BS EN 1755:2015

BSI Standards Publication

# Industrial Trucks — Safety requirements and verification — Supplementary requirements for operation in potentially explosive atmospheres

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**National foreword**

This British Standard is the UK implementation of EN 1755:2015. It supersedes BS EN 1755:2000+A2:2013 which is withdrawn.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 secretary.

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English Version

# Industrial Trucks - Safety requirements and verification - Supplementary requirements for operation in potentially explosive atmospheres

Chariots de manutention - Prescriptions de sécurité et vérification - Prescriptions supplémentaires pour le fonctionnement en atmosphères explosibles

Sicherheit von Flurförderzeugen - Einsatz in explosionsgefährdeten Bereichen - Verwendung in Bereichen mit brennbaren Gasen, Dämpfen, Nebeln oder Stäuben

This European Standard was approved by CEN on 24 July 2015.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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## Contents

Page

## European foreword

This document (EN 1755:2015) 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of an identical text or by endorsement, at the latest by May 2016, and conflicting national standards shall be withdrawn at the latest by November 2017.

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

This document supersedes EN 1755:2000+A2:2013.

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.

Informative Annex F provides details of significant technical changes between this document and the previous edition: EN 1755:2000+A2:2013.

This document is one of a series of European Standards for the safety of industrial trucks which are listed in 4.1 and in the Bibliography.

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

# Introduction

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

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

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

This standard (EN 1755:2015) covers safety requirements and their verification for industrial trucks as defined in ISO 5053-1 that are not covered exhaustively by:

— EN 1459;

— EN 1526;

— EN 1757-3;

— EN ISO 3691-1;

— EN ISO 3691-5;

— EN ISO 3691-6;

NOTE The above-mentioned standards are listed in the Bibliography or in Clause 2.

**Assessment of hazards**

The industrial truck 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 (e.g. explosive atmospheres) by the manufacturer.

In order to properly design an industrial truck and to cover all specific safety requirements, the manufacturer will have to identify the hazards that apply to the industrial truck and carry out a risk assessment. The manufacturer will then need to design and construct the industrial truck 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 could also arise from foreseeable abnormal situations.

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

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

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

— inform users of any shortcoming of the protective measures adopted;

— indicate whether any particular training is required;

— specify any need to provide personal protection equipment;

— 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 instructions will need to draw the user's attention to ways shown by experience in which the machinery ought not to be used.

This standard (EN 1755:2015) 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. Reference will also need to be made to EN ISO 12100.

# 1 Scope

This European Standard applies to self-propelled and pedestrian propelled manual and semi-manual industrial trucks as defined in ISO 5053-1 including their load handling devices and attachments (hereafter referred to as trucks) intended for use in potentially explosive atmospheres.

NOTE 1 Attachments mounted on the load carrier or on fork arms which are removable by the user are not considered to be a part of the truck.

This European Standard specifies supplementary technical requirements for the prevention of the ignition of an explosive atmosphere of flammable gases, vapours, mists or dusts by industrial trucks of equipment group II and equipment category 2G, 3G, 2D or 3D.

NOTE 2 The relationship between an equipment category (hereafter referred to as category) and the corresponding zone (area classification) is shown in informative Annex B.

This European Standard does not include:

— trucks of equipment group I;

— trucks of equipment group II, equipment category 1;

— trucks intended for use in potentially explosive atmospheres with hybrid mixtures;

— protective systems.

This European Standard is not applicable to trucks intended for use in potentially explosive atmospheres of carbon disulphide ($CS_2$), carbon monoxide (CO) and/or ethylene oxide ($C_2H_4O$) due to the special properties of these gases.

This standard is applicable to trucks intended for use in atmospheres with an ambient temperature range of - 20 °C to +40 °C, i.e. trucks built in accordance with this European Standard will be satisfactory to any service conditions within this range unless otherwise specified.

NOTE 3 The ambient temperature range -20 °C to +40 °C is in line with EN ISO 3691-1.

# 2 Normative references

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

EN 1127-1:2011, *Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology*

EN 1149-5, *Protective clothing - Electrostatic properties - Part 5: Material performance and design requirements*

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

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

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

EN 1459, *Safety of industrial trucks — Self-propelled variable reach trucks*

EN 1525, *Safety of industrial trucks - Driverless trucks and their systems*

EN 1757-3, *Safety of industrial trucks - Pedestrian controlled manual and semi-manual trucks - Part 3: Platform trucks*

EN 1834-1:2000, *Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 1: Group II engines for use in flammable gas and vapour atmospheres*

EN 1834-3, *Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 3: Group II engines for use in flammable dust atmospheres*

EN 13463-1:2009, *Non-electrical equipment for use in potentially explosive atmospheres - Part 1: Basic method and requirements*

EN 13463-3, *Non-electrical equipment for use in potentially explosive atmospheres - Part 3: Protection by flameproof enclosure 'd'*

EN 13463-5:2011, *Non-electrical equipment intended for use in potentially explosive atmospheres - Part 5: Protection by constructional safety 'c'*

EN 13463-8, *Non-electrical equipment for potentially explosive atmospheres - Part 8: Protection by liquid immersion 'k'*

EN 14986, *Design of fans working in potentially explosive atmospheres*

EN 50271, *Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen - Requirements and tests for apparatus using software and/or digital technologies*

EN 60079-0:2012, *Explosive atmospheres - Part 0: Equipment - General requirements ( IEC 60079-0:2011, modified)*

EN 60079-7, *Explosive atmospheres - Part 7: Equipment protection by increased safety "e" (IEC 60079-7)*

EN 60079-14:2014, *Explosive atmospheres - Part 14: Electrical installations design, selection and erection (IEC 60079-14:2012)*

EN 60079-15:2010, *Explosive atmospheres - Part 15: Equipment protection by type of protection "n" (IEC 60079 15:2010)*

EN 60079-17, *Explosive atmospheres — Part 17: Electrical installations inspection and maintenance (IEC 60079-17)*

EN 60079-29-1:2007, *Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases (IEC 60079-29-1:2007)*

EN 60079-29-2, *Explosive atmospheres — Part 29-2: Gas detectors — Selection, installation, use and maintenance of detectors for flammable gases and oxygen (IEC 60079-29-2)*

EN 60079-31, *Explosive atmospheres — Equipment dust ignition protection by enclosure "t" (IEC 60079-31)*

CLC/TR 60079-32-1, *Explosive atmospheres - Part 32-1: Electrostatic hazards, guidance*

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

EN 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements (IEC 61508-1)*

EN 61508-6, *Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3 (IEC 61508-6)*

EN ISO 3691-1, *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)*

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

EN ISO 20344, *Personal protective equipment - Test methods for footwear (ISO 20344)*

ISO 284, *Conveyor belts — Electrical conductivity — Specification and test method*

ISO 1813, *Belt drives — V-ribbed belts, joined V-belts and V-belts including wide section belts and hexagonal belts — Electrical conductivity of antistatic belts: Characteristics and methods of test*

ISO 9563, *Belt drives — Electrical conductivity of antistatic endless synchronous belts — Characteristics and test method*

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

## 3 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

**3.1**
**explosive atmosphere**
mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture

[SOURCE: EN 13237:2012, 3.28]

**3.2**
**potentially explosive atmosphere**
atmosphere which could become explosive due to local and operational conditions

[SOURCE: EN 13237:2012, 3.28.2]

**3.3**
**hybrid mixture**
mixture of flammable substances with air in different physical states

[SOURCE: EN 13237:2012, 3.40]

**3.4**
**auto ignition temperature**
lowest temperature (of a hot surface) at which under specified test conditions an ignition of a flammable gas or flammable vapour in mixture with air or air/inert gas occurs

[SOURCE: EN 13237:2012, 3.45]

**3.5**
**minimum ignition temperature of a dust cloud**
lowest temperature of a hot surface on which the most ignitable mixture of the dust with air is ignited under specified test conditions

[SOURCE: EN 13237:2012, 3.45.1]

**3.6**
**minimum ignition temperature of a dust layer**
lowest temperature of a hot surface at which ignition occurs in a dust layer under specified test conditions

[SOURCE: EN 13237:2012, 3.45.2]

**3.7**
**service temperature**
maximum or minimum temperature reached at specific points of the equipment when the equipment is operating at rated conditions, including ambient temperature and any external sources of heating or cooling

[SOURCE: EN 60079-0:2012, 3.50]

Note 1 to entry: Each equipment may reach different service temperatures in different parts.

Note 2 to entry: This definition applies to both electrical and non-electrical equipment and components.

**3.8**
**maximum surface temperature**
temperature used for marking of the equipment which is the highest temperature that can be attained in service under the most adverse operating conditions (but within the recognized tolerance) by any part or surface of equipment or protective system or component which can produce an ignition of the surrounding explosive atmosphere with an appropriate safety margin

[SOURCE: EN 13463-1:2009, 3.9]

Note 1 to entry: The manufacturer will prescribe the product standard and also in his particular design he should take into account the following other conditions:

a) fault conditions specified in the standard for the type of protection concerned;

b) all operating conditions specified in any other standard specified by him including recognized overloads; any other operating condition specified by him.

Note 2 to entry: The relevant surface temperature may be internal or external depending upon the type of protection concerned.

Note 3 to entry: For equipment intended for use in explosive dust atmospheres, the surface temperature is determined without any deposited dust on the equipment. See EN 13463-1:2009, 6.2.3.

**3.9**
**wheel**
circular structure able to rotate on an axle, either directly or with the use of bearing(s), with the external part in contact with the ground

[SOURCE: ISO 22877:2004, 1.1.1]

**3.10**
**castor**
assembly comprising a housing, one or more wheels, an axle and, if required, accessories

[SOURCE: ISO 22877:2004, 3.1]

**3.11**
**tyre**
outer part of a wheel, produced from different material from the wheel centre

[SOURCE: ISO 22877:2004, 1.1.6]

**3.12**
**service brake**
brake system allowing the operator to control, directly or indirectly, the speed of the truck or to bring the truck to a halt

EXAMPLE The brake can be electrical, hydraulic or mechanical or a combination of the three.

[SOURCE: ISO 6292:2008, 3.12, modified: "braking system" replaced with "brake", addition of an example]

**3.13**
**restricted breathing enclosure "nR"**
enclosure that is designed to restrict the entry of gases, vapours and mists

[SOURCE: EN 60079-15:2010, 3.7.3]

**3.14**
**safety function**
function to be implemented by a safety device, which is intended to achieve or maintain a safe state for the equipment under control (EUC), in respect of ignition hazards

Note 1 to entry: See EN 50495 for the definitions of "safety device", "safe state" and "equipment under control".

[SOURCE: EN 50495:2010, 3.7, modified, addition of Note 1 to entry]

**3.15**
**safety shutdown**
shutdown of a truck or a piece of equipment activated by a safety function to prevent potential ignition sources from becoming effective

**3.16**
**normal operation**
situation when the equipment, protective systems, and components are operating for their intended use within their design parameters

[SOURCE: EN 13463-1:2009, 3.7]

**3.17**
**malfunction**
equipment, protective systems and components do not perform the intended function

[SOURCE: EN 13463-1:2009, 3.8]

**3.18**
**expected malfunction**
disturbances or equipment faults which are known to occur in practice

[SOURCE: EN 13463-1:2009, 3.8.1]

**3.19**
**rare malfunction**
type of malfunction which may happen only in rare instances

[SOURCE: EN 13463-1:2009, 3.8.2]

**3.20**
**earthing strap**
strap made of conductive or dissipative material strong enough to withstand mechanical and chemical influences and installed to achieve potential equalization between truck chassis and the floor/ground

**3.21**
**controlled stop**
condition in which the truck is in a safe stationary state

**3.22**
**highly efficient electrostatic charge generating mechanism**
process that generates a higher rate of electrostatic charge than simple operations

Note 1 to entry: For more information, see EN 13463-1:2009, 6.7.3.

EXAMPLE 1 Rubbing, cleaning with a dry cloth, raising from a seat, walking, wiping of clothes are examples of simple operations.

EXAMPLE 2 The flow of insulating liquids or powders, high voltage spray charging, running of transmission belts are examples of highly efficient electrostatic charge generating mechanisms.

# 4 Safety requirements and/or protective measures

## 4.1 General

Trucks for use in potentially explosive atmospheres shall comply with the additional requirements given in 4.1 up to and including 4.11.

Where the additional hazards specified in normative Annex A could occur, an ignition hazard assessment in accordance with EN 1127-1 and EN 13463-1 shall be carried out, taking into consideration these hazards and the additional requirements contained in EN 13463-1 and if relevant supplemented by the specific parts of EN 13463 for other types of protection.

Trucks of Group II shall be subdivided according to the explosive gas atmosphere for which they are intended. See EN 60079-0:2012, 4.2.

Group II subdivisions:

a) IIA;

b) IIB;

c) IIB + $H_2$;

d) IIB + $C_2H_2$;

e) IIB + $H_2$ + $C_2H_2$.

NOTE 1 Trucks marked IIB are also suitable for IIA applications.

NOTE 2 Trucks marked IIB+$H_2$, IIB+$C_2H_2$ or IIB+$H_2$+$C_2H_2$ are also suitable for IIA or IIB applications.

NOTE 3 Trucks equipped with a gas detection system are specifically marked in accordance with 6.3.3 e).

NOTE 4 $H_2$ is the chemical formula for hydrogen and $C_2H_2$ for acetylene.

Trucks of Group III shall be subdivided according to the explosive dust atmosphere for which they are intended. See EN 60079-0:2012, 4.3.

Group III subdivisions:

f) IIIA: combustible flyings;

g) IIIB: non-conductive dusts;

h) IIIC: conductive dusts.

Equipment shall be selected taking into consideration any service temperatures measured during the temperature tests described in 5.1.

## 4.2 Hot surfaces

### 4.2.1 General

For category 3G and 2G trucks the maximum surface temperature of any part of the truck shall not exceed the temperature class or maximum surface temperature defined on the truck marking plate.

For category 3D and 2D trucks the maximum surface temperature of any part of the truck which can come into contact with dust clouds or dust layers shall not exceed the maximum surface temperature defined on the truck marking plate.

Maximum surface temperatures shall be determined in accordance with 5.1.

Reduction of surface temperatures by means of thermal insulation is not permitted.

NOTE 1 The relationship between the maximum surface temperature of the equipment and the minimum ignition temperature of dust layers and dust clouds is given in EN 1127-1:2011, 6.4.2 and EN 60079-14, 5.6.3.3.

NOTE 2 The possible insulation effects of a dust layer on the surface temperatures are taken into account by the safety margin to the minimum ignition temperature of a dust layer specified in EN 1127-1:2011, 6.4. and EN 60079-14, 5.6.3.3.

### 4.2.2 Temperature monitoring

Surface temperatures may be limited by the use of a temperature monitoring and control system which provides a safety shutdown in accordance with 4.3 if limiting values are exceeded.

For both category 3 and category 2 trucks, the electrical temperature monitoring and control system shall fulfil the performance level $PL_r$=c in accordance with EN ISO 13849-1 or SIL 1 in accordance with EN 61508-1.

### 4.2.3 Temperature classification

Trucks shall be classified:

a) with a temperature class in accordance with Table 1 for category 3G or 2G,

or

b) by the maximum surface temperature for category 3G, 2G, 3D or 2D.

**Table 1 — Classification of maximum surface temperatures for trucks of category 3G or 2G**

| Temperature Class | Maximum surface temperature (°C) |
|---|---|
| T1 | 450 |
| T2 | 300 |
| T3 | 200 |
| T4 | 135 |
| T5 | 100 |
| T6 | 85 |

## 4.3 Safety shutdown

The requirements of this subclause apply to the following safety (monitoring) functions:

a) hot surfaces in accordance with 4.2;

b) concentration of the flammable gas in the atmosphere surrounding the truck in accordance with 4.10.2.5;

c) insulation monitoring in accordance with 4.5.4.

A safety shutdown shall be clearly indicated by a visual alarm prior to the effective shutdown of the truck to enable the operator to bring the truck safely to a controlled stop. It is permitted to have a time delay between the alarm and shutdown up to a maximum of 30 s. During this time interval the critical operating functions of the truck shall be available.

The requirements of 4.2.1, 4.10.2.5 and 4.5.4 shall not be compromised during the time delay and/or after shutdown.

EXAMPLE Exceeding of the maximum surface temperature after shutdown due to heat soak is an example of compromising safety.

Reset of a safety monitoring function by the operator is not permitted except for shutdown caused by over temperature.

NOTE Additional organizational measures including plant safety procedures can be included in the safety shutdown reset procedure.

## 4.4 Mechanically generated sparks

### 4.4.1 Load handling devices

All surfaces of load handling devices which have or may have ground or load frictional contact shall be clad with copper, copper zinc, zinc, or non-metallic material for example rubber, thermoplastic fluoropolymer or plastic.

Alternatively in the case of combustible gas/air-mixtures of Group IIA and IIB and for combustible dust/air-mixtures, load handling devices made of stainless steel or load handling devices clad with stainless steel are permitted. Stainless steel shall have a mass percentage of at least 16,5 % chromium.

Cladded load handling devices shall have provisions to inspect for wear.

Forks shall be cladded in such a way that inspection for hair cracks on critical locations shall always be possible.

An example of how to clad load handling devices is given in Annex C.

#### 4.4.2 Fans

##### 4.4.2.1 Fans of electrical equipment

Fans being an integral part of electrical equipment shall comply with EN 60079-0 and the applicable standards for the specific type of equipment.

##### 4.4.2.2 Radiator fans on IC-engines

Taking into account design tolerances, clearances between rotating parts and fixed parts shall be at least 1/100 of the maximum diameter of the rotating part, except that the clearances need not exceed 5 mm and may be reduced to 1 mm if the opposing parts are manufactured so as to have dimensional accuracy and stability. In no case shall the clearances be less than 1 mm.

The truck chassis shall provide adequate protection against the ingress of foreign bodies that could give rise to incendive sparking.

Exposed rotating parts shall be protected at least to a degree of IP 20. See EN 60529:1991, 5.2.

##### 4.4.2.3 Other fans

Other fans shall comply with EN 14986.

#### 4.4.3 Other rotating parts

Seals shall fulfil the requirements of EN 13463-5:2011, 4.4.

Bearings shall fulfil the requirements of EN 13463-5:2011, Clause 6.

Clearances between non-lubricated moving and fixed parts shall be dimensioned to prevent frictional contact causing ignition capable hot surfaces and/or mechanical sparks.

Moving parts needing lubrication shall comply with the requirements of EN 13463-5:2011, 5.3.

In addition for category 2G and 2D trucks, rotating parts or other moving parts made of light metal alloys which are subjected to friction or impact, the material compositions shall be in accordance with EN 13463-1:2009, 6.4.4.2 or the parts shall be designed in such a manner to prevent ignition capable sparks during expected malfunction.

### 4.5 Electrical system

#### 4.5.1 General

The electrical system shall comply with the relevant requirements of:

a) EN 1175-1 for battery powered trucks;

b) EN 1175-2 for internal combustion engine powered trucks;

c) EN 1175-3 for electrical power transmission systems on internal combustion engine powered trucks.

With respect to explosion protection, the electrical system shall comply with the relevant requirements of EN 60079-14.

For reciprocating internal combustion engines, the electrical system shall comply with:

d) EN 1834-1 for category 3G and 2G,

or

e) EN 1834-3 for category 3D and 2D.

NOTE 1 EN 60079-14 applies to all electrical equipment and installations in hazardous areas whether permanent, temporary, portable, transportable or hand-held. It does not specifically apply to self-propelled trucks (mobile equipment) but the safety level ensured by this standard can be applied to trucks accordingly. The same applies to EN 60079-29-2.

NOTE 2 IT type of system earthing does not apply to trucks.

Gas detection systems shall comply with EN 60079-29-1 and EN 60079-29-2. See 4.10.

### 4.5.2 Electrical equipment

#### 4.5.2.1 General

Electrical equipment shall at least meet the equipment category of the truck in accordance with EN 60079-0:2012, Annex ZY.

#### 4.5.2.2 Electrical equipment for category 3G trucks

Electrical equipment for category 3G trucks shall provide at least an EPL Gc/category 3G level of protection in accordance with EN 60079-0 and EN 60079-15, taking into consideration the specific application of the equipment in the truck including possible frequent temperature cycles. The electrical equipment shall be clearly identified by a durable marking to show the level of protection and/or the type of protection.

NOTE 1 An example of a truck specific application is a junction box installed within the truck counterweight. It can be assessed that in this specific application for example the requirements regarding protection against impact (EN 60079-0:2012, 6.2) are fulfilled.

NOTE 2 In truck applications, for example motors, motor power controllers and luminaires using strobe lights are considered to have frequent temperature cycles as defined in EN 60079-15.

For the application of restricted breathing enclosures “nR” (see 4.10) containing:

a) normally arcing or sparking devices, and/or

b) equipment with hot surfaces where the temperature measured on the outside of the enclosure exceeds the external ambient temperature by more than 20 K measured in accordance with 5.1,

and

c) with the maximum internal surface temperature less than the marked temperature class or the maximum surface temperature in accordance with 4.2.3,

the pressure drop test of EN 60079-15:2010, 22.6 shall be replaced with the following requirements:

1. the truck shall be equipped with a gas detection system in accordance with 4.10.2 and gas sensors in accordance with 4.10.3,

and

2. restricted breathing enclosures shall comply with the requirements of 4.10.4.

The use of restricted breathing enclosures is not permitted if the enclosure contains normally arcing or sparking devices and the temperature difference between the outside of the enclosures and the ambient is more than 20 K measured in accordance with 5.1 and the maximum internal surface temperature is more than the marked temperature class or the maximum surface temperature in accordance with 4.2.3.

#### 4.5.2.3 Electrical equipment for category 2G trucks

Electrical equipment for category 2G trucks shall comply with one of the specific types of protection listed in EN 60079-0:2012, Clause 1, providing at least an EPL Gb/category 2G level of protection.

#### 4.5.2.4 Electrical equipment for category 3D and 2D trucks

Electrical equipment for category 3D trucks shall provide at least an EPL Dc/category 3D level of protection in accordance with EN 60079-0 and EN 60079-31, taking into consideration the specific application of the equipment in the truck. The electrical equipment shall be clearly identified by a durable label to show the level of protection and/or the type of protection.

NOTE An example of a truck specific application is a junction box installed within the truck counterweight. It can be assessed that in this specific application for example the requirements regarding protection against impact (EN 60079-0:2012, 6.2) are fulfilled.

Electrical equipment for category 2D trucks shall comply with one of the specific types of protection listed in EN 60079-0:2012, Clause 1, providing at least an EPL Db/category 2D level of protection.

### 4.5.3 Electrical system bipolarity

The electrical system shall be bipolar where both poles are insulated from the truck chassis except for:

a) intrinsically safe circuits;

b) insulation monitoring devices;

c) internal combustion engine glow plugs or other electrical start aid equipment;

d) electrical circuits for glow plugs and other start aid equipment on category 2G and 2D trucks which use the internal combustion engine cylinder block as part of the earth return circuit for the period during which the start aid equipment is in operation. If the start aid equipment is not in operation both the positive and negative connections shall be isolated from the power supply in accordance with EN 1834-1:2000, 5.12.

### 4.5.4 Insulation monitoring

On category 2G and 2D trucks a device shall be provided to monitor the insulation resistance between the electrical system live parts and the truck chassis. If the insulation resistance is less than 500 Ω this shall be indicated by a visual alarm followed by the automatic safety shutdown of the truck in accordance with 4.3.

It shall not be possible to restart the truck after an automatic or manual shutdown following an insulation fault, unless the insulation fault has been repaired.

The insulation monitoring device shall fulfil the requirements of performance level $PL_r$=c in accordance with EN ISO 13849-1 or SIL 1 in accordance with EN 61508-1.

### 4.5.5 Battery and battery connectors

Battery and battery connectors shall at least meet the category of the truck. See 4.5.2.

Batteries used in trucks are subjected to mechanical shock and vibration in normal operation. This consideration shall be applied when testing batteries in accordance with the requirements of EN 60079-0 and the specific type of protection listed in EN 60079-0:2012, Clause 1.

The battery shall be installed in the truck in such a way that the minimum ventilation for the battery compartment is in accordance with EN 1175-1:1998+A1:2010, 5.1.1.4.

NOTE Further information can be found in EN 50272-3.

## 4.6 Internal combustion engines

Internal combustion engines shall comply with the relevant requirements of:

a) EN 1834-1 for category 3G or 2G,

or

b) EN 1834-3 for category 3D or 2D.

NOTE EN 1834-1 and EN 1834-3 include internal combustion engine specific ignition sources, e.g. flames, hot gases (including hot particles) electrical systems and adiabatic compression.

## 4.7 Electrostatic risks

### 4.7.1 Bonding

#### 4.7.1.1 General

All conductive and dissipative parts shall be bonded to the truck chassis in order to reach potential equalization.

NOTE 1 Conductive parts are, for example, metal parts or conductive plastic materials with a surface resistance up to $10^4$ Ω. Dissipative parts are for example plastic materials with a surface resistance between $10^4$ Ω and $10^9$ Ω measured at 50 % relative humidity or $10^{11}$ Ω measured at 30 % relative humidity with a test voltage of at least 500 V ± 5 %.

Separate bonding conductors are not required if metal parts are in good conductive contact with the chassis and are adequately secured against loosening. This requirement also applies to components that are attached to the truck.

EXAMPLE Equipment attached to the truck could be lights, weighing equipment, attachments, side shifters, barrel clamps.

The bonding resistance shall not exceed $10^6$ Ω and shall be measured in accordance with 5.2.1.

NOTE 2 Further information is given in CLC/TR 60079-32-1.

#### 4.7.1.2 Insulated metal parts

Requirements for bonding do not apply to insulated metal parts with the maximum allowable capacitance as shown below, provided highly efficient electrostatic charge generating mechanisms do not occur:

a) Group IIA: 10 pF(2G and 3G trucks);

b) Group IIB: 6 pF (2G trucks) or 10 pF (3G trucks);

c) Group IIB + $H_2$ or IIB + $C_2H_2$ or IIB + $H_2$ + $C_2H_2$: 3 pF (2G trucks) or 6 pF (3G trucks);

d) Group III: 10 pF (2D and 3D trucks).

If highly efficient electrostatic charge generating mechanisms occur or the capacitance of insulated metal parts exceeds the values defined above these parts shall be bonded to the chassis.

NOTE 1 Insulated metal parts behave as capacitors which can be easily charged if they are subjected to highly efficient electrostatic charge generating mechanisms; for example the flow of hydraulic fluids. Even small insulated metal parts can have a considerable capacitance depending on their truck specific application.

Capacitance shall be measured in accordance with 5.2.2.

Insulated bolts and nuts up to the dimension of M6 or similarly sized metal parts need not be considered.

NOTE 2 Further information is given in CLC/TR 60079-32-1.

### 4.7.2 Circuit resistance

The circuit resistance between the truck chassis and the floor/ground shall not exceed $10^6$ Ω when measured in accordance with 5.2.1 in at least 2 positions. This can be achieved by the application of at least two electrically conductive wheels or at least two earthing straps or a combination of a single electrically conductive wheel and a single earthing strap.

NOTE 1 Further information regarding conductivity of materials is given in CLC/TR 60079-32-1.

Earthing straps shall be fitted to the truck chassis at the largest practical distance between each other to ensure a permanent grounding.

NOTE 2 In normal operation wheels and earthing straps can be contaminated causing loss of conductivity. A practical solution is to fit more than only two electrically conductive wheels or earthing straps or to combine the application of wheels and earthing straps.

The quantity and location of conductive wheels or earthing straps shall be clearly and durably marked on the truck chassis.

### 4.7.3 Non-conductive parts

#### 4.7.3.1 Non-conductive parts for category 3G and 2G

All non-conductive parts of for example seats, arm rests and back rests which are in continuous or frequent contact with the operator and non-conductive parts which are subjected to a foreseeable highly efficient electrostatic charge generating mechanism shall comply with one of the following:

a) the surface resistance of the non-conductive part shall not exceed $10^9$ Ω measured with a test voltage of 500 V ± 5 % and shall be bonded to the chassis in accordance with 4.7.1.1;

b) the non-conductive part shall comply with the requirements for limitation of the transferred charge in accordance with EN 13463-1:2009, 6.7.5 b) with the exclusion of the third test method (test with high voltage spray electrode);

c) the surface area of a single non-conductive part shall not be larger than 100 $cm^2$ for Group IIA or IIB or 20 $cm^2$ for Group IIB + $H_2$ or IIB + $C_2H_2$ or IIB + $H_2$ + $C_2H_2$. The size of the surfaces areas may be multiplied by 4 if the parts are surrounded by conductive frames or by 2 if the parts are bordered at the long opposite sides by conductive strips. The frames and strips shall be bonded to the truck chassis in accordance with 4.7.1.1;

d) in cases where (single) non-conductive parts are located close to each other or profiled surfaces have similar exposed parts, the dimensions of the surface areas shall comply with the dimensions given in c) and in addition, the depth of the groove between the exposed surfaces areas shall be at least 3 mm and the width of the groove at least 1 mm;

e) the surface of the non-conductive parts shall be sufficiently profiled, whereby the width of the exposed non-conductive part is not larger than 30 mm for Group IIA or IIB and not larger than 20 mm for

Group IIB + $H_2$ or IIB + $C_2H_2$ or IIB + $H_2$ + $C_2H_2$. The depth of the groove between profiled surfaces shall be at least 3 mm and the width of the groove at least 1 mm.

EXAMPLE 1 Examples of profiled surfaces according to d) and e) are given in Annex D.

f) where the non-conductive material is a coating or layer on a chassis-bonded metal surface or on a chassis-bonded conductive surface, the thickness of the coating or layer shall not exceed 2 mm for Group IIA or IIB and 0,2 mm for Group IIB + $H_2$ or IIB + $C_2H_2$ or IIB + $H_2$ + $C_2H_2$.

Non-conductive parts which are not subjected to a foreseeable electrostatic charge generating mechanism shall be provided with a warning label as specified in item 2 of Table 3 in 6.4. Alternatively at least one label with equivalent text positioned in clear vision of the operator shall be provided covering all non-conductive parts of the truck.

EXAMPLE 2 Examples of parts not likely to be subjected to a foreseeable electrostatic charge generating mechanism are panelling and transparent plastic guards.

EXAMPLE 3 An example of a part which could be subjected to a foreseeable highly efficient electrostatic charge generating mechanism is a roll-up flexible cabin door.

Non-conductive step-up and stand-on surfaces need not to be considered as being capable of retaining a significant electrostatic charge if they are made of natural rubber or provided with sufficiently profiled surfaces in accordance with e).

NOTE Further information is given in CLC/TR 60079-32-1.

#### 4.7.3.2 Non-conductive parts for category 3D and 2D

No specific requirements apply.

NOTE No specific requirements apply because although brush discharges occur normally for non-conductive parts, such discharges are non-incendive for dust-air atmospheres. For propagating brush discharges, see note 1 of 4.7.5.

### 4.7.4 Transmission belts

Transmission belts shall be dissipative in accordance with ISO 284, ISO 1813, ISO 9563 or CLC/TR 60079-32-1 or fulfil the requirements for limitation of the transferred charge in accordance with EN 13463-1:2009, 6.7.5 b).

NOTE Detailed information is given in Annex E.

### 4.7.5 Hydraulic systems

Parts of hydraulic systems subjected to highly efficient charge generating mechanisms shall comply with the following:

a) the filter assembly and other parts of the hydraulic system shall be conductive or dissipative and be bonded to the truck chassis in accordance with 4.7.1.1;

b) non-conductive parts shall comply with the requirements for limitation of the transferred charge in accordance with EN 13463-1:2009, 6.7.5 b),

or

the surface resistance of non-conductive parts shall not exceed $10^6$ Ω measured at 50 % relative humidity or $10^8$ Ω measured at 30 % relative humidity with a test voltage of 500 V ± 5 %. The non-conductive parts shall be bonded to the truck chassis in accordance with 4.7.1.1;

c) the breakdown voltage of thin sheets of non-conductive material with a thickness less than 9 mm which are in contact with chassis-bonded metal or other chassis-bonded conductive material shall not exceed 4 kV. Alternatively a) or b) shall be fulfilled.

NOTE 1 Highly efficient charge generating mechanisms on thin sheets of non-conductive materials in contact with areas of bonded metal (or other conductors) will lead to propagating brush discharges.

All parts of the hydraulic system such as filter assemblies, tanks, pipes, hoses etc. shall be assessed with respect to the possibility of excessive charge levels and adequate precautions shall be taken to avoid these.

NOTE 2 In hydraulic systems high charge densities can occur especially due to the flow of hydraulic fluid through filters.

NOTE 3 Further information is given in CLC/TR 60079-32-1.

### 4.7.6 Castors and wheels

#### 4.7.6.1 General

Castors and wheels shall not generate hazardous electrostatic discharges to the floor/ground or other parts during normal operation. This can be achieved if the castors or wheels are dissipative in accordance with 4.7.6.2.

No requirements apply to castors or wheels if:

a) castors or wheels are applied on trucks with a travel speed not exceeding 6 km/h,

or

b) the projected area of castors or wheels to the ground/floor does not exceed:

1) 100 $cm^2$ for Group IIA or IIB,

or

2) 20 $cm^2$ for Group IIB + $H_2$ or IIB + $C_2H_2$ or IIB + $H_2$ + $C_2H_2$. See Figure 1.

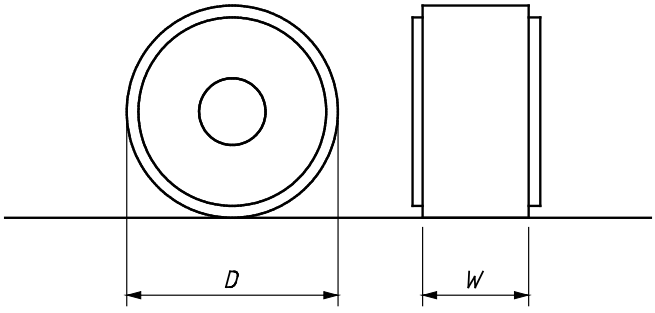



**Figure 1 — Projected area of castors or wheels**

#### 4.7.6.2 Dissipative castors and wheels

Dissipative castors and wheels shall comply with the following:

a) the tyre (non-metallic outer material) of castors and wheels shall have a maximum surface resistance of $10^9$ Ω measured using a test electrode of which the dimensions are shown in Figure 5 of EN 60079-

0:2012 with a test voltage of 500 V ± 5% with the exclusion of the pre-conditioning and relative humidity requirements for the testing of the material,

or

b) the tyre (non-metallic outer material) of castors and wheels shall comply with the requirements for the limitation of transferred charge in accordance with EN 13463-1:2009, 6.7.5 b) with the exclusion of the third test method (test with high voltage spray electrode) and the pre-conditioning and relative humidity requirements for the testing of the material.

## 4.8 Requirements for brakes, clutches and couplings

### 4.8.1 General

The surface temperatures shall comply with the requirements of 4.2.

If temperature monitoring is applied, the requirements of 4.2.2 shall be fulfilled.

NOTE Seizing of brake assemblies is considered to be a rare malfunction and is not to be considered in category 2 or category 3 trucks.

### 4.8.2 Mechanical clutches[1)] and couplings

Mechanical clutches and couplings shall comply with the requirements of EN 13463-5:2011, Clause 7.

Additionally for category 2G and 2D trucks, the requirements shall be determined taking into consideration expected malfunctions. Electrical monitoring systems used to check the level of lubrication fluid shall comply with performance level $PL_r$=c of EN ISO 13849-1 or SIL 1 of EN 61508-1.

### 4.8.3 Hydrokinetic clutches

Fluid clutches shall comply with the requirements of EN 13463-5:2011, Clause 7. Additionally for category 2G and 2D trucks, the requirements shall be determined taking into consideration expected malfunctions. Electrical monitoring systems used to check the level of lubrication fluid shall comply with performance level $PL_r$=c of EN ISO 13849-1 or SIL 1 of EN 61508-1.

### 4.8.4 Service brakes and friction clutches for category 3G and 3D trucks

In addition to 4.8.1 and EN 13463-5:2011, 8.2 service brakes and friction clutches shall comply with the following:

a) materials used for friction parts of the brakes shall be a combination of non-metallic material and cast iron or a material having the same friction properties as cast iron. Stainless steel with a mass percentage less than 16,5 % chromium or light metal alloys shall not be used;

b) non-metallic compound shall not contain more than 40 % metal by weight. The metal content shall consist of powders or thin wires (powder characteristic dp50 ≤ 100 µm and dpmax ≤ 500 µm; nominal wire diameter of 100 µm and the maximum wire diameter of ≤ 500 µm);

c) friction linings shall be bonded, pressed or riveted to brake shoes or pads; rivets if used shall be made from stainless steel with a mass percentage of at least 16,5 % chromium or copper or copper-zinc. The temperature of friction material shall not reach a level at which it starts to degrade.

---

1) English: mechanical clutch
French: embrayage mécanique
German: schaltbare, formschlüssige Kupplung

Alternatively, only for category 3D trucks, the enclosure of friction brakes and the rotating joint shall have a degree of protection of at least IP5X.

### 4.8.5 Service brakes and friction clutches for category 2G trucks

#### 4.8.5.1 General

Service brakes and friction clutches shall comply with one of the following:

a) liquid immersion in accordance with 4.8.5.2;

b) flameproof enclosure in accordance with 4.8.5.3;

c) constructional safety in accordance with 4.8.5.4.

NOTE Requirements for the protection level of electrical equipment installed on brakes or clutches is given in 4.5.

#### 4.8.5.2 Liquid immersion

Clutch and brake enclosures shall comply with EN 13463-8.

During all operations the brakes shall be moistened by lubrication fluid. It shall be possible to check the level of the lubrication fluid.

#### 4.8.5.3 Flameproof enclosure

Clutch and brake enclosures shall comply with EN 13463-3.

#### 4.8.5.4 Constructional safety

Service brakes and friction clutches shall comply with the requirements of 4.8.4.

The system shall avoid frictional contact between the backing of the brake shoes or pads and the rotating parts of the brake in case of worn friction material or axial play.

For the determination of the maximum surface temperature all parts of the brake or clutch assembly shall be taken into consideration for example brake linings, brake drums and discs.

If a temperature monitoring system is applied, the temperature switches or thermo-sensors shall be positioned in each friction lining not more than 3 mm under the surface of the lining when new. The temperature monitoring system shall comply with 4.2.2.

NOTE Determination of the maximum surface temperature of all relevant parts is given in 5.1.

### 4.8.6 Service brakes and friction clutches for category 2D trucks

In addition to 4.8.4 service brakes and friction clutches shall comply with of one of the following:

a) liquid immersion in accordance with 4.8.5.2;

b) flameproof enclosure in accordance with 4.8.5.3. In addition, enclosures shall have a degree of protection of IP6X in accordance with EN 60079-31;

c) constructional safety in accordance with 4.8.5.4. In addition, electrical equipment installed on the brake or clutch shall have a degree of protection of IP6X in accordance with EN 60079-31;

d) the enclosure shall have a degree of protection of IP6X in accordance with EN 60079-31.

#### 4.8.7 Parking brakes

For category 3G and 3D trucks a visual alarm shall indicate that the parking brake is applied. A visual alarm is not required for pedestrian trucks.

Category 2G and 2D trucks shall be equipped with a system that prevents the truck from being driven with the parking brake applied and a visual alarm shall indicate that the parking brake is applied. A visual alarm is not required for pedestrian trucks.

#### 4.8.8 Emergency stop brake

Emergency stop brakes shall comply with the requirements of EN 13463-5:2011, 8.1.

### 4.9 Requirements for pneumatic systems

Pneumatic systems shall comply with EN 13463-1 and EN 13463-5:2011, 7.6.

The level of protection of air compressors and air boosters shall at least meet the level of protection related to the equipment category of the truck in accordance with EN 13463-1.

Air compressors and air boosters shall not ingest ambient air from hazardous areas.

NOTE Ingesting air from the hazardous area causes a high risk of explosion due to compression of an explosive atmosphere in combination with possible high surface temperatures inside the pneumatic system.

### 4.10 Category 3G trucks equipped with restricted breathing enclosures “nR” and gas detection systems

#### 4.10.1 General

Trucks equipped with restricted breathing enclosures “nR” and gas detection systems in accordance with 4.5.2.2 shall comply with the requirements for:

a) gas detection systems in accordance with 4.10.2;

b) gas sensors in accordance with 4.10.3;

c) restricted breathing enclosures “nR” in accordance with 4.10.4.

#### 4.10.2 Gas detection systems

**4.10.2.1** In addition to 4.5.2.2 gas detection systems shall comply with the requirements of EN 60079-29-1 and shall be selected and installed in accordance with EN 60079-29-2 taking into consideration at least:

a) the characteristics of the flammable gas(es) and vapour(s) which are likely to be present on site;

b) the principle that effective operation of the gas detection system depends on its performance and its correct usage;

c) the characteristics of the flammable gas(es) and vapour(s) for which the truck is designed and marked;

d) the risk of malfunction of the gas detection system due to obstructions preventing the gas sensor detecting the atmosphere;

e) the gas(es) and vapour(s) for which the apparatus is suitable and the relative response characteristics to these gas(es) and vapour(s);

f) the suitability of the system for the intended conditions of use for example shock, vibration, weather influences and ingress of foreign bodies and water;

g) the system response time, warm-up time, immunity and reliability, self-test and display of operational readiness;

h) the quantity and correct position of the gas sensor(s) with respect to the type of gas(es) and vapour(s) to be detected;

i) the shutdown of the truck shall not give rise to other hazards.

Particular attention is required for the use and selection of gas sensors for the detection of acetylene due to the flammability properties of acetylene and the potential risks caused by slow response time.

NOTE Gas detection systems are synonymous with gas detectors as mentioned in EN 60079-29-1 and EN 60079-29-2 and include sensors (sampling) as well as equipment for measuring, monitoring, indicating, control and alarm functions. Gas detection systems may consist of a separate gas sensor and a separate gas detection control unit or may be one piece of equipment containing the whole measuring system from gas entry to the output signal (e.g. switching relay contact) in the event of a gas alarm.

**4.10.2.2** Gas detection systems using software and/or digital technologies shall fulfil the requirements of EN 50271.

**4.10.2.3** Gas detection systems shall comply with the following requirements.

The gas detection system shall fulfil the requirements of performance level $PL_r$=c in accordance with EN ISO 13849-1 or SIL 1 in accordance with EN 61508-1 and one of the following configurations shall be applied:

a) at least one gas sensor of which the correct functioning is confirmed by a forced gas test before truck start-up is possible,

or

b) at least two gas sensors with independent signal processing systems and independent outputs. Signal cross checking of input and output signals shall ensure that truck shutdown will occur in the event of gas detection and/or any system faults. The output voting process as defined in EN 61508-6 will be activated by the greater of either of the logic outputs. The system shall verify correct functioning of the gas detection system before truck start-up is possible.

**4.10.2.4** The gas detection system shall monitor the integrity of the sensors and any other incorporated control system and shall indicate failure of such devices by an audible and visual alarm and shall provide a safety shutdown in accordance with 4.3.

**4.10.2.5** The gas detection system shall provide an audible and visual alarm at 10 % lower explosion limit (LEL) of the calibration gas, and shall provide an audible alarm and a safety shutdown in accordance with 4.3 at 25 % LEL of the calibration gas. An automatic reset of the 10 % LEL alarm is acceptable when the ambient concentration goes below 10 % LEL.

**4.10.2.6** After a safety shutdown the gas detection system shall not be self-resetting. It shall not be possible to restart the truck without human intervention. Information for use regarding the reset procedure shall be provided by the manufacturer.

**4.10.2.7** Truck start-up shall only be possible after the gas detection system completes and verifies a self-integrity check.

**4.10.2.8** The gas detection system shall remain continuously operating independently of the truck start/stop condition.

**4.10.2.9** In the direct vicinity of the operator position a warning label shall be provided as specified in item 1 of Table 3 in 6.4 regarding the requirement to purge restricted breathing enclosures following a safety shutdown due to the detection of flammable gases, vapours or mists.

### 4.10.3 Gas sensors

**4.10.3.1** Gas sensors shall be suitably protected against impact taking into consideration the protection provided by the truck chassis. The mechanical protection shall not hinder the detection of gases and vapours.

**4.10.3.2** Gas sensors shall fulfil the vibration test requirements of EN 60079-29-1:2007, 5.4.13 with the application of procedure 1 of EN 60079-29-1:2007, 5.4.13.2.1.

**4.10.3.3** Gas sensors shall be located on the truck as follows:

a) one gas sensor according to 4.10.2.3 a) or two gas sensor according to 4.10.2.3 b) shall be fitted at the base of the truck;

b) in applications with gases lighter than air an additional sensor shall be fitted at the top of the truck;

c) on trucks with an elevating operator area an additional gas sensor shall be fitted in the direct vicinity of the load handling devices if restricted breathing enclosures are installed within this area.

### 4.10.4 Restricted breathing enclosures “nR” in combination with a gas detection system

The restricted breathing enclosures shall satisfy the requirements in accordance with EN 60079-15:2010, 23.2.3.2.1.1.

The enclosure shall include a facility for being purged and tested. After a safety shutdown caused by the gas detection system, the enclosure shall be purged with clean air or inert gas before the truck is restarted. The information for use shall specify how the enclosure purging is to be performed.

Equipment without test ports or equipment where the nominal volume changes due to pressure are not permitted in fork truck applications.

The enclosure shall be identified and marked in accordance with EN 60079-15:2010, 24.3 adding the symbol “X” for special conditions for safe use. The special conditions for safe use shall be included in the instruction handbook in accordance with 6.2.

The enclosure shall include a warning label as specified in 6.4, Table 3, item 1 and 3.

The truck shall include a warning label as specified in 6.4, Table 3, item 4.

NOTE An example of a “nR” enclosure label and a truck label is given in informative Annex G.

## 4.11 Flammability of non-metallic materials

Non-metallic materials shall be in accordance with EN 13463-1:2009, 8.3.

# 5 Verification of safety requirements and/or protective measures

## 5.1 Determination of the maximum surface temperatures

### 5.1.1 General

The maximum surface temperatures of the brakes, clutches, hydraulic system, electric motors, internal combustion engine and any other apparatus subject to possible dangerous overheating shall be determined in accordance with 5.1.4.

The maximum surface temperature shall be determined without any dust deposited on the equipment.

### 5.1.2 Test conditions

The test procedures given in 5.1.3 are carried out under the following conditions:

a) at the start of a test for electric powered trucks the traction battery shall be charged to 100 % of its rated capacity and for I.C. engine trucks the fuel tank shall be full;

b) the truck shall be driven on substantially firm, smooth, level and prepared surfaces. Alternatively, if the intended operating conditions differ, the test shall be carried out under these specific conditions.

The surface temperature of equipment and apparatus (see 5.1.1) shall be measured by means of thermal sensors positioned where the highest temperatures occur. If this is not practicable, an assessment shall be made to extrapolate the test results.

For constructional safety brakes, the temperature of the brake linings or pads shall be measured.

For oil protected brakes and clutches the temperature of the oil shall be measured.

For restricting breathing enclosures according 4.10.4 the maximum external surface temperature, the maximum internal temperature and the maximum surface temperatures of the internal components shall be measured.

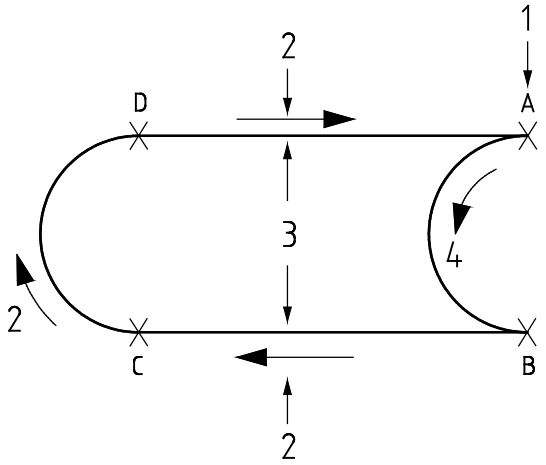
NOTE Where direct measurement of surface temperatures is not possible, other methods can be applied, e.g. extrapolation of the test results.

### 5.1.3 Test procedures

#### 5.1.3.1 Self-propelled trucks with self-propelled lifting power

This procedure does not include manually operated functions.

The truck shall be driven over the circuit given in Figure 2 as follows:




**Key**

1 lift load
2 forward drive
3 accelerate and decelerate
4 backward drive

**Figure 2 — Test cycle for trucks**

a) the test cycle starts at point A from where the truck shall be driven backwards without load to B in a safe manner as fast as possible;

b) the truck shall be driven forwards and fully accelerated from standstill to its rated speed and then immediately decelerated using the service brakes until the truck comes to a controlled stop at C. The distance to achieve its rated speed and deceleration to a stop differs from one type of the truck to the other but shall not be less than 6 m;

c) the truck shall be driven forwards from C to D in a safe manner and from D fully accelerated to its rated speed and then immediately decelerated using the service brakes until the truck comes to a controlled stop at A;

d) the circuit shall be repeated with a laden truck in the above described conditions by picking up the load in point A. The load shall be 100 % of the trucks actual capacity for which the truck is marked to;

e) after the truck has come to a stop at A, the load shall be lifted in a safe manner as fast as possible to the corresponding maximum height as mentioned on the truck information plate and then lowered and left at A. In case of trucks with specific functions, these functions shall be included in the test procedure.

The described procedure is equal to one cycle.

NOTE 1 Safe lifting can be achieved, e.g. by lifting the actual capacity for which the truck is marked to twice to half of the rated maximum lift height as indicated on the truck information plate.

NOTE 2 Typical examples of special functions are:

- an elevating operator position (order picking truck);
- mast and/or fork arms which can rotate 90° (lateral or front stacking trucks);
- a retractable mast and/or fork arms;

- special attachments.

### 5.1.3.2 Pedestrian propelled trucks with manually operated lifting function

For these trucks no specific temperature testing is required.

### 5.1.3.3 Self-propelled trucks with manually operated lifting function

The test procedure of 5.1.3.1 shall apply, but lifting of the load after coming to a stop at A is not required. Instead of lifting, the truck shall rest at point A for 10 s.

### 5.1.3.4 Pedestrian propelled trucks with self-propelled lifting function

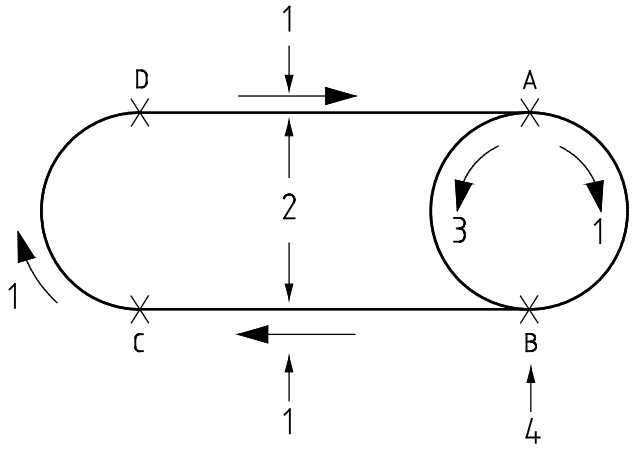
For these trucks, the test cycle is limited only to the lifting function. The load - equal to 100 % of the actual capacity for which the truck is marked to - shall be lifted with its maximum rated speed to its maximum height and then lowered. After a waiting time of 30 s the lifting cycle shall be repeated.

### 5.1.3.5 Test procedure for tractors and burden and personnel carriers

The test procedure described below for tractors also applies to burden and personnel carriers with or without a trailer provided the burden carrier is loaded to 100% of its capacity during all the cycles and for the full duration of the test.

NOTE Burden and personnel carriers often have a tow pin and can be used as tractor.

The tractor shall be driven over a circuit given in Figure 3 as follows:




**Key**

1 forward drive
2 accelerate and decelerate
3 backward drive
4 coupled with trailer

**Figure 3 — Test cycle for tractors**

a) the test cycle starts at point B from where the tractor without trailer shall be driven forwards and fully accelerated to its rated speed and then immediately decelerated using the service brakes until the tractor comes to a controlled stop at C. The distance to achieve its rated speed and deceleration to a stop differs from one type of tractor to the other but shall not be less than 6 m;

b) the tractor shall be driven forwards from C to D in a safe manner and from D fully accelerated to its rated speed and then immediately decelerated using the service brakes until the tractor comes to a controlled stop at A;

c) the tractor shall be driven backwards from A to B in a safe manner as fast as possible;

d) the circuit shall be repeated with the tractor pulling a trailer in the above described conditions but travelling from A to B in a forward direction. The load shall be 100 % of the rated towing capacity of the tractor as defined in EN ISO 3691-1. After the tractor has come to a stop at B the trailer shall be uncoupled.

The described procedure is equal to one cycle.

### 5.1.4 Measurements

The relevant test cycles as given in 5.1.3.1, 5.1.3.3, 5.1.3.4 or 5.1.3.5 shall be repeated up to a maximum of 100 cycles or until one of the following events occurs:

a) the rate of temperature rise does not exceed 2 K/h,

or

b) a temperature limiting device activates before the maximum surface temperature, as described in 5.1.5, is reached. The temperature measurements shall continue until the temperatures of all measured parts decrease,

or

c) the traction battery (electric powered trucks) is discharged to 20 % of its rated capacity or the fuel tank (I.C. engine trucks) has run empty.

It is not required to measure surface temperatures of hydraulic systems on trucks classified T1, T2 or T3 or classified with a maximum surface temperature greater than or equal to 200 °C.

Temperature measurements shall be recorded using data logging with maximum 4 s sample rate and shall be continued until all temperatures decrease.

### 5.1.5 Acceptance criteria

The truck has passed the applicable test if:

a) the temperatures measured and corrected for the maximum ambient temperature of the truck do not exceed the maximum surface temperature in accordance with 4.2.3,

or

b) the truck temperature monitoring and control system in accordance with 4.2.2 shuts down the truck when the maximum surface temperatures for which the truck has been designed and marked to are exceeded (see 4.2.3 and 6.3.3).

NOTE It is not necessary to consider any safety margins in accordance with EN 13463-1:2009, 8.2.1 on final maximum surface temperatures because the temperature test represents adverse conditions exceeding normal operation, expected malfunction or misuse.

## 5.2 Measurement of circuit resistance and capacitance

### 5.2.1 Verification and tests of circuit resistance and bonding resistance

The circuit resistance between truck chassis and the floor shall either be measured for each individual conductive wheel and/or each individual earthing strap, whichever is applied, or measured for all conductive wheels and/or all earthing straps simultaneously.

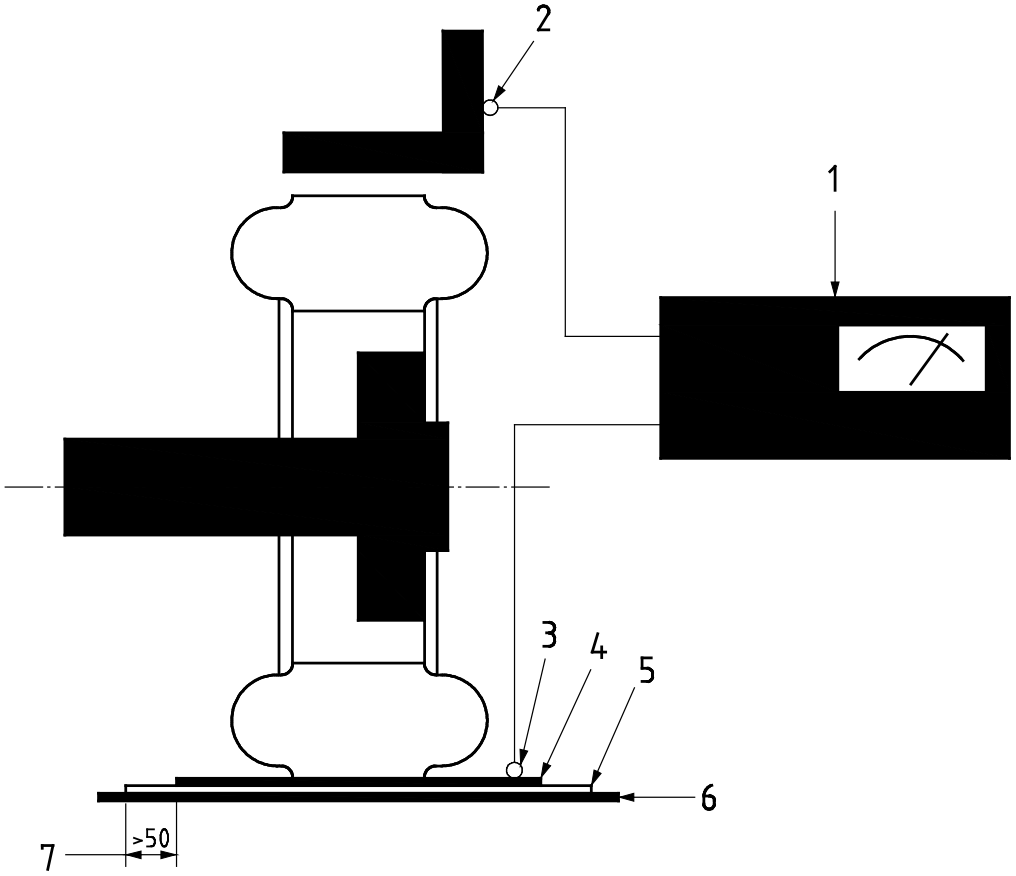
The wheel(s) or earthing strap(s) of the truck to be measured shall be positioned onto a steel plate.

The measuring probes, the probe contact position on the truck chassis, the steel plate(s) and wheel(s) shall be thoroughly cleaned from rust, grease, paint or any other contaminations or obstructing substances.

The steel plate shall be insulated from the floor e.g. by means of a PTFE insulation plate. The resistance between the steel plate and the floor shall be at least $10^{12}$ Ω. The area of the steel plate shall be larger than the projected surface area of the wheel(s) or earthing strap(s). The insulation plate shall extend at least 50 mm beyond the edges of the steel plate. A typical test set up is given in Figure 4.

A test voltage of 500 V ± 5% shall be applied between the prepared metal part of the truck chassis and the steel plate. In all cases the measured circuit resistance shall not exceed $10^{6}$ Ω.

This method may also be used for measuring bonding resistance.




**Key**

| | | | |
|---|---|---|---|
| 1 | measuring equipment | 5 | insulation material e.g. polytetrafluoroethylene (PTFE) or equivalent material |
| 2 | test point on truck chassis | 6 | floor |
| 3 | test point on steel plate | 7 | insulation material extending > 50 mm beyond steel plate |
| 4 | steel plate | | |

**Figure 4 — Typical test set up for measuring circuit resistance**

### 5.2.2 Measurement of capacitance of insulated metal parts

The capacitance of insulated metal parts (see 4.7.1.2) shall be measured using a battery powered LCR-meter with a measuring frequency of 1 kHz. The metal parts shall be measured in their actual truck location.

For each insulated metal part the capacitance shall be measured in accordance with the following procedure:

a) Measurement 1 shall be carried out connecting one probe of the LCR meter to the truck chassis and holding the other probe at a distance of approximately 5 mm from the metal part, ensuring the probe is in free air.

b) Measurement 2 shall be carried out connecting one probe of the LCR meter to the truck chassis and the other probe to the surface of the metal part. The capacitance of the metal part is defined as the difference between the two measurements.

# 6 Information for use

## 6.1 General

In addition to the requirements for the instruction handbook given in the EN ISO 3691-series of standards, EN 1459, EN 1757-3 and EN 1525, the manufacturer shall provide information for use, detailing all relevant aspects related to explosion safety as covered by this standard. This information shall be included in the truck instruction handbook.

## 6.2 Instruction handbook

### 6.2.1 Operation of the truck

The instruction handbook shall include, as applicable, at least the following information:

a) the intended and prohibited use of the truck and its attachments all in accordance with the manufacturer's design parameters;

EXAMPLE Equipment categories, temperature classes or surface temperatures, gas group subdivisions and conductive or non-conductive dusts are examples of design parameters.

b) the instructions to only conduct service and maintenance operations in a non-hazardous area e.g. filling of fuel tanks;

c) the procedure for mounting of attachments;

d) the operation of the gas detection system;

e) required actions to bring the truck to a controlled stop following a safety shutdown (see 4.3) taken into account the 30 s time delay.

### 6.2.2 Service and maintenance of the truck

All intended service conditions for the truck (e.g. rough handling, humidity effects, ambient temperature and pressure variations, effects of chemical agents, corrosion, vibration) shall be specified by the manufacturer and included in the information for use.

The instruction handbook shall include at least the following inspection and maintenance information regarding:

a) the type and frequency of inspections and maintenance operations;

b) the relevant maintenance aspects for the electrical system and gas detection system including cabling given in EN 60079-17 and EN 60079-29-2;

c) details how to purge restricted breathing enclosures with clean air after a safety shutdown caused by the gas detection system before the truck is restarted;

d) the periodic calibration of gas sensors at intervals of maximum 12 months using a calibration gas defined by the manufacturer;

e) the periodic verification of gas sensors at intervals of maximum 3 months by means of a gas injection using a verification gas defined by the manufacturer;

NOTE Detailed information on maintenance, verification and calibration is given in EN 60079-29-2.

f) maintenance and routine testing of restricted breathing enclosures;

g) minimum test and inspection intervals for the insulation resistance of the electrical system and the functioning of the insulation monitoring device;

h) the verification of sufficient clearance between stationary and rotating parts;

i) wheels, castors, earthing straps, fan belts etc. for good condition and the possible loss of conductivity due to contamination;

j) the verification of seat and non-metallic covers for bonding and surface resistance;

k) the verification of correct functioning of safety monitoring and shutdown systems including the sensors;

l) the periodic replacement of safety critical or consumable parts;

m) the verification of the correct tightness of fasteners and the correct maximum gap of flameproof joints;

n) verification of excessive wear and axial play of brake linings and in the case of constructional safety brakes the correct positioning of the thermal sensor after repair;

o) verification of the minimum thickness of 1 mm cladding of load handling devices;

p) the relevant maintenance aspects for the internal combustion engine given in EN 1834-1 and EN 1834-3;

q) verification of the integrity of enclosures protected by specific types of protection;

NOTE Information on inspection of electrical equipment is given in EN 60079-17.

r) verification of integrity of marking and warning labels.

### 6.2.3 Additional safety information

The instruction handbook shall state the warning text:

“This equipment could present hazards if it is not operated according to the information given in this instruction handbook”,

and shall include, as applicable, at least the following information:

a) description of the operational limitations of equipment marked with the symbol “X”;

b) all warnings necessary for proper operation of the equipment;

c) function of the safety devices;

d) measures in case of failures or repair;

e) footwear to be worn by the operator to comply with EN ISO 20344;

f) protective clothing to be worn by the operator, including gloves to comply with EN 1149-5;

g) a warning that trucks should only be operated in hazardous areas with dissipative floors;

NOTE Information on the requirements for conductive or dissipative floors can be found in CLC/TR 60079-32-1.

h) a warning about the possible dangerous electrostatic charging of non-conductive parts on the truck due to, e.g. contact with flexible doors or strip curtains;

i) the time interval for the testing of conductive tyres, dissipative tyres and earthing straps including the test procedure.

#### 6.2.4 Information for charging of the battery and battery handling

The instruction handbook shall contain the following additional information, taken into account the requirements for battery charging rooms and charging areas:

a) charging of batteries, if appropriate, in hazardous areas shall comply with the requirements of EN 60079-0 and EN 60079-7;

b) information about gas production during charging and discharging of the battery and requirements for battery charging stations;

c) information about suitable equipment and provisions to ensure safe battery handling;

d) information about battery charging equipment;

e) general battery information;

f) service information for batteries.

NOTE Information on battery charging rooms and areas can be found in EN 50272-3.

### 6.3 Marking

#### 6.3.1 General

The truck shall be marked on the chassis in a visible place. This marking shall be legible and durable taking into account possible chemical corrosion and mechanical abrasion.

NOTE Marking is subject to the relevant European directives.

#### 6.3.2 Minimum marking

In addition to the requirements for marking given in EN ISO 3691-1 the truck marking shall show at least the following details:

a) The symbol  ;

b) The symbol for the equipment group: II;

c) The equipment category “2” or “3” followed by:

   1) the letter “G” (concerning explosive atmospheres caused by gases, vapours or mists); and/or

   2) the letter “D” (concerning explosive atmospheres caused by dusts).

NOTE For products intended to be put on the market in the EEA, the CE marking is defined in the applicable European directives.

### 6.3.3 Additional marking according to this standard (Ex - marking)

The additional marking shall include as applicable:

a) The symbol for the explosion group: II, followed by the symbol for the subdivision: (e.g. IIA or IIB or IIB+$H_2$ or IIB+$C_2H_2$ or IIB+$H_2$+$C_2H_2$);

b) The symbol for the explosion group III, followed by the symbol for the subdivision A, B or C;

c) The marking concerning maximum surface temperatures:

   1) classified in a temperature class given in Table 1 (for trucks marked “G”); or

   2) defined by the maximum surface temperature in °C (for trucks marked “G” or “D”).

d) The marking of the ambient temperature in accordance with Table 2;

e) The symbol X to denote special conditions of safe use;

f) For trucks equipped with a gas detection system and restricted breathing enclosures the “3G” marking shall be followed by:

   1) the chemical formula or name of the specific flammable gas or gases for which the gas detection system is designed and calibrated to detect; or

   2) with the text “only for specific flammable gases” followed by the handbook symbol in accordance with ISO 15870.

**Table 2 — Truck ambient temperature marking**

| Truck ambient temperature range | Ambient temperature marking |
|---|---|
| Minimum: −20 °C<br>Maximum: +40 °C | None |
| Specified by the manufacturer | $T_a$ with special range,<br>for example: −10 °C ≤ $T_a$ ≤ +30 °C |

## 6.4 Warning labels

Warning labels shall comply with the relevant requirements of the EN ISO 3691-series of standards, EN 1459, EN 1757-3 or EN 1525.

Where any of the following warning labels are required on the equipment or truck, the text as described in Table 3 shall be applied.

**Table 3 — Text of warning labels**

| Item | Reference | Warning label text |
|---|---|---|
| 1. | 4.10.2.9 | WARNING - After truck shutdown following gas alarm, each restricted breathing enclosure shall be thoroughly purged with air or inert gas before the truck is restarted |
| 2. | 4.7 | WARNING - Non-conductive part(s) - Potential electrostatic charging hazard - Clean only with a damp cloth |
| 3 | 4.10.4 | WARNING - Open only in a non-hazardous area |
| 4 | 4.10.4 | WARNING – Restricted breathing enclosures "nR" installed on this truck |

# Annex A
(normative)

# List of significant hazards

This list contains all the significant hazards, hazardous situations and events, as far as they are dealt with in this standard, identified by risk assessment in accordance with EN 1127-1 and EN 13463-1 and which require action to eliminate or reduce the risk. See Table A.1.

NOTE The structure of the table is based on that of EN 12100. The order of lines within a group corresponds to the truck functionalities.

**Table A.1 — List of significant hazards**

| EN 1127-1 **Clause** | **Possible ignition sources** | **Potential consequences** | **Corresponding requirement** | |
|---|---|---|---|---|
| 5.1 | Hot surfaces | Ignition of an explosive atmosphere | 4.2 | Temperature range and classification |
| | | | 4.3 | Safety shut down |
| | | | 4.8 | Brakes, clutches and couplings |
| | | | 4.9 | Pneumatic systems |
| | | | 4.11 | Flammability of non-metallic materials |
| 5.2 | Flames and hot gases (including hot particles) | Ignition of an explosive atmosphere | 4.6 | Internal combustion engine |
| 5.3 | Mechanically generated sparks | Ignition of an explosive atmosphere | 4.4 | Mechanically generated sparks |
| | | | 4.8 | Brakes, clutches and couplings |
| 5.4 | Electrical equipment | Ignition of an explosive atmosphere | 4.3 | Safety shut down |
| | | | 4.5 | Electrical system |
| | | | 4.10 | Requirements for trucks equipped with gas detection systems |
| 5.6 | Static electricity | Ignition of an explosive atmosphere | 4.7 | Electrostatic discharges |
| 5.12 | Adiabatic compression and shock waves | Ignition of an explosive atmosphere | 4.6 | Internal combustion engine |
| | | | 4.9 | Pneumatic systems |

# Annex B
(informative)

# Relationship between zones (area classification) and truck categories

Table B.1 shows the relation between area classification and use of trucks in these areas based on their equipment categories.

NOTE Information regarding the use of explosion proof equipment in hazardous areas is given in the applicable European Directive.

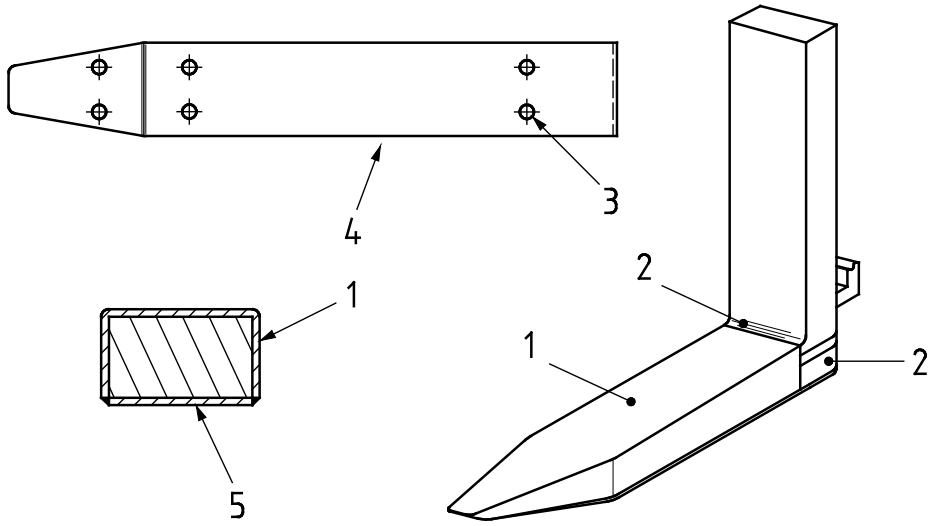
**Table B.1 — Relationship between zones and truck categories**

| Area classification | Truck category |
|---|---|
| zone 1 | category 2G |
| zone 2 | category 3G |
| zone 21 | category 2D |
| zone 22 | category 3D |

# Annex C
(informative)

# Typical example of cladding of load handling devices

The figures below shows a typical example of cladded load handling devices as referenced in 4.4.1.




**Key**

1 cladded surface on all main contact areas
2 area not cladded to enable to inspect for hair cracks
3 feature to enable wear to be measured on underside of fork (optional)
4 underside of fork
5 sectional view of fork

**Figure C.1 — Typical example of fork cladding**

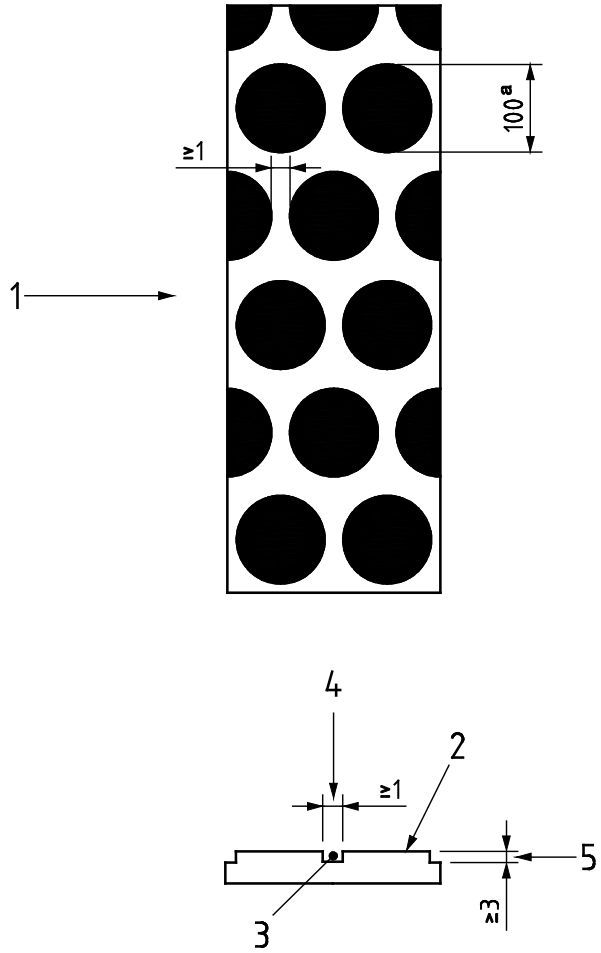
# Annex D
(informative)

# Typical examples of non-conductive surface areas according to 4.7.3.1

The figures below show typical examples of profiled surfaces referenced in 4.7.3.1.

Dimensions in millimetres except where indicated

The exposed non-conductive surfaces are shown as black areas.

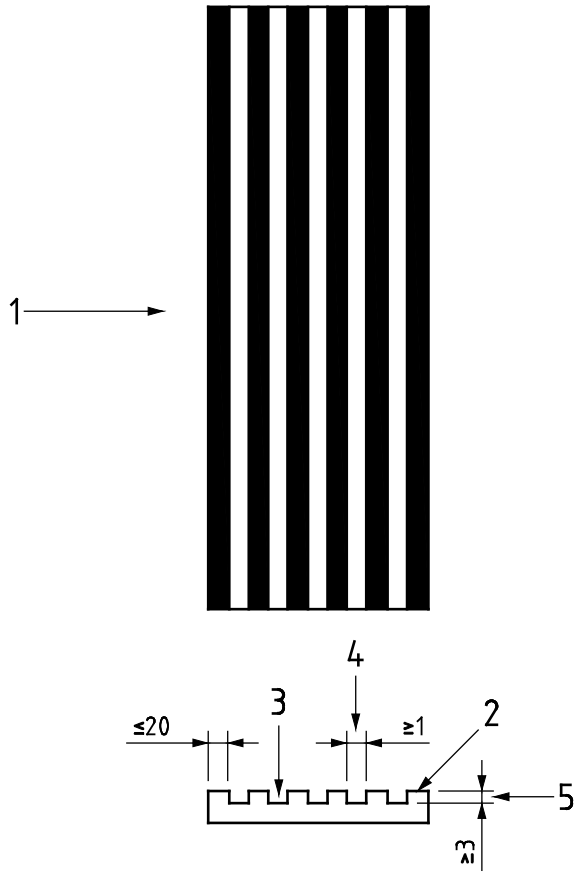



**Key**

1 profiled surface
2 exposed non-conductive surface area
3 groove
4 width of the groove
5 depth of the groove
a dimensions in $cm^2$

**Figure D.1 — Acceptable profiled surface for gas group IIA and IIB according to 4.7.3.1 d)**

Dimensions in millimetres



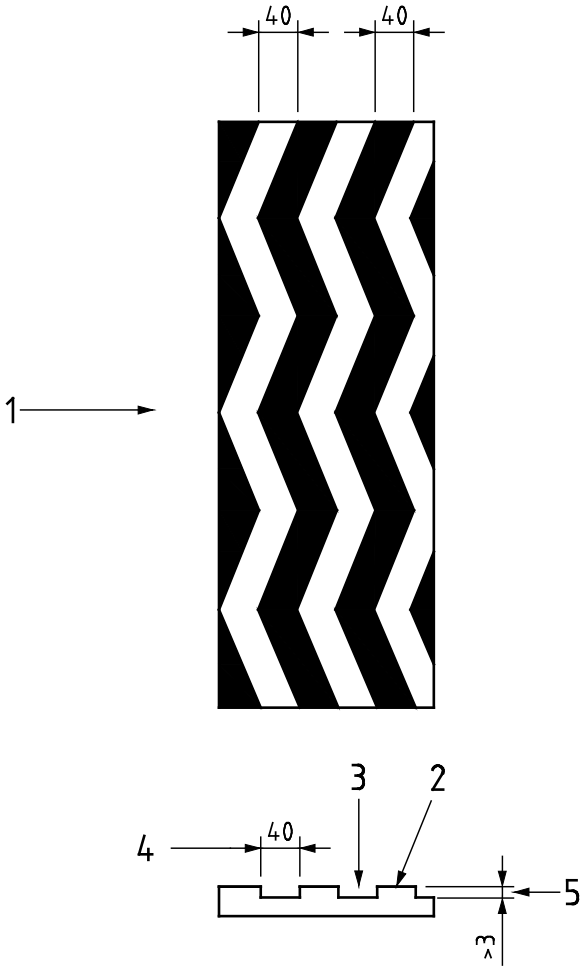

The exposed non-conductive surfaces are shown as black areas.

**Key**

1 profiled surface
2 exposed non-conductive surface area
3 groove
4 width of the groove
5 depth of the groove

**Figure D.2 — Acceptable profiled surface for gas group IIA, IIB, IIB+$H_2$, IIB+$C_2H_2$ or IIB+$H_2$+$C_2H_2$ according to 4.7.3.1. e)**

Dimensions in millimetres




The exposed non-conductive surfaces are shown as black areas.

**Key**

1 profiled surface
2. exposed non-conductive surface area
3 groove
4 width of the groove
5 depth of the groove

**Figure D.3 — Not acceptable profiled surface according to 4.7.3.1 e)**

# Annex E
(normative)

# Requirements for transmission belts in accordance with ISO 9563 or ISO 1813

**Table E.1 — Transmission belts**

<table>
<tr><th>Belt Speed</th><th>Dissipative Criteria</th><th>2G</th><th>3G</th><th>2D</th><th>3D</th></tr>
<tr><td>≤ 0,5 m/s</td><td rowspan="3">R x B / L<br>≤ 600 kΩ<br><br>See NOTE 1<br>See NOTE 2</td><td>Dissipative belt with conductive pulleys, belt connectors are permitted</td><td rowspan="3">No requirements except for those outlined in 4.7.4 of this standard</td><td>Dissipative belt with conductive pulleys, belt connectors are permitted</td><td rowspan="3">No requirements except for those outlined in 4.7.4 of this standard</td></tr>
<tr><td>0,5 - 5 m/s</td><td rowspan="2">Dissipative belt with conductive pulleys, belt connectors are not permitted</td><td rowspan="2">Dissipative belt with conductive pulleys, belt connectors are not permitted</td></tr>
<tr><td>5 - 30 m/s<br>See NOTE 3</td></tr>
<tr><td colspan="6">NOTE 1 R: resistance of the transmission belt measured between two conductive electrodes (e.g. graphite, silver paint, metal electrode);<br>L: length of the electrodes;<br>B: width of the flat belt or 2x the width of the side face of the V-belt.<br>NOTE 2 Resistances shall be measured with electrodes in accordance with ISO 9563 and ISO 1813 at 23 °C (± 2 K), no moisture condensation.<br>NOTE 3 No information is available for belt velocities greater than 30 m/s.</td></tr>
</table>

# Annex F
(informative)

# Significant technical changes between this document and the previous edition of this European Standard

The previous edition of this standard originates from the mid-nineties of the last century. At that time for non-electrical equipment only prEN 1127:1993 was available to give guidance in the developing of a standard for forklift trucks intended for use in potentially explosive atmospheres. In the last decade CEN\TC 305 developed a significant number of standards which now provide detailed information for the design and construction, testing and marking of non-electrical equipment as well as criteria for the execution of ignition hazard assessments. Also the standards for electrical equipment have evolved and have been updated on a regular basis since the first publication of this standard in 2000.

The above has been taken into account in the development of this standard which now is closely connected to the current standards for electrical and non-electrical equipment for use in potentially explosive atmospheres. In this document the technical requirements are arranged according the respective ignition hazards (hot surfaces, mechanically generated sparks, etc.) whereas in the previous edition the arrangement was based on the respective equipment categories.

Therefore this document (EN 1755:2015) contains significant changes reflecting current state of the art.

The significant changes are listed in Table F.1.

**Table F.1 — Significant changes**

| **Subject to review** | EN 1755:2015 **Clause** | **Minor and editorial changes** | **Extension** | **Major technical changes** | **Reference to** EN 1755:2000+A2:2013 **clause** |
|---|---|---|---|---|---|
| Introduction of new definitions | 3 | | X | | 3 |
| Requirements arranged according to ignition sources (instead of equipment categories) | 4 | X | | | 5 |
| Requirements for category 3G<br>Requirements for category 2G<br>Requirements for category 3D<br>Requirements for category 2D | 4 | X | | | 5.1<br>5.2<br>5.3<br>5.4 |
| Reference to EN 13463-1 | 4 | | | X | --- |
| Requirements for performance levels (PLs) and SIL for monitoring systems | 4 | | | X | 5.1.1<br>5.1.5.1 |
| Temperature classification and marking | 4.2.3 | X | | | 5.1.1 |
| Introduction of the "Safety Shutdown" concept and time delay function | 4.3 | | X | | --- |

| **Subject to review** | EN 1755:2015 **Clause** | **Minor and editorial changes** | **Extension** | **Major technical changes** | **Reference to** EN 1755:2000+A 2:2013 **clause** |
|---|---|---|---|---|---|
| Stainless steel excluded for use on load handling equipment on trucks for IIB + $H_2$, IIB + $C_2H_2$ and IIB + $H_2$ + $C_2H_2$ | 4.4.1 | | | X | 5.1.9 |
| Additional IP protection to prevent ingress of foreign bodies causing incendive sparking. IP 20 protection of exposed parts | 4.4.2 | | | X | 5.1.2 |
| Reference to EN 13463-5:2011 and EN 1127-1:2011 as current state of the art | 4.4.3 | | | X | --- |
| Requirements for internal combustion engine mounted electrical equipment (EN 1834-1) are now explicitly mentioned | 4.5.1 | X | | | 5.1.4<br>5.2.5<br>5.3.3.<br>5.4.4 |
| Reference to EPL's as current state of the art | 4.5.2 | | X | | 5.1.5<br>5.2.6<br>5.3.4<br>5.4.5 |
| Insulation monitoring device also required for category 2D trucks. Insulation resistance less than 500 Ω will be indicated by a visual alarm followed by a safety shutdown according to 4.3. Monitoring device to fulfil SIL1 | 4.5.4 | | | X | 5.2.6.1 |
| Requirements for batteries and battery connectors specified in more detail with reference to applicable standards | 4.5.5 | X | | | 5.1.5<br>5.2.6<br>5.3.4<br>5.4.5 |
| Bonding to truck chassis extended to conductive and dissipative parts which include metal parts | 4.7.1.1 | | | X | 5.1.3.1 |
| More specific requirements for non-conductive parts for category 3G and category 2G trucks | 4.7.3.1 | | | X | 5.1.3<br>5.2.4 |
| Reference to specific and updated standards regarding transmission belts applicable to all equipment categories | 4.7.4 | | X | | 5.1.3.3 |
| Introduction of requirements for wheels on 3G and 3D trucks to prevent the generation of electrostatic charges | 4.7.6 | | | X | |

| **Subject to review** | EN 1755:2015 **Clause** | **Minor and editorial changes** | **Extension** | **Major technical changes** | **Reference to** EN 1755:2000+A2:2013 **clause** |
|---|---|---|---|---|---|
| Deletion of specific type of protection and update to EN 13463-5:2011, Clause 7 as current state of the art and applicable to all categories. | 4.8.2 | | X | | 5.1.7<br>5.2.8<br>5.3.6<br>5.4.7 |
| Update to EN 13463-5:2011, Clause 11 as current state of the art and applicable to all categories. | 4.8.4 | | X | | 5.1.8<br>5.3.7 |
| Flameproof enclosures for brakes and clutches to comply with EN 13463-3 | 4.8.5<br>4.8.6 | | | X | 5.2.8.3.3<br>5.2.9.2.35.4.7<br>5.4.8 |
| Deletion of the concept of "added safety" and "pressurized" brakes<br>Introduction of "constructional safety" brakes. Reference to EN 13463-5:2011 as current state of the art | 4.8.6 | | X | | 5.2.9.2.2<br>5.2.9.2.4<br>5.4.8 |
| A visual warning not required on pedestrian trucks | 4.8.7 | X | | | 5.1.8.3<br>5.2.9.3<br>5.3.7.3<br>5.4.9 |
| Update to EN 13463-5:2011, 8.1 as current state of the art and applicable to all categories | 4.8.8 | | X | | --- |
| Update to EN 13463-1:2001 and EN 13463-5:2011, 7.6 as current state of the art | 4.9 | | X | | 5.1.6<br>5.2.7<br>5.3.5<br>5.4.6 |
| Requirements for gas detection systems including sensors updated to current EN 60079-29-1 and EN 60079-29-2 | 4.10 | | | X | 5.1.5.2.1 |
| For restricted breathing enclosures “nR” in combination with a gas detection system, the deletion of a gas penetration test and introducing the pressure drop test in accordance with EN 60079-15, 23.2.3.2.1.1 | 4.10.4 | | | X | 5.1.5.2.2<br>6.4 |
| Additional test conditions e.g. on measuring temperatures of restricted breathing enclosures | 5.1.2 | | X | | 6.2.2 |
| Principle for measuring the circuit resistance also applicable for measuring the bonding resistance | 5.2.1. | | X | | 6.3 |

| **Subject to review** | EN 1755:2015 **Clause** | **Minor and editorial changes** | **Extension** | **Major technical changes** | **Reference to** EN 1755:2000+A 2:2013 **clause** |
|---|---|---|---|---|---|
| Additional requirements for the measuring the capacitance of insulated metal parts | 5.2.2 | | | X | --- |
| Reference to EN ISO 3691, EN 1459, EN 1757-3 and EN 1525 for requirements on instruction handbooks | 6.1 | X | | | 7.1 |
| Introduction of explosion safety related instructions for the operation of the truck | 6.2.1<br>6.2.3 | | X | | 7.1 |
| Introduction of explosion safety related instructions for service and maintenance of the truck | 6.2.2 | | X | | 7.1 |
| Introduction of explosion safety related instructions for battery charging and handling | 6.2.4 | | X | | 7.1 |
| Introduction of additional quality requirements for the marking plate | 6.3.1 | | X | | 7.2 |
| Additional requirements for the marking of the applicable ambient temperature | 6.3.3 | | X | | 5.1.1<br>7.2 |
| Introduction of specific warning labels | 6.4 | | X | | --- |
| Introduction of a list of significant hazards applicable to trucks intended for use in potentially explosive area's | Annex A (informative) | | X | | --- |
| Introduction of a typical example of cladding of load handling devices | Annex C (informative) | | X | | --- |
| Introduction of typical examples of non- conductive surfaces areas according to 4.7.3.1. | Annex D (informative) | | X | | --- |
| Introduction of requirements on conductive transmission belts | Annex E (normative) | | X | | --- |
| Introduction of a list of significant technical changes | Annex F (informative) | | X | | --- |
| Warning label for ”nR” enclosures<br>Introduction of typical examples on warning labels for trucks with restricted breathing enclosures | Annex G (informative) | | X | | --- |

# Annex G
(informative)

## Warning labels for trucks with restricted breathing enclosure(s)

The figures below show typical examples of warning labels in accordance with 4.10.4 and 6.4, to be applied when restricted breathing enclosures are installed.

**Ex-Truck Ltd**

**Type: 4321CBA**

**Serial no.: 12345**

**II 3G X**

**Ex nR IIB T4 Gc**

**WARNING!!**

**RESTRICTED BREATHING ENCLOSURE "nR"**

- Open only in a non- hazardous area
- Purge enclosure after gas alarm shutdown
- Check integrity of enclosure at regular intervals or after opening

**Figure G.1 — Restricted breathing enclosure label**

**WARNING!!**
**RESTRICTED BREATHING ENCLOSURES "nR"**
**INSTALLED ON THIS TRUCK**

- Do not open in a hazardous area
- Purge enclosures after gas alarm shutdown
- Check integrity of enclosures at regular intervals or after opening

**Figure G.2 — Truck label according to 4.10.4**

# Annex ZA
(informative)

## Relationship between this European Standard and the Essential Requirements of EU Directive 94/9/EC[2]

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 94/9/EC.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the relevant Essential Requirements of that Directive and associated EFTA regulations.

**WARNING** — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

**Table ZA.1 — Correspondence between EN 1755:2015 and Directive 94/9/EC**

| Clauses / subclauses of this EN | Essential requirements (ERs) of EU Directive 94/9/EC | Qualifying remarks/Notes |
|---|---|---|
| | **1. COMMON REQUIREMENTS FOR EQUIPMENT AND PROTECTIVE SYSTEMS** | |
| | **1.0 General requirements** | |
| 4 | 1.0.1 Principles of integrated explosion safety | |
| 4 | 1.0.2 Design considerations | |
| 4, 6.1 | 1.0.3 Special checking and maintenance conditions | |
| 1 | 1.0.4 Surrounding area conditions | |
| 6.3 | 1.0.5 Marking | |
| 6.1 | 1.0.6 Instructions | |
| | **1.1 Selection of materials** | |
| 4 | 1.1.1 Explosion avoidance | |
| --- | 1.1.2 Reaction between materials | Not applicable to industrial trucks |
| 4 | 1.1.3 Selection of materials | |
| 4 | **1.2 Design and construction** | |
| 4 | 1.2.1 Safe operation throughout foreseeable lifetime | |
| 6.2.2 | 1.2.2 Components to be incorporated in the equipment | |
| --- | 1.2.3 Enclosed structures and prevention of leaks | Not applicable to industrial |

[2] Directive 94/9/EC is withdrawn with effect from 20 April 2016 on which date Directive 2014/34/EC shall come into force. References in this standard to Directive 94/9/EC shall be regarded as references to Directive 2014/34/EC.

| Clauses / subclauses of this EN | Essential requirements (ERs) of EU Directive 94/9/EC | | Qualifying remarks/Notes |
|---|---|---|---|
| | | | trucks |
| 4 | 1.2.4 | Dust deposits | |
| 4 | 1.2.5 | Additional means of protection | |
| 4 | 1.2.6 | Safe opening | Applicable to equipment installed on trucks |
| 4.1 | 1.2.7 | Protection against other hazards | |
| 4, 5 | 1.2.8 | Overloading of equipment | |
| 4 | 1.2.9 | Flameproof enclosure system | |
| | **1.3** | **Potential ignition sources** | |
| 4 | 1.3.1 | Hazards arising from different ignition sources | |
| 4.7 | 1.3.2 | Hazards arising from static electricity | |
| 4.5.3, 4.5.4 | 1.3.3 | Hazards arising from stray electric and leakage currents | |
| 4.2, 4.4, 4.8 | 1.3.4 | Hazard rising from overheating | |
| 4.6, 4.9 | 1.3.5 | Hazards arising from pressure compensation | Not applicable |
| | **1.4** | **Hazards arising from external effects** | |
| 4, 6.2.1 | 1.4.1 | External effects | |
| 4, 6.2.1 | 1.4.2 | Aggressive substances | |
| | **1.5** | **Requirements for safety-related devices** | |
| 4.2.2, 4.5.4, 4.10.2 | 1.5.1 | Functioning of safety devices | |
| 4.2.2, 4.5.4, 4.10.2 | 1.5.2 | Safety device failure | |
| 4.3 | 1.5.3 | Emergency stop restart lockout | |
| --- | 1.5.4 | Control and display units, ergonomics | Not covered; specific requirements are given in the standards listed in the Introduction |
| 4.5.2.1, 4.10 | 1.5.5 | Measuring devices | |
| 4.10 | 1.5.6 | Measuring devices, reading accuracy etc. | Not covered; specific requirements are given in the standards listed in the Introduction and 4.10.2.1 |
| 4.10.2.5 | 1.5.7 | Safety device alarm threshold | |
| 4.2.2, 4.5.4, 4.10.2 | 1.5.8 | Risk arising from software | |
| | 1.6 | Integration of safety requirements | |
| --- | 1.6.1 | Manual override | Not applicable to industrials trucks |
| 4.3 | 1.6.2 | Emergency shutdown, accumulated energy | |
| --- | 1.6.3 | Hazard arising from power failure | Not applicable to industrial |

| Clauses / subclauses of this EN | Essential requirements (ERs) of EU Directive 94/9/EC | Qualifying remarks/Notes |
|---|---|---|
| | | trucks |
| 4.5.2 | 1.6.4 Hazards arising from connections | |
| 4.10, 6.2.1, 6.2.2 | 1.6.5 Placing of warning devices | |
| | **2. SUPPLEMENTARY REQUIREMENTS FOR EQUIPMENT** | |
| | **2.0 Equipment of group I** | Not in the scope of this standard |
| | **2.1 Equipment of group II, category 1** | Not in the scope of this standard |
| | **2.2 Equipment of group II, category 2** | |
| | 2.2.1 Explosive atmospheres, gases, vapours, mists | |
| 4 | 2.2.1.1 Design and construction | |
| 4, 4.2, 5.1 | 2.2.1.2 Surface temperatures | |
| 6.2.4 | 2.2.1.3 Opening equipment only in non-active conditions | |
| | 2.2.2 Explosive atmospheres, dust/air mixtures | |
| 4 | 2.2.2.1 Design and construction | |
| 4, 4.2, 5.1 | 2.2.2.2 Surface temperatures | |
| 4, 4.6 | 2.2.2.3 Protection against dust | |
| 4.5 | 2.2.2.4 Opening equipment only in non-active conditions | |
| | 2.3 **Equipment of group II, category 3** | |
| | 2.3.1 Explosive atmospheres, gases, vapours, mists | |
| 4 | 2.3.1.1 Design and construction | |
| 4, 4.2, 5.1 | 2.3.1.2 Surface temperatures | |
| | 2.3.2 Explosive atmospheres, dust/air mixtures | |
| 4 | 2.3.2.1 Design and construction | |
| 4, 4.2, 5.1 | 2.3.2.2 Surface temperatures | |
| 4.5.2 | 2.3.2.3 Equipment, cable entries etc. | |
| | **3. SUPPLEMENTARY REQUIREMENTS FOR PROTECTIVE SYSTEMS** | Not in the scope of this standard |

# Bibliography

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[2] EN 12053, *Safety of industrial trucks — Test methods for measuring noise emissions*

[3] EN 12895, *Industrial trucks - Electromagnetic compatibility*

[4] EN 13059, *Safety of Industrial trucks — Test method for measuring vibration*

[5] EN 13237:2012, *Potentially explosive atmospheres - Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

[6] EN 16307-1, *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*

[7] EN 16307-5, *Industrial trucks - Safety requirements and verification - Part 5: Supplementary requirements for pedestrian-propelled trucks*

[8] EN 16307-6, *Industrial trucks - Safety requirements and verification - Part 6: Supplementary requirements for burden and personnel carriers*

[9] EN 50272-3, *Safety requirements for secondary batteries and battery installations - Part 3: Traction batteries*

[10] EN 50495:2010, *Safety devices required for the safe functioning of equipment with respect to explosion risks*

[11] EN 60079-29-3, *Explosive atmospheres - Part 29-3: Gas detectors - Guidance on functional safety of fixed gas detection systems(IEC 60079-29-3)*

[12] EN 60079-32-2, *Explosive atmospheres - Part 32-2: Electrostatics hazards - Tests(IEC 60079-32-2)*

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[15] EN ISO 12100, *Safety of machinery - General principles for design - Risk assessment and risk reduction (ISO 12100)*

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