Dal 1970 la ventilazione made in Italy

PRACTICAL GUIDE
to explosion protection

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Preface

The tricky thing about risks of explosion is that people don't necessarily realise that they are present at first glance.

This often means that risks are neglected or even trivialised. However, unfortunately the fact that explosions continue to occur means that this risk is still present in many areas of industry and everyday life. Serious injuries and damage to property are often the consequence of such harmful events. Preventing them is the primary objective of explosion protection, the application of which is prescribed through statutory rulings in most industrialised nations.

Sets of standards and rules are used in technology to meet the statutory requirements and to avoid risks of explosion. These standards and rules are an important instrument in implementing technical solutions for devices, which are to be used in areas with a potentially explosive atmosphere.

Since combustible and explosive materials are often used in production processes in the form of gases, vapours, mist or dusts, it is essential that the systems used in such processes and their components do not represent a risk of explosion.

Typical areas where explosive atmospheres may occur are:

- the chemical and petrochemical industry,
- mining,
- the food industry,
- mills,
- biogas facilities

Our guide provides an introduction into and an overview of explosion protection.

It focuses primarily on our fans, which are suitable for use in areas at risk of explosion.

We hope that it will assist planners, fitters and operators of systems in their daily work. However, it cannot be a substitute for studying the relevant legislation and standards.

Extracts of laws and directives quoted in this guide are snapshots and are not legally binding. Legislation can change at any time. The current texts applicable to your specific circumstances should always be consulted.

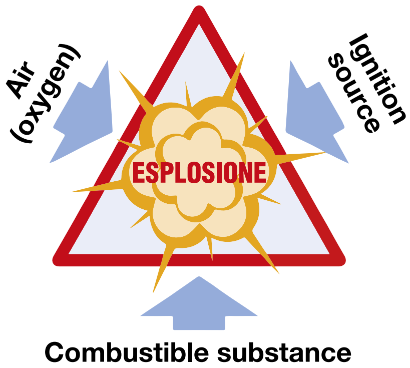
1 Physical principles of explosion hazards

1.1 What is an explosion?

An explosion is the chemical reaction that a combustible material has to a sudden increase in temperature, pressure or both at the same time. This results in a sudden increase in the volume of the material, and huge amounts of energy are released in a very small space.

1.2 Pre-requirements for an explosion

For an explosion to occur, three factors have to be present at the same time:



1.2.1 Combustible materials

The following may all be combustible: gases, mist, vapours, dusts, solid materials.
If used in workplaces and production processes, this means that a combustible substance may

- be used as a feed or auxiliary material,
- be produced as a residual, intermediate or end product or
- be produced in the event of a normal breakdown

Combustible materials may also arise when they are not wanted, for example, when storing acids or alkalis in metal containers. Here gases may be formed which, when the container is opened, produce an explosive atmosphere in combination with the oxygen contained in the air.

Generally speaking, materials which are capable of an exothermic oxidisation reaction are considered to be combustible. This applies in particular to all materials, which are classified in accordance with EU Ordinance (EC) No. 1272/2008 as

- flammable,
- highly flammable or
- extremely flammable

and are labelled as such.

Combustible gases	Combustible liquids	Dusts of combustible solids
▸ Liquid gas (butane, butene, propane, propene) ▸ Natural gas ▸ Combustible gases (e.g. carbon monoxide or methane) ▸ Gaseous combustible chemicals (e.g. acetylene, ethylene oxide, vinyl chloride)	▸ Solvent ▸ Fuels ▸ Crude oil, heating oil, lubricating oil or used oil ▸ Paint ▸ Water-insoluble or water-soluble chemicals	▸ Coal ▸ Wood ▸ Foodstuffs and feeds (e.g. sugar, flour or grain) ▸ Plastics ▸ Metals ▸ Chemicals

1.2.2 Explosive atmosphere

An explosive atmosphere is a mixture of air or oxygen with:

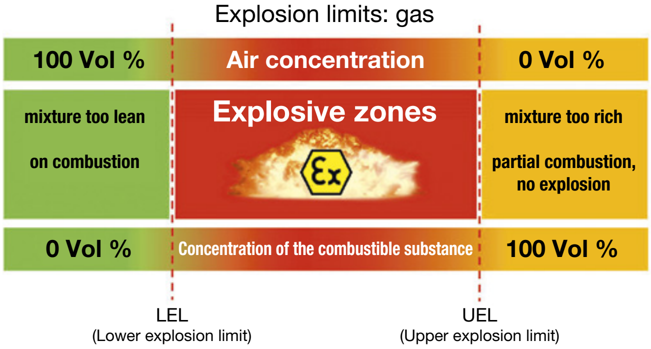
- combustible gases,
- vapours,
- mist or
- dusts

the concentration of which is within the limits of explosion.

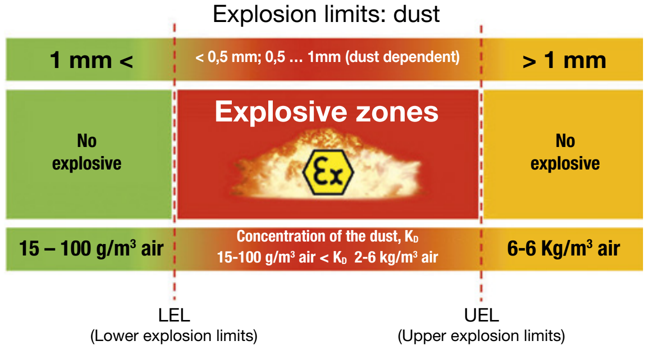
An explosion will not result from too low a concentration (lean mixture) or too high a concentration (rich mixture). In such cases, there is no combustion reaction or at the most partial stationary combustion.

The range in which an explosion can take place in the event of ignition is defined by an upper and lower limit of explosion. This depends greatly on the combustible material in question. When ignition takes place, the combustion process is transferred to the entire homogeneous mixture.

Limits of explosion of combustible materials



Limits of explosion of dusts

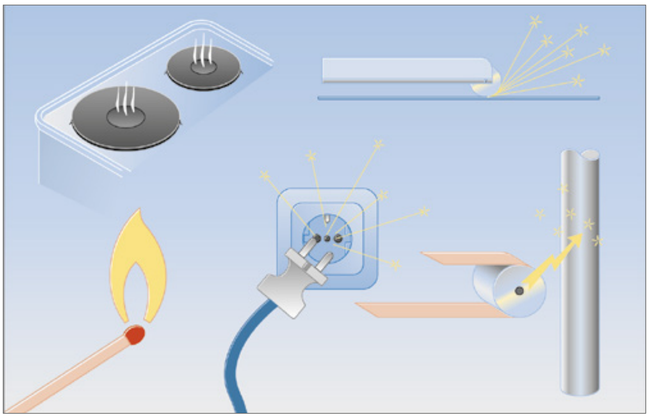


1.2.2.1 Potentially explosive area

A potentially explosive area is a place where a potentially explosive atmosphere may occur.

1.2.2.2 Sources of ignition

For an explosive atmosphere to explode, an effective source of ignition is needed. The question of whether a source of ignition is effective and whether it is able to ignite an explosive atmosphere depends mainly on the energy of the source of ignition and the composition of the explosive atmosphere.



In applications in workplaces and production processes, the following sources of ignition may be present, for example:

- hot surfaces
- naked flames
- mechanically generated sparks
- electrical systems
- static electricity
- self-ignition
- lightning
- electromagnetic waves
- ionising radiation
- ultrasound
- adiabatic compression
- exothermic reactions

1.2.2.3 Flash point

In the case of flammable liquids, an explosive atmosphere may result from the liquid evaporating.

At its flash point, a material reaches a vapour pressure or there is a corresponding concentration of saturated vapour above the material which is high enough to allow the gas/air mix with a source of ignition to catch fire for a least a short time. If the maximum room temperature is above the flash point of a combustible liquid, an explosive atmosphere may occur
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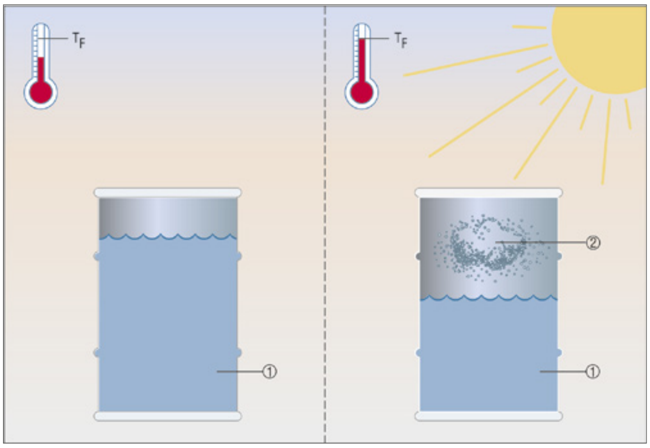


T_F Flash point ① Flammable liquids ② Explosive atmosphere

1.2.2.4 Formation of an explosive atmosphere

During application, an explosive atmosphere may occur during the production, storage, processing and transport of combustible materials.
Here are a few examples
:

Gases
- Leakages from gas bottles or gas lines
- Outlet openings (taps, burners)
- Chemical reactions
- Heating liquids
- Electro-chemical processes

Liquids
- Evaporation
- Spraying, splashing or interrupting a jet of fluid
- Leakages on pipes carrying fluids

Dusts
- Milling or sifting
- Transporting, filling or emptying
- Drying
- Swirling up dust
- Dust processes

Application example:

Wall-mounted fans for air extraction

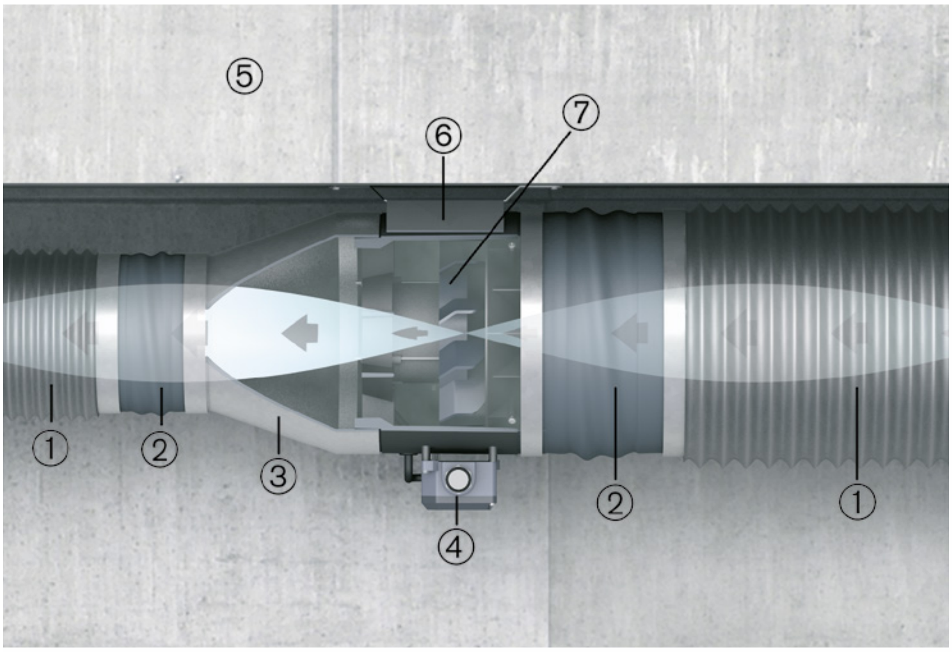
Air extraction can prevent the formation of a potentially explosive atmosphere from combustible fluids.
To achieve this, the gas/air mix is extracted from the point at which it is produced using wall-mounted fans.

① External grille
② Explosive atmosphere
③ ATEX fan

Application example:

Airstreams of an enhanced safety mixed-flow fan

Such fans are approved for the T1-T3 temperature classes and gases of the IIB+H2 explosion group. They can therefore convey an explosive atmosphere with an ignition temperature above 200 °C. Examples include vapours of petrol, diesel or heating oil.



① Ventilation duct, provided by customer
② Flexible cuffs
③ Reduction
④ Terminal box
⑤ Ceiling, girder
⑥ Fixing clamps
⑦ Enhanced-safety mixed-flow fan

2 Legal Bases of Explosion Protection

2.1 Where do the requirements come from?

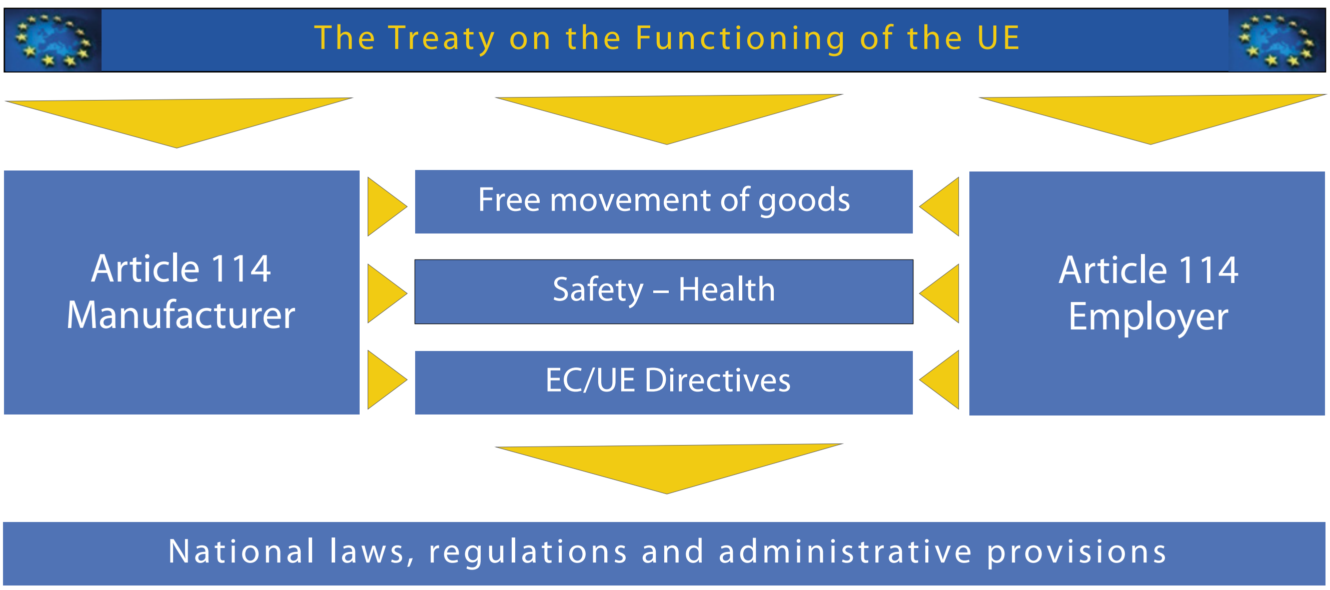
In the Treaty on the Functioning of the European Community of June 2016, Article 153 deals, among other things, with improving the working environment.

The objectives are:

1. protection of the health of workers
2. increasing safety
3. improvement of working conditions.

This ultimately led to the implementation of the respective national occupational health and safety laws in the member states of the European Union.

Likewise, Article 114 led to the establishment of a harmonisation procedure for the approximation of the laws, regulations and administrative provisions of the Member States. This led to the adoption of the relevant EC/EU directives known today and thus to their implementation in the respective national laws. The objectives included the free movement of goods in the European internal market and the health and safety of consumers and workers.



Relevant directives that have been transposed into national law in this context are, for example:

- Directive 2001/95/EC, general product safety
- Directive 2014/34/EU, equipment and protective systems intended for use in potentially explosive atmospheres
- Directive 1999/92/EC, minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres
- Directive 2014/30/EU, electromagnetic compatibility
- Directive 2006/42/EC, machinery

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2.2 EU Directives for explosion protection

Within the EU, explosion protection is specified by two directives:

- Directive 2014/34/EU: equipment and protective systems intended for use in potentially explosive atmospheres.
- Directive 1999/92/EC: minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

Directive 2014/34/EU describes:

- the obligations of the manufacturers of the products,
- sets requirements
- lays down rules for placing on the market with the aim of free movement of goods within the EU.

The directive is known as the ATEX directive (French abbreviation for ATmosphère EXplosible").
The ATEX directive contains the following specifications:

- Conformity assessment procedure
- Clustering
- Classification into categories
- Design and construction of the products
- Essential health and safety requirements

Directive 1999/92/EC is aimed at employers or operators of installations in areas with explosive atmospheres.

It is specified in this directive:

- obligations of employers to prevent and protect against explosions,
- the assessment of explosion risks,
- organisational measures (duty of coordination)
- the mandatory creation of the explosion protection document

The explosion protection document states in particular:

- that the explosion risks have been identified and evaluated.
- that appropriate measures are taken to achieve the objectives of this Directive.
- which areas have been classified into zones in accordance with Annex I to the Directive.
- which areas are subject to the minimum requirements laid down in Annex II to the Directive.
- that the workplace and work equipment, including warning devices, are designed, operated and maintained safely.
- that arrangements have been made for the safe use of work equipment in accordance with Directive 2009/104/EC (formerly 89/655/EEC).

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2.3 National laws

The EU/EC Directives require transposition into the respective national laws of the member states for the purpose of harmonising legislation.
They transpose the safety level described there into national law. All necessary specifications regarding the requirements for the condition and placing on the market of devices and protective systems, components as well as safety, monitoring and control equipment for hazardous areas are contained in these laws.
The transposition of Directive 1999/92/EC into national law contains the material requirements for explosion protection. These are essentially documentation obligations, such as the

- creation of a risk assessment and an explosion protection document,
- the prescribed protective measures against explosion hazards,
- the zone classification, and
- the use of equipment categories in zones

If work equipment is used in areas with a dangerous explosive atmosphere or if its use leads to the formation of a dangerous explosive atmosphere, the necessary protective measures must be taken in compliance with these laws.

In particular, the equipment and protective systems suitable for the respective zone in accordance with Directive 2014/34/EU must be used. These protective measures must be documented in the explosion protection document before the work equipment is used for the first time. The requirements for tests in potentially explosive atmospheres are regulated in the respective law. Accordingly, the operator is obliged to check systems used in potentially explosive atmospheres and measures for explosion protection.
Systems in hazardous areas are the entirety of the work equipment relevant to explosion protection, including the connecting elements and the parts of the building relevant to explosion protection.
The test must be performed both before initial commissioning and recommissioning after changes requiring testing. The tests must be carried out with the aim of ensuring protection against hazards due to explosions and fires at least until the next test. The tests must also determine the suitability and function of the technical protective measures that have been taken. The persons qualified to carry out the tests are also described. They must have the qualifications, skills and knowledge mentioned in the above.

2.4 Standards

In the context of the implementation of legal requirements, international and European standards are advantageous as aids in addition to the nationally applicable technical regulations. If they have been published in the European Official Journal, they have the presumption of conformity with the requirements of the respective EU directive.

Although the standards are not legally binding, their presumption of conformity creates a legal certainty for manufacturers and operators. The lists of standards harmonized under the respective directive can be viewed and downloaded free of charge from the European Union.

As a manufacturer of fans for use in potentially explosive atmospheres, Maico uses the following standards:

TYPE OF PROTECTION	CONCEPTPT	SYSTEM	STANDARD	TITLE
General requirements	Basis for ignition protection types	ATEX	EN 60079-0	Explosive atmospheres - Part 0: Equipment - General requirements
		IECEx	IEC 60079-0	
Increased Safety (elettrica)	Design measures through spacing and dimensioning	ATEX	EN 60079-7	Explosive atmospheres - Part 7: Protection of equipment through increased safety "e"
		IECEx	IEC 60079-7	
General requirements (non electrical)	Requirements for the design, construction, testing and marking of non-electrical equipment	ATEX	EN 80079-36	Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements
		IECEx	ISO 80079-36	
Constructional safety (non-electrical)	Requirements for the design and construction of non-electrical equipment	ATEX	EN 80079-37	Explosive atmospheres - Part 37: Non-electrical equipment for explosive atmospheres - Type of protection non-electrical safety construction "c", control of ignition source "b", immersion in liquids "k"
		IECEx	IEC 80079-37	
Protection by enclosure	Protection through housing construction	ATEX	EN 60079-31	Explosive atmospheres - Part 31: Equipment to protect against ignition of dust by enclosure "t"
		IECEx	IEC 60079-31	
Basic concepts and methodology		ATEX	EN 1127-1	Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology

Only the EN standards have the presumption of conformity with the ATEX directive. Since Maico also certifies its devices in accordance with IECEx, the international IEC standards that are bindingly applicable for this certificate are also considered. Since the EN standards of the same name represent a transfer from the IEC standards and the differences are not too great, this is very useful and good to handle.

The following standards can be used by the operator to obtain the presumption of conformity:

STANDARD EN	STANDARD IEC	TITOLO
EN 60079-10-1	IEC 60079-10-1	Explosive atmospheres - Part 10-1: Classification of areas. Explosive gases atmospheres
EN 60079-10-2	IEC 60079-10-2	Explosive atmospheres - Part 10-2: Classification of areas. Explosive dust atmospheres
EN 60079-14	IEC 60079-14	Explosive atmospheres - Part 14: Electrical installations design, selection and erection
EN 60079-17	IEC 60079-17	Explosive atmospheres - Part 17: Electrical installations inspection andmaintenance
EN 60079-19	IEC 60079-19	Explosive atmospheres - Part 19: Equipment repair, overhaul and reclamation

According to the EU Directive 1999/92/EC, an explosion protection document is a precondition for setting up and operating a potentially explosive facility.

The explosion protection document must contain all necessary information regarding:

- the classification of zones,
- the temperature classes or
- the ignition temperatures characteristic of the flammable substances

  and

- record the classification of gases and dusts into the appropriate groups.

Based on this information, he is able to select devices that are suitable for the application at hand. The data, which can be taken from the technical documentation and the type plate, must be checked for conformity by the operator. In addition, the required conformity markings must be affixed to the product and legible in accordance with the directive. An EU Declaration of Conformity must be enclosed, on which the manufacturer of the product declares conformity with the ATEX Directive and other applicable directives. Further documents are the operating instructions and safety information of the manufacturers whose information must be included in the risk assessment.

The equipment categories and equipment protection levels must therefore be adapted to the respective zone. Similarly, when used in gas atmospheres, the temperature classes of the equipment must match those of the explosive medium. When used in dust atmospheres, the glow and ignition temperature of the medium must be determined, and if there is a risk of a dust cloud forming, the ignition temperature of the dust cloud must be determined. Likewise, if there is a risk of dust layers forming, the maximum layer thickness that can occur must be checked. EN 60079-14 should be used to determine the safety factors.

The operator must also include ambient conditions in his considerations and check the resistance to chemical, thermal, mechanical influences or humidity of the devices planned for use. Any special operating conditions must be taken from the technical documentation of the product or clarified with the manufacturer of the product.

The operating temperature range for devices usually specified by the manufacturer is -20 °C to + 40 °C. The normative scope of application of the EN or IEC 60079-0 assumes normal atmospheric conditions and is defined as a maximum range of -20°C to 60°C. Deviating operating conditions must be tested by a notified body.

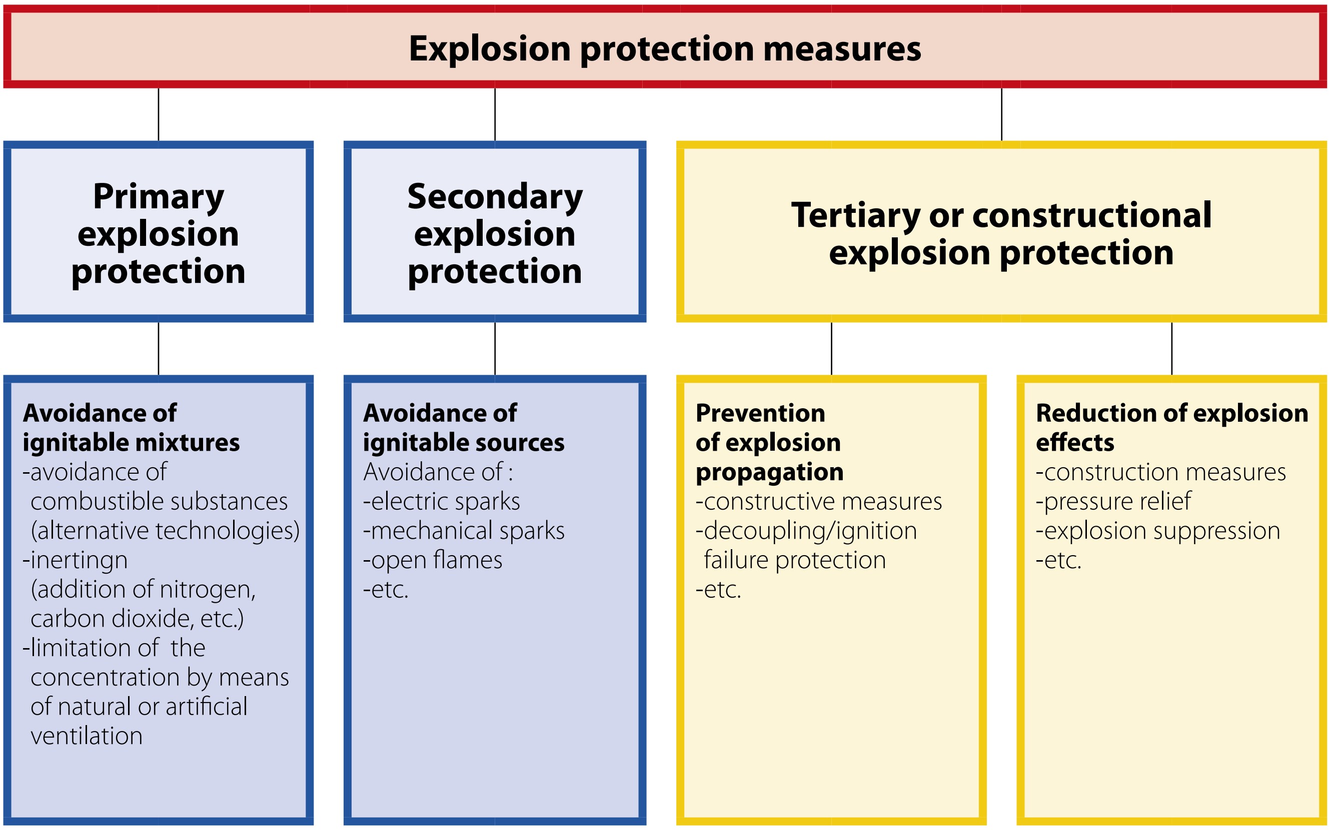
3 Technical principles of explosion protection

3.1 Explosion protection

II The risk of an explosion can be prevented or at least reduced by means of technical measures. Three types of explosion protection apply here:

- primary
- secondary
- tertiary

explosion protection.



3.1.1 Primary explosion protection

The aim of primary explosion protection is to prevent an explosive atmosphere from coming about in the first place.

The following explosion protection measures should be implemented first:

- Avoidance of combustible materials
  Use of non-combustible substitutions
- Reduction in oxygen content through inertisation:
  – Addition of an inert gas (e.g. nitrogen) or an inert dust (e.g. rock salt)
- Reduction in the concentration of the hazardous substance in the mix and therefore reduction below the lower limit of explosion by means of:
  – natural or technical ventilation
  – thinning

3.1.2 Secondary explosion protection

If the formation of an explosive atmosphere cannot be prevented, measures should be taken to prevent this explosive atmosphere from igniting. This involves assessing all potential sources of ignition and taking relevant protective measures to render them ineffective. This chapter of our guide provides a detailed description of possible protective measures and the procedure for applying secondary explosion protection.

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3.1.3 Tertiary explosion protection

If an explosion cannot be prevented through primary and secondary explosion protection measures, a design solution should be found and used.

This may be, for example:

- decoupling the system components,
- a solution to release pressure or
- a system to suppress the explosion.

3.2 Explosion groups

One of the key pre-requirements for an explosion occurring is the combustible material. There are a number of materials, which under normal circumstances will only catch fire with great difficulty, but are explosive if mixed with air and present in a particularly small particle size or with a sufficiently high ignition energy (e.g. metal dusts, aerosols).

The ignitability of an explosive atmosphere is a characteristic dependent on material. To distinguish between different risk levels, gases and vapours are divided into four explosion groups: I, IIA, IIB, IIC.

The ignitability increases from explosion group I to IIC, while the ignition energy required falls. The explosion group I classification is only used in mining.

EXPLOSION GROUP	TYPICAL COMBUSTIBLE MATERIAL
I	Methane
IIA	Acetone, petrol, heating oil
IIB	Town gas, ethylene
IIC	Hydrogen, acetylene

Dusts are categorised by type and electric conductivity in the form of specific electric resistance.

EXPLOSION GROUP	COMBUSTIBLE MATERIAL
IIIA	Flammable fluffs
IIIB	Non-conductive flammable dust, specific elettric resistance >10^3 Ω
IIIC	Conductive flammable dust, specific elettric resistance ≤ 10^3 Ω

3.3 Zone classification

Areas subject to explosion hazards are split into zones. The aim of this zone classification is to make possible explosion protection which meets require-ments from both a safety technology and economic standpoint. Different zone classifications are used for gas and dust atmospheres. Depending on zone, only certain categories of devices may be used. The same applies to the equipment protection level (EPL).

The figure below shows an example of zone classification for an explosive atmosphere containing gas:

Application example:

MAICO fans in zone 1 and zone 2

The operating company has split the production and storage sites shown into zone 0, zone 1 and zone 2.

The concentration of combustible materials in the room air is reduced through permanent cross-ventilation. This reduces the risk of explosion.

The wall-mounted fans are therefore fitted in

zones 1 and 2

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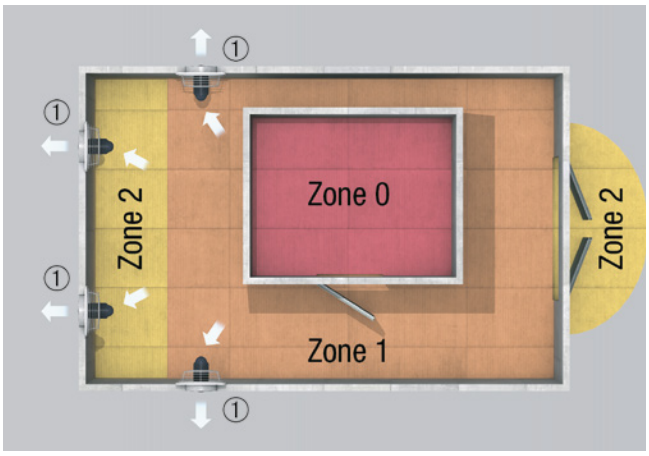


① Wall-mounted fans
Zone 0 – MAICO fans **not** appropriate
Zone 1 – MAICO fans appropriate
Zone 2 – MAICO fans appropriate

Zone classification depends on the frequency with which an explosive atmosphere occurs and the various potential risks this brings with it. Depending on the aggregation state of the combustible material, a distinction is also made between:

- gas
- vapour
- mist
- dust

3.4 Device groups and device categories

According to Directive 2014/34/EU, electrical equipment for use in areas at risk of explosion is split into two device groups and these are in turn split into categories:

- **Device group I:**
  Electrical equipment intended for use underground in areas at risk of mine gas (not included in MAICO's product range).
- **Device group II:**
  Electrical equipment in all other potentially explosive areas. Depending on risk potential, these are split into three categories. Maico produces category 2 devices.

Equipment group I

- Equipment intended for use in underground mining Works
- Application area **NOT** for MAICO fans

Equipment group II

- Equipment intended for use in other areas that may be exposed to an explosive atmosphere
- Application area for MAICO fans

Category M1
only for underground mining works

Category M2
only for underground mining works

Category 1
- Equipment for areas where a potentially explosive atmosphere is present continuously, prolonged or frequently
- Not fulfilled by MAICO fans

Category 2
- Equipment for areas with occasionally occurring explosive atmospheres
- Is fulfilled by MAICO fans

Category 3
- AEquipment for areas which no explosive atmosphere occurs or only rarely and then for a short period of time
- Is fulfilled by MAICO fans

Devices in device group II also feature a letter to identify the type of combustible material:

- **G** - for areas where there are explosive gas, vapour, mist, air mixes.
- **D** - for areas where dust may produce an explosive atmosphere.

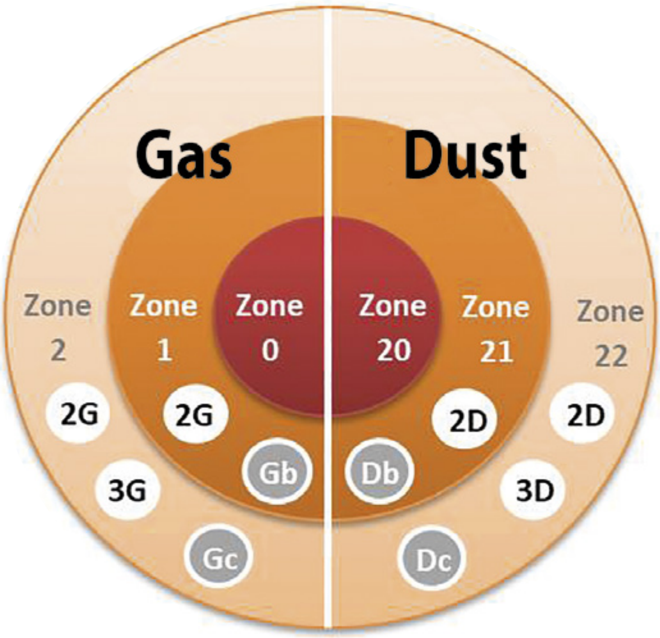
ZONES AND CATEGORIES

Combustible materials	Presence of combustible material in the potentially explosive area	Classification of potentially explosive areas	Level of protection	Device is safe...	Labelling of used equipment is required in accordance with		
					ATEX 2014/34/EU		IEC/CENELEC
					Device group	Category	Equipment protection level (EPL)
Gas, mist, liquid	Permanent	Zone 0	Very high	... during normal operations, in the event of foreseeable errors and in the events of rare incidents	II	1G, (1)G	Ga
	Occasional	Zone 1	High	... during normal operations and in the event of foreseeable errors	II	2G, (2)G	Gb
	Rare, only briefly	Zone 2	Normal	... during normal operations	II	3G, (3)G	Gc
Dust	Permanent	Zone 20	Very high	... during normal operations, in the event of foreseeable errors and in the events of rare incidents	II	1D, (1)D	Da
	Occasional	Zone 21	High	... during normal operations and in the event of foreseeable errors	II	2D, (2)D	Db
	Rare, only briefly	Zone 22	Normal	... during normal operations	II	3D, (3)D	Dc
Methane, coal dust	Permanent	Coal mining	Very high	... during normal operations, in the event of foreseeable errors and in the events of rare incidents	I	M1	Ma
	Common		High	... until the unit is switched off	I	M2	Mb

Link between zone, device category and EPL for device group II:
The equipment protection level (EPL) is a level of protection, which is defined for the device. It is based on the probability of ignition. The differences between explosive gas atmospheres, explosive dust atmospheres and explosive atmospheres in mine workings sensitive to firedamp are taken into account.

CHOOSING THE FAN CLASSIFICATION ACCORDING TO THE ZONE

Protection level	Usage area with presence of GAS		Usage area with presence of DUST		Hazardous level of the operational zone
	Category	Zone	Categoy	Zone	Explosive atmosphere
Very high	1G	0	1D	20	ALWAYS PRESENT
High	2G	1	2D	21	HIGHLY PROBABLE
Normal	3G	2	3D	22	UNLIKELY



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3.5 Ignition temperature

An explosive atmosphere catches fire when it comes into contact with e.g. a contact surface heated to the respective ignition temperature of the medium.
The ignition temperature is different for different materials and in many cases is dependent on pressure. An exothermic oxidisation reaction then occurs. This means that the rate at which heat is being produced exceeds the rate at which heat is being dissipated through thermal conduction.

3.6 Temperature classes for gases and vapours

Combustible gases and vapours can be split into temperature classes in accordance with EN 60079-14 (non-exhaustive list) on the basis of their ignition temperatures and energies.

DANGER INCREASES, REQUIREMENTS INCREASE

DANGER INCREASES, REQUIREMENTS INCREASE

Group	Minimum ignition energy	T1 (<450°C)	T2 (<300°C)	T3 (<200°C)	T4 (<130°C)	T5 (<100°C)	T6 (<85°C)
IIA	<160 μ J	Acetone Ammonia Ethane Methane Propane	Ethyl alchol n-Butane Cyclohexane 1,2 dichloreethane Acetic anhydride	Petrol Diesel fuels Jet fuels Heating oil n-Hexane	Acetaldehyde	-	-
IIB	<80 μ J	Town gas Acrilonitrile	Ethylene Ethyloxide	Ethylene glycol Hydrogen sulphide	Ethyl ether	-	-
IIC	<20 μ J	Hydrogen	Acethylene	-	-	-	Carbon disulphide

* In funzione della composizione chimica

The maximum surface temperature of equipment (for fans: the motor) must always be lower than the ignition temperature of the explosive atmosphere in which the equipment is used.

What's more, the ignition energy of any sparks produced must not exceed the minimum ignition energy of the hazardous material.

Equipment in a higher temperature class (e.g. T4) are allowed in applications where a lower temperature class is needed (e.g. T2).

For example, an electric motor with a surface temperature of 175 °C may be used in an explosive atmosphere with temperature classes T1, T2 and T3.

3.7 Ignition temperatures of dusts

There is no classification into temperature classes for combustible dusts. The ignition temperature differs depending on whether the dust is swirled up (as a cloud) or is deposited (as a layer).

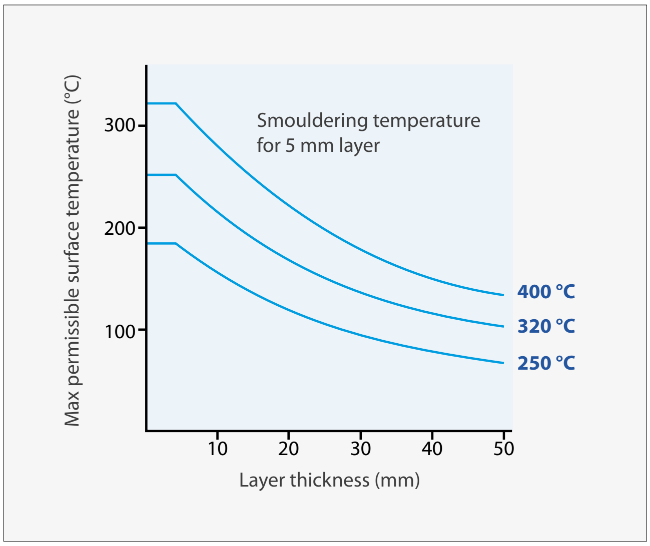
In the case of a dust cloud, the equipment's maximum surface temperature may only be 2/3 of the ignition temperature. The ignition temperature of the dust layer should also be noted for dust deposits. This ignition temperature of the dust layer is defined as the smouldering temperature and is the lowest temperature of a hot surface, at which a dust layer of 5 mm can catch fire.

It is adjusted to the maximum surface temperature of the device using a safety factor of 75 K.

Because thermal insulation is greater with a higher layer thickness of dust, the maximum permitted surface temperature of the device should be reduced yet further. The diagram on the right is used for calculation purposes and is based on EN 60079-14.

If the layer is thicker than 50 mm, the smouldering temperature should be calculated in the lab. The same is true for a layer thickness of more than 5 mm, if the smouldering temperature for a 5 mm layer thickness is less than 250 °C.

Lab testing is also needed if the device is filled entirely with combustible dust. At no critical point may the device be hotter than the lower of the two permissible surface temperatures calculated for dust clouds and dust layers.



Example for calculating the max. surface temperature with dust layers of between 5 mm and 50 mm.

The reference temperature is the lower of the two values calculated as follows:

TS1 = 2/3 Tcl (Tcl = ignition temperature of the dust cloud)

TS2 = T5mm - 75K (T5mm = ignition temperature of a 5 mm layer of dust).

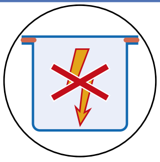
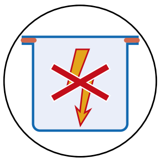
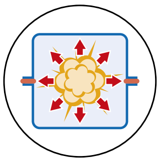
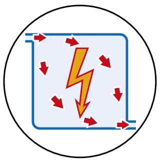
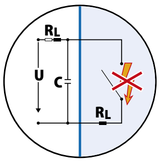
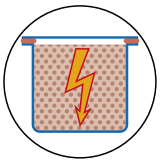
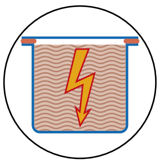
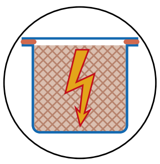
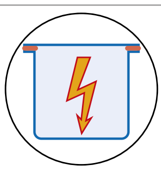
Tamm = the lower of TS1 and TS2.

CALCULATION OF THE IGNITION TEMPERATURE OF COMBUSTIBLE DUSTS

Ignition temperature of dusts	Nube Tcl	Layer T5mm
Safety temperature	Ts1 = 2/3 Tcl	Ts2 = T5mm - 75K
Maximum surface Temperature	Tammissibile = il minore tra Ts1 e Ts2	
Motor surface temperature ≤ Admissible Temperature		

3.8 Types of protection

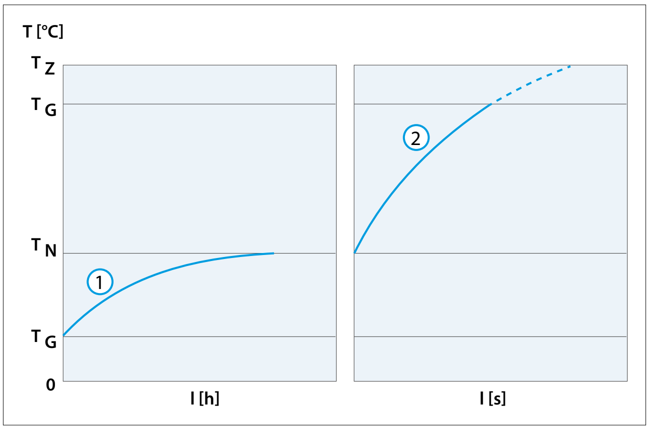
A key aspect of secondary explosion protection is the categorisation of types of protection. These are used as protective measures against explosion for electrical equipment to prevent an explosive atmosphere from igniting. Various types of protection are displayed in the table below along with their principle of function and several application examples.

	Type of protection	Principle of function	Application examples
	Increased safety "e"	Additional measures are taken on the equipment to prevent impermissibly high temperatures as well as sparks on the inside or on outer parts	Motors, terminals and terminal boxes, lights
	Constructional safety "c"	Tried and tested technical principles are applied to types of devices which do not have a source of ignition during normal operation. This is done such that the risk of mechanical errors, which may result in ignitable temperatures and sparks, is reduced to a very low level	Motors switching devices, terminal boxes, lights
	Pressure-proof enclosure "d"	Parts, which may ignite an explosive atmosphere, are enclosed in a housing. This housing withstands the pressure of an explosion in its interior and prevents the explosion from passing to the surrounding explosive atmosphere	Switching devices, motors, transformers, heaters
	Pressurisation "p"	The formation of an explosive atmosphere inside housings is prevented through use of a protective gas. This protective gas ensures excess pressure over the surrounding atmosphere.	Switch and control cabinets, analysis equipment, large motors
	Intrinsic safety "i"	The equipment only has intrinsically safe circuits. These ensure that no sparks or thermal effects can result in ignition of an explosive atmosphere	Measurement and control technology, communication technology, sensors
	Powder filling "q"	Electrical equipment or parts of electrical equipment, which may represent a source of ignition, are secured into position and completely surrounded by a fine-grain filler. This prevents an external explosive atmosphere from igniting	Capacitors
	Oil immersion "o"	Electrical equipment or parts of electrical equipment, which may represent a source of ignition, are completely surrounded by a protective liquid (e.g. oil)This prevents an external explosive atmosphere from ignitin	Starting resistances, transformers
	Encapsulation "m"	Electrical equipment or parts of electrical equipment, which may represent a source of ignition, are completely surrounded by a casting compound. This prevents an external explosive atmosphere from igniting	Sensors, switching devices
	Protection by enclosure "t"	The seal integrity of the housing prevents dust from entering or limits it to a safe level. Ignitable equipment can therefore be installed in the housing. The temperature of the housing must not cause the surrounding atmosphere to catch fire	Switching devices and systems, control, connection and terminal boxes, motors, lights

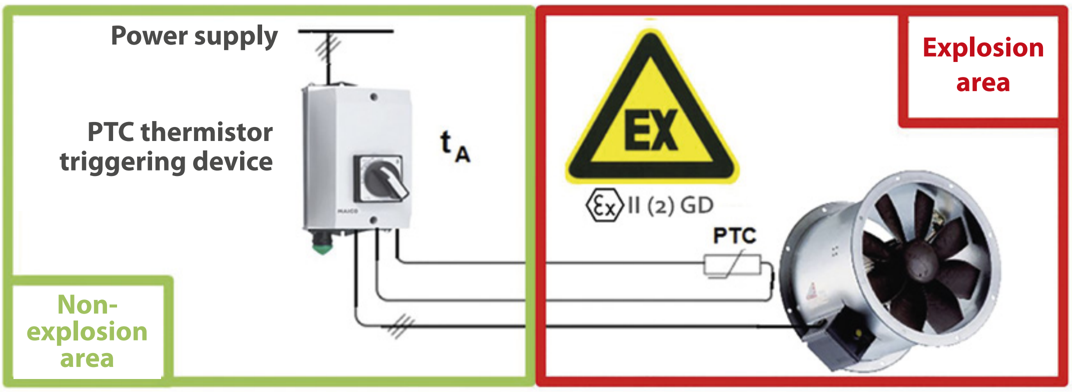
3.9 Protection concept for Maico fans

One potential source of ignition on Maico fans is their hot surface, which is produced by the motor's power loss.
During normal operation, after a while the surface temperature reaches a stable, uncritical value.
Should faults arise, if the impeller is blocked for example, this temperature will however shoot up very quickly. Without protective measures, the ignition temperature of an explosive atmosphere could therefore be reached and an explosion triggered. The motors of The Maico fans are therefore **fitted with a PTC thermistor embedded in the motor winding** in order to monitor the temperature. Once connected to the thermistor triggering device or the machine protection relay thermistor, the protection concept is therefore in place.
If a particular limit temperature is exceeded, the MVS 6 or TMS shuts down the fan.
This reliably prevents the critical temperature from being reached. Further design protective measures are achieved through the choice of material and geometry of the mechanical fan parts.

These include an air gap to prevent rotating parts from scraping, use of anti-static, temperature- and flame-resistant materials and material pairings in compliance with the relevant standards. .



① Normal operation ② Fault (blocked impeller)
T_U – Maximum ambient temperature
T_G – Temperature limit
T_N – Surface temperature during normal operation
T_Z – Ignition temperature



The thermistor triggering device must not be located in the ex area. But it does have an effect in the ex area which explains why it is subject to the ATEX directive. When labelling devices in line with this directive, category 2 is therefore placed in brackets to indicate that the device has an effect in zone 1 and/or 2.

4 Practical section / Application examples

4.1 Applications for ventilation systems in areas at risk of explosion

Typical applications for ventilation systems in areas at risk of explosion are:

- Store rooms
- Process technical applications
- Workshops
- Petrochemical industry
- Battery rooms
- Labs

A ventilation system is basically always needed in these areas to transport the combustible gases, vapours or mist in the explosive atmosphere out of the building.
Depending on application, an extra ventilation system may be needed. Failing this, an independent fresh air supply via the air grilles or shutters will suffice.

Air extraction

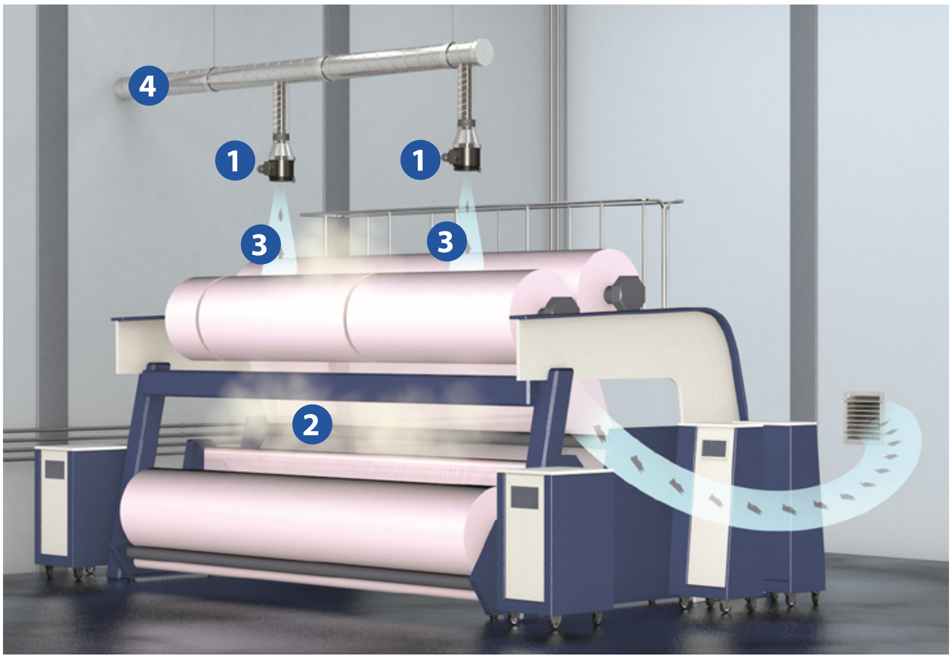
Air extraction at the exit point (e.g. edge extraction on open containers) prevents explosive substances from being distributed throughout the room.

1 Ventilation duct, provided by customer
2 Fixing cuff
3 Fan
4 Protective grille
5 Explosive atmosphere

Application example:

Air extraction from storage rooms with explosive atmospheres

MAICO fans can be used to bring the concentration of combustible gases below the limit of explosion. This reliably prevents the build-up of an explosive atmosphere. In the example shown, a mixed flow fan is extracting gases which are heavier than air. It is therefore positioned close to the ground.

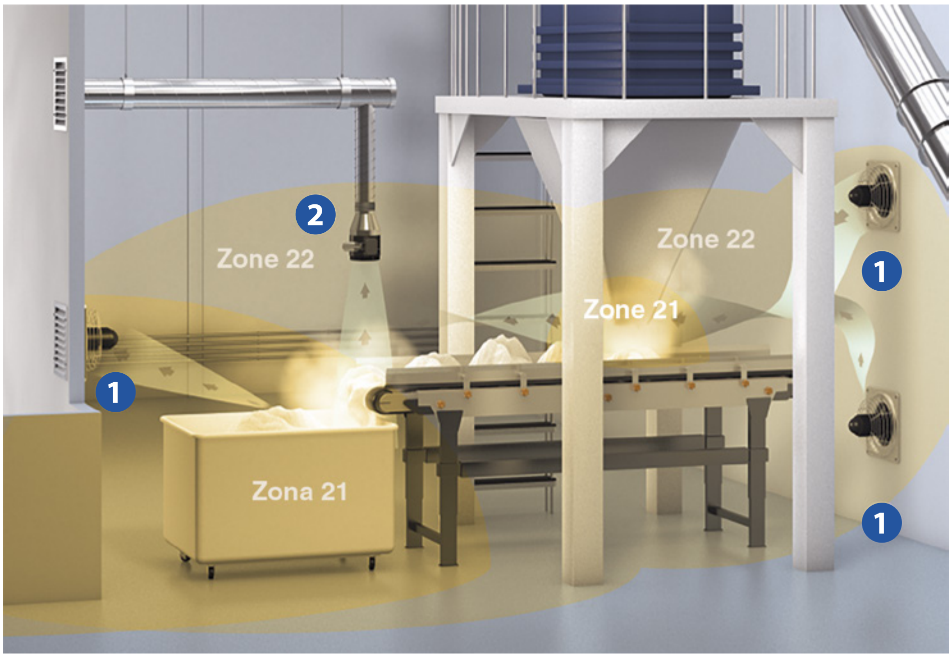


1 Enhanced- safety mixed flow fan for air extraction
2 Mix of textile dust and air
3 Exhaust air
4 Folded spiral-seams duct

Application example:

Ventilation solution in the production of textiles with explosive dust atmospheres

Duct fans are used to directly and efficiently extract the fine textile dust, made up of many different materials, such as plastic and natural yarns. The production area remains free of a flammable air mix. The system operators breathe clean air, free from fine dust, while working on the machine.



1 Wall-mounted fans
2 Ducted fan
Zone 21 - MAICO fans appropriate
Zone 22 - MAICO fans appropriate

Application example:

Milling system with explosive dust atmosphere

Different zone classifications are used for dust atmospheres. Depending on the zone, only certain device categories may be used.

1 External grille
2 Explosive atmosphere
3 Wall-mounted fan

Dilution ventilation

By distributing in the air, the concentration of combustible material is reduced such that it falls below the lower limit of explosion. The lower limit of explosion is the lower value limit for the concentration of a combustible material in a mix of gases, vapours, mist or dusts, below which a flame can no longer transmit itself independently of the source of ignition once ignited (EN 1127-1).

4.2 Technical implementation of ventilation systems in areas at risk of explosion

Experience shows that air exchange rates of at least 5/h should be aimed for in areas at risk of explosion. The values applicable in each specific case are stipulated by employers' liability insurance association requirements or corresponding rulings.

The air limit values (e.g. workplace exposure limit) or rather maximum allowable concentration values of all gases, vapours and mist present must be observed.

We would often recommend installing a fan system for active ventilation of the rooms in question in addition to air extraction and/or an exhaust air system. Controlling the air flows for outside and outgoing air can produce a slight excess pressure or partial vacuum as required.

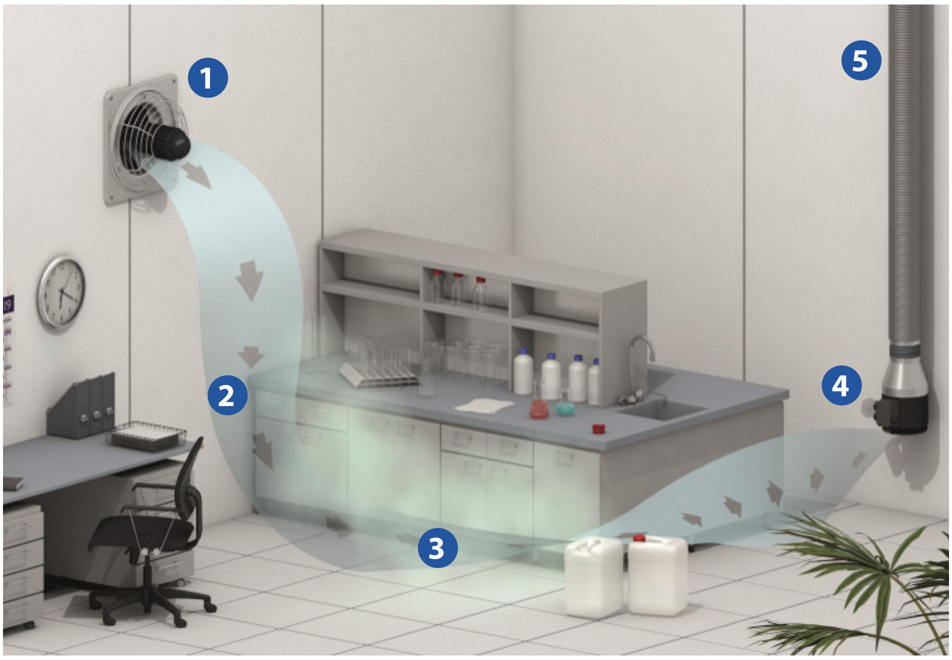
There should always be a partial vacuum in rooms with a potentially explosive area. This requires the mass flow in the supply air pipes to be lower than that in the exhaust duct.

Depending on the specific application, there are numerous ways in which the supply and exhaust air fans, ventilation ducts, supply and exhaust air openings, etc. can be arranged.

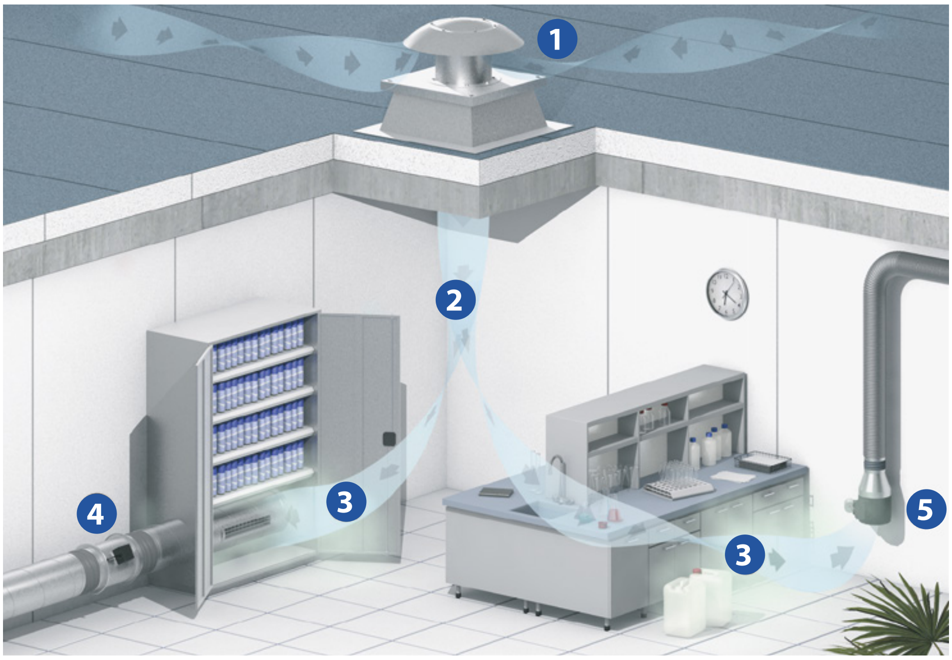
Practical examples:

Cross-ventilation

With cross-ventilation, the supply air flows through the entire room before being extracted. The supply air should be blown in near the ceiling and in parallel with it. The induction effect distributes the supply air throughout the room. The exhaust air is extracted near the floor because most combustible gases and vapours are heavier than air.
One exception is hydrogen, which collects under the ceiling, for example (see "Cross-ventilation in battery rooms application example" – page 24).

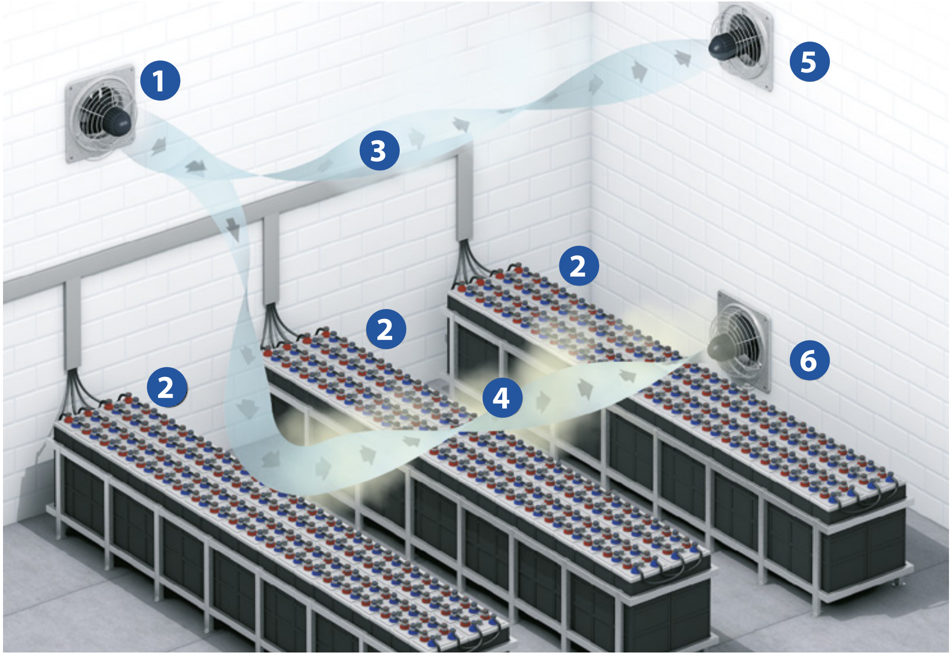


1. Wall-mounted fan
2. Air flow during cross-ventilation
3. Explosive atmosphere
4. Ducted fan
5. Exhaust Air



1. Roof fan
2. Supply air during cross-ventilation
3. Explosive atmosphere
4. Ducted fan
5. Ducted fan

In the applications shown above, the supply air is blown into the room in parallel to the ceiling. As the supply air crosses the room, it mixes well with the air already present in the room. It is then extracted either directly at the workplace, in a dangerous material cabinet with ventilation connected up directly or generally using exhaust air fans near the floor.

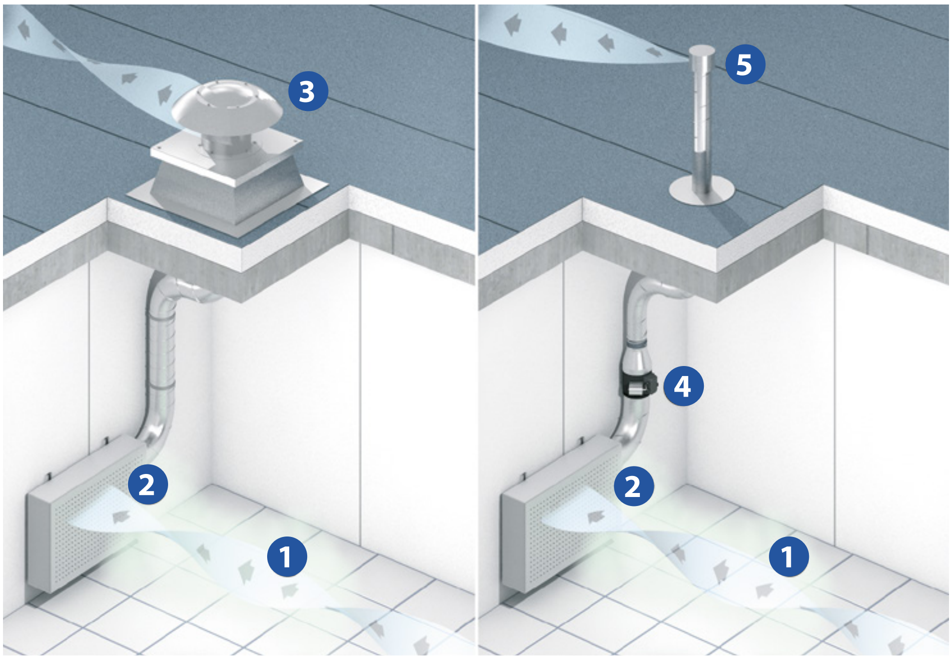


1. Supply air fan
2. Batteries on charging station
3. Explosive atmosphere (hydrogen)
4. Sulphuric acid mist
5. Exhaust air fan for extracting the hydrogen
6. Exhaust air fan for extracting the sulphuric acid mist

Application example:

Cross-ventilation in battery rooms

As the cells are charged, hydrogen is produced in the battery rooms and collects under the ceiling. With lead batteries, sulphuric acid mist forms close to the ground at the same time. Both need extracting.
To do this, equip the air extraction system with exhaust air openings at floor and ceiling height for this purpose or extract the exhaust air directly with wall-mounted fans. Supply air is fed in at the opposite end of the battery room using a separate ventilation system. If they wall-mounted fans again provide the simplest solution here for blowing in outside air.



1. Explosive atmosphere
2. Exhaust opening for exhaust air
3. Roof fan
4. Ducted fan
5. Outgoing air

5 Checklist

Quick selection of fans for potentially explosive atmospheres

Are there flammable substances in the room?
- YES Pag. 4
- NO → Explosion protection measures necessary

Can an explosive atmosphere form?
- YES Pag. 5
- NO → Explosion protection measures necessary

Explosion protection documents available?
- YES Pag. 30
- NO → Support by:
  - Ex-experts
  - Factory inspectorate
  - TUV
  - Employer's Liability Insurance Association

Take primary and secondary explosion protection measures!
- YES Pag. 10-11

Zoning of the potentially explosive atmosphere?
- YES Pag. 11
- → Approved fans for **Zone 0,20**

Eqipment of group II, category 2 or 3 opproved?
- YES Pag. 12
- → Approved fans for **category 1**

Clarify matching of relevant parameters from explosion protection documentation!
- YES

Selection help of fans
- YES Pag. 26

1

2

3

4

5

6

7

8

Selection help for MAICO fans

MAICO fans for use in areas subject to explosion hazards

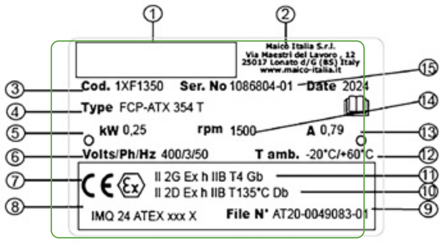
In order to select the right fan, you need to know the following:

	MAICO supplies:	Applicable for:
Device group, category	Device group II, category 2 G, in other words, suitable for explosive atmospheres with gases, vapours and mists other than mines	All product groups of the ex fans
Zone	Approved for zone 1/21 and zone 2 /22. (Zones 0, 20 not approved!)	All product groups of the ex fans
Type of protection	Product group for gas ex Device protection thanks to increased safety "e" (for the motor and electrics, standard: EN 60079-7, labelling: eb) Constructional safety "c" (for the mechanical part, i.e. the fan but not electrics, standard: EN 80079-37, labelling: h)	Product groups of the gas ex fans
	Product group for dust ex Protection for devices from dust explosions by enclosure "t" (for the motor and electrics, labelling: tb) Constructional safety "c" (for the mechanical part, i.e. the fan but not electrics, labelling: h)	Product groups of the dust ex fans
Installation location	Fans for roof, wall and duct installation	Respective product group

Performances according to:

- Maico online catalogues
- Blowdyn selection software
- Technical assistance for customized solutions

6 Example of labelling



1. Brand
2. Manufacturer
3. Fan code
4. Fan model
5. Kw
6. Voltage/Frequency
7. ATEX logo
8. Certification number
9. Technicl file number
10. Fan marking / dusts
11. Fan marking / gas
12. Working temperature
13. Absorption
14. Round per minute of the fan
15. Serial number

STRINGA TIPO
II 2G Ex h IIA T*Gb o Ex h IIB T*Gb o Ex h IIB+H2 T* Gb
II 2D Ex h IIIB T*°C Db o EX h IIIC t*°C Db

Legend:

II:	Group
2:	Category
G / D:	Suitable for use in potentially explosive atmospheres with presence of Gas / Dusts
Ex h:	Protection mode non electrical machines according to EN/ISO 80079-36
IIA / IIB / IIIB / IIIC:	Gas/Dust enclosure group
H2:	Gas mixture that can contain Hydrogen
T*:	the symbol indicating the temperature class (T6-T1) relating to GAS - Installation suitability in compliance with IEC 60079-14:2015 punto 5.6
T*°C:	Max Temperature of the exposed area (T85°C-T450°C) referred to dusts - Installation suitability in compliance with IEC 60079-14:2015 point 5.6
Gb / Db:	IEPL -Explosion Protection Level
X:	Special conditions of safety use (see specific section)

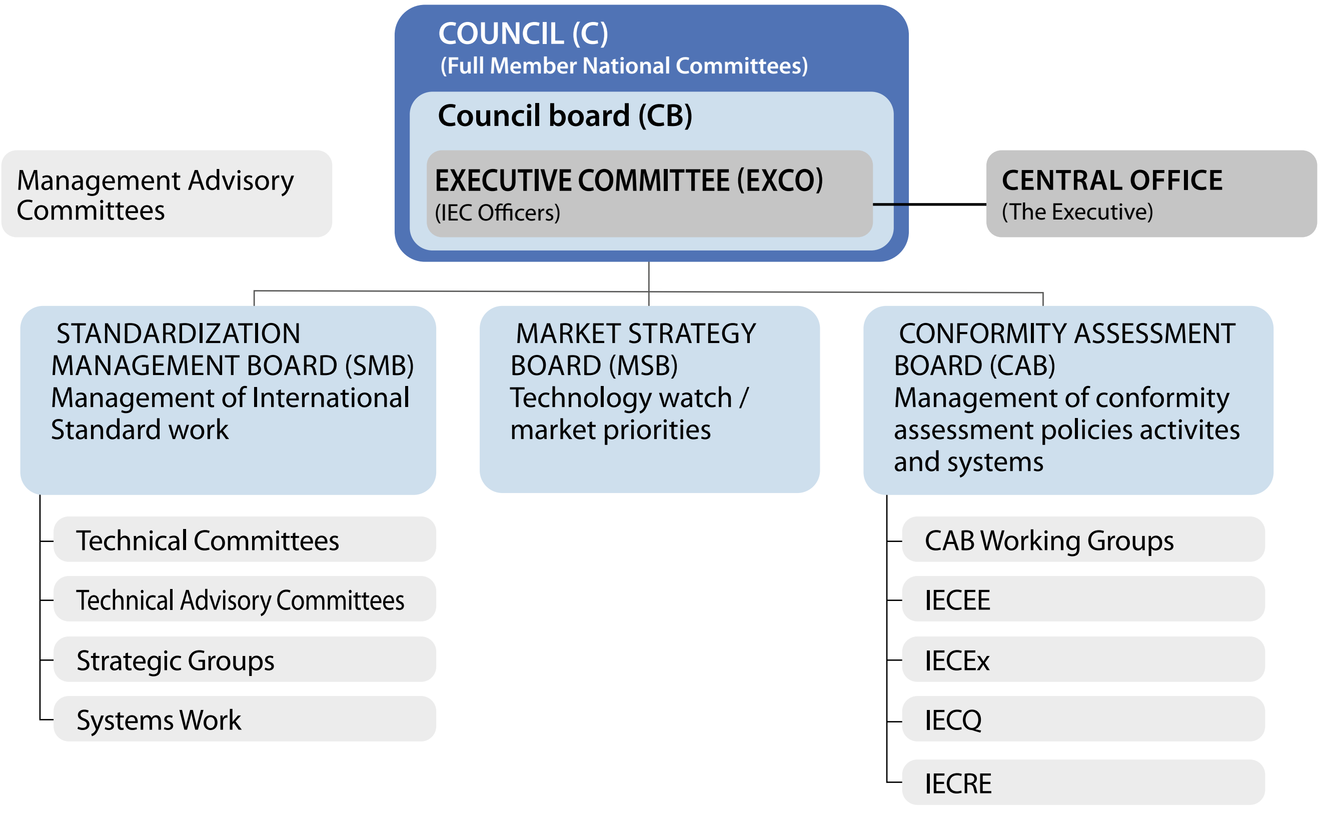
In addition to the legally required ATEX certification, some Maico fans also have the IECEx certification. **This means that they can also be supplied outside the European Union**. The condition is that the technical and regulatory requirements of the destination country are met.

How does the IECEx scheme work?

The IECEx scheme is part of the International Electrotechnical Commission, which is the main worldwide organisation for the development of electrotechnical standards and the like

The main task of the IEC is to:

- develop and maintain international standards and
- verify the conformity of electrical products and also
- verify quality management in relation to the standards produced



Conformity with the respective standards is checked in terms of:

- Safety
- Efficiency
- Reliability
- Compatibility
- Competence

through the use of independent validation and testing of

- Services
- Production processes,
- Products
- People
- Management systems

through the application of the IEC's conformity assessment system.

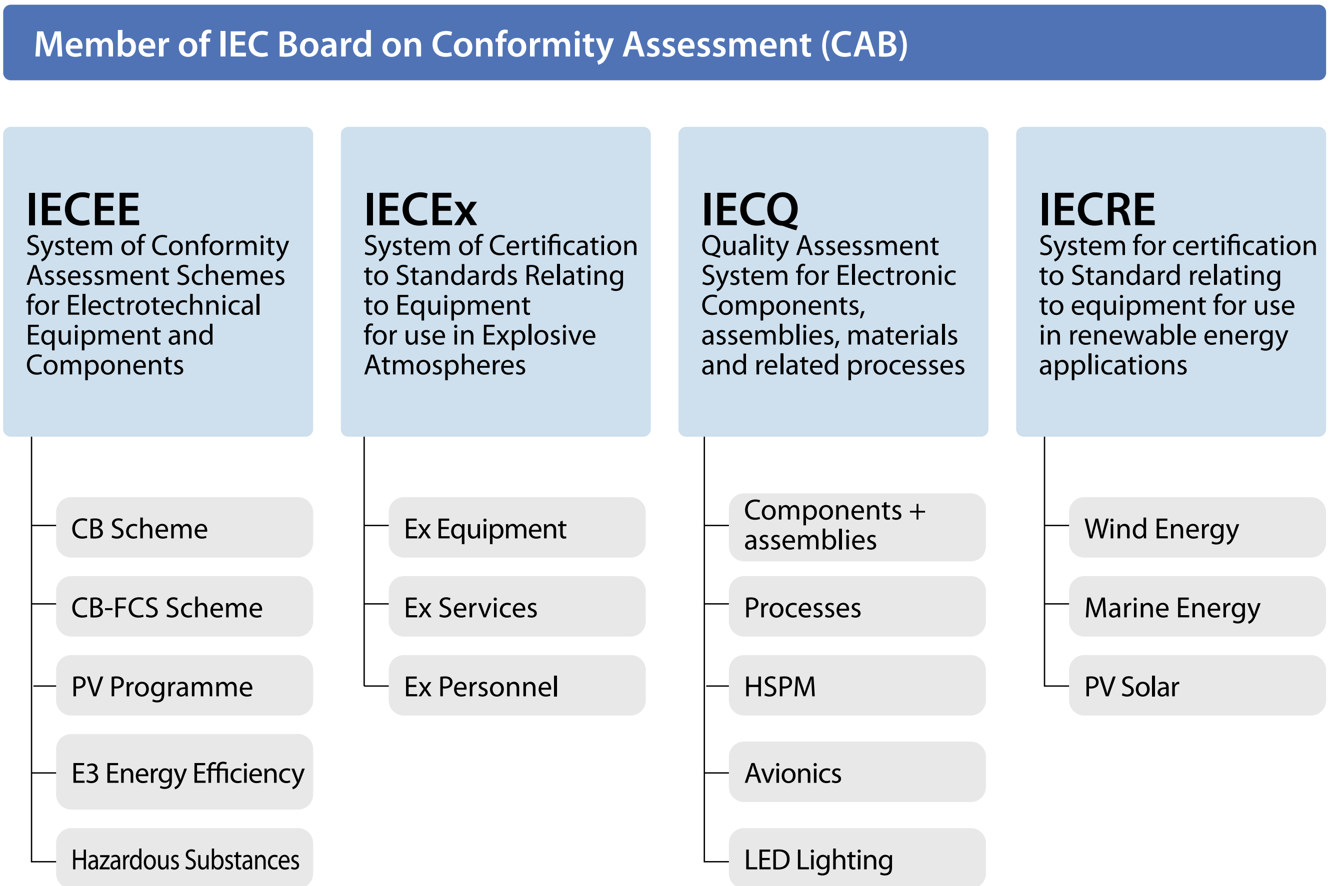


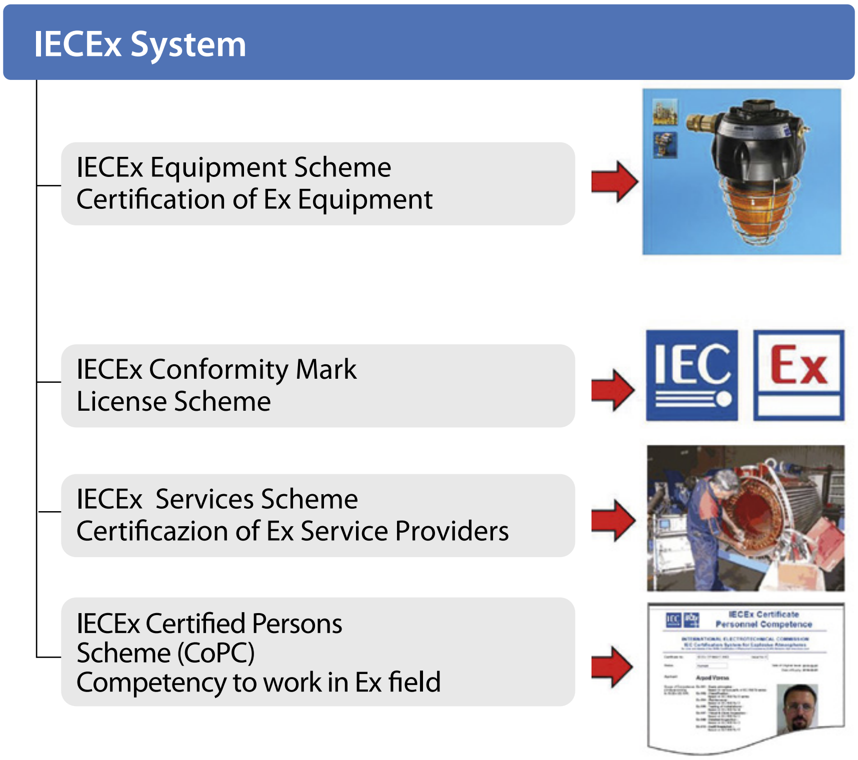
Figure 2: The IEC's conformity assessment system

The main concern of the IECEx system is to facilitate international trade in products for use in areas subject to explosion hazards while also retaining the necessary safety level.

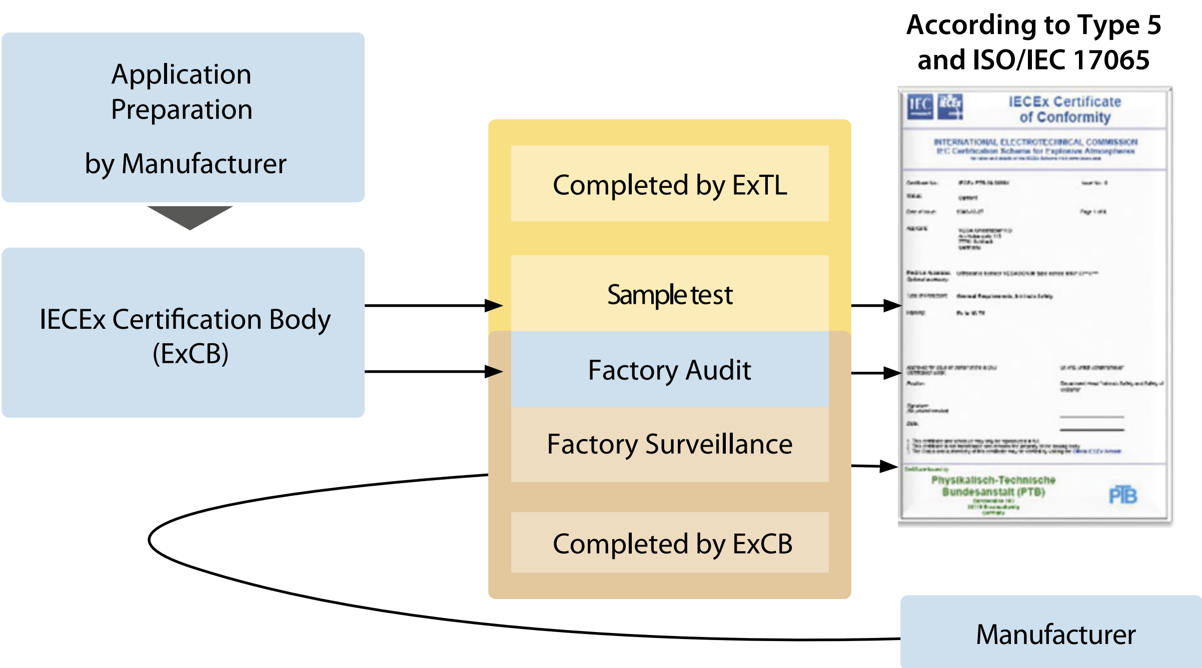
The goals of this system are as follows::

- Reduced testing and certification costs for the manufacturer
- Faster access to the respective national market
- Established confidence in the product validation process at an international level
- One single database accessible internationally for listed manufacturers.
- Continuous assurance of trustworthiness in equipment and services through IECEx certification.

There are various services within the IECEx system:



The IECEx equipment scheme involves the assessment of products for explosive areas. In order to receive this certificate, the manufacturer sends a test sample of his application to the IECEx Certification Body (ExCB), where the sample is tested in the lab. The manufacturer's production facilities are also audited by the ExCB. Repeat audits ensure that the strict normative requirements of the IEC standards which have to be applied are observed on a continual basis. The sample test results in the technical report (ExTR), which documents that the product has been tested and found to meet all relevant IEC or ISO standard requirements. This applies both to the requirements of electrical equipment, which are covered by IEC 60079 and the 61241 series of standards as well as non-electrical equipment, covered by the ISO/IEC 80079 series of standards.



Based on ISO/IEC 17065/17025+IECEx Rules + procedures + OD.

No need to conduct factory audit and surveillance for IECEx "Unit Verification" Certificate.

The audit of the production facilities results in the writing of the Quality Assessment Report (QAR), which testifies to the manufacturer's ability and competence in producing products for use in explosive environments.
The QAR is valid for three years during which repeat audits are undertaken. The test cycles are linked to the respective certification status of ISO 9001 and ISO 80079-34 certification.


IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification Scheme for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

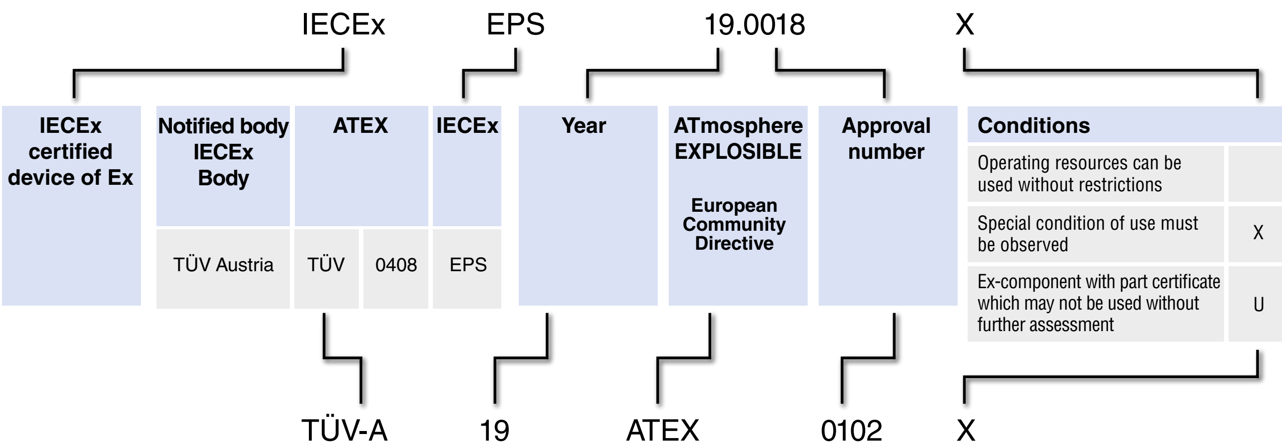
Certificate No.: IECEx EPS 19.0018X — Issue No: 0 — Certificate history: Issue No. 0 (2019-09-13)
Status: Current — Page 1 of 4
Date of Issue: 2019-09-13
Applicant: Maico Elektroapparate-Fabrik GmbH, Steinbeisstraße 20, 78056 Villingen-Schwenningen, Germany
Equipment: Fans with asynchronous motors DZQ and DZS series
Optional accessory:
Type of Protection: increased safety "e"; Protection by enclosures "t", non-electrical equipment "h"
Marking:
Ex eb IIB+H_2 T4/T3 Gb
Ex h IIB+H_2 T4/T3 Gb
Ex tb IIIB T135°C/T200°C Db IP64
Ex h IIIB T135°C/T200°C Db

Approved for issue on behalf of the IECEx Certification Body: Holger Schaffer
Position: Manager certification
Signature: (for printed version)
Date: 2019-09-13

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the Official IECEx Website.

Certificate issued by:
Bureau Veritas Consumer Products Services Germany GmbH
Businesspark A96
86842 Türkheim
Germany

Compared with ATEX, the certificate number is made up as follows::



All certificates can be viewed online at IECEx by going to www.iecex.com, from where they can also be downloaded. This can also be done via an app on Android or Apple devices..

7 Addendum / Important terms

Air extraction
Air extraction at the exit point (e.g. edge extraction on open containers) prevents explosive substances from being distributed throughout the room..

Combustible materials
Combustible materials are all substances, which are classified as flammable or highly flammable. These may be gases, liquids and dusts of combustible solids.

Detonation
Detonation is an explosion under optimum conditions.

The resultant pressure wave propagates in the supersonic range..

Explosive atmosphere
An explosion is a sudden oxidation reaction occurring with a sudden increase in temperature, pressure or both at the same time. An explosion produces pressure waves with high excess pressure..

Explosive atmosphere
A mixture of air or oxygen with combustible gases, vapours, mist or dusts under atmospheric conditions. Should this catch fire, the combustion spreads to the entire unburnt mix..

Potentially explosive area
A place where an explosive atmosphere may occur..

Explosion protection document
Whenever an explosive atmosphere is reasonably likely to occur, an explosion protection document must be produced. This should provide an overview of the results of the evaluation of the danger and the resulting technical and organisational protective measures for a system.

Flash point
Lowest temperature at which an immediately flammable gas or vapour/air mix forms above a liquid under prescribed normal conditions.

Device group
Electrical equipment for use in potentially explosive atmospheres are split into 2 groups:

- Group 1: Electrical equipment intended for use underground in areas at risk of mine gas (not included in MAICO's product range).
- Group II: Electrical equipment in all other potentially explosive areas.

Device category
Depending on risk, electrical equipment of device group II is split into three device categories..

Per i gas, questi sono

- Category 1G, (1)G offering adequate safety in the event of infrequent errors
- Category 2G, (2)G offering adequate safety in the event of foreseeable errors
- Category 3G, (3)G offering adequate safety in normal operation

For dusts, these are

- Category 1D, (1)D offering adequate safety in the event of infrequent errors
- Category 2D, (2)D offering adequate safety in the event of foreseeable errors
- Category 3D, (3)D

Limit of the explosion area
An explosion can only occur if the concentration of combustible material is between the upper and lower limit of the explosion area. So an explosive atmosphere may form inside a partially filled fuel tank, for example, while a full fuel tank is not hazardous..

Primary explosion protection measures
Prevent the formation and spread of an explosive atmosphere (e.g. ventilation, inertisation, concentration monitoring with shutdown).

Cross-ventilation
Supply and exhaust air openings are fitted at opposite ends of the ventilated room. The air then flows through the room before being extracted..

Secondary explosion protection measures
Prevent sources of ignition from having any effect: Explosion protection for electrical and non-electrical equipment with measures to protect against ignition.

Temperature classes
I gas esplosivi possono essere suddivisi in classi di temperatura in base alle loro temperature di accensione. La massima temperatura superficiale delle apparecchiature (per gli aspiratori: il motore) deve essere sempre inferiore alla temperatura di accensione dell'atmosfera esplosiva in cui vengono utilizzate.

Misure di protezione terziaria contro le esplosioni
Explosive gases can be split into temperature classes on the basis of their ignition temperatures. The maximum surface temperature of equipment (for fans: the motor) must always be lower than the ignition temperature of the explosive atmosphere in which it is used.

Tertiary explosion protection measures
Restrict the impact of an explosion to a safe extent, e.g. using explosion-proof construction, release of pressure, suppression of explosion..
By distributing in the air, the concentration of combustible material is reduced such that it falls below the lower limit of explosion. The lower limit of explosion (UEG) and the upper limit of explosion (OEG) are the lower and upper limits for the concentration of a combustible material in a mix of gases, vapours, mist or dusts, within which a flame can no longer transmit itself independently of the source of ignition once ignited (EN 1127-1).

8 Sources

- Heinz Olenik – Elektroinstallation und Betriebsmittel in explosionsgefährdeten Bereichen (Electrical installation and equipment in areas subject to explosion)
- R. Stahl – Grundlagen Explosionsschutz (Principi di protezione dalle esplosioni)
- https://www.iecex.com/
- https://www.iec.ch/dyn/www/f?p=103:63
- https://www.chemie.de/lexikon/Flammpunkt.html

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Miscellaneous

- @STAHL Publikation Grundlagen Explosionsschutz, p. 17
- https://www.iec.ch/dyn/www/f?p=103:63, p. 27
- https://www.iecex.com/information/about-iecex/, pag. 27, 30

Information relating to the practical guide to explosion protection

- Features and technical data may vary without notice, maintaining the main functional parameters of the models unchanged.
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