the orientation of the truck coordinate system around the Z_p axis, without movement of the truck following the X_p and/or Y_p axis

Note 1 to entry: See *coordinate system of the truck* (3.34).

Note 2 to entry: See Figure 1.

3.41
tiller
bar used by the operator on a truck for the purpose of steering

Note 1 to entry: It can incorporate other functions.

3.42
floor
ground
level, smooth, prepared surface to support the weight of a loaded truck

EXAMPLE Concrete, asphalt.

3.43
rated capacity
maximum load, expressed in kilograms, established by the manufacturer based on component strength and truck stability, that the truck can carry, lift and stack to the standard lift height and at the standard position of the centre of gravity

Note 1 to entry: For centre of gravity, see Annex C.

Note 2 to entry: If the lifting height of the mast is lower than the standard lift height *H*, the rated capacity is still assessed at the standard lift height.

Note 3 to entry: The rated capacity is used to compare the capacity of different manufacturers' trucks and to provide the break points used in technical standards and statistics. The operating limits for the truck are specified by its actual capacity.

[SOURCE: ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 3.15, modified — "Annex A" changed to "Annex C" in Note 1 to entry.]

3.44
actual capacity
maximum load, expressed in kilograms, established by the manufacturer based on component strength and truck stability that a truck can carry, lift and stack to a specified height, at a specified load centre distance and reach, if applicable, in normal operation

Note 1 to entry: The actual capacity depends on the configuration of the truck, including variables such as the type and lift height of the mast fitted, the actual load centre and any attachments that might be fitted. This actual capacity specifies the load-handling ability of the particular truck, as equipped. Additional actual capacity ratings with removable attachments can also be established where permitted by the appropriate stability tests or by calculation verified by empirical data.

[SOURCE: ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 3.14]

3.45
protective stop
safety-related stop function initiated by a protective device

3.46
truck speed
speed of the fastest moving point of the truck and its load(s)

3.47
braking system
combination of parts which fulfil one or more of the following functions:

— control (usually to reduce) a vehicle's speed,

— bring the vehicle to a halt or hold it stationary

[SOURCE: ISO 611:2003, 3.2]

3.48
fixed closed structure
structure acting as a guard and preventing persons from entering or reaching into the path

Note 1 to entry: This structure is mainly providing a peripheral guard, and composed of walls, panels, fences.

3.49
muting
temporary automatic suspension of a safety function

3.50
override
manual suspension of a safety function

3.51
deactivation
action to make a function no longer active

Note 1 to entry: This can be a manual or automatic action.

3.52
active detection field
area of surveillance currently monitored by the virtual bumper

3.53
operational stop
function to stop the truck until a deliberate restart action with the possibility of maintaining the power on the actuators

4 Safety requirements and/or protective/risk reduction measures

4.1 General

4.1.1 Overall requirements

The truck shall conform to the safety requirements and/or protective 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.

Zones where the trucks operate shall conform to the requirements specified in Annex A.

Annex E shall be followed to verify the health and safety requirements of this clause.

4.1.2 Normal climatic conditions

The following climatic conditions apply:

— average ambient temperature for continuous duty: +25 °C;

— maximum ambient temperature, short term (up to 1 h): +40 °C;

— lowest ambient temperature for trucks intended for use in normal indoor conditions: +5 °C;

— lowest ambient temperature for trucks intended for use in normal outdoor conditions: –20 °C;

— altitude: up to 2 000 m.

4.1.3 Electrical requirements

Safety-related parts of the control system shall conform to the performance levels of ISO 13849-1:2023, as mentioned in Table 3.

Trucks shall conform to EN 1175:2020, 4.3.8, 4.3.9 and Annex C to prevent explosion risk related to electrical energy.

In addition, the requirements of driverless trucks shall conform as follows.

a) Rough-terrain variable-reach and slewing trucks

— Rough-terrain variable-reach and slewing trucks shall conform to the requirements in either ISO 10896-1:2020, 4.3 and 4.4.7.3 for non-slewing trucks or ISO 10896-2:2016, 4.4 and 4.5.3.2 for slewing trucks.

b) Trucks other than rough-terrain variable-reach and slewing trucks

— Trucks with a manual mode, shall conform to:

— the requirements from EN 1175:2020, except Performance Levels, as specified in Table 1, and,

— for the items not covered by EN 1175:2020, the requirements from IEC 60204-1:2016+AMD1:2021 as specified in Table 2.

These requirements also apply to straddle carriers.

— Trucks without manual mode, shall conform to the requirements from IEC 60204-1:2016+AMD1:2021 as specified in Table 2.

Table 1 — Electrical requirements from EN1175:2020

	Subclauses from EN 1175:2020
General (Electricity supply)	4.1, 4.3.3, 4.3.4, 4.3.5, 4.4, 4.7, 4.9.1, 4.10, 5, Annex A, Annex B, Annex C, Annex D, Annex G
Starting	4.5, 4.6, 4.9.2.6
Failure of power supply	4.3.1, 4.3.3, 4.5, 4.6, 4.7, 4.8.3, 4.9.1, 4.9.2.3
Isolation of energy sources	4.3.6, 4.4, 4.9.1, 6, Annex A
Batteries	4.4, 4.10, 5, Annex C
Fire	4.3.7, 4.3.8, 4.3.9, 4.9.1, Annex A, Annex B, Annex C, Annex D, Annex G

Table 2 — Electrical requirements from IEC 60204-1:2016+AMD1:2021

	Subclauses from IEC 60204-1:2016+AMD1:2021
General (Electricity supply)	All except 4.3.2, 4.4.5, 5.3.5, 6.2.5, 6.2.6, 6.3.3, 7.2.2, 9.1.1, 9.4.3.1.2, 9.4.3.1.4, 9.4.3.1.5, 11.5, 18.2.4
Starting	7.3.1, 7.5, 9.2.3.2, 9.3.1
Failure of power supply	5.4, 7.5
Isolation of energy sources	5.3, 10.8

4.1.4 Stored energy components

Components which store energy and that would pose a hazard during removal or disassembly (e.g. hydraulic accumulator, capacitors or spring applied brakes) shall be provided with means to release the energy before removal or disassembly.

4.1.5 Edges or angles

There shall be no sharp edges or angles posing a hazard in the area of the:

a) rider in the normal operating position;

b) operator in the operating position;

c) access required for periodic (e.g. daily) checks.

4.1.6 Guards

Technical principle for guards shall conform to ISO 12100:2010. Guards shall conform to ISO 14120:2015.

Safety distances shall conform to ISO 13857:2019. In addition, safety distances to prevent reaching over protective structures shall conform to ISO 13857:2019, Table 2. In addition, continuous fixed closed structures shall have a minimum height of 2,1 m.

4.1.7 Interlocking devices for guards

Interlocking devices associated with guards shall conform to ISO 14119:2013.

4.1.8 Two-hand control devices

Two-hand control devices shall conform to ISO 13851:2019.

4.1.9 Transmission parts

Transmission parts such as drive shafts, couplings and belt drives, which are within the reach of a person, shall be protected with fixed guards.

4.1.10 Electro-sensitive protective equipment

Electro-sensitive protective equipment (ESPE) shall conform to IEC 61496-2:2020 or IEC 61496-3:2018.

4.1.11 Pressure-sensitive protective devices

Pressure-sensitive protective devices shall conform to ISO 13856-2:2013 and ISO 13856-3:2013 and 5.2.

4.1.12 Hydraulic systems

Hydraulic systems and their components shall conform to ISO 4413:2010.

4.1.13 Pneumatic systems

Pneumatic systems and their components shall conform to ISO 4414:2010.

4.1.14 Avoidance of automatic restart

Trucks shall be designed in such way that an automatic restart is not permitted after the actuation of any of the following:

a) emergency stop device;

b) short stroke bumper, see 4.8.2.1 e);

c) presence of the operator as described in 4.9.2.1 and 4.9.3 (e.g. seat, tiller, handles, foot pedal);

d) manual control commands (e.g. throttle, steering wheel, joystick), see 4.9.3.1 c);

e) reachable stop function according to Table A.1 and Table A.2 where Table A.1 and Table A.2 prohibit automatic restart.

Trucks shall be designed in such way that an automatic restart is not permitted after interruption of power.

4.1.15 Foot protection

Means shall be provided to avoid injury to the feet of persons standing nearby the truck.

Examples of measures are:

a) following manufacturer specifications of ESPE concerning additional stopping distances margins for feet;

b) reducing the clearance between the ground and the chassis to equal to or less than 40 mm in order to avoid feet from being trapped under the chassis;

NOTE 1 The 40 mm value reflects persons wearing safety shoes; lesser values can be applied.

NOTE 2 The value of 40 mm is taken from FEM 4.102:2017, 3.1.3.

c) ensuring foot clearance below the chassis according to ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, Figure 5. This will prevent contact with the drive and stabilizing wheels.

4.1.16 Transport of the truck and removable attachments

For trucks having a weight greater than 25 kg, the following points apply.

— For trucks intended to be lifted without disassembling, means for lifting and/or slinging points shall be provided and shall be indicated on the truck and/or in the instruction handbook (see 6.2). This requirement also applies to parts of the truck with a weight greater than 25 kg.

— For trucks intended to be transported without disassembling, means for tying-down shall be provided and shall be indicated on the truck and/or in the instruction handbook (see 6.2).

Means for lifting or tying-down and their locations shall be indicated on the truck and/or in the instruction handbook.

Locations for the slinging of a removable attachment shall be provided and shall be indicated on the attachment and/or in the instruction handbook (see 6.2).

Slinging points and tie down points for transportation of a removable attachment shall be arranged such that unexpected movement is prevented as long as the attachment is handled in accordance with the instruction handbook.

NOTE 1 Information concerning transport can be found in 6.2, 6.3 and 6.4.

NOTE 2 The value of 25 kg is taken from ISO 11228-1:2021, 4.2.3.2.

4.1.17 Seats

Where a manual mode with a rider or automatic mode with a rider is provided, seats shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.7.1, 4.7.4, or

— ISO 3691-2:2023, 4.7.1, 4.7.2, or

— ISO 3691-6:2021, 4.6.3.

4.1.18 Means of access

Where a manual mode with rider or automatic mode with a rider is provided, means of access shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.7.2, or

— ISO 3691-2:2023, 4.7.4, or

— ISO 3691-6:2021, 4.6,

as applicable.

4.1.19 High temperatures

Protective measures against risks related to high temperatures shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.5.3.1, 4.7.6, or

— ISO 3691-2:2023, 4.5.4.1, 4.7.6, or

— ISO 3691-6:2021, 4.5.3.1, 4.6.4.

4.1.20 Exhaust emissions

Protective measures against risks related to exhaust emissions shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 6.2.4, 6.2.5, or

— ISO 3691-2:2023, 6.2.4, 6.2.5, or

— ISO 3691-6:2021, 6.2.2.3.

4.1.21 Access and emergency exit

The truck shall be designed or fitted with a means of preventing a person from being enclosed within it.

Where provided, a cabin shall have an access and an emergency exit conforming to ISO 2867:2011. The emergency exit, which may be a window, shall allow escape in a different direction than that of the normal exit.

4.1.22 Driving position

Where a manual mode is provided, the following requirements apply:

a) visibility shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.10.1, or

— ISO 3691-2:2023, 4.10.1, or

— ISO 3691-6:2021, 4.9.1;

b) protection against inadvertent contact with the wheels and tracks shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.7.5, or

— ISO 3691-2:2023, 4.7.5, or

— ISO 3691-6:2021, 4.6.3.4;

c) storage of instruction handbook in driver's cabin shall conform to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.11.1.7, or

— ISO 3691-2:2023, 4.11.10, or

— ISO 3691-6:2021, 4.10.1.6.

4.1.23 Electrostatic charges

The truck shall either be designed to prevent the build-up of electrostatic charges, or means to evacuate those charges shall be provided (e.g. straps, braiding tape, chains, conductive tyres).

4.1.24 Protective structures

A protective structure as required by and conforming to:

— ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.9.1, 4.9.2, or

— ISO 3691-2:2023, 4.9.1, 4.9.2

shall be provided where the truck has at least one of the two following modes:

— automatic mode with a rider (see 4.9.2.3);

— manual mode with operator in case there is a dedicated operator position on the truck (see 4.9.3.1).

4.1.25 Errors of fitting

Where incorrect connections can lead to a hazard, the incorrect connection shall be prevented (e.g. by different connectors or coded connectors). Alternatively, connectors shall be labelled.

4.1.26 Normal stop

The truck shall be fitted with a control device (e.g. key switch) whereby the truck can be brought safely to a complete stop. Each operator control station shall be fitted with a stopping device. The truck's stop control shall have priority over the start controls. Once the truck or its hazardous movements have stopped, the energy supply to the actuators concerned shall be removed.

NOTE A normal stop is an operator intervention made locally to the truck to prevent further movement.

4.1.27 Operational stop

Where the truck is fitted with an operational stop, when actuated, the truck shall remain at a standstill until there is a deliberate action by a restart command device on the truck (for example, a person depressing a button). Where the truck is in operational stop, it shall be clearly indicated. Once the truck has stopped, this standstill shall be monitored by the safety-related control system. Fault of the safety-related monitored stop function shall result in a stop category 0 (as specified in IEC 60204-1:2016+AMD1:2021, 9.2.2).

The safety-related parts of the operational stop shall be in accordance with Table 3, item 0.

4.2 Braking system

The truck shall be equipped with a braking system that is designed to do the following:

a) operate on the interruption of the power supply;

b) activate automatically at the loss of control of the speed or steering;

c) stop the truck within the operating range of the personnel detection means as specified in 4.8.2 in the worst condition in the limits specified by the manufacturer (e.g. speed, friction, floor/ground, gradient, rated load);

d) maintain the truck and its maximum permissible load stationary on the maximum operational gradient of the floor as specified by the manufacturer.

The safety-related parts of the braking systems shall be in accordance with Table 3, item 1 and item 2.

4.3 Speed control

4.3.1 Overspeed detection

A stop shall be initiated when the truck speed exceeds the rated speed specified by the manufacturer.

4.3.2 Speed and stability

Speed shall be monitored to ensure stability according to 4.7.

The safety-related parts of the speed control system (4.3.1 and 4.3.2) shall be in accordance with Table 3, item 3 and item 8.

4.4 Automatic battery charging

Automatic charging connections rated above 60 VDC or 25 VAC shall be designed to prevent shock hazards arising from accidental contact with live parts in accordance with IEC 61558-1:2017.

A truck equipped with an automatic charging system shall be designed such that the reachable charging contacts are only activated when the truck is connected to the charging device.

Where the truck is removed from the charging points, the charging contacts of the truck shall be disconnected from the battery prior to the traction movement.

The safety-related parts of these systems shall be in accordance with Table 3, item 9.

4.5 Load handling

The load-carrying device shall be so designed that the load stays within the limits of position(s) determined by the manufacturer in any operational mode, including during an emergency or protective stop, and load transfer. This can be achieved by integrating clamps, mechanical locks, stops, etc.

As an alternative, means shall be provided to prevent the truck from moving when the load is not in the designated position on the load carrying device as determined by the manufacturer. This can be achieved by integrating a camera, sensing device, switch, etc.

Systems for lifting and tilting shall conform to ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.6.

The safety-related parts of the control systems performing these functions shall be in accordance with Table 3, items 10, 11 and 12.

4.6 Steering

The safety-related parts of the controls for the steering system shall be in accordance with Table 3, item 13.

4.7 Stability

4.7.1 General

The truck shall remain stable in all operating conditions and during all load-handling and travelling movements, including during an emergency or protective stop.

The safety-related parts of the controls for stability shall be in accordance with Table 3, item 14.

4.7.2 Tilting platform stability test

Stability for trucks with lift height more than 500 mm, shall be tested according to the applicable standard(s) below:

— ISO 22915-2:2018, Clause 5,

— ISO 22915-3:2021, Clause 5,

— ISO 22915-4:2018, Clause 5,

— ISO 22915-5:2020, Clause 5,

— ISO 22915-7:2016, Clause 5,

— ISO 22915-8:2018, Clause 5,

— ISO 22915-9:2014, Clause 6,

— ISO 22915-10:2023, Clause 5,

— ISO 22915-11:2011, Clause 5,

— ISO 22915-12:2015, Clause 6,

— ISO 22915-13:2012, Clause 5,

— ISO 22915-14:2010, Clause 5,

— ISO 22915-15:2020, Clause 5,

— ISO 22915-17:2020, Clause 5,

— ISO 22915-20:2023, Clause 5,

— ISO 22915-22:2014, Clause 5.

The stability of trucks lifting less than 500 mm shall be tested according to the test requirements specified for travelling by the appropriate International Standard for stability for a similar truck design equipped with a mast, or see 4.7.3.

4.7.3 Stability requirements for trucks not covered by 4.7.2

When trucks are designed only for a specific pre-determined automated task in a specified operating space and conditions, the truck shall conform to 5.3.2 when tested.

Conformance to the specified stability values can be determined by calculation. Calculation shall be based on empirical data for similar trucks. Such calculations shall take into account manufacturing variations and deflections of mast, tyres, etc.

4.8 Protective devices and complementary measures

4.8.1 Emergency stop

Trucks shall be provided with an emergency stop function that conforms to ISO 13850:2015. The emergency stop shall function either as a stop category 0 or as a stop category 1.

When the emergency stop device is actuated, all truck movements shall stop and power to the actuators shall be removed.

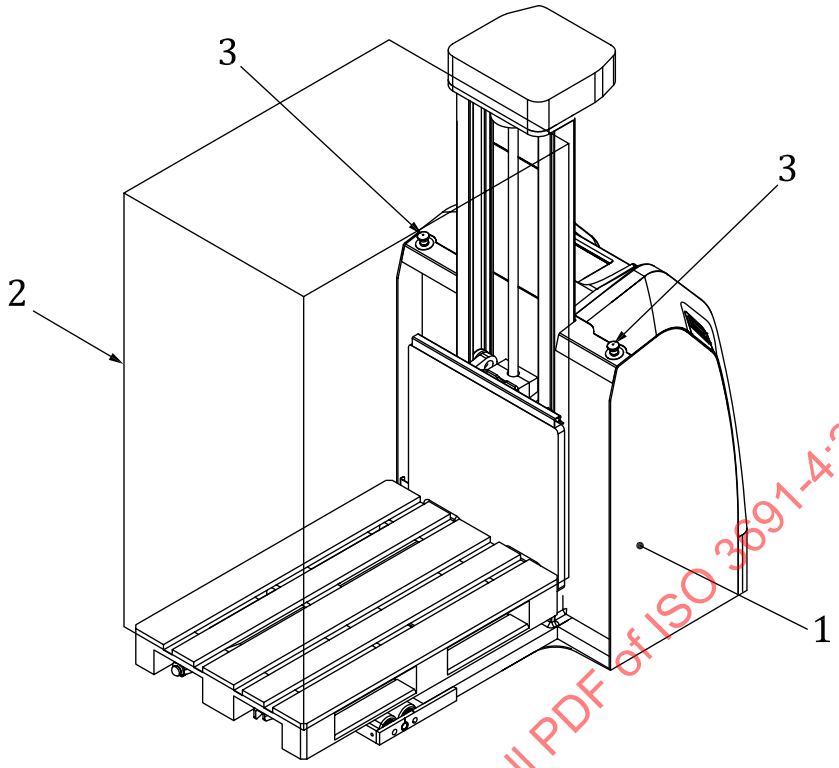
To avoid creating additional hazards it can be necessary to maintain the power to some machine actuators even after stopping the movement (for example power clamping the load) (see ISO 13850:2015, 4.1.1.5).

The emergency stop devices shall be clearly visible, identifiable and accessible from both ends and both sides of the truck. Emergency stop devices shall be fitted at maximum distance of 1 200 mm of each other on each side of the truck.

If the truck has a specified operator position with controls, an emergency stop device shall be fitted near these controls.

However, in the case of trucks carrying a load that restricts access to the emergency stop device(s), the emergency stop device(s) shall be mounted on accessible rigid part(s) of the truck closest to the hazard zone (see Figure 2, for example).

The safety-related parts of the control system for the emergency stop function shall be in accordance with Table 3, item 15.



Key

1 truck
2 load
3 emergency stops on both sides

Figure 2 — Example of emergency stops positions in case of truck with a load on fork side

4.8.2 Detection of persons in the path

4.8.2.1 Detection of persons in the intended path in automatic mode

The safety-related parts of the detection of persons in the intended path in automatic mode shall be in accordance with Table 3, items 4, 16, 17 and 20.

Trucks shall be fitted with personnel detection means; the following requirements apply.

a) Trucks shall be fitted with pressure-sensitive device according to 4.1.11 (e.g. bumpers) or ESPE (e.g. virtual bumpers) according to 4.1.10 for the detection of persons.

b) Personnel detection means shall operate at least over the maximum width of the truck and its load in the direction(s) of travel.

c) Personnel detection means shall be so designed that trucks shall stop before contact between the rigid parts of the truck or load and a stationary person (not a person stepping into the truck path or moving toward it) and conform to 5.2 or in case of contact they shall be designed such that forces shall not exceed the values of 5.2. In turning direction and in pivoting direction, for the truck side protection measures, conformance to 5.2, Test B, is sufficient.

d) When the truck has stopped due to the detection of a person in its path, and after the person has moved out of the detected range of the detecting devices mounted on the truck, the truck may restart automatically following appropriate warnings (e.g. optical and/or acoustic). If a pressure-sensitive protective device (PSPD) is fitted, a minimum delay of 2 s before restart is required.

Automatic restart shall only be possible according to the “automatic restart permitted” column of Tables A.1 and A.2.

NOTE Warning systems are specified in 4.14.

e) In the direction(s) of the actuation of the protective device where all the requirements a), b) and c) cannot be met (e.g. where the stroke of the bumper is too short or where the load extends over the sides when the truck is under it while towing or carrying the load), the following shall apply:

i) in the actuation direction, the truck speed shall not exceed 0,3 m/s;

ii) an additional stop function shall be provided if required by Table A.1 or Table A.2. In addition:

— an additional stop command device shall be installed on the truck or in the environment;

— the actuation means for this device shall be accessible within 600 mm from the hazardous point.

4.8.2.2 Measures in cases where 4.8.2.1 is not fully applicable

Where trucks are working within an operating hazard zone (area of the operating zone in which a person can be exposed to a crush/shearing hazard, for example, at load transfer areas) and the safety measures of 4.8.2.1 have to be limited or deactivated, then the following requirements shall be met:

a) if there is an escape route (at least 0,5 m wide and 2,1 m high for a pedestrian), refer to Tables A.1 and A.2 for the maximum speed limit, warnings (acoustic and/or optical), the automatic restart function and classification of the zone;

b) if there is no escape route for a pedestrian as specified in a), then refer to Tables A.1 and A.2 for the maximum speed limit, warnings (e.g. acoustic and/or optical), the automatic restart function and the classification of the zone. An additional stop function shall be implemented:

i) a personnel detection function shall be implemented and activated in order to check that the hazard zone is free of personnel. If a person is detected and the truck has stopped, automatic restart is not allowed in the same direction;

ii) if the personnel detection function cannot be implemented, an additional stop function if required by Table A.1 or Table A.2 shall be provided. This function shall be initiated by a device installed within 600 mm from the hazardous point on the truck (e.g. point of contact on or with the truck or cause of entrapment) or in the surrounding environment.

4.8.2.3 Muting of the personnel detection means

Muting function shall conform to IEC 62046:2018, 4.7.3 and 5.7.

In certain load transfer conditions, it can be necessary to mute the personnel detection means.

Personnel detection means shall be muted as late as possible to ensure the absence of persons, for example less than 180 mm from an object (e.g. load, interface, transfer station, fixed structure, block stacking).

Muting of the personnel detection system in the automatic mode is only allowed in speeds equal to or less than 0,3 m/s.

The safety-related parts of the muting of the personnel detection means shall be in accordance with Table 3, item 19.

4.8.2.4 Override of the personnel detection means

Override of the personnel detection system is only allowed in the manual or maintenance mode.

The safety-related parts of the override of the personnel detection means shall be in accordance with Table 3, item 18.

4.8.2.5 Deactivation of the personnel detection means

The personnel detection means can be automatically deactivated when a truck is working in a confined zone (according to A.2.4). The personnel detection means can be deactivated in manual mode of operation on a truck with a specified operator position (see 4.9.3.1) or tiller (see 4.9.3.2), because of the mode selection.

The safety-related parts of the deactivation of the personnel detection means shall be in accordance with Table 3, item 18.

4.8.2.6 Selection of the active detection fields

Trucks can have an automatic selection of the active detection fields based on truck speed and direction, size of the load or other criteria. This automatic selection of the active detection fields of the ESPE is part of the personnel detection system.

The selection of the active detection fields (in which the detection of a person shall trigger the protective stop function) can depend on the conditions that affect the stopping performance of the truck (e.g. loaded or unloaded, narrow or wide load, position of the truck in different zones).

Where this function is provided, the safety-related parts of the control system shall be designed such that they do not decrease the overall performance of the detection of the persons in the path as stated in Table 3.

The safety-related parts of the selection of the active detection zone fields shall be in accordance with Table 3, items 5, 6, 7, 21 and 22.

4.9 Modes of operation

4.9.1 General

Trucks can have different operating modes.

The following modes, if foreseen, shall be selected with a mode selector:

— automatic mode;

— manual mode;

— maintenance mode.

The mode selector shall prevent both unauthorized and unintentional mode selection. Unauthorized and/or unintentional mode selection shall be prevented by suitable means (e.g. by lockable key switch, code, magnetic card).

Actuation of the mode selector shall only enable the selected mode and shall not initiate truck operation by itself. A separate activation shall be required to initiate truck operation.

The selected mode shall be clearly indicated.

In case of a mode selection method other than a mechanical lockable selector (for example code keypad, RFID card reader, magnetic card reader) with restrictions for operating the truck, the manual mode can be selected by taking the tiller of a pedestrian truck (according to 4.9.3.2), stepping on the platform of a ride-on truck or sitting on the driver seat (according to 4.9.3.1).

NOTE 1 See 4.9.3 for more explanations about operations by operator.

NOTE 2 See 4.9.2.3 for more explanations about operations by the rider.

The safety-related parts of the modes of operation shall be in accordance with Table 3, item 25.

4.9.2 Automatic mode

4.9.2.1 Configuration

Automatic mode may have three configurations:

a) automatic mode (no operator nor rider);

b) automatic mode with an operator input;

c) automatic mode with a rider.

When trucks are not designed to have automatic mode with an operator input, and provisions are made for an operator position (e.g. tiller, seat, platform), the presence of the operator shall deactivate all automated functions and shall initiate a protective stop.

When trucks are not designed to have automatic mode with a rider, and provisions are made for a rider position, the presence of the rider shall deactivate all automated functions and shall initiate a protective stop.

The safety-related parts of the automatic mode of operation shall be in accordance with Table 3, item 25.

4.9.2.2 Automatic mode with an operator input

During the automatic mode, manual operations may be permitted between two fully automatic sequences. Then, the truck shall stop at designated positions and manual operation shall be under the following conditions:

a) the truck shall stand still and wait for an input from an operator;

b) controls shall be of the “hold to run” type;

c) when manual controls are activated, it shall not be possible to start the next sequence in automatic mode;

d) the manual controls shall provide means of stopping all movement;

e) where the operator’s position is not determined by the design of the truck, any motion of moving parts (e.g. forks, attachments) shall be safeguarded by guards according to 4.1.6. Otherwise, the truck shall conform to ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.4.2.6;

f) the translation and pivoting of the truck are not allowed during the operation;

g) the restart of the next sequence in the automatic mode is only possible after a voluntary action of the operator.

The safety-related parts of the automatic mode with an operator input shall be in accordance with Table 3, items 24 and 25.

4.9.2.3 Automatic mode with a rider

During the automatic mode, persons may ride on the trucks, for example during setting operations or to travel long distances, with the following conditions:

a) the truck shall stop automatically at designated locations;

b) the person/rider shall initiate the automatic mode with rider by a voluntary action;

c) means shall be provided to detect the rider at the rider’s designated position;

d) when the rider is in the designated position, the selection of the automatic mode will activate the automatic mode with a rider;

e) stopping means shall be provided within the reach of the rider;

f) rider's designated position shall be designed to prevent hazardous situations, considering the truck acceleration and deceleration forces (e.g. padding, operator restraint, compartment design);

g) means shall be provided to keep the rider(s) within the designated position while riding on the truck, [e.g. two-hand control device (according to ISO 13851:2019, 3.1), foot position sensing, fully-enclosed cabin];

h) when the rider is no longer in the designated position, the truck shall come to a protective stop;

i) rider position with an elevation function shall not be higher than 1 200 mm from the floor/ground to the platform floor.

The safety-related parts of the automatic mode with a rider, shall be in accordance with Table 3, items 23 and 25.

4.9.3 Manual mode

4.9.3.1 Manual mode with operator

During the manual mode, persons may operate the trucks (e.g. during setting operations).

Where the truck is designed to be operated manually (not for the maintenance mode specified in 4.9.4), a manual mode shall be fitted. This manual mode shall conform to the general functional principle for manual controls as specified in ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.4; ISO 3691-2:2023, 4.4; ISO 3691-6:2021, 4.4 and with all the following requirements:

a) manual controls shall be of the "hold to run" type and shall be designed to allow only intentional manual operations;

b) manual controls shall be located at the intended operator's position;

c) release of a manual control shall not cause selection of the automatic mode;

d) the operator leaving their position shall not cause selection of the automatic mode;

e) the manual controls shall provide means of stopping all movement;

f) personnel detection means may be deactivated.

The safety-related parts of the manual mode with operator shall be in accordance with Table 3, item 26.

4.9.3.2 Pedestrian-controlled trucks with tiller

When a tiller is provided for the operation in the manual mode, the following shall apply:

a) for travel and braking controls, ISO 3691-1:2011 and ISO 3691-1:2011/Amd 1:2020, 4.4.2 shall apply;

b) automatic operation shall be possible only when the tiller is in the manufacturer's specified position;

c) return of the tiller to the manufacturer's specified position shall not actuate the automatic mode;

d) moving the tiller to the manual operating position shall stop all automated functions.

The safety-related parts of the pedestrian control truck with tiller mode shall be in accordance with Table 3, item 27.

4.9.4 Maintenance mode

Where the truck is also designed to operate in maintenance mode, when in maintenance mode the following shall apply:

a) manual controls shall be of the “hold to run” type and shall be designed to allow only intentional manual operations;

b) manual controls shall be located at the intended operator’s position;

c) personnel detection means shall remain active unless there is an intentional action taken by an authorized person;

d) restrictions or override of personnel detection means are possible only if all the following additional requirements are applied:

   1) an additional mode selector to override personnel detection systems shall be fitted (e.g. by key, code, magnetic card);

   2) restrictions to hazardous operations (e.g. travel speed reduction or load handling speed restrictions) or their combinations shall be applied;

   3) the maintenance mode of the truck shall be designed so that the maximum maintenance traction speed shall not exceed:

      i) 0,7 m/s when lifting height is lower than 1 m or when the truck doesn’t have lifting function;

      ii) 0,3 m/s when lifting height is from 1 m up to 5 m;

      iii) 0,1 m/s when lifting height is over 5 m.

e) deactivation of the maintenance mode shall not cause an activation of the automatic mode.

The safety-related parts of the maintenance mode shall be in accordance with Table 3, item 24.

4.10 Trucks intended to tow trailers

Before start-up, an acoustical and/or optical signal shall be given automatically for at least 2 s. Start-up speed shall be limited to 0,3 m/s for at least 5 s and the distance equal to 500 mm plus the maximum gap between the trailers or trailer and the truck, whichever is greater.

Trucks intended to tow trailers shall be fitted with towing or coupling devices designed, constructed and arranged to reduce hazardous connections and disconnections and prevent accidental disconnection during use.

Towing and coupling devices shall be designed:

a) to withstand the traction force and compression effort (e.g. when the truck is braking);

b) for the maximum carried load.

4.11 Safety-related parts of the control system

Safety-related parts of the control system shall conform at least to the performance levels listed in ISO 13849-1:2023, Table 2.

Table 3 — Minimum performance level (PL) of safety-related parts of the control systems in accordance with ISO 13849-1:2023

Subclause in this document	Item number	Cross-reference in this document	Description of the safety function (or a part of safety function)	Main risk	Note	Minimum required PL according to ISO 13849-1:2023
4.1.27 Operational stop	0	4.1.27	Monitoring movement during the standstill of an operational stop.	Collision with person.	Control system that ensures that the truck does not move.	c
4.2 Braking system	1	4.2	Braking system control.	Collision with person.	PL function controls the deceleration function.	d
	2	4.2 d)	Ensure disengagement of braking system while driving.	Unintended motion of the truck: risk of collision. Reduction of braking performance if the battery is disconnected (unlikely).	PL function controls that brake is disengaged in order to avoid continuous braking when travelling. (Wear and release of the brake to be checked with periodic maintenance).	b
4.3 Speed control	3	4.3.1 4.3.2	Over-speed detection system (speed > truck rated speed).	Collision with person. Personnel detection not efficient due to over speed.	PL monitors that truck speed is not over the maximum rated speed. In case of malfunction, a stop shall be activated.	c
	4	4.8.2.1	Speed monitoring in case of speed < 0,3 m/s.			c
	5	4.8.2.6	Adaption of the sizes of the active detection fields of an ESPE for linear movements (e.g. forward direction, backward direction, lateral and crabbing directions).	Collision with person. Personnel detection not efficient due to different speed vs personnel detection.	Assure that the personnel detection field is consistent with actual truck speed. Travel speed monitoring can be performed by the personnel detection means.	d

Table 3 *(continued)*

Subclause in this document	Item number	Cross-reference in this document	Description of the safety function (or a part of safety function)	Main risk	Note	Minimum required PL according to ISO 13849-1:2023
	6	4.8.2.6	Adaption of the sizes of the active detection fields of an ESPE in turning and pivoting. No speed limitation in the related direction of travel.		No speed limitations.	d
	7	4.8.2.6	Adaption of the sizes of the active detection fields of an ESPE. For additional side fields in the turning and pivoting when truck speed is limited at 0,7 m/s in the related directions of travel (x and/or y) (side speed).	Collision with a person in case a wrong safety measure is selected.	All information needs to achieve the required PL. Assure that the personnel detection field is consistent with actual truck speed. Travel speed monitoring can be performed by the personnel detection means.	c
	8	4.3.1 4.3.2	Stability. See item 14.	Stability of the truck.	Assure the speed control vs stability, see item 14.	—
4.4 Automatic battery charging	9	4.4	Deactivation of charging connections.	Electrical risk.	For truck charging points they shall be disconnected prior to the truck traction movement.	b
4.5 Load handling	10	4.5 4.13.1	Checking if the load is in the intended position.	Unintended fall of a load. Loss of stability. Undetected personnel.	Only if a potential safety risk can appear: if an unintended position of the load occurs, a protective stop shall be activated.	b
	11	4.5 4.13.1	Load handler position and motion.	Unintended event (e.g. fall of a load).	Only if a potential safety risk can appear: if an unintended position of the load occurs, a protective stop shall be activated.	b

Table 3 *(continued)*

Subclause in this document	Item number	Cross-reference in this document	Description of the safety function (or a part of safety function)	Main risk	Note	Minimum required PL according to ISO 13849-1:2023
	12	4.5	Link with item 14, Stability.	Stability of the truck.	Assure the load handling vs stability; see item 14.	—
4.6 Steering	13	4.6	Link with item 14 Stability.	Stability of the truck.	Assure the steering speed control vs stability; see item 14.	—
4.7 Stability	14	4.7.1	Avoiding instability caused by speed, steering and load handling.	Stability of the truck.	Only if a potential safety risk can appear: PL control combination among stability parameters (e.g. steering speed, traction speed, load handling) are within the stability requirements.	c
4.8.1 Emergency stop	15	4.8.1	Stop hazardous movements and functions.	Intended emergency stop by a person.	Emergency stop of the truck traction and brake. Stop of all movements.	d
4.8.2 Detection of persons in the path	16	4.8.2.1	Stop the truck following the detection of a person in the direction(s) of travel.	Collision with person.	Protective stop of the truck after the detection of a person in the path.	d
	17	4.8.2.1	Stop the truck following a person detection with inadequate clearance. See Tables A.1 or A.2.	Collision with person.	Assure the personnel detection zone, the bumpers or virtual bumpers, covers the free space between the truck and the fixed closed structure, to within 180 mm from the fixed closed structure (see A.2.2).	d

Table 3 *(continued)*

Subclause in this document	Item number	Cross-reference in this document	Description of the safety function (or a part of safety function)	Main risk	Note	Minimum required PL according to ISO 13849-1:2023
	18	4.8.2.4 4.8.2.5	Override of the personnel detection means in manual mode (4.9.3) or maintenance mode (4.9.4).	Collision with person.	May require PL = d due to links to other functions that require PL = d.	c
	19	4.8.2.3	Muting of the personnel detection means.	Collision with person.	In the automatic mode, muting of the personnel detection means is not possible for a speed > 0,3 m/s.	d
	20	4.8.2.1	Stop of the truck from the load end. EXAMPLE Block storage	Crushing a person.	Protective stop of the truck after the detection of a person or the emergency stop actuated. If the stop function with PL is not possible, see 4.8.2.2 b) and Table A.1/ Table A.2.	d
	21	4.8.2.6	Conditional selection of personnel detection means protected zones.	Collision with person.	Selecting the correct field can depend on several conditions (loaded/unloaded; narrow load/wide load; different zones from A.1/A.2).	d
	22	4.8.2.6	Conditional selection of personnel detection means protected zones for additional side fields in the turning and pivoting when truck speed is limited at 0,7 m/s in the related directions of travel (x and/or y) (side speed).	Collision with a person.	Selecting the correct field can depend on several conditions (loaded/unloaded; narrow load/wide load; different zones from A.1/A.2).	c

Table 3 *(continued)*

Subclause in this document	Item number	Cross-reference in this document	Description of the safety function (or a part of safety function)	Main risk	Note	Minimum required PL according to ISO 13849-1:2023
4.9 Modes of operation	23	4.9.2.3	Detection that a rider who is intended to ride on the trucks remains in the intended position.	Fall of the person or cutting risks.	If the rider leaves the intended position, the truck shall initiate a protective stop.	d
	24	4.9.2.2 4.9.4	"Hold to run" function (except the automatic mode).	Fall of the load or cutting risks due to unexpected movements or collision with a person.	No movement if the "hold to run" control is not actuated.	c
	25	4.9.1 4.9.2 4.9.2.2 4.9.2.3	Where trucks are not designed to have automatic operation with an operator or rider mode, and provision is made for an operator position, the presence of the operator shall deactivate all automated functions.	Fall of the person or cutting risks.	If personnel are on the truck in a rider designated position, the truck shall initiate a protective stop.	c
	26	4.9.3.1	Manual mode.		Covered by the ISO 3691 series.	—
	27	4.9.3.2	Tiller position in the automatic mode.	Collision with person.	If the tiller is not in a rest position, the truck shall stop.	c
4.14 Warning systems	28	4.14	Optical, acoustical signals/ systems.	—	—	a
A.2.4.3 Access into the confined zone	29	A.2.4.3 a)	Perimeter guarding.	Collision with person.	Personnel detection means of a stop.	d

4.12 Electromagnetic immunity

The truck shall conform to EN 12895:2015+A1:2019, 4.2 for immunity.

NOTE Requirements for electromagnetic compatibility (EMC) concerning emissions are not covered by this document.

4.13 Conveyors fitted to a truck

4.13.1 Trucks fitted with conveyors

Where trucks are fitted with conveyors, all of the following shall apply:

a) the conveyors shall be stopped before any travelling of the truck;

b) the emergency stop device(s) fitted to stop the truck shall also stop the conveyors simultaneously;

c) the conveyor shall be either designed:

   i) so that the load cannot move from the positions determined by the manufacturer in any operational mode, including an emergency stopping and load transfer; or

   ii) means shall be provided to prevent the truck from moving when the load is not in the designated position on the load carrying device as determined by the manufacturer (e.g. camera, sensing device, switch).

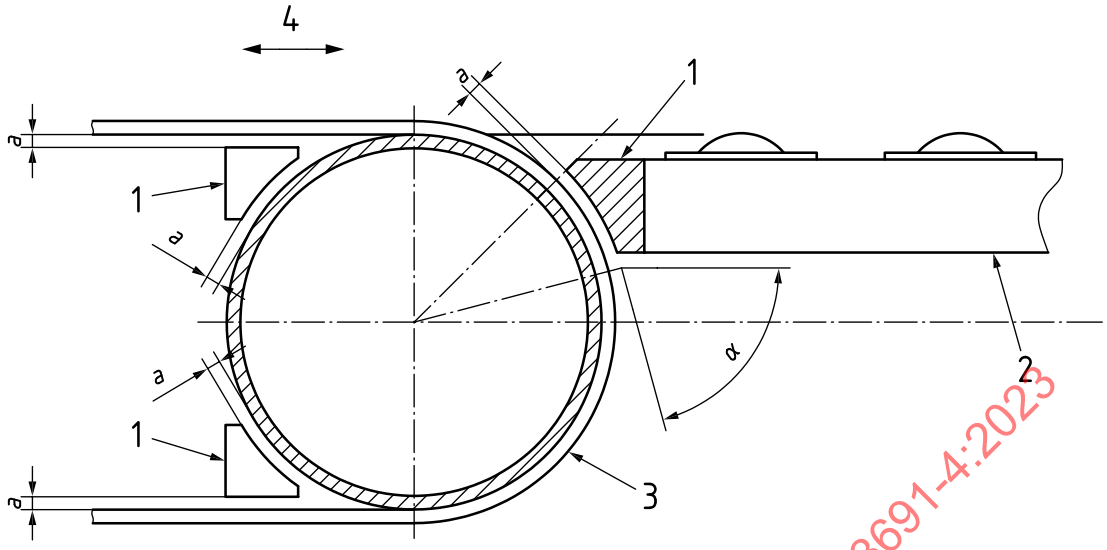
The safety-related parts of the controls of the trucks fitted with conveyors shall be in accordance with Table 3, items 10 and 11.

4.13.2 Conveyors

Hazardous points on a roller conveyor or a carrying-chain conveyor shall be protected by lateral guards (casings).

Hazardous points on a belt conveyor shall be protected either by fixed guards according to 4.1.6 or by nip guards.

The drawing-in points are considered to be avoided if they are fitted with nip guards which shall be designed to provide a continuous maximum gap of 5 mm between rotating components and fixed/rotating components (e.g. fixed components of horizontal or vertical transfer points, feed points, diverting points, horizontal and vertical transfer devices and gates). In addition, the angle between the fixed part and the moving part shall be minimum 80° (see Figure 3).



Key

1 protective device
2 table
3 belt conveyor
4 moving direction
$a \leq 5$ mm
$\alpha \geq 80°$

Figure 3 — Nip guards

Load handling on a conveyor shall conform to 4.5.

4.14 Warning systems

The warning systems shall conform to ISO 12100:2010, 6.4.3.

When the truck starts any movement after a stop condition longer than 10 s, a visible and/or acoustical warning signal shall be activated at least 2 s prior to the start of any movement, including any moving part of the truck (e.g. forks, conveyors, parts protruding from the load). A visible and/or acoustical warning signal shall be active during any movement, including any moving part of the truck (e.g. forks, conveyors). This signal may be the same signal as the warning signal prior to the start of movement.

If personnel detection means are not active, the visible and/or acoustical warning signal shall be different from the prior to the start of movement signal and moving signal.

The visible and acoustical signal shall be designed taking into account the environmental conditions (e.g. noise, light, brightness).

When the truck changes its travel direction from a straight path, a visible indication of the direction to be taken shall be given (e.g. turning signals) prior to the change of direction.

6.2.3 l) specifies required information related to visual and acoustic signals.

The safety-related parts of the warning systems shall be in accordance with Table 3, item 28.

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

5.1 General

Trucks shall be inspected to ensure that all relevant requirements of Clause 4, especially the operation of automated functions, warning and personnel detection means are appropriately identified and operate as intended. Annex E shall be followed to verify health and safety requirements of this clause.

Verification of the required performance level of safety-related parts of the control system shall be performed in accordance with ISO 13849-2:2012, 9.6.

In case of a series of identical trucks, a representative sample of trucks may be tested.

5.2 Tests for detection of persons

Person detection means requirements of 4.8.2 shall be verified as follows.

When testing the safety functions of detection means, each safety function shall be tested independently, so no other functions with different performance levels influence the results of the test (e.g. slow down fields that slow down the truck before the stopping field is activated).

For pressure-sensitive protective devices, the test methods of ISO 13856-2:2013, Clause 7 and ISO 13856-3:2013, Clause 7 are modified as follows: location and applicable test pieces and actuating forces are those described hereafter in test A and test B.

For ESPE fitted on trucks, test pieces referenced in Test A and Test B shall have an external surface reflectance from 2 % to 6 % and optical density of 1,22 (e.g. black) or greater.

Trucks shall be tested in the worst-case condition(s) (e.g. loaded, slope, turn, forward direction, backward direction) in combination with truck predetermined parameters in those case conditions.

Test shall be performed with at least 110 % of the manufacturer's specified rated capacity at maximum speed for each personnel detection means and setting as specified by the manufacturer (e.g. multiple fields). The manufacturer's specified rated capacity shall be determined in accordance with Annex C.

Test A

A cylindrical test piece with a diameter of 200 mm and a length of 600 mm shall be placed horizontally on the floor/ground and perpendicular to the direction of travel of the truck. This test shall be repeated with the test piece once at the positions left, centre and right (see Figure 4). The truck shall approach the test piece and shall stop before a contact is made between the test piece and the rigid parts of the truck or its intended load.

For contact-actuated detection means, the test piece shall be fixed relative to the floor/ground to prevent movement upon the contact and the actuating force on the test piece shall not exceed 750 N.

Test B

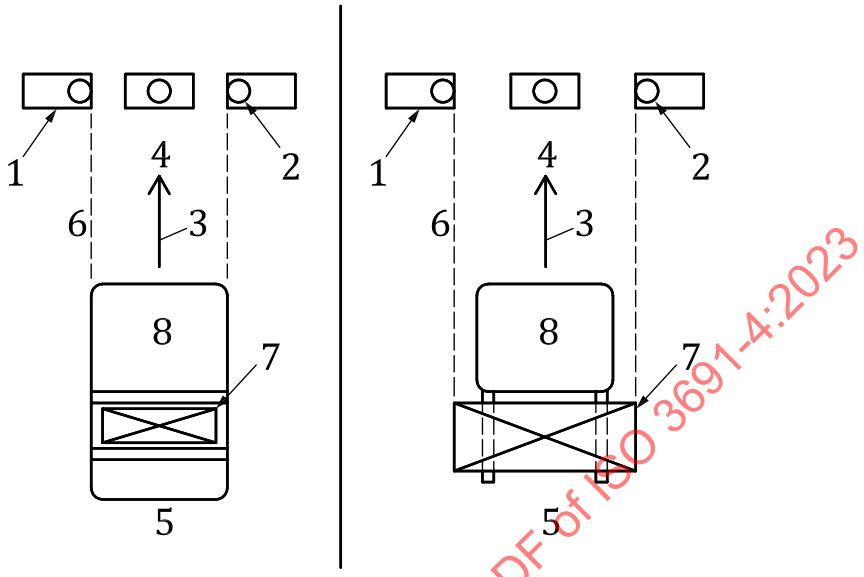
A cylindrical test piece with a diameter of 70 mm and a length of 400 mm shall replace the test piece described in Test A. The test piece shall be set vertically (see Figure 4).

The truck shall approach the test piece and shall stop before a contact is made between the test piece and the rigid parts of the truck or its intended load. This test shall be repeated three times, once at the centre-line of the detection zone and once at each end.

For contact-actuated detection means, the test piece shall be fixed relative to the floor/ground to prevent movement upon the contact and the actuating force on the test piece shall not exceed 250 N. The

static force when the bumper is compressed to the position reached in a bumper stop from a maximum energy (maximum combination of speed and gross truck weight including load) shall not exceed 400 N.

NOTE For Tests A and B, peak forces are not considered.



Key

1 test piece (A)
2 test piece (B)
3 direction of truck travel
4 truck path
5 rear of the truck
6 edge of truck path
7 load
8 truck

Figure 4 — Example of tests in certain direction of travel

5.3 Stability tests

5.3.1 General

Tests to verify stability shall be conducted according to 4.7.2. In case of a series of identical trucks, a representative sample of trucks may be tested.

5.3.2 Stability tests for trucks not covered by 4.7.2

The stability requirements of 4.7.3 shall be verified as follows.

The truck shall be tested in the worst-case condition(s) (e.g. loaded, unloaded, lift height, slope, turn, forward direction, backward direction, floor/ground slope) in combination with truck predetermined parameters in those case conditions (e.g. emergency braking deceleration, speed, controlled acceleration and deceleration, lifting speed).

Tests shall be performed with at least 110 % of actual capacity and either:

a) at least 110 % of predetermined speed for the truck configuration; or

b) at the maximum reachable speed, in case 110 % of predetermined speed cannot be reached.

The test shall not result in a hazard (e.g. tipping or sliding).

The truck is considered stable if it passes all tests without tip-over or meets the requirements by calculation. When comparing calculated and test values, the test values are considered the true measure of stability.

5.4 Fitness for purpose

5.4.1 General

The tests described in 5.4.2 and 5.4.3 shall be performed on each truck. They may be performed on representative samples for trucks produced in series where the production techniques employed and where a duly documented quality control system make it possible to guarantee that every machine produced will have identical characteristics.

5.4.2 Structural tests

The structural components of the truck and its attachments shall carry static loads of 1,25 Q_1 and 1,25 Q_2 for 15 min each, where:

— Q_1 is the rated capacity at the standard lift height and standard load centre distance in accordance with the information on the capacity plate;

— Q_2 is the actual capacity at the maximum lift height in accordance with the information on the capacity plate.

The truck shall be on a substantially level ground with the mast in the substantially vertical position and may be anchored to prevent tip-over.

The loads may be applied at the corresponding height by means independent of the truck. The test shall not result in any optical permanent deformation or damage.

For variable reach trucks, structural tests shall be in accordance with ISO 3691-2:2023, 5.2.

5.4.3 Dynamic tests

5.4.3.1 Purpose

The purpose of this test is to demonstrate the overall structural integrity in dynamic condition of the loaded truck. This test shall be performed on all individual trucks when fully assembled in worst-case conditions.

For trucks produced in series where the production techniques employed and the application of a duly documented quality control system make it possible to guarantee that every truck produced will have identical characteristics when fully assembled, dynamic tests on adequate samples of the truck are considered as fulfilling the requirement.

5.4.3.2 Test procedure

Trucks shall be tested at 100 % of each of these two capacities, Q_1 and Q_2, in a complete operating cycle, at maximum lowering speed as specified by the manufacturer, from a stationary position with a fully retracted (if applicable) load handling device (e.g. forks) to the relevant positions specified below, and back again.

Q_1 is the rated capacity at the standard lift height and standard load centre distance in accordance with the information on the capacity plate; and

Q_2 is the actual capacity at the maximum lift height in accordance with the information on the capacity plate.

The test is conducted as follows:

— bring Q_1 to fully retracted and maximum lifted position;

— bring Q_2 to maximum height.

For variable reach trucks, dynamic tests shall be in accordance ISO 3691-2:2023, 5.2.3.

In order to perform this test safely, the truck is to be secured to the ground.

5.4.3.3 Acceptance criteria

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

6 Information for use

6.1 General

Information for use shall be provided in accordance with ISO 12100:2010, 6.4.

NOTE Information for use is an integral part of the design of a driverless truck system and consists of:

a) signals and warning devices;

b) markings, signs (warning labels) and written warnings;

c) accompanying documents (e.g. instruction handbook).

6.2 Instruction handbook

6.2.1 General

The manufacturer shall provide an instruction handbook in accordance with ISO 12100:2010, 6.4.5.

The instruction handbook shall provide information on whether personal protection equipment is necessary.

6.2.2 Concerning the trucks and system

The instruction handbook(s) shall include at least the following information:

a) name and address of the manufacturer or, where applicable, the authorized representative;

b) designation of the series or type;

c) description of the system;

d) description of the truck type;

e) description of the instructions and warning labels;

f) for trucks intended to tow trailers, at least the following:

   1) maximum speed for the train,

   2) maximum slope,

   3) maximum tow-weight (in kg),

   4) relevant requirements for the trailers (e.g. dimensions, wheels),

5) height of the towing device,

6) kind of towing device (e.g. coupling ball, hook),

7) the maximum supporting force on the tow-hook (in N),

8) the drawbar pull (in N) and the period of time during which this pull can be exerted;

g) for trucks intended to lift loads, at least the following additional information:

1) the technical characteristics of the machinery, and in particular the maximum working load and, where applicable (e.g. where the position of the lifting system can restrict the capability of the load that can be lifted), a copy of the capacity plate or load chart (see information plates in 6.3.3),

2) a test report detailing the static (according to 5.4.2) and dynamic tests (according to 5.4.3) carried out by or for the manufacturer or their authorized representative;

h) procedure for truck reassembly and mounting of attachments.

6.2.3 Operation of the trucks and system

The instruction handbook(s) shall include at least the following information:

a) required training and competency of operating personnel;

b) intended uses of the system;

c) intended use of the controls;

d) function of the operating controls and displays for the trucks and system;

e) scheduled checks related to the safe operation of the truck and system (e.g. lights, brakes and alarms, personnel detecting);

f) warning of risk to personnel during systems operation (e.g. during load transfer);

g) instructions to prevent unauthorized use;

h) manufacturer's designated positions for all modes of operation (see 4.9);

i) the need for additional risk-reduction measures to be applied by the user where visibility restriction can create hazards;

NOTE Measures in the operating zone can include but are not limited to: visible or acoustical warnings triggered by a truck, special rules and/or controls at intersections with other traffic speed reductions, acoustical warnings, visible warnings, traffic lights.

j) information or instructions regarding modification of the truck, which may introduce hazards or risks not considered by manufacturers and can invalidate the existing truck risk assessment;

k) for restricted zones and for confined zones, instructions that the safeguarding of the zone shall not be reset before all persons have left these zones;

l) the meaning of warning systems (each visual and acoustic signal).

6.2.4 Routine service and maintenance of the trucks and system

Routine service and maintenance manual(s) shall include at least the following information:

a) required training and competency of person(s) undertaking servicing and maintenance;

b) procedure for the identification or detection of defects;

c) type, frequency and method of inspections and maintenance operations;

d) servicing operations for which no particular skills are required;

e) use of approved spare parts to be used, when they affect safety;

f) diagrams considered necessary for servicing and maintenance of the truck(s) and system;

g) instructions for verification that markings (e.g. decals) are in place and legible;

h) warning about modifications which can affect the safe operation;

i) use of manual controls for maintenance;

j) additional risks associated with speeds in the maintenance mode;

k) instructions for changing tyres or wheels;

l) instructions for de-energizing of stored energy components;

m) access for maintenance while working at height;

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

o) instructions for removing and reattaching guarding;

p) use of special tools or equipment if required for performing service and maintenance;

q) instructions related to maintenance mode (e.g. setting speeds of equipment).

6.2.5 Operating information

Specifications of the intended load to be handled (e.g. integrity, mass, dimensions and position) shall be provided so that the user can conform to them, thereby ensuring the operation of the truck is done as intended.

Stability conditions of use (see 4.7.2 and 4.7.3) shall be provided.

6.2.6 Information for the application

At least the following information shall be provided:

a) cleanliness and condition of paths and floor/ground markings;

b) freedom of paths from obstacles which can impede truck movements and limit the clearance in routes;

c) removal of spillage, dusts, ice, etc. from paths to avoid the risk of trucks skidding, especially during emergency braking;

d) maintenance of operating conditions of the floor/ground and equipment interfacing with trucks;

e) stopping distance test, including how to perform the test and examples of parameters that can affect the stopping distance [see 6.2.4 a)];

f) cleanliness of sensors and navigation way points (reflectors);

g) warning for persons moving towards a moving truck;

h) warning for persons stepping into the path of the truck from the side.

6.2.7 Details for floor/ground conditions

Floor/ground specifications shall include requirements for the following characteristics (as applicable):

a) flatness;

b) strength;

c) surface finish (e.g. reflectivity, friction coefficient and abrasion resistance);

d) floor/ground capping (e.g. drains, covering);

e) metal content;

f) underfloor/underground services and their locations;

g) electrical conductivity;

h) joint position and quality;

i) permitted different level of floor/ground (e.g. grades, slopes, gaps, steps).

6.2.8 Details for power sources

The instruction handbook(s) shall include, where applicable, at least the following information:

a) specification of approved power sources and on-board power source chargers;

b) procedure for safe handling of power sources, including installation, removal and secure mounting on the truck;

c) warning of risks of accumulation of explosive gases (e.g. under covers);

d) power source charging procedures and instructions;

e) description of power source (e.g. model designation, centre of gravity, service mass) and ballast when required;

f) specific instructions for the marking of the charging/refilling area.

6.2.9 Truck modification

Truck modification outside Europe can be subject to regional requirements; see ISO/TS 3691-8:2019.

6.3 Minimum marking

6.3.1 Marking

Marking shall be prominently positioned, legible and indelible (e.g. water resistant).

6.3.2 Warning signs

6.3.2.1 Warning signs for trucks

Warnings shall be in accordance with ISO 15870:2000.

If the truck is designed for an operator or operators to ride on the truck, the following warning shall be fitted in the language of the user or in symbols:

ONLY AUTHORIZED PERSONS MAY RIDE ON THIS TRUCK

Otherwise:

RIDING ON THIS TRUCK IS PROHIBITED

Symbols giving warnings of remaining hazards shall be affixed to the truck and attachments on, or in close proximity to, the hazard concerned. On stored energy devices (see 4.1.4), a warning label and the method for removing any stored energy shall be affixed to that component and noted in the service handbook.

6.3.2.2 Warning signs for the operating zones

The operating hazard zone shall be marked by a clear visible floor/ground marking and/or suitable signs. Confusion with other markings and signs (e.g. existing markings or signs) shall be avoided.

NOTE See ISO 7010:2019, ISO 7010:2019/Amd 1:2020, ISO 7010:2019/Amd 2:2020, ISO 7010:2019/Amd 3:2021, ISO 7010:2019/Amd 4:2021, ISO 7010:2019/Amd 5:2022 and ISO 7010:2019/Amd 6:2022 for suitable signs.

Restricted or confined zones shall be marked by a clear visible floor/ground marking at least at the boundaries of the zones where an access is available (e.g. zone with physical boundaries such as wall, machines, etc.).

Access for restricted and confined zones shall be equipped with the following warning, which shall be fitted in the language of the user or in symbols in Table 4.

Table 4 — Symbols

Symbol	Reference	Title
	ISO 7010-M002	Refer to instruction manual/booklet
	ISO 7010-P004	No thoroughfare

6.3.3 Information plates

The information plate(s) shall bear the following details:

a) name and address of the manufacturer or where applicable the authorized representative;

b) designation of machine: (e.g. driverless truck);

c) designation of the series or type or model;

d) mandatory marking;

e) year of construction;

f) serial or identification number;

g) unladen mass of the truck in working order and without removable attachments, and without battery in the case of battery-powered trucks, but with fork arms or integral attachments, the actual mass being permitted to vary from the stated mass by up to +5 % or 1 000 kg, whichever is the lower of the two;

h) rated capacity;

i) maximum dimensions of the load;

j) actual capacity at the maximum lift height with load centre distance. Where a secondary lift is fitted to a truck, the capacity at the maximum lift height shall be determined with the secondary mast fully elevated;

k) actual capacities at other lift heights and load centre distances, if applicable;

l) these actual capacities being visible from outside of the truck. For trucks also controlled by an operator, the capacity plate shall be readable by the operator in the normal operating position of the truck;

m) on trucks with removable batteries or other power sources, the authorized maximum and minimum battery or power source mass and the system voltage;

n) if fitted, the maximum supporting force on the towing point connection (in N);

o) if fitted, the rated drawbar pull on the towing point connection (in N);

p) nominal power in kW (e.g. marked on the engine or electric motor).

6.4 Putting into service (commissioning)

Commissioning of the truck and system shall be carried out in accordance with the technical information and the method statement supplied by the manufacturer.

The following instructions shall be provided:

a) a method statement including the necessary information and instructions for the commissioning sequence;

b) the necessary technical (e.g. mechanical and electrical) information and instructions for commissioning the truck (e.g. load specification);

c) details of any special training which is required for that purpose and the instruction to make the commissioner aware of the hazards involved;

d) recommendation of floor/ground marking during commissioning and permanent floor/ground marking at handover.

Annex A
(normative)

Requirements for preparation of the operating zones

A.1 General

This annex establishes minimum requirements for the preparation of the zones so that the truck(s) can safely operate.

When a truck travels along a continuous fixed closed structure preventing persons from entering or reaching into the path, speed and other data in Table A.1 shall be applied.

When a truck travels near to a fixed structure or an object different from a continuous fixed closed structure preventing persons from entering or reaching into the path, truck speed and other data in Table A.2 shall be applied. See Figures A.1 and A.2 for examples of clearances.

A.2 Zones

A.2.1 Operating zone

A minimum clearance of 0,5 m (width) and 2,1 m (height) shall be provided on both sides of the path. This shall be measured between the path and adjacent fixed structures along the path.

A.2.2 Operating hazard zone

A zone of inadequate clearance (see A.2.1) or a zone which cannot be protected by personnel detection means shall be designated "operating hazard zone" (see Table A.1 and Table A.2) and marked accordingly. An operating hazard zone shall be marked according to 6.3.2.2.

In this operating hazard zone, the truck speed shall be in accordance with Table A.1 and Table A.2 and the truck shall emit additional acoustical and/or optical warnings.

If there is inadequate clearance and no pedestrian escape route of at least 0,5 m wide and 2,1 m high (see Table A.1 and Table A.2, with the clearance dimensions C.1, C.2 and C.3), then personnel detection means shall be active until the distance between the edge of the active ESPE detection fields and the surrounding objects (e.g. block storages) is equal to or less than 180 mm in order to ensure this zone is free of persons.

EXAMPLE One example of an operating hazard zone can be the load transfer area (see A.2.5).

A.2.3 Restricted zone

A.2.3.1 General

A zone of inadequate clearance (see A.2.1) and that cannot be protected by personnel detection means according 4.8.2.1 shall be designated a "restricted zone" (see Table A.1 and Table A.2) and marked accordingly.

EXAMPLE Examples of restricted zones can be a block storage or a very narrow aisle (VNA).

A restricted zone shall:

a) be marked according to 6.3.2.2;

b) have access restricted to authorized personnel trained on the specific hazards;

c) not include any work place;

d) be fitted with perimeter fixed guards conforming to 4.1.6 and ISO 13857:2019, Table 2 and Table 4, at least 2,1 m high;

e) be fitted with a moveable guard (e.g. door) conforming to A.2.3.2 to provide access for the authorized personnel.

A.2.3.2 Pedestrian access

A moveable guard (e.g. door) in the restricted zone shall be designed with the following requirements:

a) to be opened outwards from the restricted zone;

b) cannot be opened from the outside except with a key or other means of identification;

c) to be opened from inside without a key;

d) with dimensions according to ISO 14122-2:2016, 4.2.2 (door with dimensions of 2,1 m height and 0,8 m width).

A.2.3.3 Truck speed

In the restricted zone, the truck speed shall be in accordance with Tables A.1 and A.2 and the truck shall emit additional audible and/or optical warnings.

A.2.3.4 Truck access to/from the restricted zone

Accesses for trucks shall be fitted with the ESPE conforming to 4.1.10 and with the additional requirements below:

a) a muting function according to IEC 62046:2018, 4.7.3 and 5.7 that shall mute this ESPE to enable the passage of those trucks allowed to enter or exit the restricted zone shall be provided. Muting of this ESPE shall end as soon as practicable for example less than 180 mm after the passage of the truck or the load, whichever is bigger;

b) where the ESPE is actuated, resuming of truck speed or truck restart shall only be possible when the ESPE is reset and after a manual restart command from outside the restricted zone by an authorized person. If the entire visibility of the hazard zone is not possible, means shall be provided to allow verification that all persons have left the restricted zone (e.g. directly or by visual aids such as mirror or camera systems [closed-circuit television, CCTV]);

c) any detection by this ESPE of a person or an unidentified object shall reduce the speed of all trucks in the restricted zone according to Table A.1 or Table A.2 for operating hazards or initiate a stop of all the trucks in the restricted zone.

A.2.4 Confined zone

A.2.4.1 General

A zone where the personnel detection means may be omitted and where any speed is allowed. This zone shall be designated “confined zone” and marked accordingly.

The confined zone shall:

a) be marked according to 6.3.2.2;

b) have access restricted to authorized personnel;

c) not include any work place;

d) be fitted with perimeter fixed guards conforming to 4.1.6 and ISO 13857:2019, Table 2 and Table 4, at least 2,1 m high;

e) be fitted with a moveable interlocked guard with guard locking (door) conforming to A.2.4.2 to provide access for the authorized personnel.

A.2.4.2 Pedestrian access for authorized personnel

A door that is considered as a moveable interlocked guard with guard locking shall be fitted. The interlocking device shall conform to 4.1.7. The interlocking device shall stop the truck when opening the door.

This door shall be designed with the following requirements:

a) opening outwards from the confined zone;

b) the door cannot be opened from the outside except with a key or other means of identification;

c) openable from inside without a key even if it is closed and locked;

d) for restarting the truck, the following steps shall be taken:

   i) the guard (door) shall be closed and locked;

   ii) it shall be verified by an authorized person that no persons are in the confined zone (e.g. visual check, camera, sensors);

   iii) a manual restart command (e.g. by key, code, magnetic card) from outside the confined zone shall be given by an authorized person.

A.2.4.3 Truck access to/from the confined zone

The truck access(es) to/from a confined zone shall be safeguarded with an ESPE conforming to 4.1.10 and with the following requirements:

a) a muting function according to IEC 62046:2018, 4.7.3 and 5.7 that shall mute this ESPE to enable the passage of those trucks allowed to enter or exit the confined zone. Muting of this ESPE shall end as soon as practicable after the passage of the truck;

b) actuation (tripping) of the ESPE shall result in the stop of those trucks for which the safety depends upon their operation in a confined zone. The safety-related parts of this function shall conform to Table 3, item 29;

c) where the ESPE is actuated, resuming of truck speed or truck restart shall only be possible when the ESPE is reset and after a manual restart command from outside the confined zone by an authorized person. If the entire visibility of the hazard zone is not possible, means shall be provided to allow verification that all persons have left the confined zone (e.g. directly or by visual aids such as mirror or camera systems [CCTV]).

Tables A.1 and A.2 are not applicable to a confined zone.

A.2.5 Load transfer area

The area shall be so arranged that the load transfer operation(s) can take place only at the designated location(s) and truck position(s).

Where the load transfer area is not designed to prevent personnel to be endangered, the area shall be considered as an operating hazard zone.

NOTE Information/examples for load transfer operations are given in Annex D.

Table A.1 — Required zone classification and other requirements in areas with continuous fixed closed structures, considering clearances and personnel detection means

	Clearance between the truck and its load against the continuous fixed closed structure[d]		Clearance from the current position to the fixed closed structure/object in the direction of travel, C3	Personnel detection means in travel direction (PLd)	Max speed[e]	Required zone classification[a]	Reachable stop function required within 600 mm	Floor/ground marking or extra warnings required	Automatic restart permitted
	Clearance on one side, C1 mm	Clearance on the other side, C2 mm	mm						
1a	> 500	> 500	> 500	ACTIVE	Rated speed	Operating	NO	NO	YES
1b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
2a	> 500	> 500	< 500	ACTIVE[f]	0,7 m/s	Operating hazard	NO	YES	YES
2b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
3a	> 500	< 500 and > 100	> 500	ACTIVE	1,2 m/s	Operating hazard	NO	YES	YES
3b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
4a	> 500	< 500 and > 100	< 500	ACTIVE[f]	0,7 m/s	Operating hazard	NO	YES	YES
4b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]

[a] Table A.1 is not applicable to confined zones.

[b] In these specific cases, automatic restart is permitted without personnel detection means if side clearance is > 500 mm on at least one side or clearance is > 500 mm from the current position to the fixed closed structure/object in the direction of travel.

[c] Refer to 4.8.2.1 e) ii).

[d] In cases where side clearance is less than 100 mm, the distance may be measured between the truck and load physical side and the continuous fixed closed structure or between the end of the bumper and the continuous fixed closed structure.

[e] For increased speeds, see zone definitions.

[f] Personnel detection means muting may apply according to 4.8.2.3.

Table A.1 *(continued)*

	Clearance between the truck and its load against the continuous fixed closed structure[d]		Clearance from the current position to the fixed closed structure/object in the direction of travel, C3	Personnel detection means in travel direction (PLd)	Max speed[e]	Required zone classification[a]	Reachable stop function required within 600 mm	Floor/ground marking or extra warnings required	Automatic restart permitted
	Clearance on one side, C1 mm	Clearance on the other side, C2 mm	mm						
5a	> 500	< 100	> 500	ACTIVE	Rated speed	Operating	NO	NO	YES
5b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
6a	> 500	< 100	< 500	ACTIVE[f]	0,7 m/s	Operating hazard	NO	YES	YES
6b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
7a	< 500 and > 100	< 500 and > 100	> 500	ACTIVE	1,2 m/s	Operating hazard	NO	YES	NO
7b				MUTED	0,3 m/s	Restricted	NO	YES	—[b]
8a	< 500 and > 100	< 500 and > 100	< 500	ACTIVE[f]	0,3 m/s	Operating hazard	YES[c]	YES	NO
8b				MUTED	0,3 m/s	Restricted	YES[c]	YES	NO
9a	< 500 and > 100	< 100	> 500	ACTIVE	1,2 m/s	Operating hazard	NO	YES	NO
9b				MUTED	0,3 m/s	Restricted	NO	YES	—[b]

[a] Table A.1 is not applicable to confined zones.

[b] In these specific cases, automatic restart is permitted without personnel detection means if side clearance is > 500 mm on at least one side or clearance is > 500 mm from the current position to the fixed closed structure/object in the direction of travel.

[c] Refer to 4.8.2.1 e) ii).

[d] In cases where side clearance is less than 100 mm, the distance may be measured between the truck and load physical side and the continuous fixed closed structure or between the end of the bumper and the continuous fixed closed structure.

[e] For increased speeds, see zone definitions.

[f] Personnel detection means muting may apply according to 4.8.2.3.

Table A.1 *(continued)*

	Clearance between the truck and its load against the continuous fixed closed structure[d]		Clearance from the current position to the fixed closed structure/object in the direction of travel, C3	Personnel detection means in travel direction (PLd)	Max speed[e]	Required zone classification[a]	Reachable stop function required within 600 mm	Floor/ground marking or extra warnings required	Automatic restart permitted
	Clearance on one side, C1	Clearance on the other side, C2							
	mm	mm	mm						
10a	< 500 and > 100	< 100	< 500	ACTIVE[f]	0,3 m/s	Operating hazard	YES[c]	YES	NO
10b				MUTED	0,3 m/s	Restricted	YES[c]	YES	NO
11a	< 100	< 100	> 500	ACTIVE	Rated speed	Operating hazard	NO	YES	YES
11b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
12a	< 100	< 100	< 500	ACTIVE[f]	0,3 m/s	Operating hazard	YES[c]	YES	NO
12b				MUTED	0,3 m/s	Restricted	YES[c]	YES	NO

[a] Table A.1 is not applicable to confined zones.

[b] In these specific cases, automatic restart is permitted without personnel detection means if side clearance is > 500 mm on at least one side or clearance is > 500 mm from the current position to the fixed closed structure/object in the direction of travel.

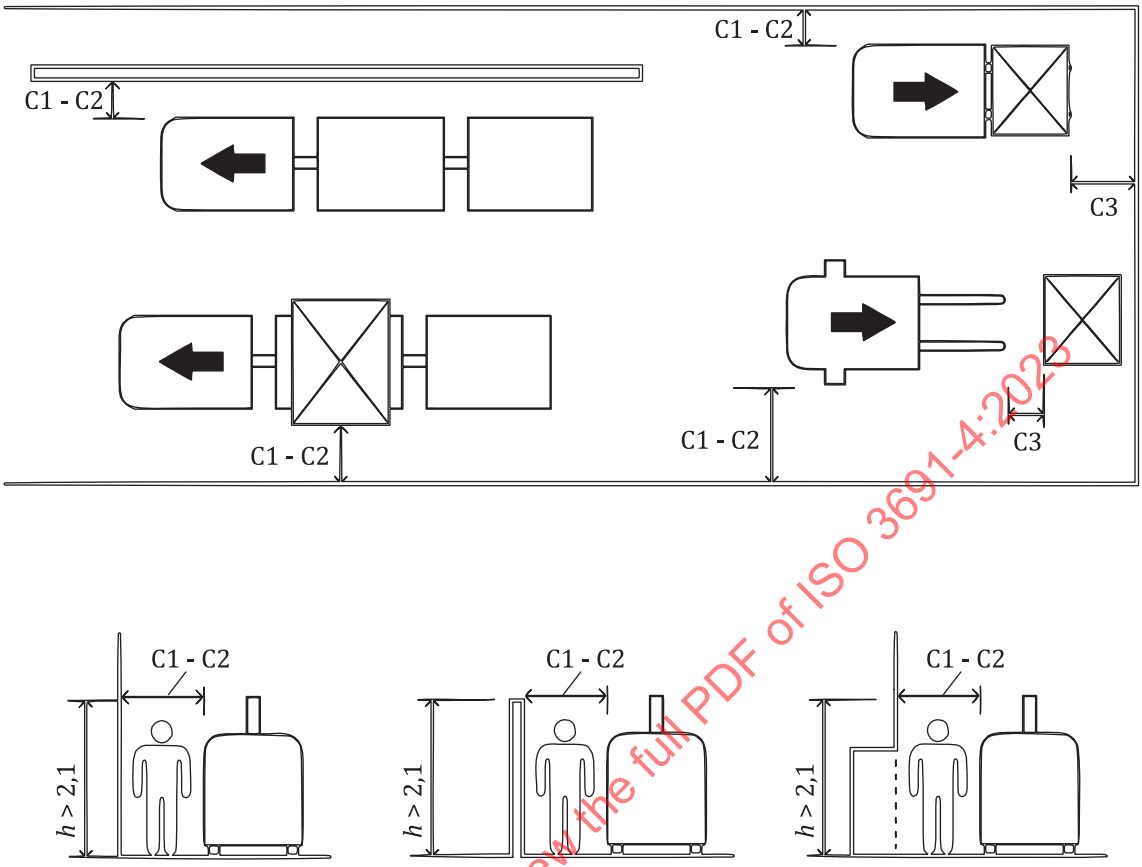
[c] Refer to 4.8.2.1 e) ii).

[d] In cases where side clearance is less than 100 mm, the distance may be measured between the truck and load physical side and the continuous fixed closed structure or between the end of the bumper and the continuous fixed closed structure.

[e] For increased speeds, see zone definitions.

[f] Personnel detection means muting may apply according to 4.8.2.3.

Dimensions in metres



Key

h height
C1 clearance on one side
C2 clearance on the other side
C3 clearance from the current position to the fixed closed structure/object in the direction of travel

Figure A.1 — Clearance

Table A.2 — Required zone classification and other requirements for general fixed closed structures and other objects: racking, columns, block storage, known or expected objects, considering clearances and personnel detection means

	Clearance between the truck physical side and its load against the fixed structure/object		Clearance from the current position to the fixed closed structure/object in the direction of travel, C3	Personnel detection means in travel direction (PLd)	Max speed	Required zone classification[a]	Reachable stop function required within 600 mm	Floor/ground marking or extra warnings required	Automatic restart permitted
	Clearance on one side, C1	Clearance on the other side, C2							
	mm	mm	mm						
1a	> 500	> 500	> 500	ACTIVE	Rated speed	Operating	NO	NO	YES
1b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
2a	> 500	> 500	< 500	ACTIVE[d]	0,7 m/s	Operating hazard	NO	YES	YES
2b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
3a	> 500	< 500	> 500	ACTIVE	1,2 m/s	Operating hazard	NO	YES	YES
3b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]
4a	> 500	< 500	< 500	ACTIVE[d]	0,7 m/s	Operating hazard	NO	YES	YES
4b				MUTED	0,3 m/s	Operating hazard	NO	YES	—[b]

[a] Table A.2 is not applicable to confined zones.

[b] In these specific cases, automatic restart is permitted without personnel detection means if side clearance is > 500 mm on at least one side or clearance is > 500 mm from the current position to the fixed structure/object in the direction of travel.

[c] Refer to 4.8.2.1 e) ii).

[d] Personnel detection means muting may apply according to 4.8.2.3.

[e] Case of 5c is an example of Very Narrow Aisle (VNA) which is for trucks guided within racking.

Table A.2 *(continued)*

	Clearance between the truck physical side and its load against the fixed structure/object		Clearance from the current position to the fixed closed structure/object in the direction of travel, C3	Personnel detection means in travel direction (PLd)	Max speed	Required zone classification[a]	Reachable stop function required within 600 mm	Floor/ground marking or extra warnings required	Automatic restart permitted
	Clearance on one side, C1	Clearance on the other side, C2							
	mm	mm	mm						
5a	< 500	< 500	> 500	ACTIVE	1,2 m/s	Operating hazard	NO	YES	—[b]
5b				MUTED	0,3 m/s	Restricted	YES[c]	YES	—[b]
5c VNA[e]				ACTIVE	Rated speed	Restricted	NO	YES	NO
6a	< 500	< 500	< 500	ACTIVE[d]	0,3 m/s	Operating hazard	YES[c]	YES	NO
6b				MUTED	0,3 m/s	Restricted	YES[c]	YES	NO

[a] Table A.2 is not applicable to confined zones.

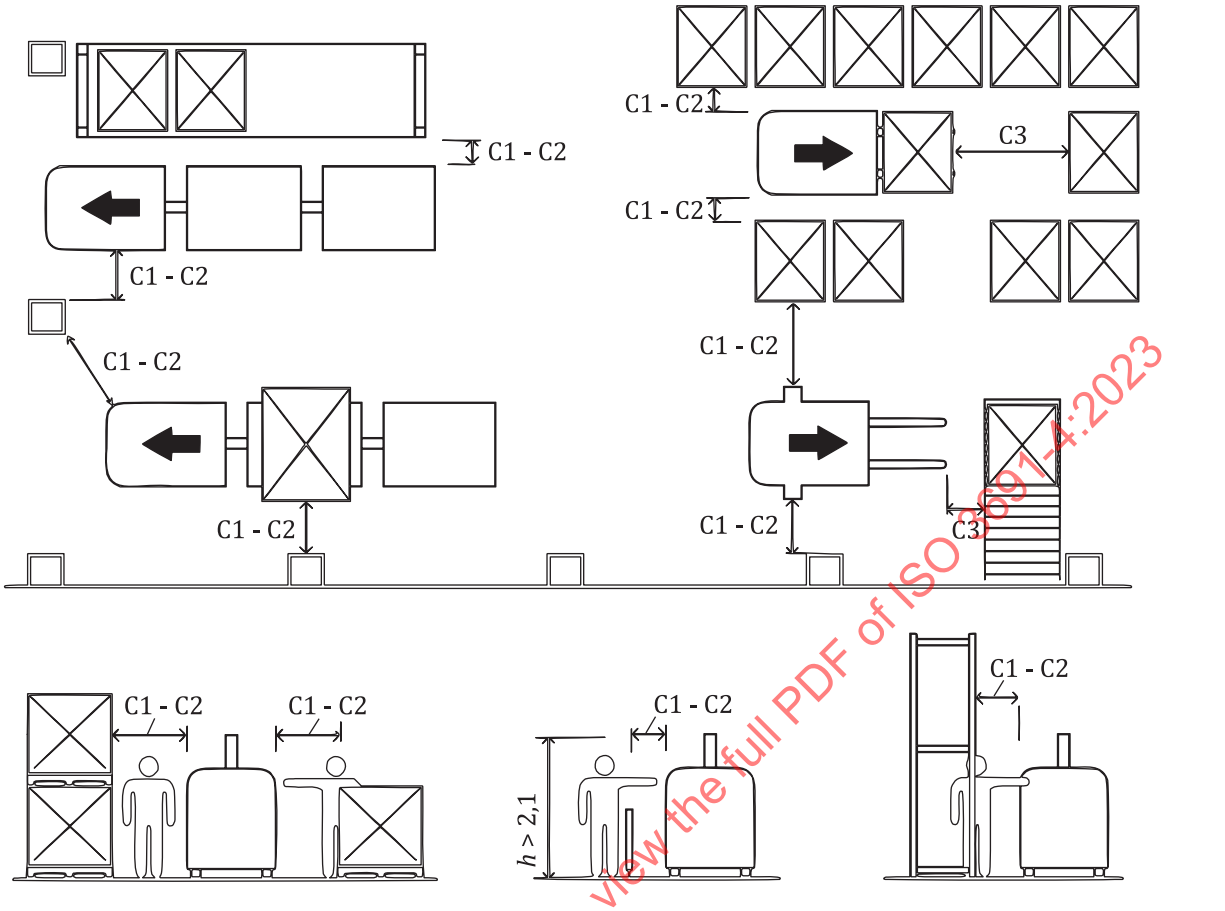
[b] In these specific cases, automatic restart is permitted without personnel detection means if side clearance is > 500 mm on at least one side or clearance is > 500 mm from the current position to the fixed structure/object in the direction of travel.

[c] Refer to 4.8.2.1 e) ii).

[d] Personnel detection means muting may apply according to 4.8.2.3.

[e] Case of 5c is an example of Very Narrow Aisle (VNA) which is for trucks guided within racking.

Dimensions in metres



Key

h height
C1 clearance on one side
C2 clearance on the other side
C3 clearance from the current position to the fixed closed structure/object in the direction of travel

Figure A.2 — Clearance

Annex B
(informative)

List of significant hazards

This list contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this document, identified by risk assessment of industrial trucks and which require action to eliminate or reduce the risk. See Table B.1.

NOTE The structure of the table is based on that of ISO 12100:2010, Table B.1. The order of lines within a group corresponds to the truck functionalities.

Table B.1 — List of significant hazards

No.	Type or group/origin	Potential consequences	Corresponding requirement
1	**Mechanical hazards**		

Table B.1 *(continued)*

No.	Type or group/origin	Potential consequences	Corresponding requirement	
	— Acceleration, deceleration, (kinetic energy) — Machinery mobility — Moving elements — Rotating elements	— Being run over — Crushing — Drawing-in or trapping — Impact	4.1.3	Electrical requirements
			4.1.4	Stored energy components
			4.1.6	Guards
			4.1.7	Interlocking devices for guards
			4.1.8	Two-hand control devices
			4.1.14	Avoidance of automatic restart
			4.1.15	Foot protection
			4.1.16	Transport
			4.1.17	Seats
			4.1.25	Errors of fitting
			4.1.26	Normal stop
			4.1.27	Operational stop
			4.2	Braking system
			4.3	Speed control
			4.5	Load handling
			4.6	Steering
			4.7	Stability
			4.8	Protective devices and complementary measures
			4.9	Modes of operation
			4.10	Trucks intended to tow trailers
			4.11	Safety-related parts of the control system
			4.13	Conveyors fitted to a truck
			4.14	Warning systems
			5	Verification of the safety requirements and/or protective/risk reduction measures
			6	Information for use

Table B.1 *(continued)*

No.	Type or group/origin	Potential consequences	Corresponding requirement	
	— Angular parts — Approach of a moving element to a fixed part — Cutting parts — Sharp edges	— Crushing — Cutting or severing — Drawing-in or trapping — Entanglement — Shearing — Stabbing or puncture	4.1.1 4.1.4 4.1.5 4.1.6 4.1.7 4.1.9 4.1.10 4.1.11 4.1.18 4.1.22 4.5 4.8 4.9 4.10 4.13 5 6	Overall requirements Stored energy components Edges or angles Guards Interlocking devices for guards Transmission parts Electro-sensitive protective equipment Pressure-sensitive protective devices Means of access Driving position Load handling Protective devices and complementary measures Modes of operation Trucks intended to tow trailers Conveyors fitted to a truck Verification of the safety requirements and/or protective/risk reduction measures Information for use
	— Elastic elements	— Crushing — Impact — Cutting or severing — Shearing — Stabbing or puncture	4.1.4 6	Stored energy components Information for use
	— Falling objects	— Crushing — Impact	4.1.4 4.1.24 4.5 4.7 4.8.1 4.9 5 6	Stored energy components Protective structures Load handling Stability Emergency stop device Modes of operation Verification of the safety requirements and/or protective/risk reduction measures Information for use

Table B.1 *(continued)*

No.	Type or group/origin	Potential consequences	Corresponding requirement	
	— Gravity (stored energy)	— Crushing — Impact	4.1.4 4.5 4.7 4.8.1 4.9 5 6	Stored energy components Load handling Stability Emergency stop Modes of operation Verification of the safety requirements and/or protective/risk reduction measures Information for use
	— High pressure	— Injection	4.1.4 4.1.12 4.1.13 6	Stored energy components Hydraulic systems Pneumatic systems Information for use
	— Stability	— Being thrown — Crushing — Impact	4.3 4.5 4.6 4.7 4.8.1 4.9 5 6	Speed control Load handling Steering Stability Emergency stop Modes of operation Verification of the safety requirements and/or protective/risk reduction measures Information for use
2	**Electrical hazards**			
	— Arc — Electromagnetic phenomena — Electrostatic phenomena — Live parts — Not enough distance from live parts under high voltage — Overload — Parts that have become live under fault conditions — Short-circuit — Thermal radiation	— Burn — Chemical effects — Electrocution — Falling, being thrown — Fire — Projection of molten particles — Shock	4.1.3 4.1.23 4.1.25 4.4 4.8.1 4.12 5 6	Electrical requirements Electrostatic charges Errors of fitting Automatic battery charging Emergency stop Electromagnetic immunity Verification of the safety requirements and/or protective/risk reduction measures Information for use
3	**Thermal hazards**			

Table B.1 *(continued)*

No.	Type or group/origin	Potential consequences	Corresponding requirement	
	— Explosion — Flame — Objects or materials with a high or low temperature — Radiation from heat sources	— Burn — Dehydration — Discomfort — Frostbite — Injuries by the radiation of heat sources — Scalding	4.1.2 4.1.3 4.1.19 4.4 5 6	Normal climatic conditions Electrical requirements High temperatures Automatic battery charging Verification of the safety requirements and/or protective/risk reduction measures Information for use
4	**Noise hazards**			
	No origin of this kind of hazard in industrial trucks covered by these specifications			
5	**Radiation hazards**			
	No origin of this kind of hazard in industrial trucks covered by these specifications			
6	**Material/substance hazards**			
	— Combustible — Explosive — Flammable — Fluid — Fume — Gas	— Breathing difficulties, suffocation — Cancer — Corrosion — Effects on reproductive capability — Explosion — Fire — Infection — Mutation — Poisoning — Sensitization	4.1.3 4.1.20 5 6	Electrical requirements Exhaust emissions Verification of the safety requirements and/or protective/risk reduction measures Information for use Explosive atmospheres are excluded in the scope.
7	**Ergonomic hazards**			

Table B.1 *(continued)*

No.	Type or group/origin	Potential consequences	Corresponding requirement	
	— Access — Design or location of indicators and optical display units — Design, location or identification of control devices — Effort — Local lighting — Mental overload/ underload — Posture — Repetitive activity — Visibility	— Discomfort — Fatigue — Musculoskeletal disorder — Stress — Any other (e.g. mechanical, electrical) as a consequence of human error	4.1.2 4.1.3 4.1.5 4.1.8 4.1.14 4.1.15 4.1.16 4.1.17 4.1.18 4.1.21 4.1.22 4.1.25 4.9 4.14 5 6	Normal climatic conditions Electrical requirements Edges or angles Two-hand control devices Avoidance of automatic restart Foot protection Transport Seats Means of access Access and emergency exit Driving position Errors of fitting Modes of operation Warning systems Verification of the safety requirements and/or protective/risk reduction measures Information for use
8	**Hazards associated with the environment in which the machine is used**			
	— Dust and fog — Electromagnetic disturbance — Lightning — Moisture — Temperature — Water — Lack of oxygen	— Burn — Slight disease — Slipping, falling — Suffocation — Any other as a consequence of the effect caused by the sources of the hazards on the machine or parts of the machine	4.1.2 4.12 6	Normal climatic conditions Electromagnetic immunity Information for use
9	**Combination of hazards**			
	E.g. Repetitive activity + effort + high environmental temperature	E.g. Dehydration, loss of awareness, heat stroke	4.1.2 6	Normal climatic conditions Information for use

Annex C
(normative)

Determination of rated capacity

C.1 Specification for high-lift trucks with masts

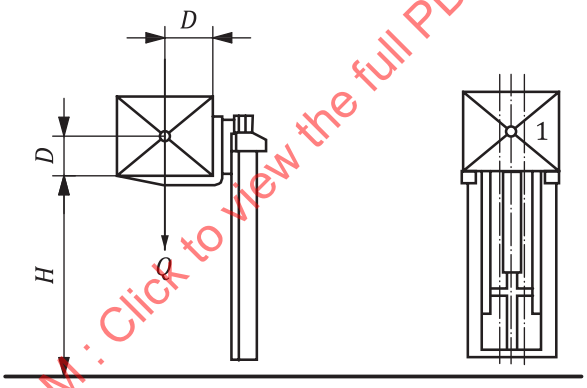
For the rated load, *Q*, the following conditions apply (see Figure C.1):

— load centre of gravity is positioned at the standard load centre distance, *D* (see C.3);

— load *Q* is vertically lifted to the standard lift height, *H* (see C.2);

— the truck is equipped with a two-stage mast that has a maximum lift equal to the standard lift height.

When the truck does not utilize a two-stage mast, it should be given a rated capacity at the standard lift height as if the mast were available.



Key

1 load centre of gravity, positioned in the longitudinal plane of symmetry between the mast uprights
D standard load centre distance
H standard lift height
Q rated load

Figure C.1 — Rated load configuration

C.2 Standard lift height, *H*

Standard lift height values, expressed in mm, are measured from the ground to the upper face of the fork blades or lifting platform, and are as follows for the trucks covered by this document:

— for pallet-stacking trucks and for counterbalanced trucks below 1 000 kg rated load, H = 2 500 mm;

— for all other types of trucks, up to and including 10 000 kg rated load, H = 3 300 mm;

— for all other types of trucks, above 10 000 kg rated load, H = 5 000 mm.

C.3 Standard load centre distance, *D*

The standard load centre distance, *D*, expressed in mm, is measured from the centre of gravity of the load measured horizontally to the front face of the fork arm shank and vertically to the upper face of the fork arm blade.

— For counterbalanced trucks, the values of *D* are according to Table C.1.

Table C.1 — Standard load centre distance

Rated load, *Q* kg		**Standard load centre distance,** *D* mm				
		400	500	600	900	1 200
0	< 1 000	X		X		
≥ 1 000	< 5 000		X	X		
≥ 5 000	≤ 10 000			X	X	
> 10 000	< 20 000			X	X	X
≥ 20 000	< 25 000				X	X
≥ 25 000						X

— For single side-loading trucks and lateral- and front-stacking trucks, *D* is as specified by the manufacturer.

— For trucks where the load centre distances differ from those specified in Table C.1 for special applications, the respective rated capacity should be specified.

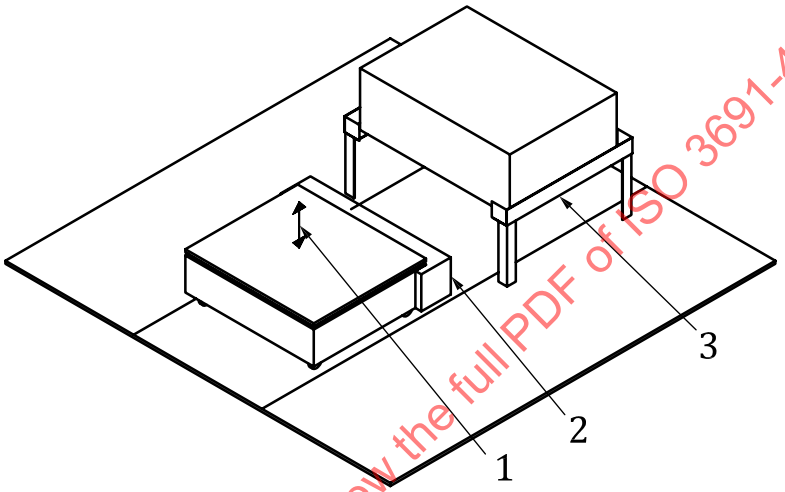
— For all other types of trucks, up to and including 10 000 kg rated load, *D* = 600 mm.

NOTE For regional deviations outside Europe, refer to ISO/TS 3691-8:2019.

Annex D
(informative)

Load transfer operations

When the load transfer operations are outside a restricted or confined zone, they shall be designed to reduce the risk of persons being injured by the rigid part of the truck (e.g. chassis, forks) or its load. See examples in Figures D.1 to D.4.



Key

1 lifting table
2 bumper
3 shield/guard

Figure D.1 — Example of transfer station: truck with embedded lifting table