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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

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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

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

For an explanation 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.*

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.

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

Introduction

General

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

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

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

— health and safety bodies (regulators, accident prevention 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 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.

Structure

An important step forward in the work on the ISO 3691 series of standards was the agreement to issue a new structure of International Standards for industrial trucks having on one side basic standards for all types of trucks and on the other side independent standards to cover the respective specific functions of industrial trucks, e.g. visibility, noise, electrical requirements, etc.

Assessment of hazards

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

In order to properly design a product and to cover all specific safety requirements, the manufacturer needs to identify the hazards that apply to their product and carry out a risk assessment. The manufacturer then needs to design and construct the product taking this assessment into account.

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

In selecting the most appropriate methods, the manufacturer needs to apply the following principles, in the order given here:

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

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

c) inform users of any shortcoming of the protective measures adopted;

d) indicate whether any particular training is required;

e) specify any need to provide personal protection equipment;

f) refer to the appropriate user's document for proper operating instructions.

Industrial trucks need to be designed to prevent foreseeable misuse wherever possible, if such would engender risk. In other cases, the manufacturer's instructions need to draw the user's attention to ways shown by experience in which the machinery ought not to be used.

This document does not repeat all the technical rules which are state-of-the-art, and which are applicable to the material used to construct the industrial truck. Refer to ISO 12100.

Global relevance

From the very beginning, the task was to revise ISO 3691:1980 to establish international basic standards to align with the major legislative regulations in, for example, the EU, Japan, Australia and North America.

Every effort was made to develop a globally relevant International Standard. That goal was achieved for most of the issues addressed. For several potential problem areas, compromises were needed and will still be needed in the future. Where divergent regional requirements remain, these are addressed by ISO/TS 3691-8.

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 of ISO 5053-1) can also be known as: “automated guided vehicle”, “autonomous mobile robot”, “bots”, “automated guided cart”, “tunnel tugger”, “under cart”, etc.

This document also contains requirements for 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.

It 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 deals with 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.

It does not give requirements for 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 (in particular ISO 13482);

— 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 is not applicable 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 3691-1:2011, *Industrial trucks — Safety requirements and verification — Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks*

ISO 3691-2:2016, *Industrial trucks — Safety requirements and verification — Part 2: Self-propelled variable-reach trucks*

ISO 3691-6:2013, *Industrial trucks — Safety requirements and verification — Part 6: Burden and personnel carriers*

ISO/TS 3691-8:2019, *Industrial trucks — Safety requirements and verification — Part 8: Regional requirements for countries outside the European Community*

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 5053-1:2015, *Industrial trucks — Terminology and classification — Part 1: Types of industrial trucks*

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

ISO 13849-1:2015, *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 — Functional aspects and design principles*

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 13857:2008, *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 15870:2000, *Powered industrial trucks — Safety signs and hazard pictorials — General principles*

ISO 22915-1:2016, *Industrial trucks — Verification of stability — Part 1: General*

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

ISO 22915-3:2014, *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 22915-5:2014, *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 22915-8:2019, *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 22915-10:2008, *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 22915-15:2013, *Industrial trucks — Verification of stability — Part 15: Counterbalanced trucks with articulated steering*

ISO 22915-20:2008, *Industrial trucks — Verification of stability — Part 20: Additional stability test for trucks operating in the special condition of offset load, offset by utilization*

ISO 22915-21:2019, *Industrial trucks — Verification of stability — Part 21: Additional stability test for order-picking trucks with operator position elevating above 1 200 mm*

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

IEC 61496-2:2013, *Safety of Machinery — Electro-sensitive protective equipment — Part 2: Particular requirements for equipment using active opto-electronic protective devices (AOPDs)*

IEC 61496-3:2008, *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, *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*

EN 1175-1:1998, +A1:2010, *Safety of industrial trucks — Electrical requirements — Part 1: General requirements for battery powered trucks*

EN 1175-2:1998, +A1:2010, *Safety of industrial trucks — Electrical requirements — Part 2: General requirements for internal combustion engine powered trucks*

EN 1175-3:1998, +A1:2010, *Safety of industrial trucks — Electrical requirements — Part 3: Specific requirements for the electric power transmission systems of internal combustion engine powered trucks*

EN 12895:2015, *Industrial trucks — Electromagnetic compatibility*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 5053-1:2015 and ISO 12100:2010 and the following apply.

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

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

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

3.1
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 equipment (PSPE) fitted to the truck that generates a signal to stop the truck on 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 prior to physical contact

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 an automatic mode with a rider who can enable or disable 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 defined by the manufacturer

3.18
enabling device
additional manually operated device used in conjunction with a start control and which, when continuously actuated, allows a machine to function

[SOURCE: ISO 12100:2010, 3.28.2]

3.19
personnel detection means
system to detect persons in the path of a truck

3.20
rated speed
travel speed of the truck as defined by the manufacturer

3.21
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.

3.22
automatic mode with a rider
operating condition where (a) rider(s) is (are) present on the truck during automatic movement

3.23
confined zone
truck operating space in which the risk reduction is provided by perimeter safeguarding

3.24
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.

3.25
operating zone
defined area in which a truck operates

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

3.26
public zone
space opened to all persons without specific training, instruction or awareness

3.27
restricted zone
physically separated space in which only authorized persons are permitted to enter

3.28
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.

3.29
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).

3.30
operator
designated person, appropriately trained and authorized, to operate the truck

[SOURCE: ISO 3691-1:2011, 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.]

