



BSI Standards Publication

Safety of industrial trucks – Electrical/ electronic requirements

National foreword

This British Standard is the UK implementation of EN 1175:2020. It supersedes BS EN 1175-1:1998+A1:2010, BS EN 1175-2:1998+A1:2010 and BS EN 1175-3:1998+A1:2010, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MHE/7, Industrial trucks.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Sicherheit von Flurförderzeugen - Elektrische/elektronische Anforderungen

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European foreword

This document (EN 1175:2020) has been prepared by Technical Committee CEN/TC 150 “Industrial trucks - Safety”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2021, and conflicting national standards shall be withdrawn at the latest by July 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1175-1:1998+A1:2010, EN 1175-2:1998+A1:2010 and EN 1175-3:1998+A1:2010.

This document specifies up-to-date requirements for electric/electronic installations of industrial trucks. Requirements are mainly based on safety functions and not only on safety related parts and take into account exclusively electric/electronic elements. This approach significantly increases the design details of the safety aspects, therefore Technical Committee CEN/TC 150 “Industrial trucks - Safety” has agreed on requesting an overlapping period of 24 months from the date of publication (DAV) of this document to the date of withdrawal (DOW) of EN 1175-1:1998+A1:2010, EN 1175-2:1998+A1:2010, EN 1175-3:1998+A1:2010, in order to allow manufacturers to update their technical construction files.

The main changes compared to the previous EN 1175 series are:

- applicability to both internal combustion engine and electric battery driven industrial trucks;
- definition of the PL_r for safety functions of the control system;
- design specifications for safety-related parts and control systems;
- specific safety requirements for Li ion energy sources;
- updated connectors and contactors requirements;
- rules for the design of the electric/electronic assistance systems;
- new standard references.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

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

This document is of relevance 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).

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.

1 Scope

This document specifies the electrical requirements for the design and construction of the electrical installation in self-propelled industrial trucks that are within the scope of ISO 5053-1, except variable reach trucks as defined in ISO 5053-1:2015, 3.21 and 3.22, straddle carriers as defined in ISO 5053-1:2015, 3.18 and 3.19, and specific functions, parts and/or systems utilized for the automatic operation of driverless industrial trucks as defined in ISO 5053-1:2015, 3.32. It provides the electrical/electronic and safety-related parts of control system requirements for those self-propelled industrial trucks identified above to complete the requirements in the relevant part of the EN ISO 3691 and EN 16307 series of documents.

NOTE 1 Reference is made to this document in other standards which cover the non-electrical requirements of the various industrial truck types.

The requirements of this document are valid when trucks are operated under the following climatic conditions:

- defined in the applicable parts of the EN ISO 3691 series and the EN 16307 series;
- relative humidity in the range 30 % to 95 % (not condensing).

This document deals with safety requirements for all electrical and electronic components of industrial trucks, including electrically actuated hydraulic/pneumatic valves. It specifies minimum performance levels required for safety functions realized by safety related parts of control systems. It is intended to be used to avoid or minimize hazards or hazardous situations listed in Annex I. These situations can arise during the operation in the area of use for which it is designed and during maintenance of trucks in accordance with the specifications and instruction given by the manufacturer.

This document does not deal with hazards which could occur:

- a) during construction;
- b) when operating in potentially explosive atmospheres;
- c) because of malfunction of non-electric safety-related parts of control systems, e.g. hydraulic and pneumatic elements like pistons, non-electric valves, pumps etc.

NOTE 2 The level of the defined required performance for electrical safety related control systems can be used as a guideline to determine the performance of non-electric systems.

NOTE 3 Hazards due to penetration of water and dust are covered by the definition of PL_r of safety functions, according to EN ISO 13849-1:2015.

2 Normative references

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

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

EN 16307 (all parts), *Industrial trucks — Safety requirements and verification*

EN 50565-1:2014, *Electric cables — Guide to use for cables with a rated voltage not exceeding 450/750 V (U₀/U) — Part 1: General guidance*

EN 60034-8:2007,¹ *Rotating electrical machines — Part 8: Terminal markings and direction of rotation (IEC 60034-8:2007)*

EN 60068-2-27:2009, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock (IEC 60068-2-27:2008)*

EN 60068-2-6:2008, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal) (IEC 60068-2-6:2007)*

EN 60204-1:2006,² *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60332-1-2:2004,³ *Tests on electric and optical fibre cables under fire conditions — Part 1-2: Test for vertical flame propagation for a single insulated wire or cable — Procedure for 1 kW pre-mixed flame (IEC 60332-1-2:2004)*

EN 60384-14:2013,⁴ *Fixed capacitors for use in electronic equipment — Part 14: Sectional specification — Fixed capacitors for electromagnetic interference suppression and connection to the supply mains (IEC 60384-14:2013)*

EN 60529:1991,⁵ *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989)*

EN 60664-1:2007, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests (IEC 60664-1:2007)*

EN 60695-11-10:2013, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods (IEC 60695-11-10:2013)*

EN 60947-4-1:2010,⁶ *Low-voltage switchgear and controlgear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters (IEC 60947-4-1:2009)*

EN 60947-5-5:1997,⁷ *Low-voltage switchgear and controlgear — Part 5-5: Control circuit devices and switching elements — Electrical emergency stop device with mechanical latching function (IEC 60947-5-5:1997)*

EN 61643-11:2012, *Low-voltage surge protective devices — Part 11: Surge protective devices connected to low-voltage power systems — Requirements and test methods (IEC 61643-11:2011)*

EN 62281:2017, *Safety of primary and secondary lithium cells and batteries during transport (IEC 62281:2017)*

EN 62485-3:2014, *Safety requirements for secondary batteries and battery installations — Part 3: Traction batteries (IEC 62485-3:2014)*

¹ As impacted by EN 60034-8:2007/A1:2014.

² As impacted by EN 60204-1:2006/A1:2009 and EN 60204-1:2006/corrigendum Feb. 2010.

³ As impacted by EN 60332-1-2:2004/A1:2015 and EN 60332-1-2:2004/A11:2016.

⁴ As impacted by EN 60384-14:2013/A1:2016.

⁵ As impacted by EN 60529:1991/A1:2000 and EN 60529:1991/A2:2013.

⁶ As impacted by EN 60947-4-1:2010/A1:2012.

⁷ As impacted by EN 60947:1997/A1:2017.

EN 62620:2015, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Secondary lithium cells and batteries for use in industrial applications (IEC 62620:2014)*

EN 62619:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for secondary lithium cells and batteries, for use in industrial applications (IEC 62619:2017)*

EN IEC 62902:2019, *Secondary batteries — Marking symbols for identification of their chemistry (IEC 62902:2019)*

EN ISO 3691 (all parts), *Industrial trucks — Safety requirements and verification*

EN ISO 3691-1:2015,⁸ *Industrial trucks — Safety requirements and verification — Part 1: Self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks (ISO 3691-1:2011, including Cor 1:2013)*

EN ISO 3691-3:2016, *Industrial trucks — Safety requirements and verification — Part 3: Additional requirements for trucks with elevating operator position and trucks specifically designed to travel with elevated loads (ISO 3691-3:2016)*

EN 16307-1:2013+A1:2015, *Industrial trucks — Safety requirements and verification — Part 1: Supplementary requirements for self-propelled industrial trucks, other than driverless trucks, variable-reach trucks and burden-carrier trucks*

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

EN ISO 6743-4:2015, *Lubricants, industrial oils and related products (class L) — Classification — Part 4: Family H (Hydraulic systems) (ISO 6743-4:2015)*

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

ISO 3287:1999, *Powered industrial trucks — Symbols for operator controls and other displays*

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

3 Terms and definitions

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

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp/ui>

⁸ As impacted by EN ISO 3691-1:2015/A1:2020.

3.1 U_n **nominal voltage of the truck system**

designated value of the voltage of the electrical system and to which its characteristics are referred

3.2**nominal battery voltage**

number of battery cells connected in series multiplied by the nominal cell voltage, relative to the chemical technology of the cell

Note 1 to entry: If the battery consists of cells connected in series and in parallel, the nominal voltage is defined by the number of cells, which are arranged in one line of cells connected in series.

3.3**drive system**

electrically controlled system moving truck on ground, generating torque with effect on one or more drive wheels

3.4**low speed**

travel speed below 0,4 m/s for pedestrian trucks and below 0,7 m/s for all other types of trucks

3.5**LHS****electrical load handling system**

system for electrical or electronically controlled load handling

3.6**electrical steering**

electrical or electronic system controlling the angular position of the wheel(s) of the truck with respect to its vertical longitudinal centre plane

Note 1 to entry: See Annex F for examples.

3.7**assistance system**

system intended to improve the operational performance, the ergonomics of industrial trucks, or to warn the operator about hazards due to improper use in the specific operation related to the work environment and application

Note 1 to entry: Assistance systems are not necessary for the safe operation of industrial trucks and are not covered by EN 1526, *Safety of industrial trucks — Additional requirements for automated functions on trucks*. Assistance systems must be clearly distinguished from safety functions.

3.8 PL_r **required performance level**

performance level (PL) applied in order to achieve the required risk reduction for each safety function

[SOURCE: EN ISO 13849-1:2015, 3.1.24]

3.9

setpoint

operator's physical actions on the intended control device

Note 1 to entry: For travelling, the actuation of the accelerator control.

3.10

actpoint

actual physical value of the system output

Note 1 to entry: Examples of actpoint are: truck speed, position of truck steered wheel(s) energised solenoid and the combination of voltage, current and frequency applied to a drive motor.

3.11

service brake

braking system allowing the operator to control, directly or indirectly, the speed of the truck or to bring the truck to a halt

[SOURCE: ISO 6292:2008, 3.12]

Note 1 to entry: The service brake can also be activated by the electronic control system of the truck.

Note 2 to entry: The service brake can also serve as a parking brake.

3.12

parking brake

braking system allowing a vehicle to be held stationary mechanically, even on an inclined surface, particularly in the absence of the operator

[SOURCE: ISO 6292:2008, 3.11]

3.13

safety function

function of the machine whose failure can result in an immediate increase of the risk(s)

[SOURCE: EN ISO 12100:2010, 3.30]

3.14

risk

combination of the probability of occurrence of harm and the severity of that harm

[SOURCE: EN ISO 12100:2010, 3.12]

3.15

type test

test to the requirements of this document of an example of devices, systems or complete trucks representative of the production, including the relevant range of options provided by the manufacturer of the truck, as part of the verification of compliance with this document

3.16

routine test

tests carried out during series production necessary to maintain compliance with this document

3.17**control circuit**

electrical circuit used for the control, including monitoring, of the truck and its electrical equipment

3.18**auxiliary circuit**

electrical circuit that controls lights, fans and other accessories

3.19**power circuit**

circuit that supplies power from the energy source to units of equipment used for truck operation

3.20**energy source**

unit for energizing equipment of the truck used for productive operation

Note 1 to entry: Energy sources for trucks can be:

- batteries based on different technologies;
- liquid or gaseous fuel combined with internal combustion engine or fuel cell;
- AC power sources.

3.21**frame fault**

accidental connection of a live part to the truck frame or exposed conductive parts

3.22**IC truck**

truck equipped with an internal combustion engine of which the power is transferred to a mechanical, hydraulic or electrical system

3.23**normal operating position**

position in which the operator is able to control all functions for driving and load handling as defined by the manufacturer

Note 1 to entry: Additional positions are permitted to be defined by the manufacturer if it is not possible to control all the functions of the truck from a single position. A rotating seat or stand-up end-control truck with more than one operating direction is considered as being or having a single operating position.

[SOURCE: EN ISO 3691-1:2015, 3.8]

3.24**high voltage truck**

truck whose U_n is greater than 120 V DC or 50 V AC and less than or equal to 1 500 V DC or 1 000 V AC under idle or fully charged condition

3.25**OPC****operator-presence control**

device that detects the presence of the operator in the normal operating position

3.26

electric powered assisted steering system

mechanical and/or hydraulic steering system powered by an electrical system

4 Requirements

4.1 Introduction

Trucks shall comply with the safety requirements and/or protective measures of this clause. In addition, the truck shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards which are not dealt with by this document.

4.2 Validation of safety functions

The design of safety functions shall be validated in accordance with EN ISO 13849-1:2015, Clause 8.

4.3 General requirements

4.3.1 Low voltage/high voltage

Safety shall not be compromised at any voltage level that can occur.

Electrical systems of trucks powered by lead-acid batteries shall be designed so that all functions operate in the voltage range from 70 % up to 120 % of the nominal battery voltage. These limits shall be adapted to other energy sources technologies by the manufacturer.

NOTE Limits set by the manufacturer for other energy sources are outside the scope of this document.

4.3.2 Frame fault

The electric circuits shall be so designed or protected, that frame faults shall not cause hazardous inadvertent movements that cannot be corrected or compensated by the operator. Compliance shall be verified by means of the type test of 4.10.4.

4.3.3 Protection from ingress of water and dust

The electrical installation of the trucks in operating condition shall be designed and constructed such that the protection from harmful ingress of water and dust is in accordance with the environmental conditions in which the truck is designed to operate, including reasonably foreseeable misuses, as defined in the instruction handbook (see EN ISO 3691-1:2015, 6.2.2).

NOTE Standardised degrees of protection provided by the enclosure of the electrical equipment are given in EN 60529:1991.

4.3.4 Protection against electric shock

Non-insulated live parts of trucks in the operating condition shall be protected to a degree of IPXXB preventing direct contact. For top surfaces, the minimum degree shall be IPXXD in accordance with EN 60529:1991.

Access to an electrical enclosure containing uninsulated live parts in excess of nominal voltage 60 V DC or 25 V AC shall be possible only using a tool.

Indirect contact with live parts shall be avoided by electric separation of the protection devices in accordance with EN 60204-1:2006, 6.3.2.3.

It shall be possible to electrically disconnect the energy sources for maintenance and replacement operations. An easily accessible switch, connector or disconnectable battery terminals meets the intent of this requirement.

For energy sources with nominal voltage greater than 60 V DC or 25 V AC live parts shall be protected against direct contact.

4.3.5 Connection to the frame

4.3.5.1 Battery powered trucks

There shall be no electrical connection to the truck frame, except for:

- a) frame fault detection system;
- b) electric/electronic circuits with a nominal voltage not greater than 60 V DC which are galvanically separated from the energy source;
- c) connection to the earthing terminal of on-board chargers;
- d) suppression capacitors. If the nominal battery voltage exceeds 60 V DC, minimum requirement for the capacitor shall be Class Y in accordance with EN 60384-14;
- e) the screen of shielded cables and components. This condition shall meet the requirements of the insulation resistance testing in 4.10.2;
- f) suppression resistor for ESD reduction, the system shall meet the requirements of 4.10.2.

4.3.5.2 IC trucks

- a) Electrical system with nominal voltage not greater than 48 V (starter battery):
 - one pole of the electrical system may be connected to the truck frame;
 - all conductors not connected to the truck frame shall be effectively insulated and where necessary protected against thermal and mechanical damage;
 - there shall be means to disconnect both poles of the starter battery from the truck for service purposes;
- b) electrical system with nominal voltage greater than 48 V (hybrid drive system):
 - electrical systems with nominal voltage greater than 48 V shall be electrically insulated and galvanically separated from frame, with the exceptions listed in 4.3.5.1 a), b), d), e) and f);
 - control and auxiliary circuits shall have a maximum voltage not greater than 120 V DC or 50 V AC. Where the energy source maximum voltage is greater, control and auxiliary circuits shall be electrically and galvanically separated from the energy source;
 - for maximum voltages greater than 120 V DC and 50 V AC, equipotential bonding shall be provided between the frame of the vehicle and conductive enclosures, e.g. motor frames.

4.3.6 Protection from residual voltages

After disconnecting energy sources, the voltage of the capacitors in power circuits shall be less than 60 V DC after 10 s.

If the above condition is not technically achievable or practicable a warning/safety label shall be provided. This warning label shall be permanent and indelible and shall be affixed on, or in close proximity to, the enclosure containing the capacitors.

NOTE Safety signs EN ISO 7010 W001 and EN ISO 7010 W012 can be used.

4.3.7 Overcurrent protection

Power, control and auxiliary circuits shall be provided with overcurrent protection that is sized to prevent overheating of the smallest size conductor.

Overcurrent protective devices shall be capable of interrupting the maximum fault current without creating a fire hazard.

Overcurrent protective devices in the control and power circuits shall be as close as practicable to the energy source. Non-resettable overcurrent protective devices shall be identified according to the replacement rating of the device.

If the overcurrent protection is realized by electronic systems, e.g. by inverters or DC/DC converters, this function shall be in accordance with PL_r as defined in Table 6.

Overcurrent protective devices shall be identified, and rating of these devices shall be indicated on the electrical diagram.

Replaceable overcurrent protective devices shall be provided with rating which shall be located on the truck, adjacent or close to the device itself.

NOTE For further information regarding location of overcurrent protective devices see EN 60204-1:2006, 7.2.8 and EN 60204-1:2006, Annex D (informative).

4.3.8 Fire and heat hazards (installation of arcing and sparking parts)

Any arcing part in a power circuit shall be enclosed or installed to adequately reduce the possibility of flame or molten material causing a risk of fire.

Relevant parts shall be accessible for servicing and inspection.

4.3.9 Sparking or heat dissipating electrical components

Sparking components and components which can reach a temperature of 300 °C or more under normal operating conditions, shall not be located where potentially explosive gas/air mixtures can be present. Battery connectors shall be accepted as non-sparking components if they are not used as an emergency switching-off device.

4.3.10 Electromagnetic radiation

4.3.10.1 Non-ionising radiation

Where trucks are fitted with non-ionising radiation devices related to the operation of the truck, the radiation shall be minimized with consideration to the influence on persons, in particular with the effect on active or non-active implantable medical devices by complying with EN 12895:2015+A1:2019, 4.1, 5.1 and 5.2.

4.3.10.2 External radiation

Operation of trucks shall not be hazardously influenced by external radiation and for that purpose trucks shall at least comply with EN 12895:2015+A1:2019, 4.2, 5.1 and 5.3.

NOTE For detailed information regarding electromagnetic compatibility refer to EN 12895:2015+A1:2019.

4.4 Energy sources

4.4.1 General

Energy sources shall conform to Annex C.

Connectors used for connecting energy sources to industrial trucks and to the charging equipment shall conform to the requirements of Annex A.

4.4.2 Connection to the mains

4.4.2.1 Battery charging

When external charging supply cables are connected to the truck, truck movement shall be prevented. This safety function shall be in accordance with PL_r as defined in Table 6. This does not apply to trucks designed only for permanent charging during operation.

The requirement is not intended for starter batteries.

4.4.2.2 On board charger and/or additional components

When trucks are fitted with on-board chargers or other devices connected to the mains, e.g. heaters, the requirements of EN 60204-1:2006, 6.3, 7.2.1 and Clause 8 up to and including 8.2 shall apply.

Enclosures containing equipment connected to the mains supply shall be in accordance with IPXXB of EN 60529:1991. However, for top surfaces the degree of protection shall be in accordance with at least IPXXD.

When the mains supply cables are connected to the truck it shall not be possible to induce any truck movement. This safety function shall be in accordance with PL_r as defined in Table 6.

NOTE 1 Where a main external power supply socket could be switched off this requirement can be met by an interlock when the charger plug is in the home stowed position.

A position shall be provided on the truck to safely and properly store the cable, where permanently attached.

NOTE 2 The protective earth conductor of the on-board charger and additional components connected to the mains is essential for the protection against electrical shock in case of insulation fault.

4.4.3 Electrical energy sources for IC trucks (hybrid systems)

Energy sources based on capacitors, e.g. electric double layer capacitors, shall be equipped with warning signs for residual voltage.

Energy sources based on battery technology shall be equipped with a switching off device in accordance with 4.9.1.3. They shall be manually disconnectable and shall be automatically disconnected in case of an electrical fault related to the power system. They shall be provided with warning signs referring to high stored energy at high voltage. The warning signs shall be permanent and indelible.

4.4.4 Connectors

Connectors for energy sources shall conform to Annex A.

Connectors not fitted with locking devices as defined in A.3.9 shall be arranged so that dead weight and environmental effects e.g. vibration or acceleration do not lead to an unintended disconnection of the connector.

4.4.5 Direct current contactors

Contactors shall be designed and manufactured to withstand the stresses occurring during installation and normal use. For additional information see the relevant part of EN 60947.

Electromagnetic contactors used for performing safety functions shall conform to Annex B.

Truck manufacturers shall select and install contactors, and provide information for maintenance with the instruction handbook, in accordance with the specifications and instructions of the contactor manufacturer.

4.4.6 Electric drive system

Motors, converters, generators and energy sources shall conform to Annex D.

4.4.7 Electrical Components

Conductors and cables shall conform to Annex G.

4.5 Travel and brake control systems

4.5.1 General

For the drive system the following are considered as safe and can be used to achieve a safe state e.g. in case of a failure in the drive system:

- a) no driving torque, on the condition that the truck has an additional braking system which can be activated by the operator;
- b) automatic braking by the drive system and/or by the braking system till and during standstill;
- c) automatic speed reduction to a specific limit based on type, application and condition of the truck so long as the operator has full control and release of the speed control leads to the stopping of powered movement.

Failures of the electrical system leading to behaviour as mentioned in a), b) or c) or any combination thereof may be treated as a non-safety relevant failures.

NOTE 1 Control actions to achieve a safe state are only required for safety-related parts of control systems of Category 2 and higher as defined in EN ISO 13849-1.

NOTE 2 Additional information regarding the correspondence between requirements of 4.5 and most common causes of hazard can be found in Annex J.

NOTE 3 Experience shows that safe conditions designed in accordance with a) lead to an approximate braking effect which is 50 % of that achieved by options b) or c).

NOTE 4 Limitation in the use of a), b) and c) to achieve a safe state is indicated in the appropriate subclauses.

4.5.2 Travel control system

The travel control system shall be so arranged that on level ground the truck will start from standstill only when the control(s) for speed and direction are activated. For IC trucks, after engaging direction control, low speed is allowed without activation of the speed control.

Means shall be provided to avoid any truck movement when:

- switching on the travel control system;
- starting the engine of an IC truck.

Any initial activation of the drive system shall only be possible from the neutral position of the speed and/or directional control(s).

These safety functions shall be in accordance with the PL_r as defined in Table 2.

NOTE Restart of the engine by a start/stop system is not considered as starting the engine.

4.5.3 Monitoring of operating position

On sit-on rider-controlled trucks a separate device (OPC), independent of the speed control (accelerator), shall automatically bring an active drive system to a safe state, as defined in 4.5.1 a) or b) when the operator leaves the normal operating position.

On stand-on rider-controlled trucks a separate device (OPC), independent of the speed control (accelerator), shall automatically bring an active drive system to a safe state, as defined in 4.5.1 b) when the operator leaves the normal operating position.

Nuisance deactivation of the OPC due to operating conditions, such as rough ground, shall be prevented. The safe state shall be initiated not later than 2,0 s after deactivation of the OPC. This time delay shall be reduced to maximum 0,2 s when the speed control device is released. In addition to the deceleration provided by the OPC, the braking system shall be available to the operator.

Powered travel movement from standstill after the operator returns to the normal operating position shall occur only when the traction control device is activated from the neutral position.

During deceleration following release of the OPC while travelling, powered travel movement can be restored automatically provided that the speed control is active. Restoring the powered travel movement shall not cause hazardous accelerations which cannot be controlled by the operator.

Where separate travel controls other than those at the normal operating position are provided according to EN ISO 3691-1:2015, 4.4.2.6 the OPC can be overridden when this system is used. It shall not be possible to override the OPC when operation is from the normal operation position (e.g. interlock).

It shall be ensured that the resulting hazards when an additional control remote from the driving position is used are sufficiently reduced by additional measures, e.g. safe speed/acceleration limitation and/or personal detection means, where trucks are designed for travel controlled from outside and the detection device of operator position overridden.

These safety functions shall be in accordance with the PL_r as defined in Table 2.

4.5.4 Tiller controlled trucks

4.5.4.1 Tiller brake function for pedestrian controlled trucks

If the tiller brake function with tiller in upper or lower end position according to EN ISO 3691-1:2015, 4.4.2.4 b/c is realized using an electrical/electronic system, the safety function shall be in accordance with the PL_r as defined in Table 2.

If the tiller brake function can be overridden by a travel control device, additional measures shall be applied for travelling at the upper end position of the tiller, for example speed limitation or sustained action. These additional safety functions shall be in accordance with the PL_r as defined for the tiller brake function.

4.5.4.2 Tiller head safety device

The function of the tiller head safety device shall be in accordance with EN ISO 3691-1:2015, 4.4.2.4, d.

The tiller head safety device may be disabled when the truck is travelling away from the operator. Activation and deactivation shall be automatic and not accessible to the operator to ensure that the tiller head safety device is not disabled while the truck is travelling towards the operator.

For trucks designed to operate with the tiller in its upper and/or lower rest position, the braking function shall be initiated by activating the tiller head safety device. This safety function shall be in accordance with the PL_r as defined in Table 2.

4.5.4.3 Tiller head safety device on platform trucks

On trucks with foldable operator platform the tiller head safety device may be automatically deactivated when the platform is folded down.

Means can be provided to allow the operator to deactivate the tiller head safety device when the platform is folded down if the function is restored automatically to active mode by the operator presence system as well as by switching on the truck. Permanent activation and deactivation shall not be accessible to the operator.

The mode of the tiller head safety device (active or inactive) shall be indicated to the operator if it can be deactivated in accordance with the requirements of the first paragraph of this subclause. If such indication is realized by electric/electronic means, this safety function shall be in accordance with the PL_r as defined in Table 2.

4.5.5 Automatic restoration of drive system

The automatic release of the drive system from a limited mode shall not cause an unsafe movement.

If the truck speed near or equal to zero is caused by a speed limitation and the limitation is exceeding a time specified by the manufacturer, a release of the speed limitation shall be possible only after return to neutral position of the speed control. Speed and time duration can depend on truck type and acceleration rate.

The return to neutral is not required if the operator activates a function that cancels the limiting condition, e.g. release of the speed limitation by lowering the load below a specific lift height.

This safety function shall be in accordance with the PL_r as defined in Table 2.

4.5.6 Deviation from setpoint

4.5.6.1 General

The drive system shall be so designed that any deviation from operator setpoint caused by an electrical fault which could result in hazardous truck movement that cannot be controlled by the operator in the normal operating position is prevented.

4.5.6.2 Uncontrolled acceleration from standstill on level ground

The drive system shall be so designed that uncontrolled hazardous acceleration from standstill on level ground is prevented.

This safety function shall be in accordance with the PL_r as defined in Table 2.

Any uncontrolled acceleration caused by an electrical failure is treated as hazardous when the criteria defined in Table 1 are exceeded.

Movement from rest in the wrong direction shall be considered hazardous.

Table 1 — Limits for acceptable uncontrolled acceleration/movements

Percentage of maximum truck acceleration at start	Maximum time [s]	Maximum travel distance [m]
above 75 up to 100	0,2	
above 32 up to 75	0,4	
up to 32		0,5

NOTE Maximum truck acceleration at start is the maximum acceleration that the truck can perform from stationary when unladen.

4.5.6.3 Unintended truck behaviour while truck is moving

The drive system shall be so designed that unintended hazardous truck behaviour while truck is moving is prevented. This safety function shall be in accordance with the PL_r as defined in Table 2.

The following behaviour caused by an electrical failure is considered hazardous:

- a) no reaction of reverse or neutral travel direction when demanded by the operator;
- b) acceleration unrelated to the operator input and uncontrollable by operator adjustment of speed control (accelerator) during travel operation on level ground that:

- is higher than 30 % of the maximum acceleration achievable by the truck under no fault condition

and/or

- which results in a speed that exceeds the operator requested speed setpoint by more than 20 % of maximum speed achievable by the truck under no fault condition.

NOTE List item a) is only relevant for trucks with separate direction selector.

4.5.7 Unintended deceleration

Under normal operating conditions as defined in EN ISO 3691-1:2015, 4.1.3, unintended deceleration caused by an electric/electronic failure of the electronic controlled service brake, parking brake or the drive system shall not lead to tip-over. Inherently safe design of electronic controlled service brake shall be considered as satisfying this requirement.

This safety function shall be in accordance with the PL_r as defined in Table 2.

4.5.8 Electrically/electronic controlled service brake

Electrical and electronic control systems of the service brake shall be designed to ensure the required brake function operates correctly or fail safe.

The design shall ensure that an electrical failure will not increase the risk of brake failure e.g. because of friction caused by a permanently partly released brake. This safety function shall be in accordance with the PL_r as defined in Table 2.

NOTE Examples of supervision of the correct functioning of a non-inherently safe mechanical brake are the monitoring of the braking pressure, the position of the brake cylinder or the current of the braking coil.

4.5.9 Parking brake systems

4.5.9.1 Trucks with automatic parking brake

- a) Automatic operation of parking brakes shall not result in hazardous situations. The control system of the parking brake shall be designed to prevent the automatic release of the parking brake not intended by the operator.

Where activating the travel control device can result in automatic release of the parking brake, it shall not result in hazardous truck movements which cannot be controlled by the operator.

These safety functions shall be in accordance with the PL_r as defined in Table 2.

- b) With the truck at standstill, the parking brake shall be applied if the operator is not in the normal operating position.

This safety function shall be in accordance with the PL_r as defined in Table 2.

- c) When the truck is designed to hold the truck on a ramp stationary or at low speed by the drive system and the travel control is released, the parking brake shall be activated automatically before the drive system loses the ability to hold the truck.

This safety function shall be in accordance with the PL_r as defined in Table 2.

- d) Failure of the control system of an automatically applied parking brake shall be indicated to the operator (see EN ISO 3691-1:2015, 4.2.2.1).

The safety function of failure detection shall be in accordance with PL_r as defined in Table 2.

4.5.9.2 Trucks without automatically applied parking brake

If the movement of a truck without an automatically applied parking brake is actively controlled or minimized by the drive system, measures shall be taken so that the operator becomes aware of this situation, e.g. creeping of the truck on a ramp at low speed.

Measures shall be taken to warn the operator before leaving the truck (see EN ISO 3691-1:2015, 4.2.2.1) without applying the brake as long as the power supply of the truck is not switched off by the operator.

If the required warning is realized by an electric/electronic system, it shall be in accordance with the PL_r as defined in Table 2.

4.5.9.3 Indication of parking brake state

Automatically or manually applied parking brake state shall be indicated to the operator when engaged. The exceptions to this requirement are brake systems fitted to stand-on and pedestrian controlled trucks equipped with a brake system that will automatically engage upon release of the brake actuating control in accordance with EN ISO 3691-1:2015, 4.3.3.

An electrical indication of the parking brake state is not required when power supply of the truck has been switched off (see EN ISO 3691-1:2015, 4.2.2.1).

This safety function shall be in accordance with the PL_r as defined in Table 2.

4.5.10 Speed limitation

The electrical system limiting truck speed shall be so designed that the admissible maximum speed on level ground is not exceeded. In the event of an electrical fault the transition to the safe state, as defined in 4.5.1 a) and c) shall be initiated.

The following speed limitation functions shall be in accordance with the PL_r as defined in Table 2:

- a) lateral- and front-stacking trucks in accordance with EN ISO 3691-3:2016, 4.4.1;
- b) travel speed limitation to comply with braking and stability requirements, e.g. trucks specifically designed to travel with elevated loads;
- c) reach trucks with elevated mast in accordance with EN ISO 3691-1:2015, 4.2.3.3;
- d) speed limit of counterbalance trucks to ensure dynamic stability in accordance with EN 16307-1:2013+A1:2015, 4.11;
- e) pedestrian controlled trucks in accordance with EN 16307-1:2013+A1:2015, 4.3;
- f) if triggered by platform and/or side guards' position in accordance with EN ISO 3691-1:2015, 4.7.3.3;
- g) operating from outside the truck in accordance with EN ISO 3691-1:2015, 4.4.2.6;
- h) trucks with attachments for freight containers in accordance with EN ISO 3691-1:2015, 4.6.5.5;
- i) stand-on and foldable platform trucks in accordance with EN 16307-1:2013+A1:2015, 4.3.

NOTE See Annex E for speed limitation as operator assistance.

4.5.11 Interface for speed limitation

If trucks are provided with interfaces for external speed limitation, changes of speed caused by the external system shall be limited by the truck logic to a level that can be controlled by the operator (for instance see 4.5.5, 4.5.7).

The external speed limitation shall not exceed the limit set by the truck controller.

NOTE Systems for speed limitation installed by the person responsible for the operation of a truck, giving the maximum speed setpoint to the truck control unit via an electrical interface are outside the scope of this document. Suitable requirements consistent with this document, can be determined by risk assessment by the responsible person.

Table 2 — Performance levels of drive system

Clause	Reference chapter or paragraph	PL _r in accordance with EN ISO 13849-1:2015 of referenced safety function (truck type)								
		Counterbalance lift trucks	Pallet trucks		Pallet stacking trucks		Trucks with elevating operator position	Trucks with elevating load position	Reach trucks	Industrial tractors
			Pedestrian controlled	Rider controlled	Pedestrian controlled	Rider controlled				
4.5.2	Travel control system	c	b	b	b	b	c	c	c	c
4.5.3	Monitoring of operating position	b		b		b	c	b	b	b
4.5.4.1	Tiller brake function for pedestrian controlled trucks		c		c					
4.5.4.2	Tiller head safety device		c		c					
4.5.4.3	Tiller head safety device on platform trucks		a		a					
4.5.5	Automatic restoration of drive system	a	a	a	a	a	a	a	a	a
4.5.6.2	Uncontrolled acceleration from standstill on level ground	c	b	b	b	b	c	c	c	c
4.5.6.3	Unintended truck behaviour while truck is moving	b	b	b	b	b	b	b	b	b
4.5.7	Unintended deceleration	c			c	c	c	c	c	
4.5.8	Electrically/electronic controlled service brake	c	c	c	c	c	c	c	c	c
4.5.9.1 a	Automatic release of parking brakes	c	a	a	a	a	c	c	c	c
4.5.9.1 b	Automatic activation of parking brakes at standstill	b	a	a	a	a	b	b	b	b
4.5.9.1 c	Automatic activation of parking brakes on a ramp	b	a	a	a	a	b	b	b	b
4.5.9.1 d	Detection of failure of automatic parking brakes	a	a	a	a	a	a	a	a	a

Clause		Reference chapter or paragraph	PL _r in accordance with EN ISO 13849-1:2015 of referenced safety function (truck type)									
			Counterbalance lift trucks	Pallet trucks		Pallet stacking trucks		Trucks with elevating operator position	Trucks with elevating load position	Reach trucks	Industrial tractors	
				Pedestrian controlled	Rider controlled	Pedestrian controlled	Rider controlled					
4.5.9.2		Trucks without automatically applied parking brake	a						a	a	a	
4.5.9.3		Indication of parking brake state	a					a	a	a	a	
4.5.10 a		Speed limitation for lateral- and front-stacking trucks	c					c	c	c		
4.5.10 b		Speed limitation to comply with braking and stability requirements	c			c	c	c	c			
4.5.10 c		Speed limitation with the reach mast elevated								c		
4.5.10 d		Speed limitation of counterbalance trucks for dynamic stability	c									
4.5.10 e		Speed limitation for pedestrian trucks		b		b						
4.5.10 f		Speed limitation triggered by platform and/or side guards		b	b	b	c					
4.5.10 g		Speed limitation for operation from outside the truck	c		c		c	c	c	c	c	
4.5.10 h		Speed limitation for trucks with attachments for freight containers	c									
4.5.10 i		Speed limitation for stand-on and foldable platform trucks	c		c		c					
Key												
			: The definition of a PL _r for the safety function is not defined in this document.									
NOTE Annex H (informative) contains a cross reference between the types of industrial truck of this table and the types of ISO 5053-1.												

4.6 Electrical load handling system

4.6.1 General

A stationary LHS is considered as a safe state.

NOTE 1 The stationary condition can be achieved by taking the LHS to one or more of the following states, as applicable considering the type of truck and the technology used:

- a) electric motor which powers the load handling system directly, switched off;
- b) oil supply system deactivated;
- c) electrical actuated valves switched off, where the hydraulic system is possibly kept under pressure.

Even when the LHS is controlled by manually operated valves, the requirements regarding LHS safety functions realized by an electric/electronic system shall be fulfilled.

NOTE 2 Additional information regarding the correspondence between requirements of 4.6 and most common causes of hazard can be found in Annex J.

4.6.2 Movement from standstill

Movement of a function of the LHS from standstill shall be possible only by operating the dedicated control for an LHS function, e.g. joysticks.

Means shall be provided to avoid any movement of a function of the LHS:

- while switching on the system;
- while starting the engine of an IC truck.

After switching on the LHS control system and/or after starting the engine, initial activation of the LHS shall only be possible from the neutral position of the controls intended for LHS.

This safety function shall be in accordance with the PL_r as defined in Table 3.

NOTE 1 Restart of the engine by a start/stop system is not considered as starting the engine.

NOTE 2 Movement of LHS functions caused by a non-electric fault is not part of this safety requirement, e.g. creeping of lifting system caused by leakage of hydraulic valves.

4.6.3 Monitoring of operating position

On sit-on and stand-on trucks a separate device (OPC) independent of the LHS controls shall automatically bring an active LHS to a safe state, as defined in 4.6.1, if the operator leaves the normal operating position. Nuisance deactivation of the OPC due to operating conditions, such as rough ground, shall be prevented. The safe state shall be initiated not later than 2,0 s after deactivation of the OPC.

If the LHS function is electric/electronic controlled this time delay shall be reduced to maximum 0,2 s when the LHS control device is released.

Powered LHS movement after the operator returns to the normal operating position shall occur only when the LHS control device is activated from the neutral position.

This safety function shall be in accordance with the PL_r as defined in Table 3.

Where separate LHS controls remote from the normal operating position are provided, separate device for detecting the normal operating position can be overridden when the remote controls are selected.

4.6.4 Deviation from setpoint

The LHS shall be so designed that deviation from operator setpoint, caused by an electrical fault, which could result in hazardous truck movement is prevented.

The following behaviour is considered as hazardous:

- a) movement from standstill, longer than a time of 0,2 s, without activating LHS controls;
- b) unintended hazardous deviation from setpoint of an active LHS function. The level of deviation depends on the LHS function. Hazardous deviations are those deviations from setpoint that the operator is not able to control, and which lead to loss of load or stability.

For specific applications a time less than 0,2 s can be required, e.g. electric/electronic controlled load clamp devices.

These safety functions shall be in accordance with the PL_r as defined in Table 3.

4.6.5 Load clamp devices

Trucks equipped with attachments which hold the load by power (for instance, paper clamps) shall feature controls with a secondary action to prevent unintentional release of the load in accordance with EN ISO 3691-1:2015, 4.4.4.1.

If the prevention of unintentional release is realized by an electric/electronic system this safety function shall be in accordance with the PL_r as defined in Table 3.

4.6.6 Limitation of load movement functions

Electrical/electronic speed - and/or position - control and limitation systems shall be in accordance with the PL_r shown in Table 3.

For limitation of load movement as operator assistance see Annex E.

An LHS limiting function shall be considered a safety function if it is required for passing the truck stability type tests, e.g. tilting angle limitation, maximum reach of the mast, limitation of the side shift displacement.

Table 3 — Performance levels of LHS system

Clause	Reference chapter or paragraph	PL _r in accordance with EN ISO 13849-1:2015 of referenced safety functions (truck type)							
		Counterbalance lift trucks	Pallet trucks		Pallet stacking trucks		Trucks with elevating operator position	Trucks with elevating load position	Reach trucks
			Pedestrian controlled	Rider controlled	Pedestrian controlled	Rider controlled			
4.6.2	Movement from standstill	c			c	c	c	c	c
4.6.3	Monitoring of operating position	b		b		b	c	b	b
4.6.4 a	Movement from standstill	c			c	c	c	c	c
4.6.4 b	Deviation of an active LHS function	a			a	a	a	a	a
4.6.5	Load clamp devices	c			c	c		c	c
4.6.6	Limitation of load movement functions	c			c	c	c	c	c
Key : The definition of a PL _r for the safety function is not defined in this document.									
NOTE Annex H (informative) contains a cross reference between the types of industrial truck of this table and the types of ISO 5053-1.									

4.7 Steering

4.7.1 General

The hazards resulting from failures of electric or electric assisted steering systems are dependent on the type of the steering system. The following safety functions shall be applied to the corresponding steering system.

NOTE 1 To define when a redundant backup steering system in addition to electric steering is required is out of the scope of this document.

NOTE 2 Additional information about steering systems can be found in Annex F.

NOTE 3 Additional information regarding the correspondence between requirements of 4.7 and most common causes of hazard can be found in Annex J.

4.7.2 Electrical/electronic steering

4.7.2.1 General

Electrical/electronic steering control systems shall be designed to avoid hazardous deviations not controllable by the operator.

4.7.2.2 Unintended steering movements

A single electrical/electronic fault shall not lead to a risk of an unintended operation caused by the steering system.

Within 0,1 s from the start of an unintended steering movement:

- a) on trucks not provided with backup steering, the fault shall be detected, the stop of the unintended steering operation and a controlled stop shall be initiated;
- b) on trucks provided with backup steering, the fault shall be detected, the stop of the unintended steering operation shall be initiated, the backup steering system shall be activated automatically.

These safety functions shall be in accordance with PL_r shown in Table 4.

4.7.2.3 Supervision of steering system

An electrical/electronic fault potentially leading to loss of steering functions (for instance breakdown of steering controller or output stage, loss of power supply) shall on trucks:

- a) without a backup steering system initiate a controlled stop; or
- b) with backup (secondary) system initiate an automatic activation of the backup (secondary) system.

This safety function shall be in accordance with PL_r shown in Table 4.

NOTE For additional information about steering systems see Annex F.

4.7.2.4 Backup steering warning

A single electrical/electronic fault as described in 4.7.2.2 and 4.7.2.3 on trucks provided with backup steering shall activate a warning to the operator.

This safety function shall be in accordance with PL_r as defined in Table 4.

4.7.2.5 Deviation from setpoint

The steering control system shall detect potentially hazardous deviations between setpoint and actpoint.

Hazardous deviations are those deviations from setpoint that the operator is not able to control. In case of hazardous deviations, one of the conditions defined in 4.5.1 shall be initiated within 0,1 s.

This safety function shall be in accordance with PL_r as defined in Table 4.

4.7.3 Electric powered assisted steering systems

Any failure of the electrical part of an electric powered assisted steering system shall not prevent the truck from maintaining the path being steered.

A failure of the electric powered assisted steering system shall be signalled to the operator. This safety function shall be in accordance with the PL_r as defined in Table 4.

NOTE When a failure of the electrical part of an electric powered assisted steering system causes reduced steering performance, the truck may be automatically brought to one of the conditions defined in 4.5.1.