Requirements on valves for combustible gases in accordance with ATEX 100a

EU Directive 94/9/EC came into force on July 1, 2003 and specifies new requirements to be applicable for valves and their electrical components when they are to be used for combustible gases. The various sub-zones of explosion-endangered areas are to be defined for this purpose in the context of a formal appraisal as a function of release source, degree of ventilation and availability. Flange gaskets, shaft sealing rings and stuffing-box packings constitute secondary release sources which must be taken into account in classification of the various zones.
The electrical equipment for Zone 2 must be produced and tested on the manufacturer's responsibility and must for flameproof enclosure type "n" fulfil the requirements of Directive 94/9/EC for Category 113G; they are to be marked with the symbol. The manufacturer is required to certify conformity.
System and plant engineers, and the operators of combustion systems, will in future need to consider during the planning and basic engineering stages which of the two options, investment in ventilation systems or investment in equipment in conformity with 94/9/EC, is the more cost-effective solution.

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EU Directive 94/9/EC came into force on July 1, 2003 and specifies new requirements to be applicable for valves and their electrical components when they are to be used for combustible gases. The valves are used as gas bearing valves, for example at hot water boilers and steam boilers (DIN EN 12952-8, DIN EN 12953-7), as well as for gas-fired industrial furnaces or industrial heating lines (DIN EN 746).

On planning and designing of the technical equipment fluid data as well as the environmental conditions play an important role.

With passing the guidelines 94/9/EG in 1994, a harmonization of the various legal guidelines of the EC member states for appliances and protection systems for explosion-endangered zones was initiated.

This guideline is also known under the term ATEX 100a (ATEX for Atmosphères Explosibles, 100a for article 100a of the 1. contract for the foundation of the EC) and controls the nature of appliances and protection systems.

The product guideline ATEX 100a was realized as German law on December 20th, 1996 and with the 11th decree with regard to the law concerning the safety of appliances.

Classification of line zones into ex-zones

In the context of a formal appraisal of the explosion risks the planner of the line defines the zones of the line and of its components according to EN 60079-10 (VDE 0165 part 101) depending on

- release source
- degree of ventilation
- availability of ventilation.

Release source

Release sources are sites or places where combustible gases, vapours or liquids may come into contact with the atmosphere. In accordance to the probability of the existence of an explosive gas atmosphere the release sources are determined as per degree of release.

Continuous: Permanent release, of which it is expected that it will be long-term.

Primary: Release to be expected periodically or occasionally during normal operation.

Secondary: A release which is not to be expected during normal operation, and if it occurs it is only rare and for a short time.

Release sources with secondary degrees of release at valves are for example shaft sealing rings and stuffing-box packing.

Ventilation

The power of the ventilation is determined via the determination of the hypothetical volume, which describes the extension of the explosion-endangered atmosphere around the release source in case of the existence of a ventilation. On

the basis of this volume with regard to the line and the size of the room and the remaining of an explosive atmosphere the power of the ventilation can be calculated depending on the release source and can be classified as strong, medium or low.

Strong: The hypothetical volume is very small or even negligible as compared to the ventilation volume. The concentration is immediately reduced to a safe degree. In case of the ventilation being in operation, it can be assumed, that the release source will not produce any explosive atmosphere. In practice there usually only is a strong ventilation in case of a local, technical ventilation system (local suction system) around the source, in case of small closed areas or very small release volumes.

Medium: A considerable dilution of the released combustible vapours or gases. The hypothetical volume is smaller than the dimension of the line or, respectively, the size of the room.

Low: The hypothetical volume is bigger than the dimension of the line or the size of the room or the lingering time is too long. In the outside there will generally be no low ventilation, unless the airflow is obstructed, for example in pits.

Degrees of availability

Apart from the release source and the ventilation the availability plays an important role for the determination of the explosion zones, since it has an essential influence on the forming of an explosive atmosphere.

Good: There practically is permanent ventilation; for example this can be guaranteed by the existence of a redundancy of the ventilation, or by realizing the breakdown of the ventilation with immediate introduction of a back-up system. A natural ventilation in outside areas may be called good, since a wind velocity of 0.5 m/s is practically always achieved.

Sufficient: Ventilation is available during normal operation. Interruptions are permissible if they only occur for a short time and if they do not occur frequently. This, however, requires a monitoring of the ventilation and respective measures for the reduction of the repair time.

Low: Ventilation, which does not correspond to the requirements of sufficient or strong, in case of which, however, no long-term interruptions are to be expected, i.e. a strong ventilation, which does not show any long-term interruptions, but is frequently out of order has a low availability.

The result of this evaluation is shown in **Table 1** (Source: Table B.1 of DIN EN 60079-10).

This table shows that in case of secondary release sources like for example shaft sealing rings and stuffing-box packing, etc., the ventilation rate and the availability have a considerable influence on the determination of the zone.

Example for a determination

A valve with a spindle sealing by means of a stuffing-box packing is in a closed gas-bearing pipe system. There is natural and sufficient ventilation. For this case a periphery of 1 m around the spindle sealing is determined as zone 2. Frequently the valves are installed into the pipe system with flange gaskets.

Due to these additional release sources the zone radius is increased by the building length of the valve, so that for example in case of DN 150 zone 2 will be determined within a radius of 1.5 meters.

New requirements for electrical apparatus in zone 2

Due to a usually non-existent technical ventilation and due to a medium degree of ventilation, valves for combustible gases frequently belong to zone 2. This means that the actuators and sensors necessary for the automation of the process must also be suitable for zone 2.

On the contrary to the former national regulation these appliances must in future be marked according to 94/9/EG and the manufacturer must confirm the conformity.

Appliances of the apparatus group II and the category 3G or even higher, for example 2G or 1G, may be used in zone 2. Category 3 includes appliances which are operated according to the parameters stated by the manufacturer and under a normal degree of safety.

Appliances of the apparatus group II3G must not feature any predictable ignition sources to be expected and the surface temperature occurring must not exceed the maximum temperature according to regulation. The requirements are described in DIN EN 50021 "Electrical apparatus for explosion-endangered zones, type of protection 'n' ".

Appliances of this group are not subject to any building type control, but are designed, produced and marketed according to the module "internal production control" under the responsibility of the manufacturer.

UNI-Geräte is manufacturer for safety shut-off valves, control slides and con-

Table 1: Appraisal of explosion-endangered zones

Ventilation	Degree of ventilation						
	strong			medium			low
	availability			availability			availability
	good	sufficient	low	good	sufficient	low	good, sufficient, low
Continuous	Zone 0 NE*) not endangered [1])	Zone 0 NE*) Zone 2 [1])	Zone 0 NE*) Zone 2 [1])	Zone 0	Zone 0 + Zone 2	Zone 0 + Zone 2	Zone 0
Primary	Zone 1 NE*) not endangered [1])	Zone 1 NE*) Zone 2 [1])	Zone 1 NE*) Zone 2 [1])	Zone 1	Zone 1 + Zone 2	Zone 1 + Zone 2	Zone 1 or Zone 2 [3])
Secondary [2])	Zone 2 NE*) not endangered [1])	Zone 2 NE*) not endangered	Zone 2	Zone 2	Zone 2	Zone 2	Zone 1 and even Zone 0 [3])

1) Zone 0 NE*), Zone 1 NE*) and Zone 2 NE*) state a theoretical zone, which under normal conditions has a negl igible extension.

2) Zone 2 which is formed by a secondary de gree of release may exceed a zone, which was determined on the basis of a primary or continuous degree of release; in this case the biggest possible distance is to be chosen

3) Is zone 0, if the ventilation is so low if there is such a release that there a ctually is a permanently explosive atmosphere (i. e. you approach the condition "no ventilation")

Note: "+" means: surrounded by

This is new as per ATEX:
1. Definition of apparatus categories and the allocation to ex zones
2. Application of ATEX for appliances of category II3G
3. The dust-ex protection and therefore the respective zone definitions 20, 21 and 22
4. Inclusion of non-electrical appliances
5. Working out of an explosion protection document
6. Formal appraisal of explosion risks
7. Working out of an EC conformity declaration and the attaching of the CE-symbol

Conditions in explosion-endangered areas

Combustible material	Risk	Zone	Apparatus category
gases, vapour, smoke	permanent, long-term or frequent	0	II 1G
gases, vapour, smoke	sometimes	1	II 2G
gases, vapour, smoke	rare, and if, only short term	2	II 3G
dusts	permanent, long-term or frequent	20	II 1D
dusts	sometimes	21	II 2D
dusts	rare, and if, only short term	22 conductive dusts non-conductive dusts	II 2D II 3D

Protection types

Protection type	Marking	Zone of possible use	Principle of protection
pressure-proof housing	EEx d	1 or 2	transfer of an explosion to the outside is excluded
powder filling	EEx q	1 or 2	
increased safety	EEx e	1 or 2	avoiding of sparks and temperatures
inherent safety	EEx i	1 or 2	energy restriction of sparks and temperatures
pressurizing	EEx p	0, 1 or 2*)	Ex atmosphere is kept apart from the ignition source
encapsulation	EEx m	1 or 2	
oil immersion	EEx o	1 or 2	
protection type „n“	EEx n	2	different principles of protection
protection by housing	IP	20/21/22	Ex atmosphere is kept apart from the ignition source

*) ia-use in zone 0,1,2 / ib-use in Zone 1,2

trol butterfly valves for combustible gases and liquids but also for hot-air and flue gases. Together with the magnetic or pneumatic actuator the valves are checked according to design as safety stop-valves according to EN 161 or EN 264 and are used as stop valves in front of burners or as main isolating valves in front of the boiler house.

Control slides and butterfly valves are used to control and mix burnable gas and air. UNI valves are used in all sectors of fuel engineering and power station technology.

In connection with ATEX solenoid drives were modified under the responsibility of the manufacturers for type of protection "n" (**Figure 1**).

Within the frame of the tests the drives were classified into different temperature classes. The temperature class was executed as experiment for all solenoid drives at 110 % of the nominal voltage. The measurable surface temperature in case of maximum environmental temperature must be 5° C below the maximum permissible temperature.

Fig.1: 25-EVSA 20NH-4 solenoid valve

Table 2: Temperature category

Temperature-class	Maximum surface temperature °C
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

The maximum surface temperature is defined via the temperature class **(Table 2)**.

The operator determines the temperature class depending on the gases used **(Table 3)**. As far as fuel engineering is concerned usually a temperature class of T3 or lower is necessary. Spark-producing units, like for example a solenoid valve control with relay or a mechanical limit switch must be protected in a suitable way, for example hermetically housed in.

Suitability of the encapsulation is proven by a test. Five test samples are stored in an oven at 80 °C for 7 days; afterwards – at room temperature – they are submerged in hot water (75 °C to 85 °C) for at least two minutes. During the submergence process no bubbles must be observed leaving the hermetic encapsulation.

To avoid the formation of sparks, which may occur on accidental pulling out of the appliance plug from the solenoid drive, the plug must have a screwed connection to the drive. Additionally the drive is marked with the note "Do not disconnect when charged" (**Figure 2**).

Table 3: Classification of gases and vapours as per CENELEC/IEC/NEC 505

	T1	T2	T3	T4	T5	T6
Explosions sub group	Gases and vapours					
I	methane	–	–	–	–	–
II A	ammonia, methane, ethane, propane	ethanol, cyclohexane, n-butane, n-hexane,	benzene, general jet propulsion fuel, n-hexane, heating oil	acetal-dehyde	–	–
II B	town gas, acrylonitrile	ethylene, etylenoxide	etylen glycols, hydrosulphide	ethyl ether	–	–
II C	hydrogen	ethyne (acetylene)	–	–	–	carbon-disulfide

As per 94/9/EG the following markings are necessary for the UNI solenoid drives, as well as the CE-sign for the observation of all European guidelines:

Ex II3G EEx nA II T4/5, or respectively, Ex II3G EEx nC II T5.

Spark-free electrical equipment is marked with "nA" and equipment which causes sparks, however, which is protected in a suitable way is marked with "nC".

Requirements for mechanical components

In addition to the electrical equipment the mechanical components of the valve are checked with regards to sparking, conductivity and electrostatic charge.

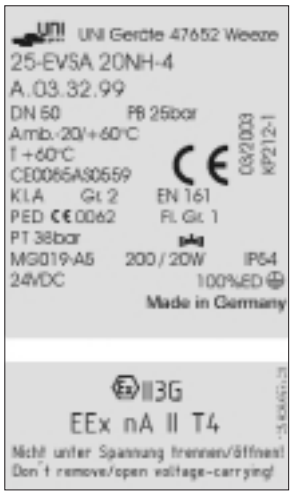

Fig. 2: Marking on a series EVSA solenoid valve

Generally the potential energy in case of lifting and turning valves is not sufficient to produce a spark by spring fracture or adjusting movements. The conductivity is realized by the use of crown gears at screw connections for metal units or electrically conductive plastic materials.

Literature

[1] DIN EN 60079-10, VDE 0165 part 101: Electrical equipment for gas explosion endangered zones, evaluation of explosion endangered zones

[2] DIN EN 50021: Electrical equipment for explosion endangered zones protection type "n"

[3] Lienenklaus, E.; Wettingfeld, K.: VDE Schriftreihe 65: Electrical explosion protection as per DIN VDE 0165