



Cables and Lines for Hazardous Areas

Topical booklet no. 0005



SAMCON
Prozessleittechnik GmbH

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History of revisions

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1 Introduction

This document is primarily intended for operators and installers of explosion-protected plants. The purpose of this brochure is to help them in the selection of suitable cables and cable entry components, as well as the combination of them which is very important because properties of cables and circuits in explosive areas are an integral part of the electrical explosion protection.

At a first glance, it seems to be simple and trivial but actually this is not the case. The classic European explosion protection (Directive 2014/34/EU, hereinafter, ATEX Directive") refers to a device, for example, a lamp, a measuring instrument, a camera, or the like. Safety of such devices is usually ensured by the use of one or several ignition protection types which are clearly defined in the applicable norms and standards: For example, IEC/EN 60079-1 standard describes the function of the ignition protection type "Flameproof Enclosure".

The responsible party for complying with this ignition protection type is the manufacturer of the device. In general, to get an approval of an ex-protected device, the manufacturer can proceed, as follows:

1. He determines the design of the device and the applicable protection type in order to make the device safe.
2. Then a testing laboratory, selected by the device manufacturer (for example, PTB in Brunswick, Germany), checks whether the design of the manufactured device complies with the safety requirements.
3. If the device passes all tests, the testing laboratory issues a certificate of conformity and the manufacturer can introduce the device to the market.

But: Neither the manufacturer nor the testing laboratory are obliged to determine in detail, what kind of cable gland has to be used.¹

Moreover, for the above-mentioned certification of flameproof devices (Ex-d) or devices with increased safety (Ex-e), there are no defined requirements on cables and cable glands which have to be used and neither the cable itself nor the cable glands are determined, much less tested. Cables and lines are not included in the scope of the ATEX Directive and therefore cannot be certified in accordance with it.

¹ Sometimes they do that, but mostly they do not. Almost all flame-proof devices undergo a test without cable connection.

If an improper cable or cable gland is selected, the entire protection system can become unsafe. This can cause problems as the following example shows: A flameproof device (Ex-d) generates 10 bar of explosion pressure; however, the selected combination of cable and cable gland can withstand only 6 bar. As a result, the device is not safe.

Summary:

1. Usually the manufacturer tests the flameproof devices without cables.
2. Cables and lines are not included in the scope of the ATEX Directive.
3. Improper cables and/or cable glands can impair the device's protection class and cause an explosion.

The international standards (IEC) as well as the European norms (CENELEC) are aware of this problem: The norms and standards of the applicable ignition protection categories (Ex-d, Ex-e), determine more and more concrete and in detail the general as well as specific requirements of cables and wires. This also applies to the "user norm": IEC/EN 60079-14: Electrical installations design, selection and erection.

The technical scope, e.g. for cable glands, is defined in the standard IEC/EN 60079-0/1 for devices, however, it is not the device manufacturer's obligation to select the proper cables and lines. This is an obligation of the installer and/or operator of plants in the hazardous area. This transfer of responsibility is difficult but sensible and basically, the responsibility hierarchy defines the following procedure:

1. The device manufacturer is responsible for his device, namely up to the thread into which the cable gland is introduced.
2. The manufacturer of the cable gland is responsible that the cable glands for defined cable types (e.g. of certain diameters, from/to) are safe up to a pressure of 30 bar.
3. Finally, the installer and/or operator of the Ex-device are responsible for the correct selection of the suitable cable and matching it with the appropriate cable gland.

The primary aim of this document is to help operators and installers of plants in hazardous areas to observe their responsibilities. For this purpose, this document defines and explains the required cable properties and also provides examples of useful and not so useful combinations of cable and cable glands.

In addition, this document describes, in a broad sense, our subjective "best practice" approach and does not claim to be fully complete and precise, despite careful research. This document cannot substitute a thorough research and study of the applicable standards and does not relieve the manufacturer, installer or operator from their assigned duty to take responsibility for safety.

Moreover, in this document, we only deal with the ignition protection categories Ex-d and Ex-e, with an emphasis on flameproof enclosures. Intrinsically safe circuits (Ex-i) and their cables or devices in pressurised enclosures (Ex-p) and their cables usually represent special installations which are explicitly described in the applicable equipment standards.

General requirements for cables are described in Section 9.3 of the IEC/EN 60079-14 norm. Some items of this norm deal with "exotic" special cables and lines which are only very rarely used in regular configurations (e.g. aluminium conductors, flat ribbon cables, easy tear, etc.). This document deals with regular copper or fibre-optic cables which are commonly used for configuration and planning tasks.

2 Mechanical design

Of course, a cable for hazardous areas should be mechanically robust. No engineer would come up with the idea of taking a regular office network patch cable and install it in an hazardous area. But when is a cable considered to be mechanically robust?

The IEC/EN 60079-14 norm determines the following:

2.1 Jacket material

The outer sheath of the cable must be made of thermoplastic, thermosetting, or elastomeric material....

Almost all commercial cables fall into one of these categories. For example, PUR cables can be duroplastic, thermoplastic or elastomeric, depending on the degree of cross-linking. If you are unsure whether your cable is part of one of the above-mentioned groups, it is better to ask the manufacturer.

2.2 Shape of the Cable

Cables must be circular² and compact ...

They must be circular, because the cable entries have circular rubber seals, which assure the necessary sealing of the cable.

They must be compact, because a less-compact stranded line will not withstand the contact pressure of the cable gland's rubber ring. In this case, the static friction between the rubber ring and cable will not be sufficient to ensure the necessary compressive strength. Especially when introducing the cable directly into the flameproof enclosure (Ex-d), the cable's circular shape and compactness are major technical properties ensuring the cable safety.



Fig. 2-1: Sufficiently circular and compact cable



Fig. 2-2: This cable is not sufficiently circular and compact

² The standard explicitly permits special cables such as ribbon flat cables; however, it also demands the usage of the appropriate cable gland. In planning practice, usually only round cables are used.

However, this standard does not explicitly define any permissible tolerances regarding the cable's circularity shape and it does not explicitly determine the maximum permissible deviation from circularity so that the cable is still considered "circularly stranded". In order to verify the cable's suitability, a simple overpressure test can be used: The combination of an Ex-d enclosure, a cable and a cable gland must withstand a pressure of 30-bar without the cable getting loose from the cable gland. See testing stand (Fig. 2-3).



Fig. 2-3: Pressure testing devices for cable and cable gland combinations

Note: In Figure 2-2 we can see an improper cable: It has a suitable cable gland but can withstand a pressure of only 14 bars which means that it is 16 bars less than required by the standard for Ex-d cable glands. The test has clearly shown that the cable is not suitable because it has no compact design and no circular stranding.

Terminal compartments or boxes with increased safety (Ex-e) do not need to withstand high pressures. In this case, the requirements on cable compactness and circularity are derived from the protection category and the design of the respective Ex-e cable entry.

2.3 Embedding and fillers

Any bedding or sheath shall be extruded. Fillers, if existing, must not be hygroscopic ... Today, pressure or sheath extrusions are standard technologies used in cable production and modern commercial cables are provided with non-hygroscopic fillers. If in doubt regarding these two parameters, ask the manufacturer of the cable.

2.4 Potential ignition/flame transmission

Theoretically, especially in large flameproof housings with correspondingly high explosion pressures, flame transmission through the cable can occur. This issue is, only rather generally, described in Section 9.3.2 of IEC/EN 60079-14. Basically, the requirement is: Any potential probability of flame transmission through the cable (e.g., gaps between wires) must be prevented. But it is neither explained nor described what kind of cables may allow this phenomenon nor how to prevent such risks. In the following subsections, we explain the technical background of this issue.

2.4.1 Potential flame transmission between insulated cores

Copper wires and their insulation are usually circular. Thus, if such components are not pressure-extruded but simply twisted with each other, there will be some clearance or gap between them through which gas and air can escape. If the "shape" (length-to-width ratio) of such clearance is worse than the shape of the housing's flameproof gap, the cable will be the bottleneck of the Ex-d protection category (see Figure 2-4: Flame transmission 2 - Clearance between cables).

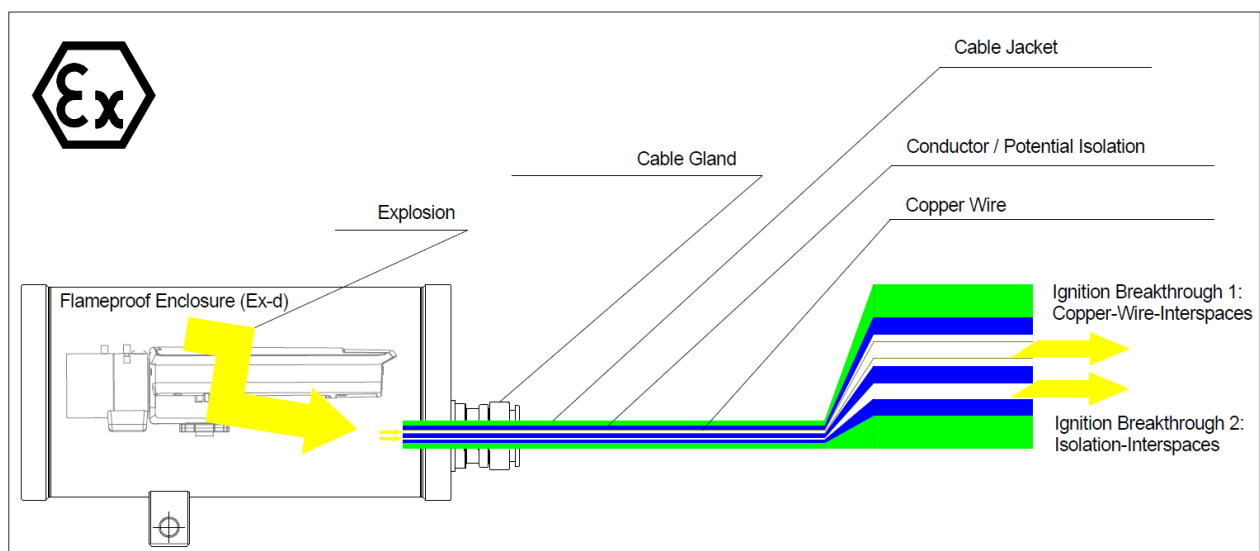


Fig. 2-4: Sketch of the flame transmission in cables

The consequence is that the length and the mechanical robustness of the cable are important parameters. The longer the cable, the greater the length-to-width ratio of a potential gap and thus the safer the system.

Where you have to anticipate this risk?

This risk exists if the cable does not meet the criteria for the of prevention zone entrainment, i.e. when the wire has poor longitudinal tightness³ (see the following chapter and appendix E of the IEC/EN 60079-14).

³ In the following chapters it is clearly defined what good or poor longitudinal tightness means.

How to face this risk correctly?

For this purpose, the IEC/EN 60079-14 standard offers two possible measures:

The first one is to use IEC/EN 60079-14 barrier glands (see Section 10.6.2). In such glands, the clearance between insulated cores is filled with modelling clay or cast resin (compound). Such barrier glands reliably prevent the flame transmission between the insulated cores, however, a disadvantage is the higher labour costs due to the kneading of the compound. Moreover, such cable glands cannot be installed at low temperatures because the compound needs a certain minimum curing temperature.

The second possible method is to use a cable which is as long as possible, provided that it is sufficiently robust. In this respect, the IEC/EN 60079-14, Section 10.6.2 requires a minimum length of three meters. This method makes sense: the cable length directly influences the length-to-width ratio of the cable.

2.4.2 Potential flame transmission between individual cores

Individual wires can be stranded (braid). For example, AWG22/7 reflects a braid with 7 circular stranded single core wires, whereas AWG22/1 is a rigid wire. In these cases, too, there are clearances between individual circular cores causing the same problem as described above. Here also, if push comes to shove, there is a bad length-to-width ratio of the clearance between the cores, thus impairing the flame-proof gap of the entire protection system.

Where you have to anticipate this risk?

This risk exists if the wire does not meet the criteria for the prevention of zone entrainment, i.e. the when the wire has poor longitudinal tightness (see the following chapter and appendix E of the IEC/EN 60079-14).

Note: The flame transmission caused by clearances between the wire cores of large cross-sections is higher than of smaller cross-sections - simply because of the shape geometry. We only know a prototype-examination in which flame transmission was proven for a very short wire (Ex-d - Ex-e-wire cable bushing) of 95 mm² nominal cross section.

How to face this risk correctly?

A barrier gland does not prevent hazards. For maximum permissible cross-sections and cable lengths, refer to the respective user manual. If you are not sure, ask the manufacturer of the Ex-d device to confirm the usability of the cables and inlets. Moreover, you should also pay attention to the mechanical robustness of the cable and to the required minimum length of 3 metres.

2.5 Risk of zone entrainment and longitudinal tightness

The "longitudinal tightness" or "pressure resistance in longitudinal direction" or "longitudinal breathing" is a certain property of the cable. It derives from the cable structure and can be precisely measured. Hereinafter, this property is referred to as "longitudinal tightness" of a cable. Regarding the explosion protection, it is an important criterion - in two respects:

1. Cables with a good longitudinal tightness are safer with regard to prevention of flame transmission (device safety). For more details on this issue, see the previous chapter.
2. Long cables of a good longitudinal tightness reliably prevent zone entrainment (safety of devices and plants).

So the above are actually two good reasons to go into greater detail and to explain the terms "longitudinal tightness" and "zone entrainment".

What does longitudinal tightness mean?

What does the longitudinal tightness actually mean? This can be easily explained on the basis of our test rig for the cable longitudinal measurement (Figure 2-5): A pressure-resistant 5-litre box has two ports: The first port is intended for connecting an air pump (left side of the picture), the second one is for connecting the cable which is supposed to be tested (right side of the picture).

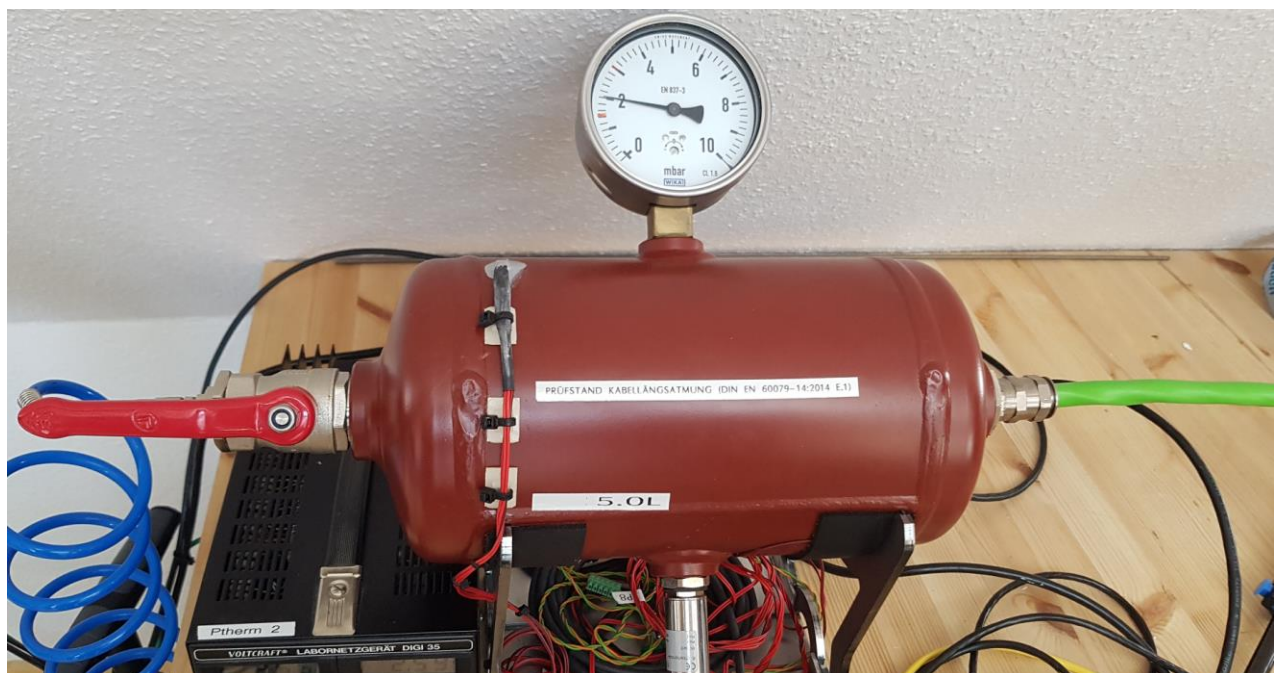


Fig. 2-5: Test rig for measuring the cable's longitudinal tightness

What would happen if the you pump up a vessel, e.g. with 300Pa (which is actually not a lot)? The result will range between two extremes:

If the cable on the pictures right hand side is, in longitudinal direction, hermetically tight, e.g. like a steel bolt, the pressure remains at 300Pa since the air cannot escape. However, if the cable leaks like a water hose, the pressure in the vessel will rapidly drop.

Conclusion: If you stop the time which is needed for a defined pressure drop (e.g. between 300Pa and 150Pa), you will get a reliable criterion for the longitudinal tightness: For cables with a good longitudinal tightness, the pressure drop from e.g. 300Pa to 150 Pa, takes at least 5 seconds. For cables with a poor longitudinal tightness, the pressure will drop much faster.

Please note: Fibre-optic breakout cables hold the pressure less than one second!

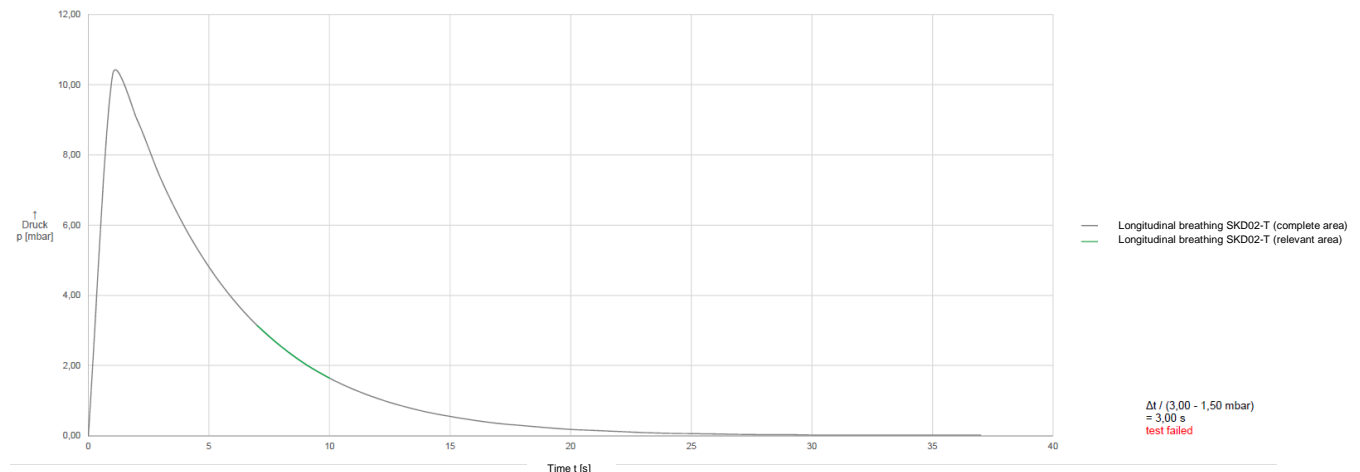


Fig. 2-6: Measurement of a cable with a poor longitudinal tightness (test failed)

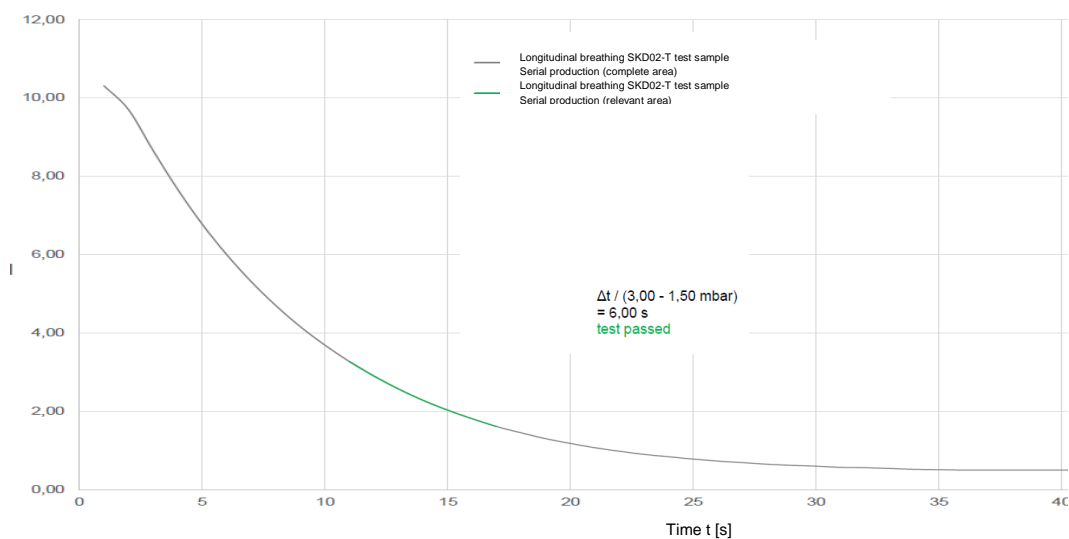


Fig. 2-7: Measuring a cable with a good longitudinal tightness (test passed)

What does zone entrainment mean?

Usually cables are used to connect a device with a control cabinet – if necessary, via a terminal box. Explosion-proof devices are typically placed in ATEX zones 1 or 2 whereas control cabinets are usually installed in safe areas. This means that the cable which connects a device with a control cabinet typically connects two different ex zones: for example, Ex zone 1 and a safe area. So if the cable has a poor longitudinal tightness and, in addition, an unfavourable pressure condition, it can happen that the gas starts to escape through the cable. The explosive gas can penetrate into the safe area and cause an ignition. That is why such explosive gas escaped is also called “zone entrainment” (see Figure 2-8).

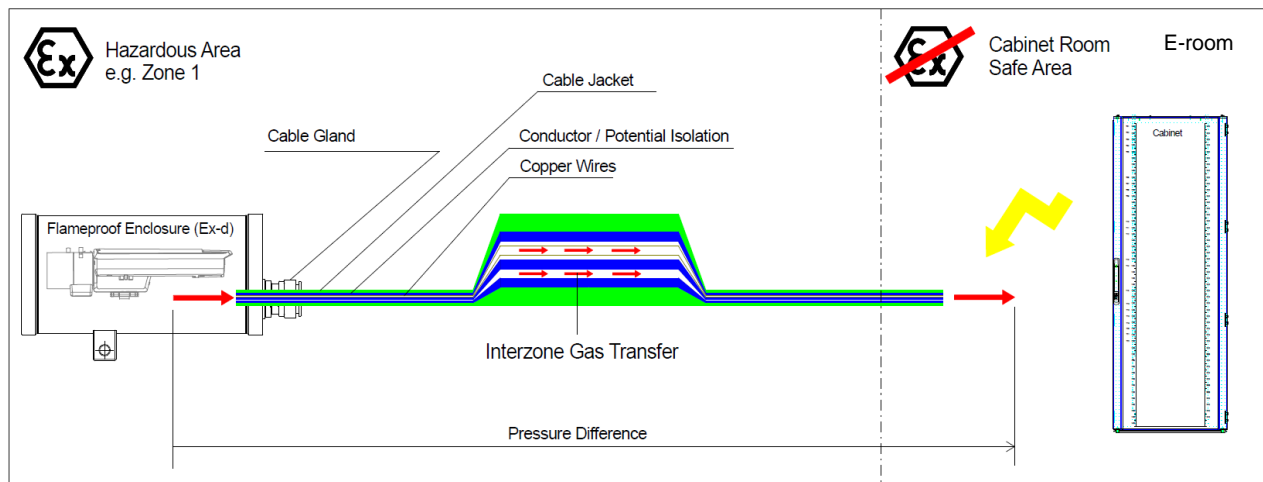


Fig. 2-8: Sketch of zone entrainment

How to face this risk correctly?

If possible, cables with a good longitudinal tightness and which fulfil the criteria of IEC/EN 60079-14 should be used.

If this is not possible, e.g. in case of fibre-optic cables, you can improve the situation by using threaded barrier cable glands. They will reliably prevent the gas escape though the clearance between the insulated wires. If you have to patch several cables with poor longitudinal tightness in an electric enclosure, you can also consider creating a light atmospheric excess pressure e.g. by means of a suitable air conditioning system. The slight excess pressure (in comparison to the field) in the electric enclosure can prevent the risk of zone entrainment.

3 Environmental, process and application parameters

3.1 Flame resistance

The requirements on flame propagation are described in Section 9.3.9 of the IEC/EN 60079-14 norm. Cables must be flame-retardant in accordance with IEC 60332-1-2, or IEC 60332-2-2 which means that if the cable is exposed to a 1KW flame, no flame propagation should occur.

Otherwise, an ignitable spark in the safe area would be transmitted via the cable in the ex-area which inevitably would cause an explosion.

If flame-retardant cables are not available for these applications, the norm offers options such as fire-safe laying of cables or fire barriers for such cases. In the practice, firewalls are often used, however, if possible, it is better to use flame-retardant cables.

3.2 UV Resistance

If the cables in explosive areas are exposed to ultraviolet (UV) rays, the cable's UV resistance is a very important characteristic. If a cable is not UV-resistant, it will lose its steadiness when exposed to UV rays and become porous. Consequently, an important requirement such as robustness of the sheath is no longer guaranteed. Only in Section 9.3.7, the IEC/EN 60079-14 standard describes risks and dangers of UV rays, stating that cables are laid in such a manner that they are protected against the effects of UV rays, though in practice this it is not always possible.

How to face this risk correctly?

If there is a risk of UV exposure, always use UV-resistant cables. You can get the cable UV-resistance confirmed by the cable manufacturer. For appropriate criteria for the practice, please see UL 2556 Sec. 4.2.8.5 (720h).

3.3 Surface Temperature

Depending on the electric current loads, wires and cables can get hot. In the hazardous area, hot surfaces can cause an ignition (the ignition temperature of carbon disulphide lies at only 95°C). Thus, it is clear that the cable must not become hotter than the equipment to which the cable supplies the electric current. Or, to put it another way: the surface temperature of cables must not exceed the temperature class of the system. The IEC EN 60079-14 standard deals with these issues in Section 9.3.8.

3.4 Ambient Temperature

This characteristic is not defined in the installation standard, probably, because it is self-explanatory: Use the cable only within the ambient temperature range specified by the manufacturer.

3.5 Oil and Mud Resistance

Especially in the off-shore sector, hazardous areas are often polluted with oil or drilling mud, e.g. in "shaker-rooms" or on drilling platforms. In such cases, you should make sure that the cables withstand these rough ambient conditions. The basic rule is: oil and drilling sludge pollution must not impair the cable's properties which are relevant for the explosion protection.

The IEC/EN 60079-14 building and installation does not deal with this subject but you can refer to the IEC 60811-2-1 standards (e.g. IRM 902, 4h at 70°C) for oil resistance, as well as to the Norwegian standard NEK 606 for drilling sludge resistance.

If in doubt, you can also ask the cable manufacturer whether any relevant tests were made for this cable.

4 Installation

Since the European standards and the IEC explosion protection norms apply to the devices and not to the cables, the latter must be laid so that they are protected against damage. The IEC/EN standard deals with the installation issues in Chapter 9.3.7 "Avoidance of damage".

The main rules are:

- When laying the cables, protect them in such a way that they withstand all possible mechanical, chemical and environmental risks.
- Pay attention to the maximum permitted bending radii (min. $8 \times D_a$).
- Do not bend the cable directly behind the gland. Leave a few centimetres (min. 2.5 cm) of a straight cable behind the gland.

5 Flexible Cables for Stationary or Mobile Devices

In hazardous areas, generally also flexible cables can be used for stationary devices as many times, drag-chain cables are required for applications. Nevertheless, it is sensible to examine closely the application. How many cycles has the cable to withstand? At what bending radius and temperature? Best is to discuss the application requirements with the cable manufacturer. The relevant standard is very vague: everything can be planned and used - from a robust plastic insulated cable up to a light rubber hose cable - as long as it is ensured that the cable cannot be damaged. If you have to plan cabling for portable and mobile devices, you should also look up the sections of the IEC/EN 60079-14 Building and Installation Standard regarding the maximum voltages, currents, cross-sections, as well as the grounding requirements.

6 Fibre-optic Cables

In hazardous areas, fibre-optic cables, especially directly inserted into flameproof chambers, are considered potentially more critical than copper wires. In this case, it is not relevant how much energy is transported⁴, but rather what longitudinal tightness can be achieved by the cable. In practice, neither classic fibre-optic cables with or without cable dividers nor "breakout cables" are known which comply the criteria for longitudinal tightness in accordance with Annex E of IEC/EN 60079-14.

Classic fibre-optic cables with cable dividers or splice fields require a lot of space. For such an installation, it is advisable to use an Ex-e terminal chamber. This reliably prevents flame transmission through the cable; however, it does not exclude the risk of zone entrainment.

Breakout cables can be quite easily inserted into Ex-d chambers. They are already pre-fabricated for plug-in assembly.

For fibre-optic cables, the following rules stood the test of the practice:

1. For cable glands into flameproof chambers, always use barrier glands to reduce to a minimum the risk of flame transmission through the cables.
2. Ensure mechanical robustness and circularity of the cables (see Section 2).
3. If in doubt, ask the manufacturer of the cable glands whether they are compatible with the fibre-optic cable selected by you.

⁴ This question is related to the device. It depends on the used ignition protection type and is explicitly described in IEC/EN 60079-28.

7 Selection of the Cable Gland

The selection of suitable cable glands is described in detail in Section 10 of IEC/EN 60079-14. Among the criteria described above, the following rules can be derived from the cabling practice for direct Ex-d entries:

1. Always use device-certified⁵ glands which comply with your device, both in terms of the explosion protection parameters, and with regard to the ambient parameters.
2. If all the parameters referred to in Chapter 2 are fulfilled and the cable is at least 3 metres long, cable glands with rubber ring sealings can be used
3. If the cable is shorter than three meters, use barrier glands.
4. If there is a risk of zone entrainment and the cable has no sufficient longitudinal tightness, secondary measures must be initiated in order to prevent zone entrainment.

Note: These rules and recommendations for the practice do not relieve the reader from the necessity to carefully read and understand the IEC/EN 60079-14. SAMCON bears no liability for the above recommendations.

Sources:

Directive 2014/34/EG:
IEC/EN 60079-0
IEC/EN 60079-1
IEC/EN 60079-7
IEC/EN 60079-14
UL 2556 Sec. 4.2.8.5 (720h)
NEK 606
IEC/EN 60811-2-1

⁵ See Tutorial: ATEX devices; components certificate

8 Template: Declaration of Conformity

Herstellereklärung

Declaration of manufacturer / Déclaration de fabricant

Der Hersteller / The manufacturer / Le fabricant

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erklärt in alleiniger Verantwortung, dass sein Produkt
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auf das sich diese Erklärung bezieht, mit der/den folgenden Normen oder normativen Dokumenten
übereinstimmt:

referred to by this declaration is in conformity with the following standards or normative documents:

auquel se rapporte la présente déclaration, est conforme aux normes ou aux documents normatifs suivants:

DIN EN 60079-14 Kapitel 9.3 & Anhang E

„Kabel und Leitungen, die für die feste Verlegung in explosionsgefährdeten Bereichen verwendet werden, müssen für die Umgebungsbedingungen im Betrieb geeignet sein. Kabel und Leitungen müssen sein:“

„...ummantelt mit einem thermoplastischen, duroplastischen oder elastomeren Werkstoff“ sein. „Sie müssen kreisförmig und kompakt sein. Jegliche Einbettungen oder Mäntel müssen extrudiert sein. Füllstoffe, falls vorhanden, dürfen nicht hygroskopisch sein.“

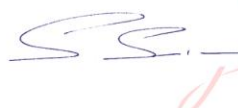
„Kabel und Leitungen für äußere feste Verlegung müssen solche Kennwerte für die Flammenausbreitung aufweisen, dass sie die Prüfungen nach IEC 60332-1-2 bestehen“

„Kabel und Leitungen müssen UV-Beständig sein und im Außenbereich verlegt werden können“

„Ein Stück Kabel mit einer Länge von 0,5 m sollte typgeprüft werden, indem es unter konstanten Temperaturbedingungen in ein abgedichtetes Gehäuse von 5 l ($\pm 0,2$ l) eingebaut wird. Das Kabel gilt als zulässig, wenn die Zeitspanne, die erforderlich ist, um einen inneren Überdruck von mindestens 0,3 kPa (30 mm Wassersäule) auf 0,15 kPa (15 mm Wassersäule) fallen zu lassen, nicht weniger als 5 s beträgt.“

„Der Mantel sollte kreisrund verseilt sein und aus mechanisch ausreichend dickem PUR bestehen.“

„Das Kabel sollte hinsichtlich sämtlicher Eigenschaften verlegt einer Umgebungstemperatur von -60°C bis +80°C standhalten“



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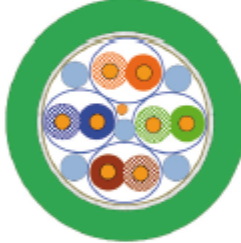



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190829-SKDP02-T Konformitätserklärung 60079-14.doc


9 Exemplary cables:

Product / Model		Description
SKD01-T 		System Cable Digital No.01 - T Special cable for use in arctic temperatures (-60°C) Outer diameter: $\varnothing 9.1 \pm 0.2$ mm Material: PUR - flame retardant (IEC 60322-1-2 1KW flame) Construction: 4 x 2 x AWG22/1 shielded
SKD02-T 		System Cable Digital No.02 - T Special cable for hazardous areas in accordance with IEC/EN 60079-14 Outer diameter: $\varnothing 8.9 \pm 0.3$ mm Material: PUR - flame retardant (IEC 60322-1-2 1KW flame) Construction: 4 x 2 x AWG23/1 shielded High speed CAT6 industrial Ethernet cable for fixed installations
SKDP03-T 		System Cable Digital No.03 - T Special cable for hazardous areas in accordance with IEC/EN 60079-14 Outer diameter: $\varnothing 12.4 \pm 0.3$ mm Material: PUR - flame retardant (IEC 60322-1-2 1KW flame) Construction: 4 x 2 x AWG23/1 shielded GN J/W 3G1.5 High speed CAT6 industrial Ethernet cable for fixed installations with additional power elements




Hazardous Areas Characteristics:

-  The cable meets the requirements for cables in hazardous areas in accordance to IEC/EN 60079-14 Chapter 9.3.
-  The cable meets the requirements for cables in hazardous areas to avoid inter-zone gas-transfer in accordance to IEC/EN 60079-14 Appendix E.

Environmental Characteristics:

-  The cable is tested at -60°C at fixed installation. Refer to the datasheet for temperatures regarding installation and flexible use.
-  The cable is tested at +80°C at fixed installation. Refer to the datasheet for temperatures regarding installation and flexible use.
-  The cable is sunlight resistant in accordance with UL 2556 Sec. 4.2.8.5 (720h).
-  The cable is flame retardant in accordance with IEC 60332-1-2.
-  The cable is oil resistant in accordance with IEC 60811-404 (7x24h at 90°C).
-  The cable is mud resistant in accordance with NEK 606.
-  The cable is suitable for drag chain use: 1 million bending cycles, bending radius 20 x D, at a speed of 4 m/s, acceleration 4 m/s², max. travel distance 10 m at 20°C.

Electrical/Network Characteristics:

-  The cable is tested according to the following standards: IEEE 802.3 : Ethernet 10Base-T; Fast Ethernet 100Base-T ; Gigabit Ethernet 1000Base-T @ 95-meter
-  The cable is tested according to the following standards: IEEE 802.3at; PoE+, max. 30W per channel, max 95m.
-  The cable is constructed with an additional power element: Square: 3 x 1,5 mm², Color code: BK-BU-GNYYE.

10 Notes



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