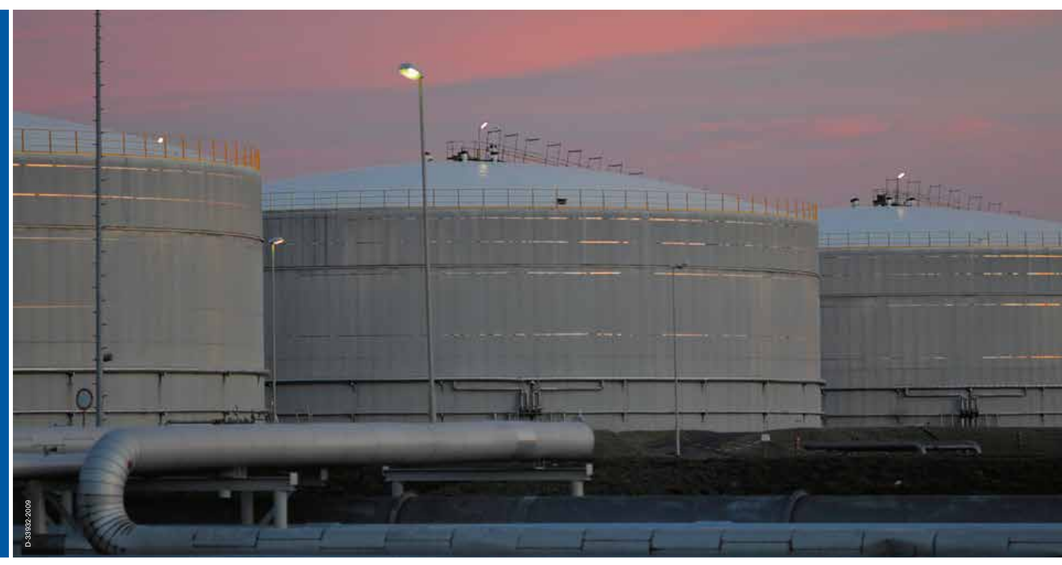
# ATEX

## 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,<br>Flames and hot gases,<br>Mechanically generated sparks,<br>Electrical apparatus,<br>Stray electric currents and cathodic corrosion protection,<br>Static electricity,<br>Lightning,<br>Radio frequencies from 9 kHz to 300 GHz,<br>Electromagnetic waves in the range from 0.1 µm to 1000 µm,<br>Ionizing radiation,<br>Ultrasonics,<br>Adiabatic compression (shock waves),<br>Chemical reaction | Air,<br>Atmospheres containing oxygen concentrations higher than the Oxygen Limit Concentration (OLC)<br><br>Remark:<br>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)

| | Oxygen limit concentration OLC in the total mixture of fuel / air / inert gas | |
|---|---|---|
| Fuel | Inertization with $N_2$ | Inertization with $CO_2$ |
| Benzene | 11.2 mol% $O_2$ | 13.9 mol% $O_2$ |
| 1.3-Butadiene | 10.4 mol% $O_2$ | 13.0 mol% $O_2$ |
| Butane | 12.1 mol% $O_2$ | 14.5 mol% $O_2$ |
| Carbon monoxide | 5.0 mol% $O_2$ | 5.0 mol% $O_2$ |
| Ethane | 11.0 mol% $O_2$ | 13.3 mol% $O_2$ |
| Gasoline | ≈ 11.8 mol% $O_2$ | ≈ 14.5 mol% $O_2$ |
| Hexane | 12.1 mol% $O_2$ | 14.5 mol% $O_2$ |
| Hydrogen | 4.8 mol% $O_2$ | 4.8 mol% $O_2$ |
| Methane | 11.6 mol% $O_2$ | 14.1 mol% $O_2$ |
| Pentane | 11.6 mol% $O_2$ | 14.4 mol% $O_2$ |
| Propane | 11.8 mol% $O_2$ | 14.2 mol% $O_2$ |
| Propene (Propylene) | 11.5 mol% $O_2$ | 14.1 mol% $O_2$ |

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

| Preventive explosion protection | |
|---|---|
| **Primary explosion protection** | **Secondary explosion protection** |
| Explosive atmosphere avoided or limited (controlled) | Explosive atmosphere cannot be ignited |
| Concentration < Lower Explosion Limit (LEL)<br>Liquids: temperature < flash point<br>$O_2$-concentration < Oxygen limit concentration (OLC) | i Energy and power limited<br>d, e Protected by mechanical construction<br>m, o, q Ex-atmosphere separated<br>p Ex-atmosphere excluded |

### MEASURING FUNCTION FOR EXPLOSION PROTECTION

**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)

Type approved acc. to 2014/34/EU

Area of operation: equipment group and device category

**Area of operation**
Equipment certified according to the directive 2014/34/EU is additionally marked to identify the application area of the equipment, or to determine – for associated electrical devices – where the cabling may lead to. The marking shows the equipment group (I or II), followed by the equipment category (1, 2, or 3) and a capital letter (G for gas and D for Dust) to characterize the potentially explosive atmosphere.

**Equipment group, device categories and zones**
Places where a potentially explosive atmosphere can occur are classified in terms of zones according to the likelihood of the occurrence of such atmospheres. Depending on the zone only equipment of a corresponding equipment group and device category is allowed to be used.

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

| | Hazardous places are classified in terms of zones on the basis of the frequency and duration of the occurrence of an explosive atmosphere: |
|---|---|
| **Zone 0** | 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. |
| **Zone 1** | A place in which an explosive atmosphere consisting of a mixture with air or flammable substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally. |
| **Zone 2** | 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. |
| **Zone 20** | 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. |
| **Zone 21** | 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. |
| **Zone 22** | 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 |
|---|---|---|---|
| **Gases, vapours and mists** | | | |
| 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 |
| **Dust** | | | |
| 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 |
| **Mining** | | | |
| 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 |

Type approved acc. 2014/34/EU

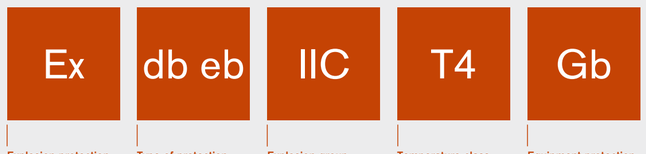
Area of operation: Equipment group and device category

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

| Gas / Vapour | LEL in vol% | LEL in g/m³ | Flash-point* in °C | Vapour pressure at 20 °C in mbar* | Ignition temperature in °C |
|---|---|---|---|---|---|
| Acetone | 2.5 | 60 | < -20 | 246 | 539 |
| Acetylene | 2.3 | 24 | Gas | Gas | 305 |
| Acrylo nitrile | 2.8 | 64 | -5 | 117 | 480 |
| Ammonia | 15.0 | 107 | Gas | Gas | 630 |
| Benzene | 1.2 | 39 | -11 | 100 | 498 |
| 1.3-Butadiene | 1.4 | 31 | Gas | Gas | 420 |
| i-Butane | 1.3 | 31 | Gas | Gas | 460 |
| n-Butane | 1.4 | 33 | Gas | Gas | 372 |
| n-Butene | 1.6 | 38 | Gas | Gas | 345 |
| n-Butyl acetate | 1.2 | 58 | 22 | 11 | 390 |
| n-Butyl acrylate | 1.2 | 63 | 38 | 5 | 268 |
| Chlorobenzene | 1.3 | 60 | 28 | 12 | 593 |
| Cyclohexane | 1.0 | 35 | -17 | 104 | 244 |
| Cyclopentane | 1.4 | 41 | -37 | 346 | 320 |
| Diethylether | 1.7 | 50 | -45 | 586 | 175 |
| Dimethylether | 2.7 | 51 | Gas | Gas | 240 |
| 1.4-Dioxane | 1.4 | 51 | 11 | 38 | 375 |
| Epichlorohydrin | 2.3 | 86 | 28 | 16 | 385 |
| Ethanol | 3.1 | 59 | 12 | 58 | 400 |
| Ethene (Ethylene) | 2.3 | 26 | Gas | Gas | 440 |
| Ethyl acetate | 2.0 | 73 | -4 | 98 | 470 |
| Ethyl benzene | 0.8 | 44 | 23 | 10 | 431 |
| Ethylene oxide | 2.6 | 47 | Gas | Gas | 429 |
| n-Hexane | 1.0 | 35 | -22 | 160 | 225 |
| Hydrogen | 4.0 | 3.4 | Gas | Gas | 560 |
| Methane | 4.4 | 29 | Gas | Gas | 600 |
| Methanol | 6.0 | 73 | 9 | 129 | 440 |
| Methyl chloride | 7.6 | 160 | Gas | Gas | 625 |
| Methylethylketone | 1.5 | 45 | -10 | 105 | 404 |
| Methyl methacrylate | 1.7 | 71 | 10 | 40 | 430 |
| n-Nonane | 0.7 | 37 | 30 | 5 | 205 |
| n-Octane | 0.8 | 38 | 13 | 14 | 206 |
| n-Pentane | 1.1 | 33 | -40 | 562 | 243 |
| Propane | 1.7 | 31 | Gas | Gas | 450 |
| i-Propanol (IPA) | 2.0 | 50 | 12 | 43 | 399 |
| Propene (Propylene) | 2.0 | 35 | Gas | Gas | 455 |
| Propylene oxide | 1.9 | 49 | -37 | 588 | 430 |
| Styrene | 1.0 | 42 | 30 | 7 | 490 |
| Tetrahydrofurane | 1.5 | 46 | -14 | 200 | 230 |
| Toluene | 1.0 | 39 | 4 | 29 | 530 |
| o-Xylene | 1.0 | 43 | 30 | 7 | 470 |

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

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




Explosion protection acc. EN 60079-0 | Type of protection | Explosion group | Temperature class | Equipment protection level (EPL)

**Type of Protection**
If it is not possible to avoid the presence of dangerous potentially explosive atmospheres by means of primary explosion protection measures, then secondary protection measures have to be taken to avoid the ignition of a potentially explosive atmosphere by different ways of protection.

**Explosion Group**
Explosion group I covers electrical apparatus for mining applications endangered by firedamp (coal dust and methane containing atmospheres). Explosion group II is for all remaining potentially explosive atmospheres. This group is divided into IIA, IIB, and IIC. These subdivisions are based on the different non-transmission of an internal ignition and the ignitability of the gases and vapours. A IIC-classified equipment covers any gas or vapour.

**Temperature Class**
Electrical devices of explosion group II are classified into temperature classes in respect to their maximum surface temperatures being in contact to the flammable atmosphere. The ignition temperature of the flammable gas must always be higher than the maximum surface temperature. A T6-classified equipment covers any gas or vapour.

**Equipment protection level (EPL)**
Level of protection assigned to equipment based on its likelihood of becoming a source of ignition. The equipment groups and device categories of the Article 114 correspond to the equipment protection level of the EN 60079-0.

### 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

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

| | | Explosion group (without explosion group I) | | |
|---|---|---|---|---|
| | | IIA | IIB | IIC |
| **Temperature class** and surface temperature of the equipment | **Ignition temperature** of gas or vapour | Gases and vapours with low ignitability | Gases and vapours with medium ignitability | Gases and vapours with high ignitability |
| T1 (max. 450 °C) | > 450 °C | Acetone 539 °C | Hydrogen cyanide 538 °C | Hydrogen 560 °C |
| | | Ammonia 630 °C | | |
| | | Benzene 498 °C | | |
| | | Ethyl acetate 470 °C | | |
| | | Methane 600 °C | | |
| | | Toluene 530 °C | | |
| T2 (max. 300 °C) | > 300 ... ≤ 450 °C | n-Butane 372 °C | 1.3-Butadiene 420 °C | Acetylene 305 °C |
| | | n-Butanol 343 °C | 1.4-Dioxane 375 °C | |
| | | n-Butylene 345 °C | Ethylene 440 °C | |
| | | Methanol 440 °C | Ethyleneoxide 429 °C | |
| | | Propane 450 °C | | |
| | | i-Propanol 399 °C | | |
| | | Vinyl chloride 415 °C | | |
| T3 (max. 200 °C) | > 200 ... ≤ 300 °C | n-Hexane 225 °C | Acrolein 217 °C | |
| | | n-Heptane 204 °C | Dimethyl ether 240 °C | |
| | | Kerosene 210 °C | Ethyl glycol 235 °C | |
| | | n-Nonane 205 °C | Hydrogen sulfide 260 °C | |
| | | n-Octane 206 °C | | |
| | | Triethyl amine 215 °C | Tetrahydrofurane 230 °C | |
| T4 (max. 135 °C) | > 135 ... ≤ 200 °C | Acetaldehyde 155 °C | Diethyl ether 175 °C | |
| | | Trimethyl amine 190 °C | Dimethyl glycol 197 °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)

Explosion protection acc. EN 60079-0 | Type of protection | Dust group | Max. surface temperature | Equipment protection level (EPL) | IP-rating (2nd digit not relevant for dust)

### EXPLOSION GROUP III (DUST)

| Marking | Type of dust | Allowed equipment |
|---|---|---|
| IIIA | combustible flyings | IIIA, IIIB and IIIC |
| IIIB | non-conductive dust | IIIB and IIIC |
| IIIC | conductive dust | IIIC only |

### MAX. SURFACE TEMPERATURE AND LIMIT TEMPERATURE

| Max. temperature of a device's surface in contact with dust in case of failure: | |
|---|---|
| Temperature 1 | 2/3 of minimum ignition temperature of the present dust |
| Temperature 2 | Minimum glow temperature of the present dust minus 75 Kelvin (for layers up to 5 mm thickness) |

The smaller value of both these temperatures is the limit temperature. The limit temperature must be greater than the maximum surface temperature of the device.

### SAFETY CHARACTERISTICS OF DUSTS (EXTRACT)

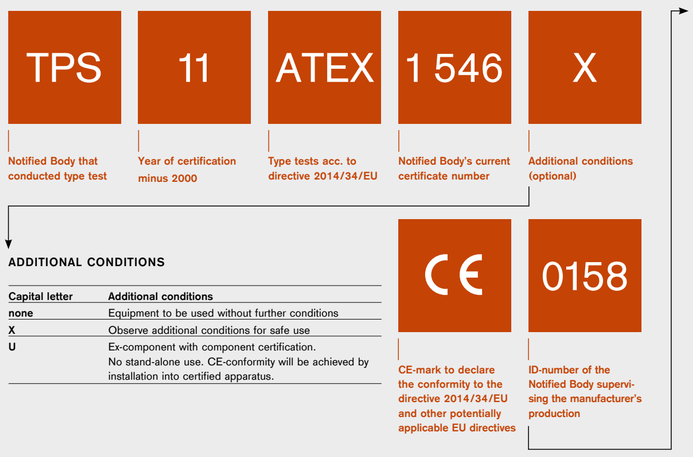
| Dust group | Product (Dust) | Lower Explosion Limit | Glow temperature | Ignition temperature | Limit temperature |
|---|---|---|---|---|---|
| IIIB | Brown coale | 60 g/m³ | 225 °C | 380 °C | 295 °C |
| IIIB | Cereals | 60 g/m³ | 290 °C | 420 °C | 215 °C |
| IIIB | Hard coal | 60 g/m³ | 245 °C | 590 °C | 170 °C |
| IIIB | Paper | 30 g/m³ | 300 °C | 540 °C | 225 °C |
| IIIB | Powdered milk | 60 g/m³ | 340 °C | 440 °C | 265 °C |
| IIIB | Soot | 60 g/m³ | 385 °C | 620 °C | 310 °C |
| IIIB | Starch | 125 g/m³ | 290 °C | 440 °C | 215 °C |
| IIIB | Sulphur | 30 g/m³ | 280 °C | 280 °C | 186 °C |
| IIIB | Wheat flour | 125 g/m³ | 450 °C | 480 °C | 320 °C |
| IIIB | Wood flour | 30 g/m³ | 300 °C | 400 °C | 225 °C |
| IIIC | Powdered aluminum | 15 g/m³ | 280 °C | 530 °C | 205 °C |
| IIIC | Powdered iron | 125 g/m³ | 300 °C | 310 °C | 206 °C |
| IIIC | Powdered zinc | 250 g/m³ | 440 °C | 570 °C | 365 °C |
| IIIB | Polyvinylchloride | 60 g/m³ | 380 °C | 530 °C | 305 °C |

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

| First digit | Second digit |
|---|---|
| Protection against solid bodies | Protection against liquids |
| 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 water jets |
| 6 dust-tight, necessary for Zone 21 | 6 Protection against heavy seas |
| | 7 Protection against effects of immersion |
| | 8 Protection against indefinite immersion |

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

### CERTIFICATION BY THE NOTIFIED BODY




Notified Body that conducted type test | Year of certification minus 2000 | Type tests acc. to directive 2014/34/EU | Notified Body's current certificate number | Additional conditions (optional)

CE-mark to declare the conformity to the directive 2014/34/EU and other potentially applicable EU directives | ID-number of the Notified Body supervising the manufacturer's production

### ADDITIONAL CONDITIONS

| Capital letter | Additional conditions |
|---|---|
| none | Equipment to be used without further conditions |
| X | Observe additional conditions for safe use |
| U | Ex-component with component certification. No stand-alone use. CE-conformity will be achieved by installation into certified apparatus. |

### NOTIFIED BODIES IN EUROPE AND IDENTIFICATION NUMBER (EXTRACT)

| ID-number | Notified Body | Country |
|---|---|---|
| 0080 | INERIS | France |
| 0081 | LCIE | France |
| 0102 | PTB | Germany |
| 0123 | TPS (TÜV Süd Product Service) | Germany |
| 0158 | DEKRA EXAM | Germany |
| 0163 | LOM | Spain |
| 0344 | DEKRA (KEMA) | Netherlands |
| 0402 | SP | Sweden |
| 0408 | TÜV-A | Austria |
| 0470 | NEMKO | Norway |
| 0492 | ISSeP | Belgium |
| 0499 | SNCH | Luxemburg |
| 0518 | SCS (Sira Certification Service) | United Kingdom |
| 0539 | DEMKO | Denmark |
| 0589 | BAM | Germany |
| 0637 | IBExU | Germany |
| 0722 | CESI | Italy |
| 1180 | Baseefa | United Kingdom |

**Dräger PIR 7000**

**Dräger Polytron® 7000**

**Dräger X-am® 8000**

**Dräger X-zone® 5500**

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