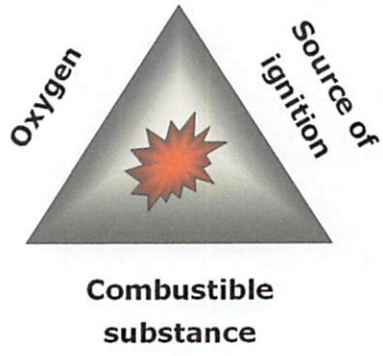
Principles for explosion protection

Development of an explosive atmosphere

An explosion is a rapid expansion of gasses as a consequence of a chemical reaction. It occurs when the heat developed in an exothermic reaction cannot be carried off fast enough and thus the speed of reaction is further increased. In order for this reaction to be possible, three parameters are required.
As a basis, a combustible substance must be present. This substance must combine with the oxidation agent oxygen (generally obtained from the ambient air) in the appropriate ratio to form a combustible mixture. In order for the explosion reaction to start, an appropriate source of energy in the form of a spark, a fire, or a hot surface must additionally be present.



Effects of an explosion

In an explosion, at first a pressure wave is generated, followed by a heat wave that causes further destruction. In the same way as in a chain reaction, the explosion may propagate. Due to combustion of mostly chemical substances, toxic vapours and smoke are generated that both have a lasting damaging/polluting effect on the environment.
Mine disasters in China, the dust explosion at Roland Mills in Bremen, the explosion on the oil rig Piper Alpha off the British coast or the explosion at a pipeline in Nigeria each are repeated demonstrative examples of the devastating effects an explosion may have.

Legal foundations

By issuing the Directives 2014/34/EU and 1999/92/EC, the European Union created the basis for standardised explosion protection within Europe.
While Directive 1999/92/EC (users' directive) regulates operational safety, including all tools and devices for operation in systems with potentially explosive areas, Directive 2014/34/EU governs manufacturing of devices and protective systems for potentially explosive atmospheres. Interpretation of these directives is described by the standards listed below:

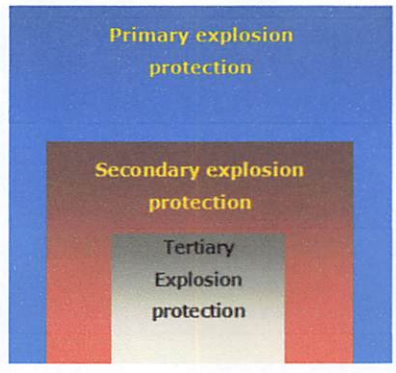
Norm	Titel
EN 1127-1	Explosion prevention and protection. Part 1 Basic concepts and methodology
EN 1127-2	Explosion prevention and protection. Part 1 Basic concepts and methodology for mining
EN 13237	Concepts for equipment and protective systems in potentially explosive atmospheres
EN ISO 80079	Group of standards on non-electrical equipment for use in potentially explosive atmospheres
EN 60079-ff	Electrical apparatus for use in explosive gas and dust atmospheres
EN 14797	Explosion venting devices

National law

These directives have been implemented by the legislature of the individual member states by means of corresponding legal provisions and regulations. In Germany, these directives have been implemented by the safe working act (BetrSichV) as well as the hazardous material act (GefStroffV) (based on operational safety regulation, 1999/92/EC) and the product safety act (ProdSG) (based on Explosion protection regulation, (2014/34/EU), these all are interpreted in detail by rules by the technical rules (e.g. TRBS, TRF, TRGS,...). There is also a collection of explosions protection rules by the employers mutual insurance association (EX-RL DGUV Regel 113-001) and by rules by the VDI (the association of german engineers) (e.g. VDI 2263).

The operational safety regulation

Among other things, the operational safety regulation obligates employers to document their monitoring systems used in potentially explosive atmospheres in an explosion protection document. In order to be able to efficiently implement explosion protection, it is required for employers to be familiar with their plants and systems and to be able to correctly evaluate, assess and document the hazard potential of such plants and systems in the sense of explosion protection. A methodical approach to explosion protection is to first analyse the substances, their distribution and the probability of their occurrence. If, on the basis of this analysis a potentially explosive atmosphere may occur, appropriate measures for prevention of development of such an atmosphere, measures for prevention of effective sources of ignition and any required constructional measures for prevention of the destructive effects of an explosion must be taken.



Another result of this analysis is the zone plan including an exact classification of potentially explosive sections or areas of the plant according to frequency and duration of occurrence. This zone plan must be included in the explosion protection document and is used by the operator as a basis for assessment of the safety situation in the areas in which the tools and devices are used. The standards EN 60079-10 for explosive gas atmospheres and for explosive atmospheres with presence of combustible dust helps in creation of the zone plan.

Ex-Zone	Probability of occurrence
Zone 0/20	Permanently, frequently or over a long period
Zone 1/21	Occasionally during normal operation
Zone 2/22	Only temporarily, not in normal operation

In addition to the description of substance-relevant data and their probability of occurrence within the zone plan, the explosion protection document must also include all measures for prevention of ignition sources, constructional measures for explosion protection, and finally also commissioning and maintenance of the plant or system.

The operational safety regulation (annex 3) also regulates which categories of tools and devices may be installed in which zone.

Zone	0	1	2	20	21	22*
Device category	1G	2G	3G	1D	2D	3D

* Special requirements In areas with conductive dust in zone 22 must be observed!

Principles for explosion protection

The explosion protection regulation

The explosion protection regulation (11. ProdSV) is the national implementation of Directive 2014/34/EU in Germany and regulates the distribution of devices and protection systems for potentially explosive atmospheres. In this way a consistent basis for assessment has been created by this directive, in order to eliminate trade limitations between the countries of the European Union.

Ignition protection types

For manufacturers of devices for use in potentially explosive atmospheres, the series of harmonised standards EN 60079-, EN 61241- and EN 13463- are the works to be observed for design and construction. Consequently the manufacturers are provided with a large range of possibilities to find the ideal and most efficient solution for themselves and the special requirements with regard to design and field of application. In many cases the types of ignition protection are combined. For example, a flameproof housing with a wiring space with increased safety is marked as "Ex de". A junction box may be marked with Ex e for explosive gas atmospheres or with Ex t for atmospheres with combustible dust.
For a detailed explanation on marking of electrical apparatus, please see the enclosed Exepd poster.
Example marking of non-electrical devices e.g. Ex h IIB T4 Gb.

Short designation	Standard No.	Description
Ignition protection types for electrical apparatus used in explosive gas atmospheres		
Ex d	60079-1	Flameproof enclosure
Ex p	60079-2	Pressurised enclosure
Ex q	60079-5	Powder filling
Ex o	60079-6	Oil immersion
Ex e	60079-7	Increased safety
Ex i	60079-11	Intrinsic safety
Ex n	60079-15	Zone 2 apparatus
Ex m	60079-18	Encapsulation
Ignition protection types for electrical apparatus used in atmospheres with combustible dust		
Ex t	60079-31	Protection by enclosure
Ex p	60079-2	Pressurised enclosure
Ex i	60079-11	Intrinsic safety
Ex m	60079-18	Encapsulation
Ignition protection types for non-electrical apparatus		
80079-36		General requirements
80079-37		Protection types

Quality assurance

In Directive 201/34/EU continuos monitoring of production is required. For devices and components of category 1 and 2, the quality assurance system must be approved by a notified body. Any such devices and components are additionally identified by the CE mark, including the number of the notified body.

CE Mark

The manufacturer confirms compliance with the applied directives by attaching the CE mark to their devices and by providing the appertaining declaration of conformity.