

Aspects regarding the selection of cable glands for electrical equipment intended for use in potentially explosive atmospheres

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Abstract. In industrial installations located in potentially explosive atmospheres, the safe operation of electrical equipment depends not only on correct design but also on the proper use of cable glands. These components are essential for maintaining the protection type of the equipment, whether it is flameproof enclosure, increased safety, pressurization etc. In practice, nonconformities frequently arise due to the incorrect selection or improper installation of cable glands, directly affecting the safety of the equipment and, consequently, the entire installation. Common issues include the use of unsuitable cable glands, incompatibility with the cable type (armoured or unarmoured), improper tightening torque, missing seals, or compromised ingress protection (IP) levels. This paper aims to highlight the essential selection criteria for cable glands: compatibility with the type of protection, cable type and size, sealing and mechanical protection requirements, as well as specific environmental conditions. It also analyses applicable standards and presents examples that illustrate the consequences of inadequate choices. By addressing this topic, the paper seeks to raise awareness of the importance of execution details and promote best practices in assembling equipment used in Ex environments, in compliance with the relevant regulatory requirements.

1 Introduction

In today's industrial context, the safety of processes carried out in high-risk environments such as those characterized by potentially explosive atmospheres is of critical importance. Electrical installations used in such areas must be designed, built, and maintained in strict compliance with European and international regulations, in order to prevent any possible source of ignition.

One of the essential yet often overlooked components in this context is the cable gland. Although it may appear to be a secondary element in the structure of electrical equipment, the cable gland plays a crucial role in preserving the certified protection type of the device. An incorrect selection, improper installation, or disregard for environmental conditions can lead to a loss of sealing, short circuits, or possibly causing an ignition within the equipment.

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This paper aims to address the technical and regulatory considerations that must be taken into account when selecting and correctly installing cable glands for electrical equipment intended for use in potentially explosive atmospheres. In addition, it highlights some of the most common field errors and provides practical recommendations to help avoid them.

2 General considerations

2.1 Legal and normative framework

The selection and installation of cable glands for electrical equipment used in potentially explosive atmospheres must comply with specific technical and regulatory requirements. These components are not interchangeable accessories. They are classified as standalone equipment according to the ATEX Directive [1] and must be subject to proper conformity assessment procedures before being placed on the market.

Cable glands must be ATEX-certified and bear the CE marking along with the appropriate Ex marking. They must be accompanied by a Declaration of Conformity and must be used in line with the manufacturer’s instructions. According to the directive, both manufacturers and distributors are responsible for ensuring that products placed on the EU market meet the essential health and safety requirements for use in explosive atmospheres [1].

From a technical standpoint, according to the standard [2], cable glands must be compatible with the protection method of the equipment they are connected to, especially for flameproof enclosures (Ex d) and increased safety type protection (Ex e). They must ensure sufficient mechanical strength, thermal resistance, and ingress protection (IP) as required for the application.

2.2 Selection of cable gland devices

The installation and selection requirements are further detailed in the standard [3], which emphasizes the importance of compatibility with the cable type (armoured or unarmoured), and the necessity of following the manufacturer’s installation instructions, including torque and sealing specifications. Improper selection or installation can compromise the protection level and invalidate the certification.

A structured approach to the selection of cable gland devices is essential to maintain the explosion protection integrity of electrical equipment. The compatibility between the type of cable gland and the protection concept of the equipment is clearly specified in the standard [2] which outlines permitted combinations.

Table 1. Selection of cable gland devices, based on the enclosure Type of Protection

Type of Protection of the Ex Equipment	Type of Protection of the cable entry devices			
	Ex "d"	Ex "e"	Ex "n"	Ex "t"
Ex "d"	X			
Ex "e"	X	X		
Ex "i" and Ex "nL" – Group II ^a	X	X	X	
Ex "i" – Group III ^a				X
Ex "m"	Ex "m" would not normally be applied to wiring connections. The Type of Protection for connections shall suit the wiring system used.			
Ex "n" except Ex "nL"	X	X	X	

For Ex "nR"				
Ex "o"	Ex "o" would not normally be applied to wiring connections. The Type of Protection for connections shall suit the wiring system used			
Ex "p", all types	X	X	X ^b	
Ex "pD", Ex "p" – Group III				X
Ex "q"	Ex "q" would not normally be applied to wiring connections. The Type of Protection for connections shall suit the wiring system used.			
Ex "s"	Only as allowed by the conditions of the Ex-Equipment certificate.			
Ex "t"				X
X denotes permitted use. ^a Only applicable if a Specific Condition of Use for the intrinsically safe Ex Equipment requires the use of entry devices complying with IEC 60079-0. Cable entry devices will also need to meet a minimum degree of protection (IP Code) for the installation. ^b Only permitted for Gc installations				

This table provides a comprehensive overview of which types of cable glands (e.g., Ex d, Ex e, Ex t) are suitable for various equipment protection techniques. For example, Ex d enclosures require cable glands that preserve the flameproof integrity of the equipment and are tested according to specific criteria such as flame transmission, pressure containment, and impact resistance. In contrast, Ex e protection focuses on preventing arcs and high temperatures, thus requiring glands that offer high ingress protection (typically IP54 or higher), strain relief, and no risk of sparking [4].

In mixed or less common configurations, such as Ex p, Ex q, or Ex t, the selection must follow additional rules, often involving the specific conditions of use and the need for further verification of ingress protection and mechanical robustness. The table also makes it clear which combinations are not allowed or require specific justifications or exceptions.

By referencing this standard, engineers and technicians can ensure that each cable gland used in Ex environments is technically and legally compliant, contributing directly to the overall safety and reliability of the installation.

Selecting the appropriate cable gland is essential to preserve the certified explosion protection of electrical equipment. The decision must be based on both regulatory requirements and technical compatibility with the installation environment and cable characteristics. While general guidance is provided [3] through reference tables (see Table 1), the actual selection process must also account for additional criteria such as mechanical, thermal, and chemical constraints.

2.2.1 Cable type compatibility

A fundamental aspect of gland selection is the type of cable used: armoured or unarmoured. For Ex d enclosures, unarmoured cables typically require the use of barrier glands, which prevent the passage of gases along the cable cores by means of a compound-sealed barrier. Armoured cables can be used with standard Ex d glands as long as the armour is properly terminated and earth continuity is ensured. In Ex e or Ex t applications, the focus shifts to effective sealing and strain relief rather than flame or gas containment.

2.2.2 Thread type and size

Cable glands must be mechanically compatible with the threaded entries of the enclosure. Common thread types include metric (ISO), PG, NPT, and BSP, and mismatches between gland and enclosure threads are a frequent cause of nonconformities. Using mismatched threads is strictly prohibited and considered a major nonconformity under standard [3].

2.2.3 Material selection

The gland material must be suitable for the environmental conditions in which it will operate. Options include:

- Brass (nickel-plated) – common, corrosion-resistant, but may not be ideal in aggressive chemical atmospheres.
- Stainless steel – suitable for corrosive or offshore environments.
- Aluminium alloy – lightweight, but less resistant to corrosion unless properly treated.
- Plastic – never used in Ex d type protection, but acceptable in Ex e for non-hazardous external conditions.

Material compatibility also extends to the cable sheathing. Using incompatible materials can lead to degradation, loss of sealing, or loss of mechanical strength.

2.2.4 Ingress protection (IP) rating

To comply with the applicable standards [2, 3], glands must provide a minimum IP54 ingress protection in most Ex-environments. However, IP66 or higher is often used in industrial practice, especially in outdoor or high-humidity environments, to ensure better sealing and long-term durability. It is essential that glands are installed with all sealing components intact, including O-rings and washers, to maintain this level of protection.

2.2.5 Temperature range

It is essential that cable glands are chosen with appropriate temperature ratings, considering both the surrounding environment and the surface temperature of the connected equipment. Both high and low extremes can affect sealing performance and material integrity. Glands that are not rated for the correct temperature range may harden, crack, or lose elasticity over time.

2.2.6 Chemical and mechanical resistance

In environments with corrosive gases, solvents, or mechanical vibration, special gland materials and sealing technologies may be required. Cable glands are also exposed to dynamic stresses from cable movement and temperature changes, making proper strain relief essential.

2.2.7 Certification and marking

Every gland used in an Ex-application must be individually certified and marked accordingly. This includes the ATEX logo, protection type (e.g., Ex d IIC Gb), temperature rating (T-rating), IP rating and the range of cable diameters for which the gland is approved. Any omission or mismatch of markings may invalidate the equipment's conformity with the applicable standard [3].

This level of detail ensures that cable glands do more than simply "fit", they function as integrated safety components that sustain the explosion protection integrity of the system under real-world operating conditions.

2.2.8 Blanking plugs and unused cable entries

In applications where pre-machined threaded entries in Ex enclosures are not in use, it is mandatory to seal them using certified blanking plugs. These plugs must:

- Be ATEX certified for the same type of protection as the enclosure (e.g., Ex d, Ex e),
- Be mechanically compatible with the thread type and size of the entry,
- Provide the same or higher IP rating as the equipment.

The use of uncertified or improvised plugs (e.g., plastic caps, generic hardware store fittings) is a serious nonconformity and compromises the integrity of the explosion protection system.

Thread adapters or reducers may be used with cable glands only if they are certified and explicitly allowed by the enclosure's documentation. In Ex d enclosures, threads are often part of the flame path, so modifications are generally prohibited unless stated otherwise in the type certificate.

For stopping plugs, adapters are not permitted under any circumstances. They must be installed directly into the certified threaded entries to maintain protection integrity, as required by the standard [3].

3 Role of cable glands in explosion-protected equipment

Cable glands serve as critical components in the overall explosion protection of electrical equipment used in hazardous areas. Although they may appear to be simple mechanical accessories, their function is integral to maintaining the certified protection level of the enclosure. A cable gland does not merely provide a path for cable entry, it maintains mechanical stability of the connection, sealing against environmental factors, and, most importantly, preservation of the equipment's Ex protection method.

For flameproof enclosures (Ex d), the gland must ensure that any internal explosion within the enclosure cannot propagate to the surrounding atmosphere. This requires a flameproof barrier that withstands pressure, prevents flame transmission and maintains mechanical integrity under stress. Typically, this is achieved through the use of barrier glands filled with compound material, especially when unarmoured cables are used [5]. Improper selection or installation of such glands compromises the enclosure's ability to contain an explosion, rendering the entire system non-compliant.

In increased safety applications (Ex e), where the focus is on eliminating ignition sources during normal operation, cable glands must offer reliable strain relief, high ingress protection (usually IP54 or higher), and no possibility of sparking due to movement or loosening. These glands do not require flameproof features, but must still be certified for Ex use and installed according to the manufacturer's specifications.

Additionally, cable glands play a vital role in:

- Maintaining pressure in pressurized enclosures (Ex p),
- Protecting against dust ingress in Ex t environments,
- Ensuring that cable sheaths are properly sealed, avoiding moisture or gas ingress that could lead to failure or explosions,
- Preserving the temperature class of the equipment by preventing heat transfer or concentration at the cable entry point.

In each of these scenarios, the cable gland is not a generic part but a critical safety component specific to the equipment's explosion protection type. If the gland fails or is

improperly installed, it can invalidate the equipment's explosion protection and introduce severe safety risks.

Consequently, the role of the cable gland extends far beyond mechanical entry, it is a decisive factor in ensuring that the equipment performs safely and remains compliant with explosion protection requirements throughout its lifecycle.

4 Common installation errors and field nonconformities

Despite the availability of clear standards and certification requirements, field inspections continue to reveal a wide range of installation errors related to cable glands in Ex environments. These errors, although sometimes perceived as minor, can critically affect the explosion protection integrity of the equipment, leading to serious safety risks and loss of compliance with ATEX directives.

4.1 Use of non-certified cable glands

A common error is the use of cable glands that are not certified for use in potentially explosive atmospheres. These may lack appropriate ATEX markings, temperature class, or compatibility with the equipment's protection method. Their use voids the equipment's compliance and introduces serious safety risks.

4.2 Incompatibility with the protection method

Cable glands must match the protection type of the enclosure (e.g., Ex d, Ex e). Installing an Ex e gland on an Ex d enclosure, is a critical nonconformity. It compromises flameproof integrity and violates explosion protection.

4.3 Missing or damaged sealing components

Improper tightening, missing O-rings or washers, and incorrect assembly often result in loss of IP protection. This allows dust, gas, or moisture to enter the enclosure, particularly dangerous in Ex t environments where dust accumulation can lead to overheating.

4.4 Improper use of blanking plugs

Blanking plugs are designed to seal unused entries and must be certified for Ex use. In some cases, however, they are drilled or modified to act as cable entry points, which is strictly prohibited.

4.5 Improper cable selection or gland-cable mismatch

Using an armoured-cable gland with an unarmoured cable (or vice versa) results in poor clamping and sealing. Additionally, if the cable's outer diameter does not match the gland's rated clamping range, ingress protection is compromised.

4.6 Installation responsibility and supply chain gaps

A significant number of installation errors originate not from technical complexity, but from gaps in the responsibility chain between equipment manufacturers and end users. In most

cases, Ex equipment manufacturers deliver flameproof enclosures or increased safety assemblies without cable glands installed, unless the customer explicitly requests otherwise.

This approach is justified: the manufacturer cannot anticipate the cable type, diameter, or gland material needed for each installation scenario. However, if this aspect is not properly addressed and coordinated at the project level, it often results in:

- the use of uncertified or incompatible glands in the field,
- mismatches in thread type or size between gland and enclosure,
- missing documentation required for conformity assessment and inspection.

To avoid such issues, the selection and procurement of Ex-certified cable glands should be treated as an integral part of the design and installation process, and not left to on-site improvisation.

5 Case studies and practical observations

5.1 Improper use of stopping plug as cable gland



Fig. 1. Improvised cable entry using a drilled stopping plug

In this case, a stopping plug was drilled and used as an improvised cable entry on a flameproof transmitter enclosure. The modification allowed a cable to pass through the plug, with no strain relief or sealing element.

Observed Issues:

- The stopping plug is not certified for use as a cable entry device.
- No sealing or clamping is applied to the cable.
- The enclosure's flameproof integrity is compromised.
- No documentation or marking exists to prove compliance of this modified solution.

Consequences:

- The equipment loses its Ex d certification due to unauthorized modification of the enclosure.
- Any ignition inside the enclosure could lead to flame propagation through the modified entry.
- IP protection is completely lost at this point, allowing ingress of moisture, gas, or dust.

Corrective Actions:

- Replace the modified plug with a certified Ex d cable gland appropriate for the cable diameter and type.
- Ensure the gland is selected and installed in accordance with to the applicable standards [2, 3, 6].

- Document the configuration with updated inspection records and certificates of conformity.

5.2 Improved blanking plugs and cut cables



Fig. 2. Improved stopping plug using a cut cable inserted into a cable gland

In multiple installations, cable glands have been used with short segments of cut cable as an improvised stopping plug. Although the glands themselves may be certified, the use of severed cable sections in place of proper certified blanking plugs is not compliant with the applicable standards [2, 3, 6].

This practice introduces multiple hazards. Even if the cable is tightly compressed in the sealing ring of the gland, the extremely short length makes it unsuitable as a means of explosion containment. In the event of an internal explosion, the flame or pressure wave can escape through the interstitial space between the conductors and the outer sheath, potentially compromising the flameproof integrity of the Ex d enclosure.



Fig. 3. Improved stopping plug using a cut cable inserted into a cable gland and uncertified blanking element

In this case, a similar nonconformity, as in Fig.2 has been observed, a short cable inserted into a gland on top of a flameproof enclosure. While the gland itself may be certified, the cable segment is not long enough to act as an explosion-proof barrier. Moreover, the plug visible on the upper side of the enclosure appears corroded and lacks any visible certification or traceability, which further raises concerns about IP integrity and compliance with the standard [6].



Fig. 4. Improvised stopping plug using a cut cable inserted into a cable gland and uncertified blanking element

A similar improvised solution is used in the above installation, a cable gland filled with a cut cable instead of being properly sealed with a certified blanking plug. Again, the gland does not provide a proper flame path barrier due to the minimal length of the inserted cable, and another unoccupied threaded entry is sealed with an unmarked metallic plug, which is not verifiable as compliant.

Even if the plugs are metallic and appear robust, their lack of certification makes them non-compliant with the standard [6] and the ATEX Directive [1].

The standard requires that blanking plugs used in Ex d enclosures must be of a certified type, explicitly listed in the equipment documentation or accompanied by their own conformity declaration. A corroded surface, like in the first image, further raises concerns about environmental protection (IP rating) and long-term integrity.

These practices, although often driven by field constraints or material availability, undermine the very concept of flameproof integrity and should be corrected through proper equipment selection and planning.

Observed Issues:

- A cut cable has been inserted into the gland to block the entry, rather than using a certified blanking plug.
- There is no flameproof or gas-tight barrier between the enclosure interior and the external environment.
- The method is not recognized by any applicable standard and is technically unsafe.

Consequences:

- Due to its short length, the cable segment does not provide a sufficient barrier against gas or flame propagation.
- Hot gases may escape through interstitial gaps between the conductors and the sheath.
- Standard [3] require a minimum cable penetration length (typically 1 meter) when cables are used as part of the flameproof barrier, a condition clearly not met here.
- This invalidates the Ex d protection and would be rejected during compliance inspections.

Corrective Actions:

- Remove the cut cable and install a certified Ex d blanking plug matching the enclosure's thread and type of protection.
- Ensure all unused entries are properly sealed using components listed in the equipment documentation.
- Verify compliance according to the applicable standards [2, 3, 6].

5. 4 Improper cable entry sealing using polyurethane foam in Ex d enclosure



Fig. 5. Polyurethane foam used to seal cable entry in an Ex d flameproof enclosure

This case involves a flameproof (Ex d) enclosure into which several cables have been routed without using any certified cable glands. Instead, the open entry point has been filled with polyurethane foam to hold the cables in place. This practice is sometimes seen in the field when installers attempt to adapt standard industrial methods to Ex environments without understanding the technical and legal implications.

Observed Issues:

- No Ex d certified cable glands are used.
- The enclosure's flameproof entry is obstructed with polyurethane foam.
- The foam has no certification or tested flameproof properties.
- The installation provides neither sealing nor mechanical strain relief.

Consequences:

- Polyurethane foam is not permitted as part of the flameproof barrier.
- In the event of an internal explosion, hot gases and flames may escape through the unsealed cable entry.
- The equipment completely loses its Ex d certification and becomes unsafe for hazardous locations.
- This type of nonconformity can lead to immediate rejection during inspections or audits and exposes personnel to explosion risk.

Corrective Actions:

- Remove the foam and reconfigure the cable entry using Ex d certified cable glands appropriate for each cable.
- Follow the enclosure manufacturer's documentation for permitted entry configurations.
- Verify and document the sealing and mechanical clamping in accordance with the standards [2, 3, 6].

5.5 Distribution box with incorrect use of a certified gland



Fig. 6. Ex e distribution box with cable gland used as blanking plug

This Ex e distribution box shows a mostly compliant installation, including:

- Certified cable glands on the left, used with appropriate cable types;
- A proper Ex e stopping plug in the lower-right corner.

However, the gland in the top-right corner, although certified, is used incorrectly:

- It remains installed without a cable, likely in an unused entry;
- In such cases, the correct practice is to remove the gland and replace it with a certified Ex e stopping plug;
- Leaving an empty gland in place compromises the enclosure's ingress protection (e.g., IP54).

Corrective Action:

Remove the gland from the unused entry and replace it with a certified stopping plug to restore conformity with Ex e installation rules and maintain IP rating integrity.

6 Conclusions

The correct selection and installation of cable glands and blanking plugs in explosive atmospheres remains a critical element in maintaining equipment integrity, operational safety, and regulatory compliance. While these components are often perceived as secondary accessories, their role in preserving the protection concept (Ex d, Ex e, etc.) is fundamental [7, 8].

Field inspections and real-world examples presented in this paper show that nonconformities continue to occur frequently, even in professionally executed projects. These include the use of uncertified glands or plugs, improper adaptation to cable type or thread form, missing sealing components, and incorrect use of glands to seal unused entries.

Such deviations are not always the result of technical complexity but often stem from unclear responsibilities during the procurement and installation phases. Manufacturers typically deliver enclosures without glands or blanking plugs unless explicitly specified, leaving room for improvised or incorrect decisions at site level.

To avoid these issues, all components used in Ex installations must be:

- selected according to the protection concept of the equipment,
- certified individually for Ex use [9],
- installed following the manufacturer's documentation,
- and compliant with applicable standards [2, 6].

Attention to detail, documentation, and adherence to standard-based installation practices are essential for ensuring the safety of Ex equipment throughout its lifecycle. A rigorous and traceable approach to cable entry design should be treated as a core engineering responsibility, not an afterthought.

This paper aims to raise awareness among professionals working in hazardous environments about the critical importance of proper gland and plug selection, and to encourage the adoption of best practices based on proven standards and certification requirements.

Equally important is the role of the personnel involved in these installations.

All workers responsible for the selection, installation, inspection, or maintenance of Ex components must be adequately trained, aware of the associated risks, and formally authorized to work in explosive atmospheres in accordance with applicable legislation and standards [10].

Building awareness, enforcing technical discipline, and ensuring proper certification at every level of execution are essential steps in preventing installation errors and preserving safety in Ex environments.

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