

Industrial trucks for use in potentially explosive areas - placing on the market in compliance with Directive 94/9/EC and EN 1755¹

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Industrial trucks are used for handling containers with hazardous substances, including transport in their storage areas or for transport in filling and mixing plants. In such areas, gases, vapours, mist or dust may escape both under normal conditions and in the event of failures. When these substances get into contact with ambient air, they form explosive gas-air or dust-air mixtures, i.e. a potentially explosive atmosphere. This atmosphere may ignite in the presence of hot surfaces, hot exhaust gases, impact and friction sparks at mounted electrical and non-electrical parts, or as a result of electric sparks or electrostatic discharge. To prevent explosions in a potentially explosive atmosphere, industrial trucks are operated as explosion-protected equipment.

Measures that have to be taken to avoid potential sources of ignition at the truck itself are listed in the European EN 1755 standard. The requirements for placing explosion-protected equipment on the European market are regulated by Directive 94/9/EC (ATEX Directive).

The present paper explains the interaction between Directive 94/9/EC, other EC Directives and EN 1755 in connection with the placing on the market of explosion-protected industrial trucks. The paper in particular wants to show when an explosion-protected industrial truck should be inspected by a notified body in compliance with Directive 94/9/EC.

Directive 94/9/EC

The ATEX Products Directive 94/9/EC [1] defines the rules and regulations for placing explosion protected equipment and protective systems as well as safety, controlling and regulating devices on the market. This Directive is the first directive to also include non-electrical explosion-protected equipment on a European scale. Friction brakes, hydrodynamic couplings or hydraulic systems, may, for instance, produce an ignition risk when allowed to heat excessively.

In its Annex II, Directive 94/9/EC specifies the essential health and safety requirements that producers of explosion-protected equipment have to observe, compliance with which has to be proved in the form of conformity assessment procedures as set out in Article 8 of Directive 94/9/EC.

Current technological knowledge must be applied without delay and as far as possible. This means that equipment must be manufactured in compliance with generally accepted codes of practice and on the basis of the latest version of standards. European Standards that have been harmonised with respect to one or more than one EC Directive(s) may be presumed to conform

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with the requirements of the corresponding Directives. They are published in the Official Journal of the European Union.

The placing on the market in compliance with EC Directives

As of 30 June 2003, equipment, protective systems as well as safety, controlling or regulating devices have had to conform with Directive 94/9/EC to be able to be placed on the market. In Germany, this European Directive was translated into national law with the 11th Ordinance relating to the Equipment and Product Safety Act (11th GPSGV) [2]. On 8 November 2011, the new Product Safety Act [3] transposed the previous 11th GPSGV into the 11th Ordinance relating to the Product Safety Act - 11th ProdSV [4].

Industrial trucks must, in addition, also comply with all other relevant EC Directives, such as the Machinery Directive 2006/42/EC [5] or the EMC Directive 2004/108/EC [6].

An explosion-protected industrial truck may only be placed on the European market by one manufacturer who has to assume general responsibility. The company/person placing a product on the market need not necessarily be the manufacturer of that product, but that company/person must comply with all obligations set forth in the relevant EC Directives for that product and must be based in the European Union. This is due to the fact that in the European Union, only the company/person placing a product on the market can be held liable in connection with liability and legal issues. In the paragraphs below, this paper will always use the term "manufacturer" wherever it actually addresses the "manufacturer or his authorised representative within the Community".

Whoever subjects a product that has already been placed on the European Market to major modifications, thus creating a new product (e.g. a non-explosion protected industrial truck is converted so that it becomes an explosion-protected industrial truck) becomes the manufacturer of that product and will consequently be responsible for the complete "new" product. This means that only one CE marking has to be affixed on the explosion-protected industrial truck and only one declaration of conformity has to be issued. Any other marking on the industrial truck has to be removed. Exempted from this regulation is the CE marking of equipment that is used inside the industrial truck and that carries a CE mark to comply with Directive 94/9/EC or other EC Directives.

There are two options for placing explosion-protected industrial trucks on the market:

- The explosion-protected industrial truck is developed, designed and manufactured by the manufacturer as an explosion-protected product, however the manufacturer may make use of the services of third parties, who are commissioned to perform certain steps in the production process and thus act as an "extended workbench". In that case, the manufacturer is responsible for the outsourced production processes. The manufacturer prepares the declaration of conformity and affixes the marking.

- An industrial truck that had originally not been intended for use in potentially-explosive atmospheres is equipped with the safety features or modified for explosion protection requirements by a converting company. Any non-explosion protected parts are removed and replaced with explosion-protected ones. The converter places the explosion-protected industrial truck on the market, prepares the declaration of conformity for the complete piece of equipment (conformity with all relevant directives) and affixes the marking. The converter also has to remove the marking that had been provided by the manufacturer of the original piece of equipment, because it does now no longer apply.

If, for instance, the user of the industrial truck commissions the conversion of the industrial truck for explosion protection requirements, the user becomes the manufacturer with all consequences that follow from this fact. Details of the notion of "manufacturers of industrial trucks" can be found in a VDMA position paper [7].

Conformity assessment

The conformity assessment of explosion-protected equipment depends on the equipment group and the equipment category of that equipment. Equipment group I applies to equipment intended for use in underground parts of mines and surface installations of said mines. Equipment group II applies to equipment intended for use in other places liable to be endangered by explosive atmospheres.

Directive 94/9/EC uses the term equipment category as a measure of the absence of ignition sources. In equipment group II, categories 1, 2 and 3 are listed:

- Category-1 equipment is characterised by a very high degree of safety, which makes it suitable for use in areas in which potentially explosive atmospheres are present continuously, for long periods or frequently (use in zones 0 or 20).
- Category-2 equipment is characterised by a high degree of safety, which makes it suitable for use in areas in which potentially explosive atmospheres are likely to occur (use in zones 1 or 21).
- Category-3 equipment is characterised by a normal degree of safety, which makes it suitable for use in areas in which potentially explosive atmospheres are unlikely to occur or, if so, only infrequently and for a short period (use in zones 2 or 22).

In view of the special hazard situations and the protective measures to be taken with equipment category 1, explosion-protected industrial trucks cannot fall into this category.

The requirements for the conformity assessment procedure for category-2 equipment are set out in Article 8 (1) letter b) of Directive 94/9/EC, in which

- (i) requires for electrical equipment and internal combustion engines an EC Type Examination Certificate and monitoring of the quality assurance system by a notified body, and
- (ii) requires for other equipment that the manufacturer assess himself (manufacturer self-assessment) with internal control of production, the related documentation having to be deposited with a notified body.

Industrial trucks consist of different electrical and non-electrical pieces of equipment and components, the assembly of which is defined in the ATEX Guidelines [8] as an assembly or equipment combined from different parts.

In connection with *"Fork lift trucks intended for use in potentially explosive atmospheres"*, the "Consideration Paper" of the Standing Committee of the Commission [9] points out for industrial trucks of category 2 that the combined equipment (fork-lift truck) is *"neither electrical equipment nor another internal combustion engine"*, provided the manufacturer ensures that no additional ignition risk can result from the combination of components. With internal control of production and by depositing the technical documentation with a notified body, the manufacturer in this case complies with the requirements of Directive 94/9/EC.

In particular the assessment of assemblies in which a wide range of equipment of types of protection Increased Safety "e", Flameproof Enclosure "d" or Intrinsic Safety "i" or combustion engines is used can leave much room for interpretation regarding additional ignition risks. This room for interpretation has in the past often led to situations in which no EC Type Examination Certificates were issued for category-2 industrial trucks, although this did not always appear to be justified. Negative experience has led to some rethinking, and today a more differentiated approach is taken in this matter. Today's view is that an EC Type Examination Certificate is required for the complete assembly, if there are additional electrical ignition risks, or ignition risks concerning the combustion engine, when equipment is assembled.

For manually operated pallet trucks of category 2G, no type examination as defined by Directive 94/9/EC is made, because no additional ignition risks have to be expected to result from assembling the equipment. Even if a weighing device is attached, an EC type examination is not necessarily required for the "industrial truck" assembly. Irrespective of what has just been said, a separate EC Type Examination Certificate would be necessary for the weighing device, if it is electrical category-2 equipment.

In addition to the EC type examination, the manufacturer must have a quality assurance system in place, which must be assessed by a notified body.

For equipment category 3, Directive 94/9/EC does not require the involvement of a notified body; it places the responsibility on the manufacturer.

Individual explosion-protected industrial trucks may, irrespective of the equipment category, also be subjected to EC unit verification by a notified body in accordance with Article 8 (1) letter d) of Directive 94/9/EC.

A European standard that appeared in the year 2000 already defined the specific requirements for explosion-protected industrial trucks. Since then, this EN 1755 standard [10] has been amended with a first supplement. The standard describes the specific measures that have to be taken for avoiding ignition risks in connection with industrial trucks, and it makes reference to various European standards [11 - 13] in which basic requirements are defined for explosion-protected equipment. Figure 1 illustrates possible measures for avoiding ignition risks in connection with industrial trucks.

Examination of industrial trucks and documentation

If an EC type examination is justified for the complete industrial truck, a completely assembled specimen is used as an example for the required testing in accordance with EN 1755. This also includes checking the documentation, which must consist of a description and the relevant drawings, for compliance with the items listed in the standard and with the specimen itself. Examination also involves:

- a visual and functional examination of the electric and hydraulic functions;
- temperature-rise measurements for the hydraulic system, the brake system and the prime movers, the systems being loaded until a steady state is reached or the temperature monitoring device responds;
- measurement of the surface resistance and leakage resistance of rubber and plastic elements to earth, and examination of the potential equalisation among the metallic components,
- assessment of equipment and components that come with their own EC Type Examination Certificate (e.g. flameproof enclosures, lamps, internal combustion engines).

If explosion-protected industrial trucks are driven by a internal combustion engine, this engine must also be examined in compliance with EN 1834, an EC type examination by a notified body being required for equipment category 2.

Based on EN 1755, and possibly additional standards, the examination documents have to specify the extent to which the routine test that is required during the production process has to be performed and what measuring equipment and auxiliaries have to be used.

After successful assessment of the explosion-protected industrial truck, the manufacturer prepares the EC Declaration of Conformity, which he hands out to the customer together with the industrial truck and the instructions for operation.

Technical examples of industrial truck equipment

The manufacturer or the converter of an industrial truck decides whether additional ignition risks may result from the assembly of equipment that has already been type approved so that a notified

body has to become involved for the "industrial truck of category 2" assembly. Whether or not all ignition risks are in this case detected very much depends on the available explosion protection knowledge. The examples that are listed below are to highlight some technical designs and possible problems as well as relevant information.

- **Mounted parts** that come with an EC Type Examination Certificate as a component ("U" certificates) must be examined together with the industrial truck by a notified body; an EC type examination becomes obligatory for the industrial truck.
- If a commercial internal combustion engine e.g. **Diesel engine** is equipped in a workshop with a conversion kit, which carries an EC Type Examination Certificate for explosion protection, this internal combustion engine does not automatically become an "explosion-protected internal combustion engine". In compliance with Directive 94/9/EC, this engine must be subjected to a type test regarding compliance with the temperature class and the required temperature monitoring features. It must also be demonstrated that the necessary flame arresters and spark arresters are suited for reliably preventing flame or spark transmission into the surrounding potentially explosive atmosphere. If the necessary parameters are complied with, an EC Type Examination Certificate is issued for category-2 combustion engines.
- Explosion-protected industrial trucks that are driven by an explosion-protected internal combustion engine e.g. Diesel engine must be examined in respect of the installation conditions and in respect of the operating conditions that are specified for the Diesel engine. This can have an effect on the required temperature monitoring features and means that an EC type examination is required for the industrial truck.
- If an industrial truck is fitted with **windows made from plastic** that can be charged electrostatically [11], the industrial truck is not suited for use in potentially explosive atmospheres even if a note "only clean with a moist cloth" draws the attention of the user to the risk of electrostatic charging. This is accepted only, for instance, for light fixtures that are permanently installed in the ceiling of a room and can neither be electrostatically charged or discharged as a result of unintentional contact. Plastic parts of an industrial truck cannot be reliably prevented from becoming electrostatically charged. When the EN 1755 requirements are complied with, the manufacturer can himself assess this ignition risk and take the necessary protection measures – the need to have a notified body perform an EC type examination cannot be derived from these conditions alone.
- If an operational **friction brake** comes with a temperature sensor in the brake lining, the brake lining cannot be replaced without a temperature sensor. Even if a temperature sensor should be subsequently fitted, the safety requirements are not complied with, unless a new EN 1755 examination is made. Safety measures must be taken for cases in which the fitted temperature sensor might be destroyed by the braking action or is affected by a series fault. In accordance with Directive 94/9/EC, a friction brake has to be classified as "another device" and assessed by the manufacturer himself, i.e. an EC type examination is not necessarily required.
- Brakes with a flameproof enclosure, on the other hand, have to be subjected to experimental testing for non-transmission of internal ignition and to a test for determination

of the maximum explosion pressure. The required explosion tests can normally not be performed by the manufacturer himself. Regarding the protection level, these brakes compare to an electrical enclosure of Flameproof Enclosure "d" type of protection [14]. The test should be made by a test organisation with sufficient experience in explosion tests. This can however not be construed to be a legal basis for the need of an EC type examination both for the (non-electrical) flameproof brake and for the explosion-protected industrial truck. If the brake forms an integral part of an electrical flameproof enclosure, e.g. part of an electric drive, an EC type examination must be made for the flameproof enclosure as an electrical piece of equipment. If additional ignition risks, such as excessive heating, follow from the assembled equipment, an EC type examination should also be made for the assembly.

- During operation, hot surfaces or mechanically produced sparks may occur on purely **mechanical mounted parts**, such as the mast, barrel gripper, hydraulic-fluid tanks, which can then ignite a potentially explosive mixture. Electrostatic discharge may also occur inside the oil container, if the flow velocity of the hydraulic fluid reaches a certain level. This may, in particular, be the case when insulated metal elements, such as filters, are installed inside the hydraulic circuit. This explains why the ignition risk has to be assessed for all mounted and installed parts. Detailed information may be obtained from the EN 13463 series of standards (as amended). What has been said above for friction brakes, also applies in this case: the need for an EC type examination for the complete industrial truck cannot be derived on this basis alone.
- **Electric motors** with their own EC Type Examination Certificate are tested and certified for defined electrical designs and ambient conditions (e.g. duty type and monitoring system). When motors are installed in the confined space of industrial trucks, the ambient conditions differ from the test conditions, because the frame elements and the housing cover of the industrial truck only provides for limited cooling, and this may lead to an inadmissible temperature rise. As a result, the limiting temperatures may be exceeded, and the electronic system for monitoring the motors may trip prematurely. These additional ignition risks in connection with electric motors that have already been certified have to be considered and assessed as part of an EC type examination.

The above examples show that various additional ignition risks have to be accounted for when assembling an explosion-protected industrial truck. If a category-2 industrial truck is exclusively composed of mechanical equipment and attached parts, as is for instance the case with a manually operated pallet truck, the manufacturer is normally able to assess the ignition risk himself. An obligation for performing an EC type examination cannot be inferred. If, however, an industrial truck is equipped with electrical equipment or internal combustion engines e.g. Diesel engine, this equipment is itself subject to an EC type examination. If additional ignition risks cannot be excluded for this equipment as a result of the assembly of the equipment, an EC Type Examination Certificate for the complete industrial truck is justified in accordance with the Guidelines pertaining to Directive 94/9/EC [8].

Control of production

In accordance with Directive 94/9/EC, the manufacturer must take measures for production control as part of his quality management system. Whenever the equipment has been subjected to an EC type examination, Directive 94/9/EC requires the participation of a notified body, i.e. the notified body reviews the production control measures as part of an audit. This applies to explosion-protected industrial trucks of category 2 for which equipment assembly has produced an additional ignition risk for electrical equipment and/or the combustion engine so that the manufacturer has a notified body perform an EC type examination. The special production control measures required for explosion protection are set out in EN 80079-34 [15].

Summary

Explosion-protected industrial trucks are equipment within the meaning of Directive 94/9/EC. The manufacturer of explosion-protected industrial trucks may place this equipment on the EU market only if he has fulfilled the requirements of Directive 94/9/EC and of all other relevant Directives; he must also go through the conformity assessment procedure that is set out in Directive 94/9/EC. For explosion-protected industrial trucks of category 2 that may be affected by additional ignition risks in connection with electrical equipment and combustion engines as a result of equipment assembly, an EC type examination must be made by a notified body.

Explosion-protected industrial trucks must be clearly marked, and there may only be one responsible manufacturer for the complete unit. Dual marking by two or more manufacturers is not accepted. The marking must comply with all relevant EC Directives.

Possible measures for industrial trucks (Category 2G)

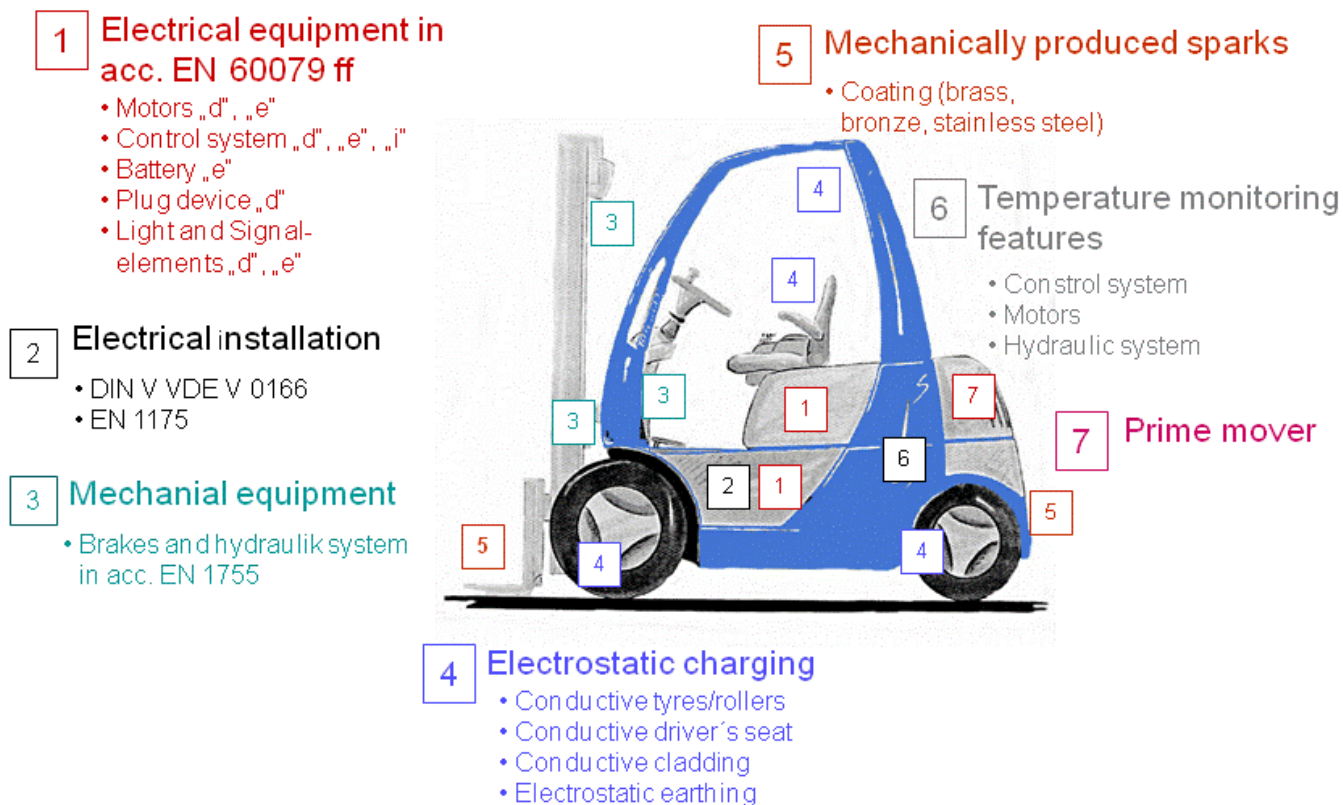


Fig. 1: Possible measures for industrial trucks



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