

EXPLOSION PROTECTION ACCORDING TO EUROPEAN STANDARD (ATEX)

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- Basics (physical, chemical)
- Explosion protection for manufacturer
- Explosion protection for operator



What is an explosion?

- **Oxidation reaction** with a **sudden rise of temperature and/or pressure**

Results:

- sudden volume expansion
- release of large amount of energy



<https://www.youtube.com/watch?v=Qb7sKEFreaE>



Requirements for an explosion?

Flammable substance

Gases

Liquids

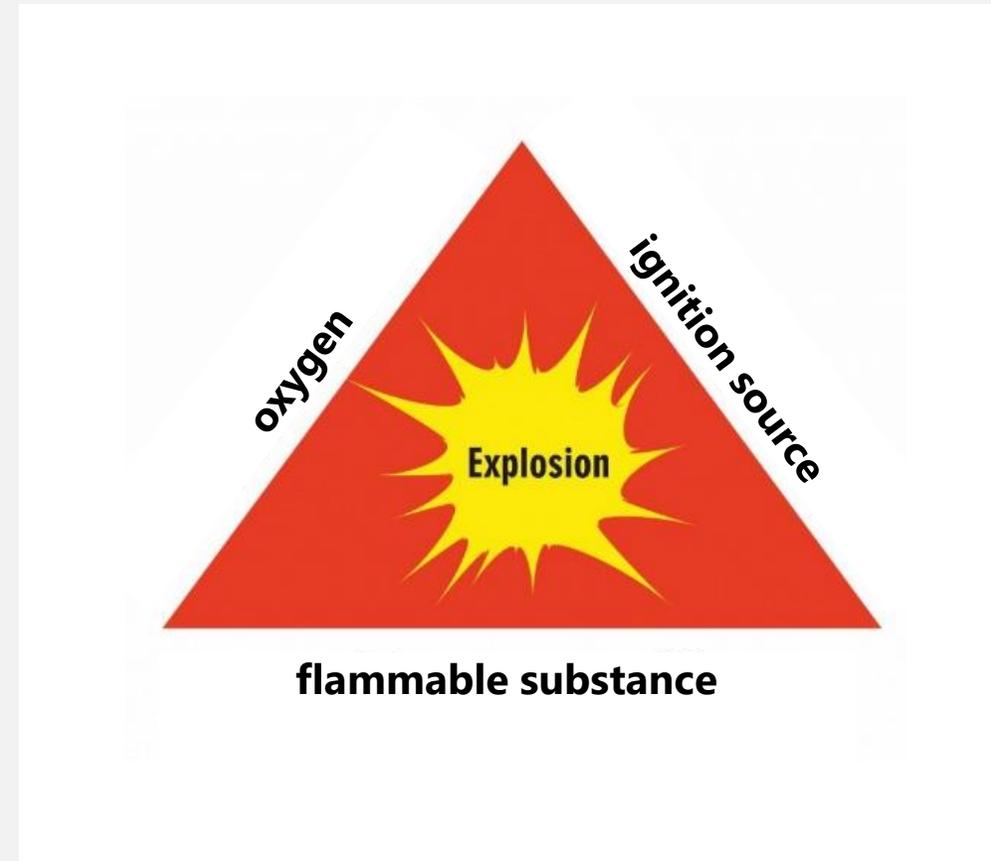
- with flash point below operating temperature
- when sprayed

Solids in shape of powders, filaments

Differentiation Gas (G) and Dust (D)

Oxygen

Ignition source



➤ Hazardous explosive mixtures (gases)

- 1 L liquid propane gas (C₃H₈)
- \cong 580 g
- \cong 295 L gaseous propane
- \cong 17.353 L of hazardous explosive mixture
- concentration of 1,7 Vol.-% (LEL)
- LEL = lower explosion limit



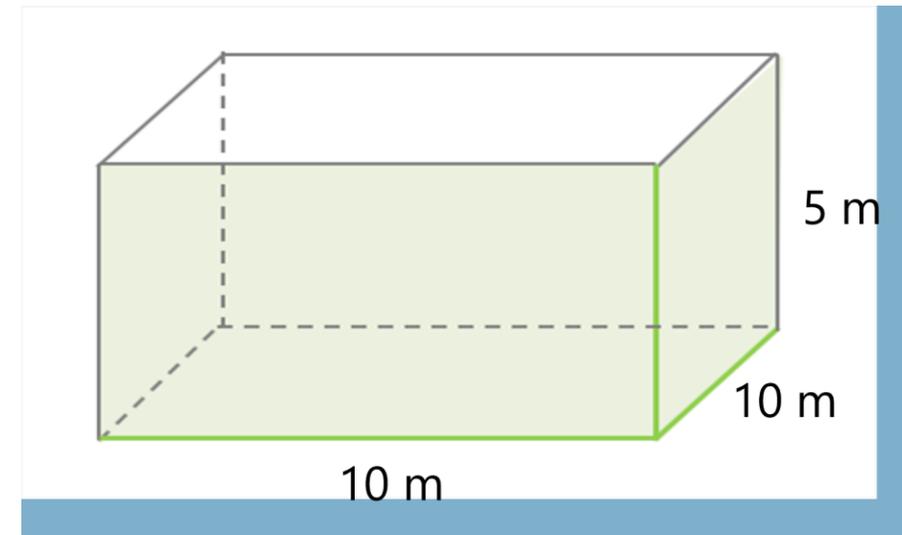
➤ Hazardous explosive mixtures (liquids)

- 7 ml of gasoline (Benzin)
- approx. 1,6 L gasoline vapour
- approx. 200 L of dangerous explosive mixture
- concentration of to 0,6 Vol.% (LEL)



➤ Hazardous explosive mixtures (dust)

- A room of 100 m² with a height of 5 m
- Floor with a 1 mm layer of flour
- LEL of 100 g/m³
- In case of swirling up the whole room is filled with dangerous explosive dust mixture



Oxygen

- Normal atmospheric conditions
- Approx. 21 Vol.-%





Ignition sources

Potential ignition sources according EN 1127-1

1	Hot surfaces	Moving/rotating parts, friction
2	Flames and hot gases	Hot process air
3	Mechanically generated sparks	Moving/rotating parts, friction, impact sparks
4	Electrical systems	Electrical components
5	Electrical equalizing currents	Electrical components
6	Static electricity	Charging of components and product

7	Lightning strike	No outdoor installation
8	Electromagnetic waves(< 3 x 10 ¹¹ Hz)	high frequency, microwaves
9	Electromagnetic waves(> 3 x 10 ¹¹ Hz)	microwaves, optical radiation
10	Ionizing radiation	radioactivity
11	Ultrasonic	
12	Adiabatic compression and shock waves	e.g. Combustion in motors
13	Exothermic reactions, spontaneous combustion	Chemical reactions



Static electricity

- Special ignition source
- Can be caused by the product itself
- General measure is earthing / potential equalisation

TRGS 727

	Type of discharge	Relevance	Extra measure
1	Spark discharge	Gases, vapour, mists, dust	-
2	Corona discharge	Gases, vapour, mists	-
3	Brush discharge	Gases, vapour, mists	Minimize non-conductive surfaces
4	Propagating brush discharge	Gases, vapour, mists, dust	Avoidance of thin insulating layers and coatings or disruptive voltage < 4 kV
5	Thunderbolt-like discharge	-	-
6	Bulk cone discharge	Gases, vapour, mists, dust	If needed technical measures (pressure resistance, pressure relief, inertisation, ...)



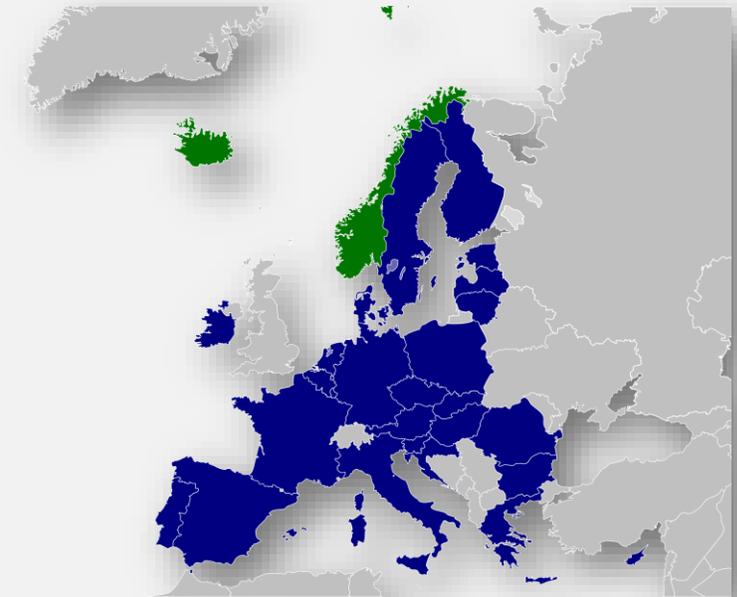
[ISSA 35]

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ATEX = **A**Tmosphères **E**Xplosibles

- Two directives in the EU
 - 1999/92/EG for operator
 - 2014/34/EU for manufacturer
- Transferred into national law
 - eg. in Germany:
 - 1999/92/EG >>> Hazardous Substances Ordinance (GefStoffV)
 - 2014/34/EU >>> Explosion Protection Product Ordinance (11. ProdSV)



2014/34/EU ATEX product directive

- For manufactures only!
- Defines levels of safety
- Defines who is allowed to certified conformity
- List of types of protection
- Links to a list of harmonized EU standards
- Classification of equipment

Goals:

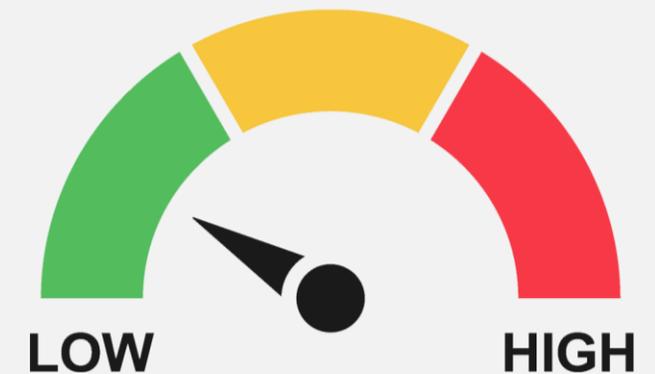
- Safe equipment for use in hazardous explosive areas
- Defined intended use of equipment





Levels of safety

Category	Level of safety	for Zone	EPL*
3	normal (predictable faults)	2 / 22	c
2	high (3 + frequent / expected faults)	1 / 21	b
1	very high (2 + seldom faults / two simultaneous faults)	0 / 20	a



* from ISO and IEC standards



Conformity assessment

Category	Product	Modules of conformity assessment		
3 (c)	All	A - Internal production control		-
2 (b)	Misc.	A - Internal production control	+	Deposit of technical documentation
	Combustion engines and electrical equipment	B - EU-type examination	+	C1 - type based on internal production control plus supervised product testing OR E - type based on product quality assurance
1 (a)	All	B - EU-type examination	+	D - type based on quality assurance of the production process OR F - type based on product verification
(EPL)	Alternative: Individual examination by a notified body (TÜV, DEKRA, ...)			



EU-type examination



Translation

EC-Type Examination Certificate

- (1) Equipment and protective systems intended for use in potentially explosive atmospheres - Directive 94/9/EC
- (2) No. of EC-Type Examination Certificate: **BVS 14 ATEX E 057 X**
- (3) Equipment: **Sensor type FLP**-***AE**
- (4) Manufacturer: **TST electronics GmbH**
- (5) Address: **Berliner Strasse 42, 58135 Hagen, Germany**
- (6) The design and construction of this equipment and any acceptable variation thereto are specified in the appendix to this type examination certificate.
- (7) The certification body of DEKRA EXAM GmbH, notified body no. 0158 in accordance with Article 9 of the Directive 94/9/EC of the European Parliament and the Council of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive. The examination and test results are recorded in the test and assessment report BVS PP 14.2127 EG.
- (8) The Essential Health and Safety Requirements are assured by compliance with:
 - EN 60079-0:2012 **General requirements**
 - EN 60079-11:2012 **Intrinsic Safety**
 - EN 60079-26:2007 **Equipment with EPL Ga**

- (10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the appendix to this certificate.
- (11) This EC-Type Examination Certificate relates only to the design, examination and tests of the specified equipment in accordance to Directive 94/9/EC. Further requirements of the Directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.
- (12) The marking of the equipment shall include the following:

Ex II 1/2G Ex ia IIB T4 Ga/Gb

DEKRA EXAM GmbH
Bochum, dated 6th June 2014

Signed: Simanski

Certification body

Signed: Dr. Eickhoff

Special services unit

Page 1 of 3 to BVS 14 ATEX E 057 X
This certificate may only be reproduced in its entirety and without change.
DEKRA EXAM GmbH Dinnendahlstrasse 9 44809 Bochum Phone +49.234.3696-105 Fax +49.234.3696-110 zs-exam@dekra.com



Types of protection



10 for electrical equipment

e Increased safety

d flameproof enclosures

i intrinsic safety

...

6 for non-electrical equipment

h construtlional safety

h control of ignition sources

h flameproof enclosures

...

Types of protection for electrical equipment in explosive atmospheres					
Type of protection	Symbol	Zone	Diagram	Main application	Standard
general requirements					IEC 60079-0 EN 60079-0 UL 60079-0
increased safety	e, eb ec	1 2		terminal and junction boxes, control stations for installing Ex components (with a different type of protection), squirrel-cage motors, light fittings	IEC 60079-7 EN 60079-7 UL 60079-7
flameproof enclosures	da d, db dc	0 1 2		switchgears, control stations, indicating equipment, control systems, motors, transformers, heating equipment, light fittings	IEC 60079-1 EN 60079-1 UL 60079-1
pressurized enclosure	px, pxb py, pyb pz, pzc	1 21 1 21 2 22		switchgear and control cabinets, analysers, large motors <i>old identification for dust pD21, pD22</i>	IEC 60079-2 EN 60079-2 UL 60079-2
intrinsic safety	ia ib ic	0 20 1 21 2 22		instrumentation technology, fieldbus technology, sensors, actuators [Ex ib] = associated electrical apparatus – installation in the safe area <i>old identification for dust: iaD = for use in Zone 20, 21, 22 ibD = for use in Zone 21, 22</i>	IEC 60079-11 EN 60079-11 UL 60079-11
				intrinsically safe systems	IEC 60079-25 EN 60079-25 UL 60079-25
liquid immersion	o, ob oc	1 2		transformers, starting resistors	IEC 60079-6 EN 60079-6 UL 60079-6
				powder filling	q, qb
encapsulation	ma mb mc	0 20 1 21 2 22		switchgear with small capacity, control and signalling units, display units, sensors <i>old identification for dust: maD = for use in Zone 20, 21, 22 mbD = for use in Zone 21, 22</i>	IEC 60079-18 EN 60079-18 UL 60079-18
type of protection "n"	nA, nAc nC, nCc nR, nRc	2 2 2		all electrical equipment for Zone 2 nA = non-sparking devices nC = sparking devices and components nR = restricted breathing enclosures	IEC 60079-15 EN 60079-15 UL 60079-15
optical radiation	op_ op_ op_	0 20 1 21 2 22		op is = inherently safe optical radiation op pr = protected optical radiation op sh = optical radiation interlock	IEC 60079-28 EN 60079-28
protection by enclosure	ta tb tc	20 21 22		switchgear, control stations, junction boxes, control boxes, motors, light fittings <i>old identification: tD A21 = under procedure A for Zone 21 tD B21 = under procedure B for Zone 21</i>	IEC 60079-31 EN 60079-31 UL 60079-31 IEC 61241-1 EN 61241-1 ISA 61241-1

Types of protection for non-electrical equipment in explosive atmospheres			
Type of protection	Diagram	Main application	Standard
basic methods and requirements			ISO 80079-36 EN ISO 80079-36
constructional safety "c"	h	couplings, pumps, gear drives, chain drives, belt drives <i>old marking according to EN 13463-5: c</i>	ISO 80079-37 EN ISO 80079-37
control of ignition sources "b"	h	pumps, belt drives <i>old marking according to EN 13463-6: b</i>	ISO 80079-37 EN ISO 80079-37
liquid immersion "k"	h	submerged pumps, gears <i>old marking according to EN 13463-8: k</i>	ISO 80079-37 EN ISO 80079-37
flameproof enclosures "d"	h	brakes, couplings <i>old marking according to EN 13463-3: d</i>	IEC 60079-1 EN 60079-1
protection by enclosure "t"	h	equipment for explosive dust atmospheres	IEC 60079-31 EN 60079-31
pressurized enclosure "p"	h	pumps	IEC 60079-2 EN 60079-2



Explosion groups

- I Mining only
- II Gases, vapours and mists
- IIA high ignition energy needed**
- IIB medium ignition energy**
- IIC low ignition energy, most critical**
- III Lint, fibers, dust
- IIIA flammable lint and fiber**
- IIIB non-conductive dust**
- IIIC conductive dust (metal dust)**

IIA	Isopropyl alcohol
IIB	Ethanol
IIC	hydrogen



Temperature classes

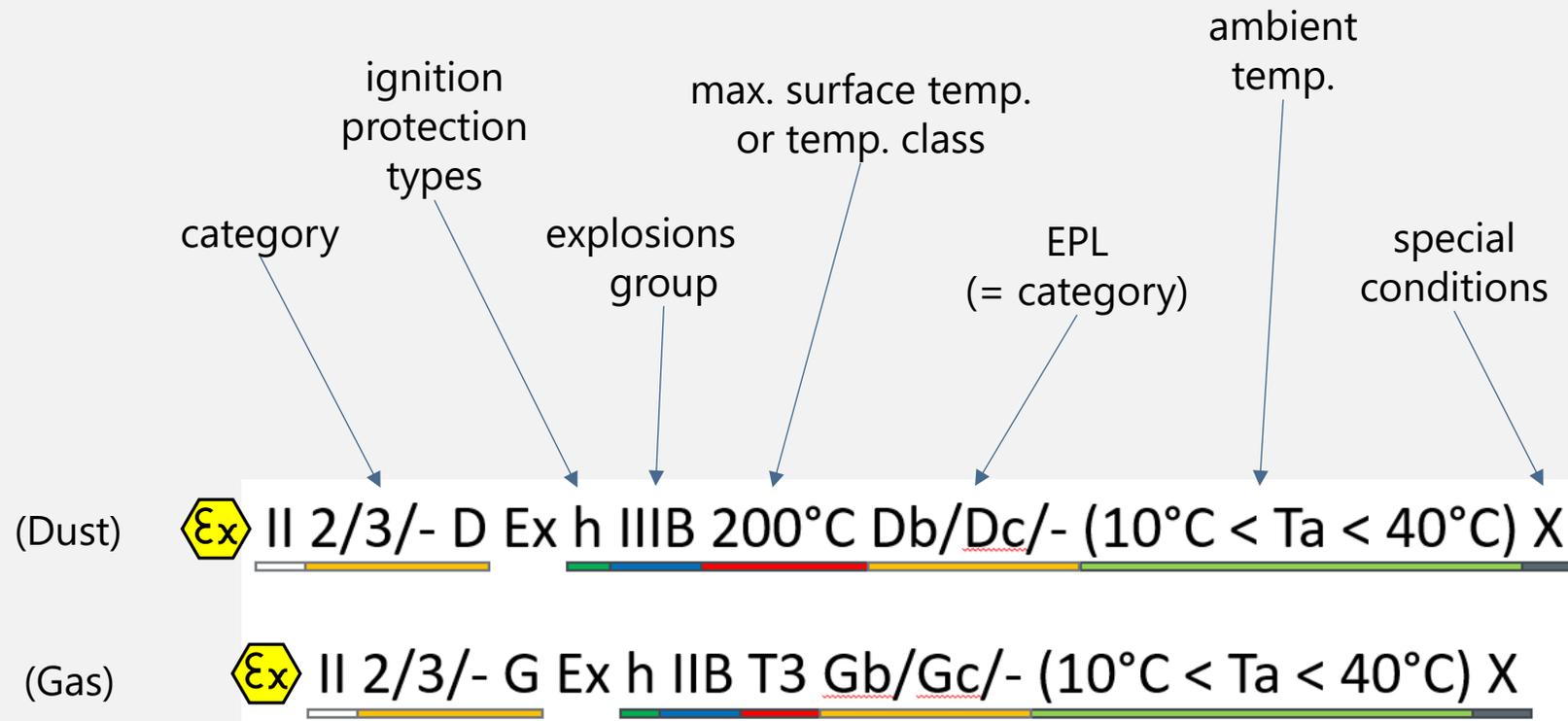
	Max. surface temp.
T1	450 °C
T2	300 °C
T3	200 °C
T4	135 °C
T5	100 °C
T6	85 °C

- Gases and liquids assigned to temperature classes T1...T6
- Direct max. surface temperature for solids (dust, powder, ...)
- Safety distance acc. level of safety

Category	G	D
3	100 %	66 %
2	80 %	66 %
1	80 %	66 %



Product classification



1999/92/EG ATEX operator directive

- Explosion protection assessment
- Zoning
- Explosion protection document





Explosion protection assessment

Operator must evaluate the risk of explosion

- What kind of substances are processed?
- Does their amounts or concentrations lead to explosion hazards? How is the production process running?
- What equipment is used for the process?
- Frequency and duration of hazardous explosive mixtures?
- Which ignition sources might occur?
- What would be the impacts of an explosion?

Goal: acceptable residual risk with regard to personnel and material assets



Zones

3 grades regarding frequency and duration of occurrence of hazardous explosive atmosphere

zones G / D

Continuously, for long periods or frequently

→ 0 / 20

- Normally inside plant only
- During normal operation
- Concentration above 50% LEL
- Dusty processes (mixing, FBD)

Occasionally

→ 1 / 21

- Neighbouring areas to zone 0/20
- Openings to zone 0/20
- Frequently dust deposits (not removed immediately)

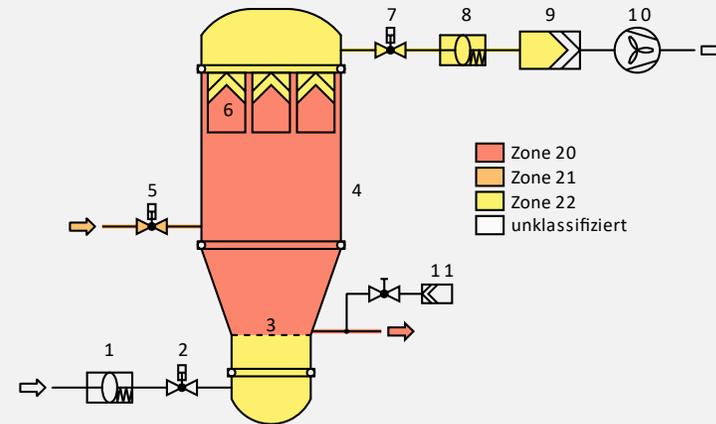
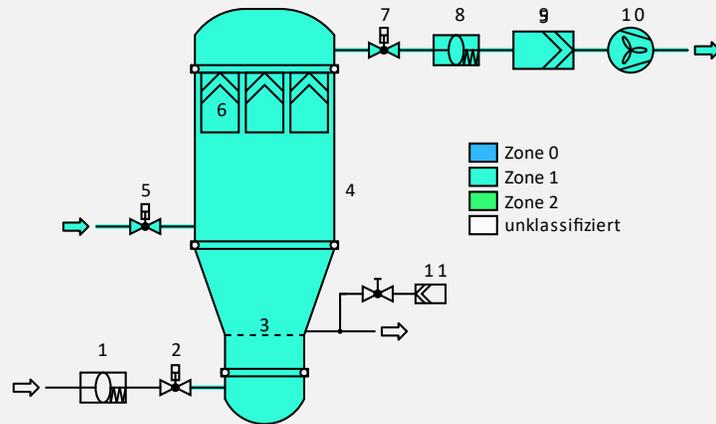
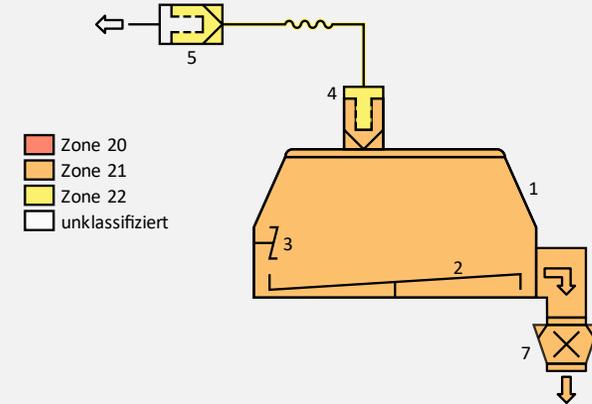
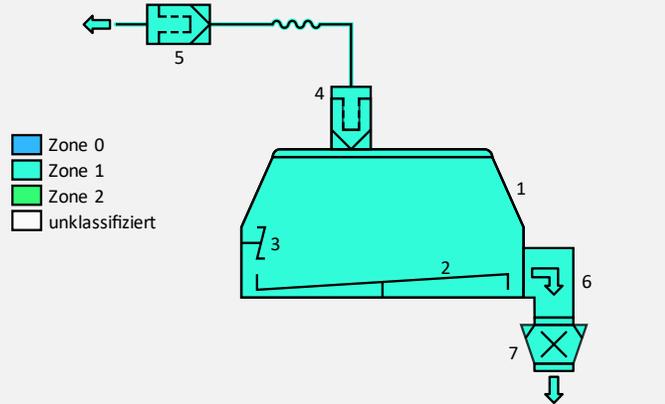
Seldom (normally not, but if short time only)

→ 2 / 22

- Neighbouring areas to zone 1/21
- Concentration below 25% LEL
- Occasionally thin dust layers that (not removed immediately)

Zones can be limited even within room

Zone plans





Explosion protection document

- According to ATEX operator directive
- legally bound to create a comprehensive documentation
- General information (company, location, responsible person)
- Basis and Result from the explosion protection assessment
- Zoning
- Organizational measure (training, SOPs, etc.)
- Technical measures (pressure shock resistance, inertisation, etc.)
- Inspection and maintenance plan



Inspections

- Equipments acc. ATEX are subject to official inspection intervals
- Regulated by local law
- Additional to inspections acc. operating manual
- Check of documentation
- DE:
- Specially trained personnel only
- Before start-up, after repair, on authority request
- Interval 1 ... 6 years



Further information sources

DGVU (German Social Accident Insurance)

DGVU 213-106 Explosionsschutzdokument*

BG RCI (Insurance for mining, chemistry and)

Explosionsschutzdokument (examples, checklist)*

EX-RL – examples for zoning*

ISSA (International Social Security Association)

ISSA Guide for Risk Assessment - Hazards arising from Explosions

TRGS (Technical rules for hazardous substances)

TRGS Brand- und Explosionsschutz (State of the art)*

* Documents in german only

THANK YOU FOR
YOUR ATTENTION!

Christian Koring, DIOSNA