

# ATEX

## Explosion protection and gas detection

### Ex-marking and meaning

The ATEX Directives are mandatory in the countries of the EU plus the countries of the European Free Trade Association (EFTA).

#### Directive 2014/34/EU

Article 114 (formerly ATEX 100a)  
Approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

Relevant to  
- Placing on the market and maintenance  
- Equipment and protective systems for hazardous areas  
- Conformity assessment procedure

Essential health and safety requirements (EHSR)

- General requirements  
- Assessment of the environment  
- Marking of equipment  
- Definition of potential ignition sources  
- Risk assessment of software  
- Risk assessment conc. gas, fibres, mists and dust

Equipment groups and categories (Annex 1)

#### Directive 1999/92/EC

Article 137 (formerly ATEX 118a)  
Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

Application to  
- Avoiding potentially explosive atmospheres (primary explosion protection)  
- Protection against explosions  
- Assessment of explosion risks  
- Requirements for work equipment and work places  
- Marking of hazardous places

Relevance of the explosion protection document  
Definition of zones (Annex 1)  
Minimum requirements for the protection of workers (Annex 2)

#### CONDITION FOR AN EXPLOSION: SOURCE OF IGNITION + OXYGEN + FLAMMABLE MATERIAL

Source of Ignition	Oxygen	Flammable material
Hot surfaces, Flames and hot gases, Mechanically generated sparks, Electrical apparatus, Stray electric currents and cathodic corrosion protection, Static electricity, Lightning, Radio frequencies from 9 kHz to 300 GHz, Electromagnetic waves in the range from 0.1 µm to 1000 µm, Ionizing radiation, Ultrasonics, Adiabatic compression (shock waves), Chemical reaction	Air, Atmospheres containing oxygen concentrations higher than the Oxygen Limit Concentration (OLC)  Remark: Article 114 is binding for atmospheric conditions, and so is not applicable for oxygen enriched atmospheres (Article 1)	Atmospheres with concentrations of flammable material higher than the Lower Explosion Limit (LEL)

#### OXYGEN LIMIT CONCENTRATION (OLC)

Fuel	Oxygen limit concentration OLC in the total mixture of fuel / air / inert gas	Inertization with N <sub>2</sub>	Inertization with CO <sub>2</sub>
Benzene	11.2 mol% O <sub>2</sub>	13.9 mol% O <sub>2</sub>	13.9 mol% O <sub>2</sub>
1,3-Butadiene	10.4 mol% O <sub>2</sub>	13.0 mol% O <sub>2</sub>	13.0 mol% O <sub>2</sub>
Butane	12.1 mol% O <sub>2</sub>	14.5 mol% O <sub>2</sub>	14.5 mol% O <sub>2</sub>
Carbon monoxide	5.0 mol% O <sub>2</sub>	5.0 mol% O <sub>2</sub>	5.0 mol% O <sub>2</sub>
Ethane	11.0 mol% O <sub>2</sub>	13.3 mol% O <sub>2</sub>	13.3 mol% O <sub>2</sub>
Gasoline	11.8 mol% O <sub>2</sub>	14.5 mol% O <sub>2</sub>	14.5 mol% O <sub>2</sub>
Hexane	12.1 mol% O <sub>2</sub>	14.5 mol% O <sub>2</sub>	14.5 mol% O <sub>2</sub>
Hydrogen	4.8 mol% O <sub>2</sub>	4.8 mol% O <sub>2</sub>	4.8 mol% O <sub>2</sub>
Methane	11.6 mol% O <sub>2</sub>	14.1 mol% O <sub>2</sub>	14.1 mol% O <sub>2</sub>
Pentane	11.8 mol% O <sub>2</sub>	14.4 mol% O <sub>2</sub>	14.4 mol% O <sub>2</sub>
Propane	11.8 mol% O <sub>2</sub>	14.2 mol% O <sub>2</sub>	14.2 mol% O <sub>2</sub>
Propene (Propylene)	11.5 mol% O <sub>2</sub>	14.1 mol% O <sub>2</sub>	14.1 mol% O <sub>2</sub>

#### EXPLOSION PROTECTION MEASURES ACC. TO 2014/34/EU, ANNEX II, 1.0.1

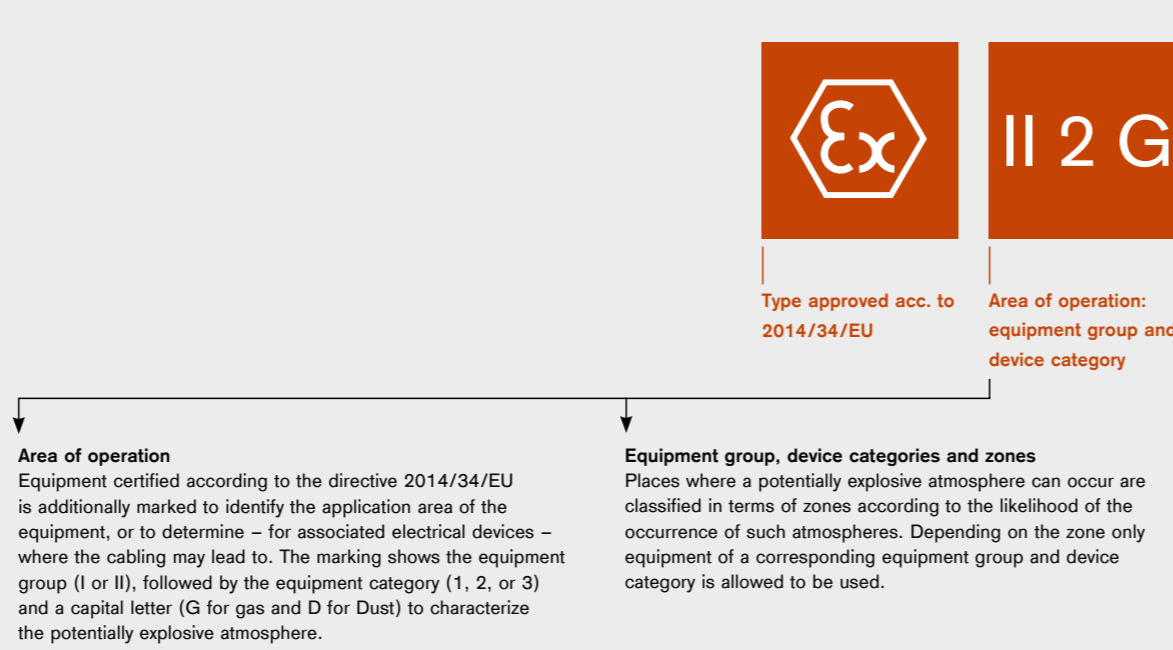
Primary explosion protection	Preventive explosion protection	
	Explosive atmosphere avoided or limited (controlled)	Secondary explosion protection
Concentration < Lower Explosion Limit (LEL)	i	Energy and power limited
Liquids temperature < flash point	d, e	Protected by mechanical construction
O <sub>2</sub> -concentration < Oxygen limit concentration (OLC)	m, o, q	Ex-atmosphere separated
MEASURING FUNCTION FOR EXPLOSION PROTECTION	p	Ex-atmosphere excluded

Measuring function for explosion protection (2014/34/EU, Annex II, 1.5.5)  
Devices for the measurement of gas concentrations lower than the LEL are suitable to activate countermeasures in case of too high concentrations and thus reduce the risk of explosive danger. If used like this, gas detection instruments have to be performance tested and certified by the Notified Body. This is also true for associated devices which are not installed in the hazardous area. The marking of such devices is e.g. II (2) G.

#### HARMONIZED STANDARDS UNDER THE DIRECTIVE 2014/34/EU CONCERNING GAS DETECTION (FURTHER STANDARDS SEE OFFICIAL JOURNAL OF THE EUROPEAN COMMUNITIES):

EN 1127-1	Explosive atmospheres - Explosion protection and prevention - Part 1: Basic concepts and methodology
EN 50 104	Electrical apparatus for the detection and measurement of oxygen - Performance requirements and test methods
EN 50 271	Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen - Requirements and test for apparatus using software and/or digital technologies
EN 60079-29-1	Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases
EN 60079-29-4	Explosive atmospheres - Part 29-4: Gas detectors - Performance requirements of open path detectors for flammable gases
EN 50270	Electromagnetic compatibility - Electrical apparatus for the detection of combustible gases, toxic gases and oxygen

#### MARKING ACCORDING TO 2014/34/EU (ARTICLE 114)



#### CLASSIFICATION OF HAZARDOUS PLACES ACCORDING TO ATEX 137, ANNEX I, 2

Zone	Description
<b>Zone 0</b>	A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is present continuously, or for long periods or frequently.
<b>Zone 1</b>	A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.
<b>Zone 2</b>	A place in which an explosive atmosphere consisting of a mixture with air of flammable substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.
<b>Zone 20</b>	A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is present continuously, or for long periods or frequently.
<b>Zone 21</b>	A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.
<b>Zone 22</b>	A place in which an explosive atmosphere in the form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

#### DEVICE CATEGORY, EQUIPMENT PROTECTION LEVEL AND ZONES

Device category acc. to 2014/34/EU	Equipment Protection acc. to IEC 60079-0	Degree of protection	Use of equipment acc. 1999/92/EC
<b>Gases, vapours and mists</b>			
II 1G	Ga	Very high level of protection, sufficient safety in case of two faults	to be used in zones 0, 1 and 2
II 2G	Gb	High level of protection, sufficient safety to handle frequent device malfunction or one fault	to be used in zones 1 and 2
II 3G	Gc	Normal level of protection, sufficient safety during normal operation	to be used in zone 2 only
<b>Dust</b>			
II 1D	Da	Very high level of protection, sufficient safety in case of two faults	to be used in zones 20, 21 and 22
II 2D	Db	High level of protection, sufficient safety to handle frequent device malfunction or one fault	to be used in zones 21 and 22
II 3D	Dc	Normal level of protection, sufficient safety during normal operation	to be used in zone 22 only
<b>Mining</b>			
I M1	Ma	Very high level of protection and a high degree of safety	Equipment may be kept energised in case of explosion risk
I M2	Mb	High level of protection and a high degree of safety	Equipment must be de-energised in case of explosion risk

#### SAFETY CHARACTERISTICS OF GASES AND VAPOURS (EXTRACT) ACC. TO IEC 60079-20:1-2010

Gas / Vapour	LEL in vol%	LEL in g/m <sup>3</sup>	Flash-point in °C	Vapour pressure at 20 °C in mbar*	Ignition temperature in °C	Gas / Vapour	LEL in vol%	LEL in g/m <sup>3</sup>	Flash-point in °C	Vapour pressure at 20 °C in mbar*	Ignition temperature in °C
Acetone	2.5	60	< -20	246	539	Ethyl acetate	2.0	73	-4	98	470
Acetylene	2.3	24	Gas	305	305	Ethyl benzene	0.8	44	23	10	431
Acrylo nitrile	2.8	64	-5	117	480	Ethylene oxide	2.6	47	Gas	Gas	429
Ammonia	15.0	107	Gas	Gas	630	n-Hexane	1.0	35	-22	160	225
Benzene	1.2	39	-11	100	498	Hydrogen	4.0	3.4	Gas	Gas	560
1,3-Butadiene	1.4	31	Gas	Gas	420	Methane	4.4	29	Gas	Gas	600
n-Butane	1.3	31	Gas	Gas	460	Methanol	6.0	73	9	129	440
n-Butanol	1.4	33	Gas	Gas	372	Methyl chloride	7.6	160	Gas	Gas	826
n-Butyl acetate	1.4	43	35	7	343	Methyl ethyl ketone	1.5	45	-10	105	404
n-Butene	1.8	38	Gas	Gas	345	Methyl methacrylate	1.7	71	10	40	430
n-Butyl acetate	1.2	58	22	11	390	n-Nonane	0.7	37	30	5	205
n-Butyl acrylate	1.2	63	38	5	268	n-Octane	0.8	38	13	14	206
Chlorobenzene	1.3	60	28	12	583	n-Pentane	1.1	33	-40	562	243
Cyclohexane	1.0	35	-17	104	244	Propane	1.7	31	Gas	Gas	450
Cyclopentane	1.4	41	-37	346	320	i-Propanol (IPA)	2.0	50	12	43	399
Diethylether	1.7	50	-45	586	175	Propene (Propylene)	2.0	35	Gas	Gas	455
Dimethylether	2.7	51	Gas	Gas	240	Propylene oxide	1.9	49	-37	588	430
1,4-Dioxane	1.4	51	11	38	375	Styrene	1.0	42	30	7	490
Epichlorohydrin	2.3	86	28	16	385	Tetrahydrofuran	1.5	46	-14	200	230
Ethanol	3.1	59	12	58	400	Toluene	1.0	39	4	29	530
Ethene (Ethylene)	2.3	26	Gas	Gas	440	o-Xylene	1.0	43	30	7	470

\* Flashpoint is only defined for flammable liquids, vapour pressure only reasonable for liquids.



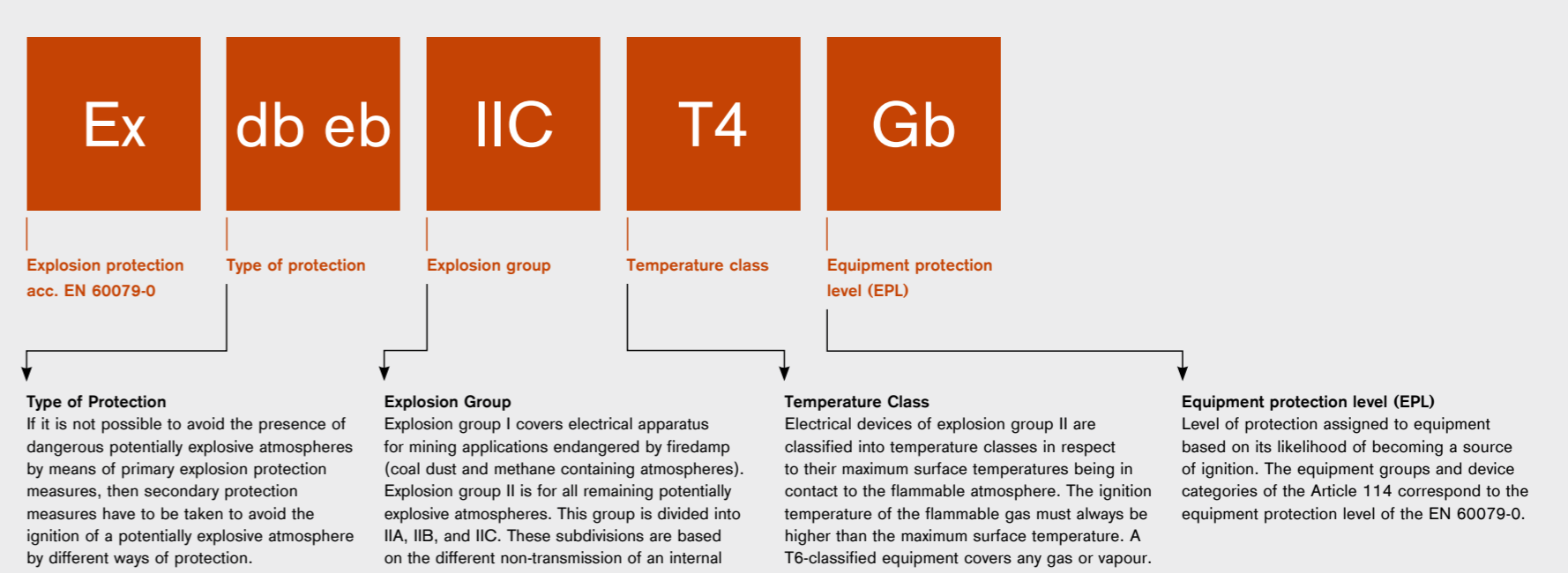
Dräger PIR 7000

Dräger Polytron 7000

Dräger X-amt 8000

Dräger X-zone 5500

#### MARKING ACC. TO EN 60079-0 (GAS EXPLOSION PROTECTION)



#### EXPLOSION GROUP I AND II (GAS)

Marking	Gases and vapours	Allowed equipment
I	Mining (only fire damp, methane)	I
IIA	low ignitability, typical gas: propane	IIA, IIB und IIC
IIB	medium ignitability, typical gas: ethylene	IIB und IIC
IIC	high ignitability, typical gas: hydrogen	IIC only

#### TYPES OF PROTECTION (EXTRACT) AND HARMONIZED STANDARDS

Standard	Type of protection	Marking acc. to Equipment Protection Level (EPL)
IEC/EN 60079-0	General requirements	a = very high protection for Zone 0, 20; b = high protection for Zone 1, 21; c = increased protection for Zone 2, 22
IEC/EN 60079-1	Flameproof enclosure	Ex da
IEC/EN 60079-7	Increased safety	Ex db, Ex dc, Ex eb, Ex ec
IEC/EN 60079-11	Intrinsic safety	Ex ia, Ex ib, Ex ic
IEC/EN 60079-15	Type of protection "n"	Ex nA, Ex nAc*, Ex nB, Ex nC*, Ex nR, Ex nRc*
IEC/EN 60079-18	Encapsulation	Ex ma, Ex mb, Ex mc
IEC/EN 60079-28	Optical radiation	Ex olc
IEC/EN 60079-31	Protection by enclosure	Ex ta, Ex tb, Ex tc

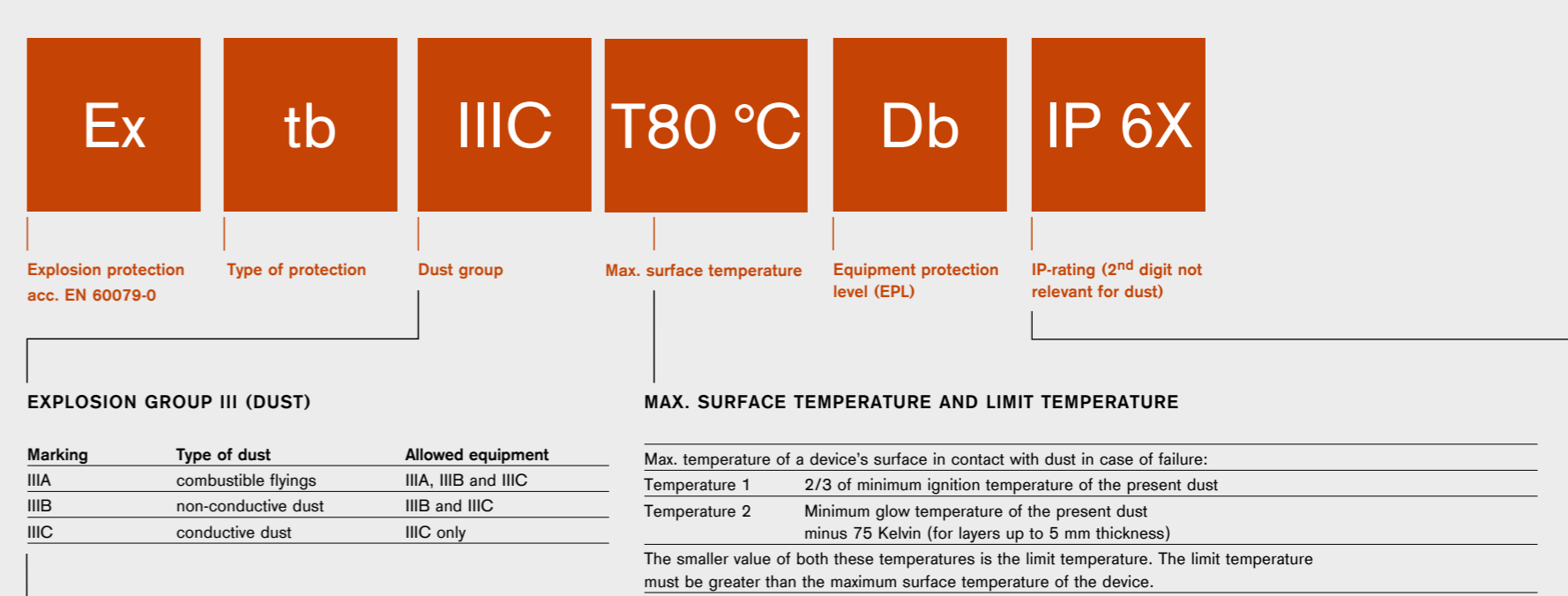
\* the second, alternative marking implies the Equipment Protection Level

**Associated electrical device**  
Associated electrical devices are installed in the safe area, the signal cables however lead into the hazardous area. For devices housing intrinsically safe electrical circuits, the type of protection is marked by using brackets, e.g. II (1) GD [Ex ia] IIC.

#### CLASSIFICATION OF GASES AND VAPOURS

Temperature class and surface temperature of the equipment	Ignition temperature > 450 °C	Explosion group (without explosion group I)		
		IIA	IIB	IIC
T1 (max. 450 °C)	> 450 °C	Acetone 539 °C	Hydrogen cyanide 538 °C	Hydrogen 560 °C
T2 (max. 300 °C)	> 300 ... ≤ 450 °C	Ammonia 630 °C Benzene 498 °C Ethyl acetate 470 °C Methane 600 °C Toluene 530 °C	1,3-Butadiene 420 °C	Acetylene 305 °C
T3 (max. 200 °C)	> 200 ... ≤ 300 °C	n-Butane 372 °C n-Butanol 343 °C n-Butylene 345 °C Methanol 440 °C Propane 450 °C i-Propanol 399 °C Vinyl chloride 415 °C	n-Hexane 226 °C	Acrolein 217 °C
T4 (max. 135 °C)	> 135 ... ≤ 200 °C	n-Heptane 204 °C Hexene 210 °C n-Nonane 205 °C n-Octane 206 °C Triethyl amine 215 °C	Diethyl ether 240 °C Ethyl glycol 235 °C Hydrogen sulfide 260 °C Tetrahydrofuran 230 °C	Diethyl ether 175 °C Propionaldehyde 188 °C
T5 (max. 100 °C)	> 100 ... ≤ 135 °C			
T6 (max. 85 °C)	> 85 ... ≤ 100 °C			Carbon disulfide 90 °C

#### MARKING ACCORDING TO EN 60079-0 (DUST EXPLOSION PROTECTION)



#### SAFETY CHARACTERISTICS OF DUSTS (EXTRACT)

Dust group	Product (Dust)	Lower Explosion Limit	Glow temperature	Ignition temperature	Limit temperature
IIIB	Brown coals	60 g/m <sup>3</sup>	225 °C	380 °C	295 °C
IIIB	Cereals	60 g/m <sup>3</sup>	290 °C	420 °C	215 °C
IIIB	Hard coal	60 g/m <sup>3</sup>	245 °C	590 °C	170 °C
IIIB	Paper	30 g/m <sup>3</sup>	300 °C	540 °C	225 °C
IIIB	Polyvinylchloride	60 g/m <sup>3</sup>	380 °C	530 °C	305 °C
IIIB	Powdered milk	60 g/m <sup>3</sup>	340 °C	440 °C	265 °C
IIIB	Soot	60 g/m <sup>3</sup>	385 °C	620 °C	310 °C
IIIB	Starch	125 g/m <sup>3</sup>	290 °C	440 °C	215 °C
IIIB	Sulphur	30 g/m <sup>3</sup>	290 °C	290 °C	188 °C
IIIB	Wheat flour	125 g/m <sup>3</sup>	450 °C	480 °C	320 °C
IIIC	Wood flour	30 g/m <sup>3</sup>	300 °C	400 °C	225 °C
IIIC	Powdered aluminum	15 g/m <sup>3</sup>	280 °C	530 °C	205 °C
IIIC	Powdered iron	125 g/m <sup>3</sup>	300 °C	310 °C	206 °C
IIIC	Powdered zinc	250 g/m <sup>3</sup>	440 °C	570 °C	365 °C

#### IP-CODE (MARKING NECESSARY FOR APPARATUS IN DUST EX-ATMOSPHERES)

First digit	Second digit
0 no protection	0 no protection
1 Protection against objects > 50 mm	1 Protection against vertically dripping water
2 Protection against objects > 12 mm	2 Protection against 75° to 90° dripping water
3 Protection against objects > 2.5 mm	3 Protection against sprayed water
4 Protection against objects > 1 mm	4 Protection against splashed water
5 dust-protected, necessary for Zone 22	5 Protection against heavy seas
6 dust-tight, necessary for Zone 21	6 Protection against effects of immersion
	8 Protection against indefinite immersion

Example: IP66: Dust-tight and protected against heavy seas

#### CERTIFICATION BY THE NOTIFIED BODY