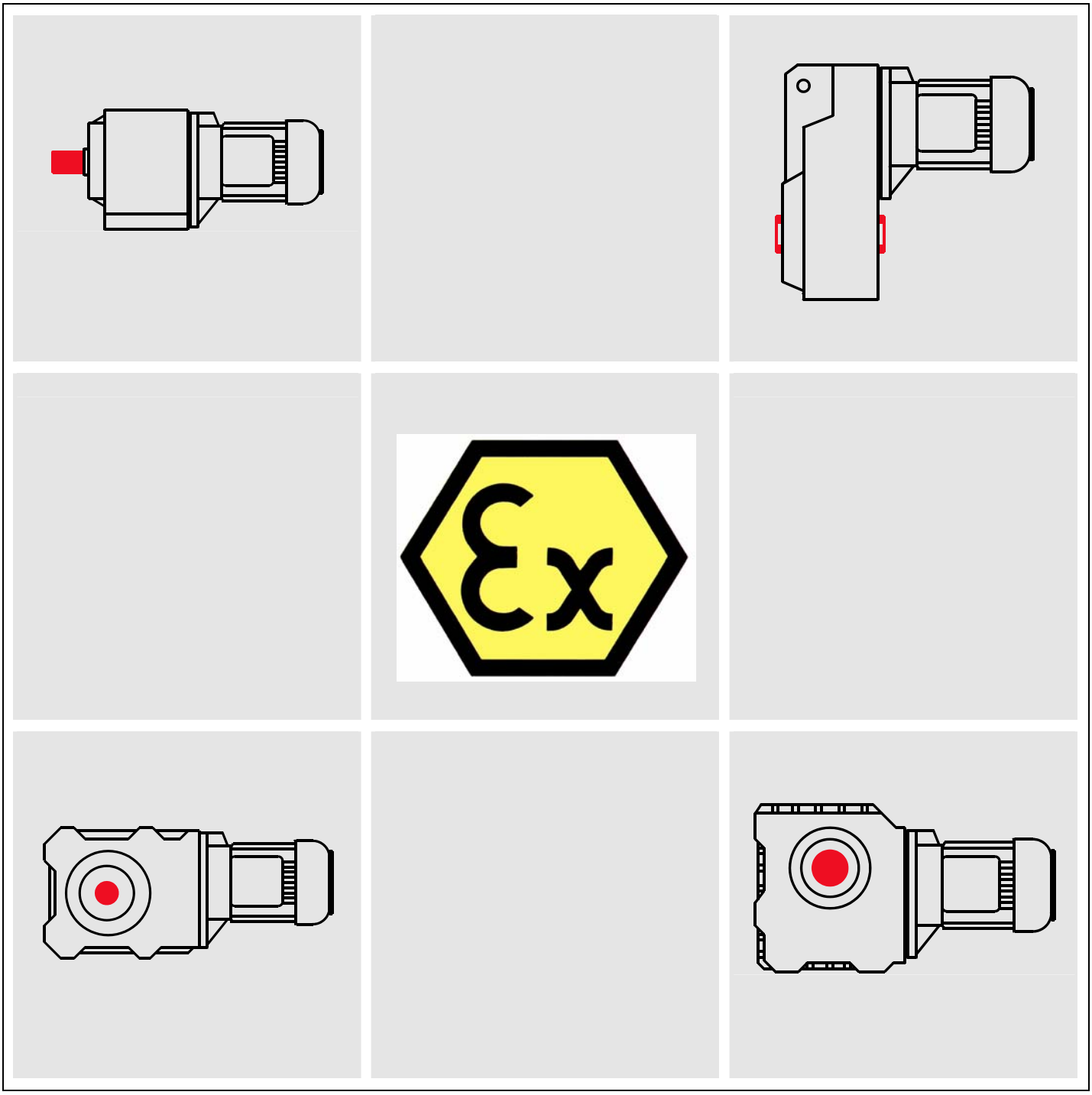
Electronic Information EI 2803 E

Geared motors meet ATEX requirements



BAUER geared motors

Geared motors meet ATEX requirements

by H. Greiner

Electrical apparatus for potentially explosive atmospheres had been standardised on European level as early as 1978. A new approach has been marked by ATEX in 1994 by specifying basic requirements in the "Directive 94/9/EC of the European parliament and the council" which will become binding for explosionproof equipment (both electrical or non-electrical) to be placed on the market commencing from 01.07.2003.

Some of the aspects related to geared motors are described in this article.

1 Basic meaning of "ATEX"

	specific marking for explosion protection
ATEX	derived from Atmosphères explosibles; usual abbreviation complemented by Article number of the Treaty establishing the European Community
ATEX 100a	Directive 94/9/EC on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosive atmospheres; now with new Article number 95 correct ATEX 95 (but usually still quoted ATEX 100a) binding for placing on the market from 01.07.2003. Transposition into British Law by Statutory instruments number 192 of 1996
ATEX 118a	Directive 1999/92/EG on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres; now with new Article number 137 correct **ATEX 137** (but usually still quoted **ATEX 118a**) binding for new installations from 01.07.2003 binding for existing installations to comply with the requirements from 01.07.2006

2 Classification of areas (Zones) and equipment (Categories)

To determine the extent of measures necessary to avoid effective ignition sources, the hazardous places are classified into zones based on the frequency and duration of occurrence of a hazardous explosive atmosphere.
The extent of measures taken in the design of equipment or apparatus is classified into categories.

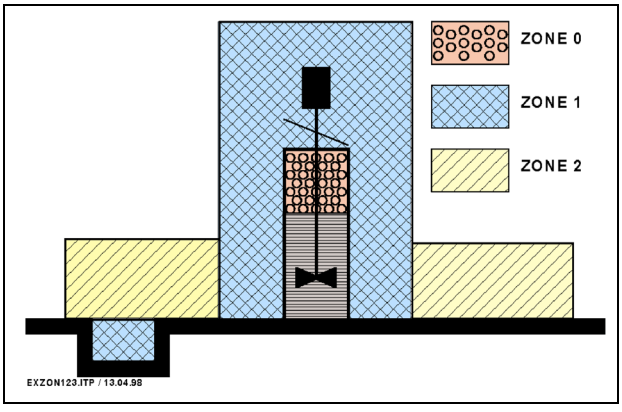


Fig. 2

Agitator as an example for area classification in IEC/EN 60079-10
(shading of areas complies with the standard; colours are not standardised)

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Explosive atmosphere	Area classification		Equipment classification	
	Zone	Frequency and duration of occurrence	Category	Level of protection
Gas	**0**	continuously or for long periods or frequently	**1 G**	very high even in the event of rare incidents related to the equipment assured – by independent second means of protection – in the event of two independent faults
Dust	**20**		**1 D**	
Gas	**1**	likely to occur in normal operation occasionally	**2 G**	high even in the event of frequently occurring disturbances
Dust	**21**		**2 D**	
Gas	**2**	not likely in normal operation, persisting for short period only	**3 G**	normal during normal operation
Dust	**22**		**3 D**	

3 Types of protection required for motors for use in Zones

In order to meet the required level of protection (Category) ATEX would allow to meet the basic requirements of the Directive without following a specific Standard. Electrical motors are usually designed and tested in accordance with appropriate standards and certified by a notified body.
The following table gives the types of protection for motors related to the zones:

Zone	Explosive atmosphere	Type of protection for motors	Standards for design and testing		Standards for installation	
			current	future	current	future
0	Gas	2 independent protections e.g. "e" and "d" (special)	EN 50284	-	EN 60079-14	-
1	Gas	General **EEx e** **EEx d** **EEx p**	EN 50014 EN 50019 EN 50018 EN 50016	-	EN 60079-14	-
2	Gas	**EEx nA** or to 60079-14 Clause 5.2.3	EN 50021	-	EN 60079-14	-
20	Dust	**not permissible** (see Clause 26.2 of Std.)	EN 50281-1-1	EN 61241-0 EN 61241-1	EN 50281-1-2	EN 61241-14
21	Dust	**EEx tD**	EN 50281-1-1	EN 61241-0 EN 61241-1	EN 50281-1-2	EN 61241-14
22	Dust	**EEx tD**	EN 50281-1-1	EN 61241-0 EN 61241-1	EN 50281-1-2	EN 61241-14

For electrical machines the following types of explosion protection are customary:

- ☐ Increased Safety "e"
- ☐ Flameproof enclosure "d"
- ☐ Pressurised apparatus "p"
- ☐ Non-sparking "nA"
- ☐ Dust explosion protected "tD"

Their choice will depend upon the nature of the potentially explosive atmosphere concerned and the likelihood of its occurrence (Zone).
Within their fields of application, types of explosion protection *"e",* "d" and "p" are equivalent according to the Standards and legal requirements.
There are, however, in practice different evaluations as to their field of use. These differences arise partly for technical and economic reasons, but also because particular stipulated practices have been established over many years – in British and American markets for example.

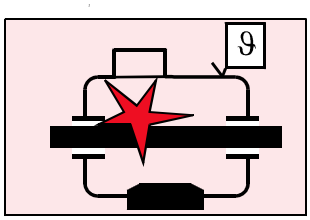
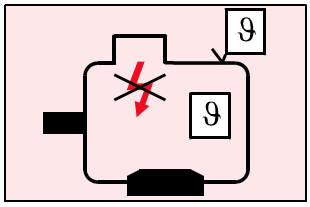
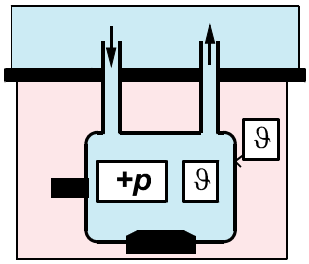
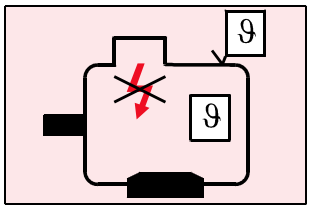
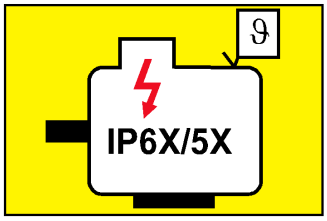
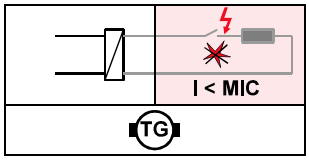
Symbol	Principle	Type of protection
d		**Flameproof enclosure "d"** A type of protection of electrical apparatus in which the enclosure will withstand an internal explosion of a flammable mixture which has penetrated into the interior without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive atmosphere consisting of one or more of the gases or vapours for which it is designed. [IEV 426-06-01] ***Usual application:*** Inverter-fed three-phase cage-motors DC motors
e		**Increased safety "e"** A type of protection in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks inside and on external parts of electrical apparatus which does not produce arcs or sparks in normal service. [IEV 426-08-01] ***Usual application:*** Three-phase cage-motors
p		**Pressurization "p"** A type of protection of electrical apparatus in which safety is achieved by means of a protective gas maintained at a pressure above that of the surrounding atmosphere. [IEV 426-09-01] ***Usual application:*** Large electrical machines of all kind
nA		**Type of protection "n"** Type of protection applied to electrical apparatus such that, in normal operation and in certain abnormal conditions specified by the standard, it is not capable of igniting a surrounding explosive atmosphere. ***Usual application:*** TEFC three-phase cage motors
tD		**Dust tightness and temperature control** All relevant measures specified in the relevant standard (e.g. dust ingress protection and surface temperature limitation) applied to electrical apparatus protected by enclosure to avoid ignition of a dust layer or cloud ***Usual application:*** TEFC three-phase cage motors
i		**Intrinsically-safe circuit** A circuit in which any spark or thermal effect produced either normally or in specified fault conditions is incapable, in the specified test conditions, of causing ignition of a given gas or vapour. ***Usual application:*** Tacho generators

Fig. 3 Principles of types of protection applicable on rotating electrical machines

4 Adjustable speed via variable frequency (VF)

As in many other fields, in the chemical process industry there is an increasing demand for steplessly adjustable speed control.
Apart from minor differences in the winding design, frequency-controlled three-phase geared motors are identical to the standard listed geared motors. Their complete protection against both dust and hose water (Degree of protection IP 65) thus enables them to be installed without further consideration in the most demanding conditions, including therefore the most adverse environments. The complex and sensitive components which were once necessary for stepless speed variation are now all transferred to the frequency inverter which, irrespective of the location of the drive, can be installed in a machine room or control cubicle in a safe area where it can be readily maintained and supervised. The motor is fed at variable frequency which is linked to the mains power system via intermediate circuit.
Of all the possible methods of obtaining a stepless speed variation, the frequency-controlled three-phase induction motor alone permits this special separation between the complex speed control elements and the simple drive elements. This form of control is thus suitable for drives which are sited in particularly difficult or inaccessible locations.

4.1 Potential of energy saving

A study carried out by the Fraunhofer Institut Systemtechnik und Innovationsforschung (ISI) [Fraunhof Institute for Systems Technology and Innovative Research] estimates that energy losses in the operation of pumps (PUMPS), fans (VENT), compressors (COMPR) and other actuator systems can be reduced by up to 50 % by the combined or targeted use of energy-saving electric motors (EEMs), variable speed drives (VSDs) and appropriate control systems in the driven machinery (SYST) (Fig. 4.1).

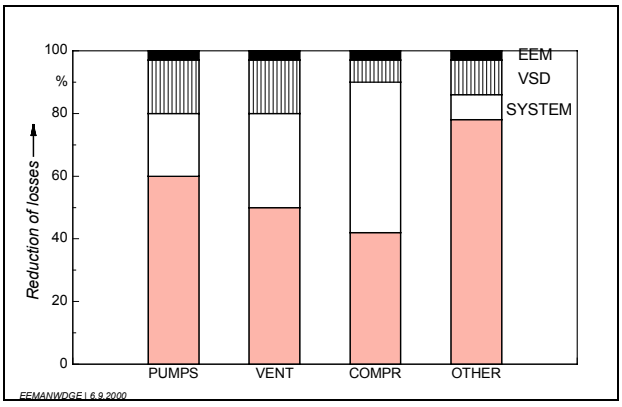


Fig. 4.1
Potential reduction of losses (see text for explanations)

4.2 Rules for the application of VF motors in areas with explosion hazard

There is a major difference between motors with type of protection "d" or "e" because of the fact that in case of "e" both winding and rotor temperature need to be monitored whilst in case of "d" motors it is sufficient to keep the surface temperature of the housing below the limits set by the temperature class of the relevant gas.

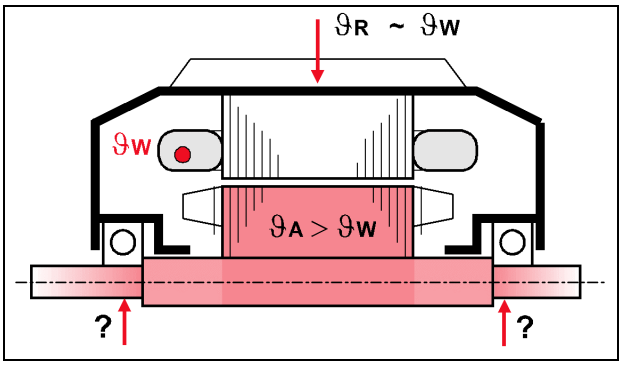


Fig. 4.2
Limits for the detection of actual temperatures by thermistors embedded in the motor winding

ϑ_W Winding
ϑ_R Housing
ϑ_A Rotor cage

? temperature at shaft extensions need to be checked by the motor manufacturer

4.2.1 Type of protection "d"

The Standard EN 60079-14 in their Clause 10.5 amended by the Note 3 that will be added in the forthcoming edition give clear instructions regarding the application and protection of electrical machines when fed from converters:
"Motors supplied at varying frequency and voltage require either:

a) means (or equipment) for direct temperature control by embedded temperature sensors specified in the motor documentation or other effective measures for limiting ***the surface temperature of the motor housing***. The action of the protective device shall be to cause the motor to be disconnected. ***The motor and converter combination does not need to be tested together***; or

b) the motor shall have been type-tested for this duty as a unit in association with the converter specified in the descriptive documents according to IEC 60079-0 and with the protective device provided.

NOTE 1 In some cases, the highest surface temperature occurs on the motor shaft.

NOTE 2 For motors with protection type "e" terminal boxes, when using convertors with high-frequency pulses in the output, care should be taken to ensure that any overvoltage spikes and higher temperatures which may be produced in the terminal box are taken into consideration.

NOTE 3 ***A current-dependent time lag protective device*** (in accordance with clause 7, point a)) **is *not to be regarded as an 'other effective measure'".***

4.2.2 Type of protection "e"

The following specification is condensed from EN 60014, Clause 11.2.4 amended by the Note that will be added in the forthcoming edition:

"Motors supplied at varying frequency and voltage by a converter shall have been ***type tested for this duty as a unit*** in association with the converter specified in the descriptive documents according to IEC 60079-0 and with the protective device provided or shall be evaluated in accordance with IEC 60079-7.

NOTE Additional information on the application of converter-fed motors can be found in IEC 60034-17. Major concerns include over-temperature, high frequency and over-voltage effects, and bearing currents."

4.2.3 Preference for VF-motors with flameproof enclosure "d"

The type test required for the combination of an "e"-motor together with a modified and documented converter type leads to a complicated and expensive testing procedure and ***an "EC Type examination certificate"*** needs to be issued ***by a notified body***.
In case of the "d"-motor with embedded temperature sensors (thermistors) the ***manufacturer*** will draw up a ***"EC Declaration of conformity"*** and the user may select a suitable frequency converter of ***any type or make***. The latter procedure is preferred by the majority of OEMs and users.

5 Non-electrical equipment for potentially explosive atmospheres

The new approach of ATEX includes detailed requirements for
- ☐ non-electrical equipment for installation in places with potentially explosive atmospheres
- ☐ equipment for use in the presence of combustible dust.

Dust explosion protection will be a matter to be dealt with in a forthcoming article.

Statistics such as Fig. 5 indicate that there had been good reasons to include non-electrical equipment in the framework of ATEX.

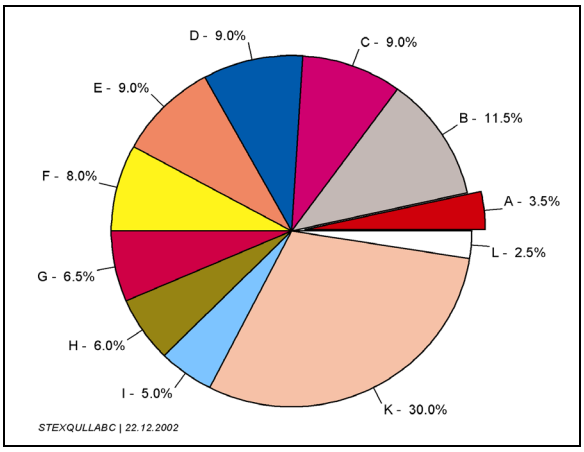


Fig. 5.1
Share of ignition sources causing dust explosions
A electrical apparatus
B not known
C glowing of a dust layer
D electrostatic discharge
E friction
F open fire
G hot surface
H self ignition
I welding
K mechanical sparks
L other

ATEX defines:
"Equipment means machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection or prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy for the processing of material and which are capable of causing an explosion through their own potential sources of ignition."
The requirement is to be applied on the gear unit of a geared motor; as well as on the driven machine or processing equipment if installed in classified areas with explosion hazard. In order to ***declare the conformity*** the manufacturer of the driven equipment has to assess and register the ***ignition hazard***.
This task is simplified if for the geared motor as a component a separate assessment has been performed. Such assessment could be based on the ATEX requirements only. It is positive for the product if the investigation has been based on an existing or draft standard, however.
For the assessment of the example given in Fig. 5.2 among other the following standards have been taken into account:

EN 1127	Explosive atmospheres, Explosion prevention and protection; Basic concepts and methodology
EN 13463	Non-electrical equipment for use in potentially explosive atmospheres
EN 13463-1	Basic methods and requirements
EN 13463-5	Protection by constructional safety
EN 13463-8	Protection by liquid immersion "k"

BAUER geared motors

Danfoss Bauer GmbH D-73734 Esslingen	CE
GETRIEBE / REDUCER / REDUCTEUR	
No	**A /**
Type	
Ex II 2 G c k II T / Ex II 2 D c k T<160 °C / EN 13463-1/ -5/ -8	
Reduction i	
max. n_1	/min
max. M_2	**Nm**
max. P	kW
BF/SF f_B	

Fig. 5.2 Example for marking a gear unit

Ex	Specific marking for explosion protection
II	For use other than underground
2	Category 2 (Zone 1 or 21)
G	Areas with gas, vapour or mist
c	Type of protection "constructional safety c"
k	Type of protection "liquid immersion k"
II	Explosion group
T4	Temperature class
D	Areas with combustible dust
T<160 °C	Maximum surface temperature of enclosure
EN	Standards taken into account in assessment

Currently a range of standards EN 13463 ***"Non-electrical equipment for potentially explosive atmospheres"*** is prepared by CEN with new types of protection.

Figure 5.3 explains the principles of the types of protection applicable for mechanical equipment:

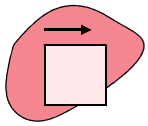
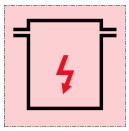
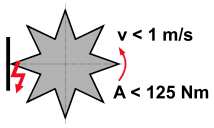
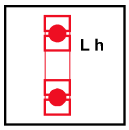
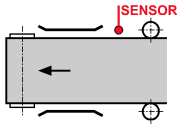
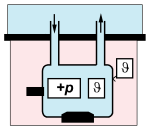
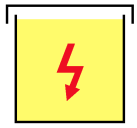
- 2	**fr**	Flow restricting enclosure	
- 3	**d**	Flameproof enclosure	
- 4	**i**	Inherent safety	
- 5	**c**	Constructional safety	
- 6	**b**	Control of ignition source	
- 7	**p**	Pressurisation	
- 8	**k**	Liquid immersion	

Fig. 5.3 Principle of the types of protection used with non-electrical equipment;
Range of Standards EN 13463 (at present in the draft state)

The ignition risks caused by any non-electrical equipment must be assessed and documented.
Depending on the Category (Zone) the manufacturer and/or a notified body will be active – see table.

Category	Zone		issued by	registered with	Certificate
	Gas	Dust			
1	0	20	notified body	notified body	EC Type examination certificate by notified body
2	1	21	manufacturer	notified body	EC Declaration of Conformity by manufacturer
3	2	22	manufacturer	manufacturer	EC Declaration of Conformity by manufacturer

References:

1 Directive 94/9/EC of 23 March 1994
on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosive atmospheres
www.europa.eu.int/comm/enterprise/atex

2 Directive 1999/92/EG of 16 December 1999
on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres
www.europa.eu.int/comm/enterprise/atex

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