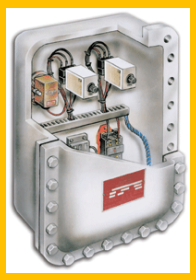
# MIE TALK – February 2017



## USE OF FLAMEPROOF ENCLOSURES IN EXPLOSIVE GAS ATMOSPHERES

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## Introduction

Fire and explosions are a major threat to life and asset integrity in hydrocarbon production facilities as well as in mines. For any explosion to occur there must be an associated ignition source present during a flammable atmosphere release

If a fault develops in a piece of electrical equipment located in an area where flammable gases are present, the fault could cause a disaster if the equipment is not Ex certified that can be used in explosive atmospheres. Flame proof enclosures are some of the protection types used in hazardous locations to prevent explosions and fires. It is important that end users fully understand what they are allowed to do with that Flame proof (Ex d) enclosure so as not to invalidate the certification of the complete equipment.

## Legislation

**Electrical Machinery Regulation 9(2)**

No person may use electrical machinery in locations where there is danger of fire or explosion owing to the presence, occurrence or development of explosive or flammable articles, or where explosive articles are manufactured, handled or stored, unless such electrical machinery, **with regard to its construction relating to the classification of the hazardous locations in which it is to be used, meets the requirements** of the safety standard incorporated for this purpose in these Regulations under section 44 of the Act.

**Note: Remember selection of Explosion Protected Equipment will always follow the area classification.**

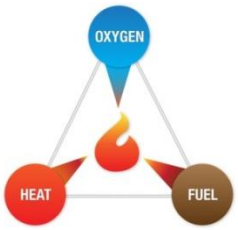
The following requirements are non-negotiable:

| | |
|---|---|
| 1 | Equipment is appropriate to EPL - Gb or Gc /Zone - 1 or 2 requirement of the location – Ex d |
| 2 | Equipment group is correct – IIA; IIB; IIC |
| 3 | Equipment temperature class is correct – T1 toT6 |

# What is flame proof equipment and where can I use it?

Flame proof equipment is the type of protection in which the parts which could ignite an explosive atmosphere are located inside an enclosure which **can withstand the pressure** of an explosion of the explosive mixture inside, and **prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure**. Technically unavoidable gaps are so long and narrow that hot gases jetting out will have lost their power to cause ignition by the time they reach the outside of the enclosure.

All three components can be present at flameproof equipment:




**EPL: Gb & Gc**

**Applicable standards: SANS 60079-1**

**Note: Flame proof equipment is suitable for Zone 1 and Zone 2 locations**

**Table 1: Classification of equipment for use in hazardous locations**

| 1 | 2 |
|---|---|
| **Hazardous zone** | **Equipment classification** |
| **0**<br>**Present continuously or for long periods 1000hrs + per year** | **EPL: Ga**<br><br>Intrinsically safe apparatus of category "ia" (Ex ia) with overvoltage surge protection compliant with an approved standard (note 1). |
| **1**<br>**Could occur periodically during normal operation 10-1000 hrs per year** | **EPL: Gb**<br><br>Intrinsically safe equipment of category "ia" or “ib” (Ex ia or Ex ib) (note 1)<br>Flameproof (Ex d) equipment<br>Specially protected (Ex s) equipment<br>Increased safety (Ex e) equipment (note 2)<br>Encapsulated (Ex m) equipment |
| **2**<br>**Present during abnormal operation, short period’s 0.1-10hrs per year** | **EPL: Gc**<br><br>Any type of equipment suitable for zone 0 or zone1<br>Intrinsically safe apparatus of category "ic" (Ex ic)<br>Non-sparking (Ex nA) or (ec) equipment |

**NOTE** 1 All intrinsically safe circuits (Ex i circuits) should have system certification from an approved testing/certification body to ensure that the various devices in the circuit, with the interconnecting wiring and cabling, are compatible and suitable for the application.

The following information should be submitted for certification of Ex i circuits:

a) a loop diagram showing all equipment and cabling or wiring;

b) information about the equipment characteristics indicated on the loop diagram and in the form of a certificate by an approved testing/certification body; and

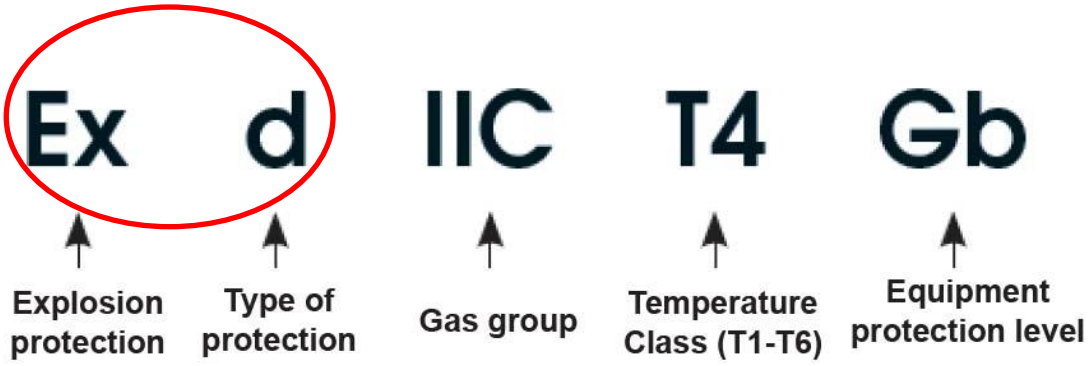
c) cabling and wiring information indicating cable types and lengths as well as resistance, capacitance and inductance characteristics.

**NOTE 2** Ex e motors should not be used in hazardous locations unless approved overload protective devices are used with such equipment and precautions taken to ensure that such protection cannot be rendered ineffective during use.

**NOTE 3** Equipment ratings should be taken into account so as not to cause overheating that leads to excessive surface temperatures.

## Marking of flame proof equipment

Flame proof equipment can be identified by the following marking:




## Construction of flame proof equipment

In order to certify flame proof enclosures, the enclosure must be strong enough not to fracture or distort under the internal pressures generated in order to contain explosions and prevent propagation. When testing a product for Explosion proof protection, it will have to undergo an actual explosion within simulated environments at a SANAS Accredited Test Laboratory (ATL).

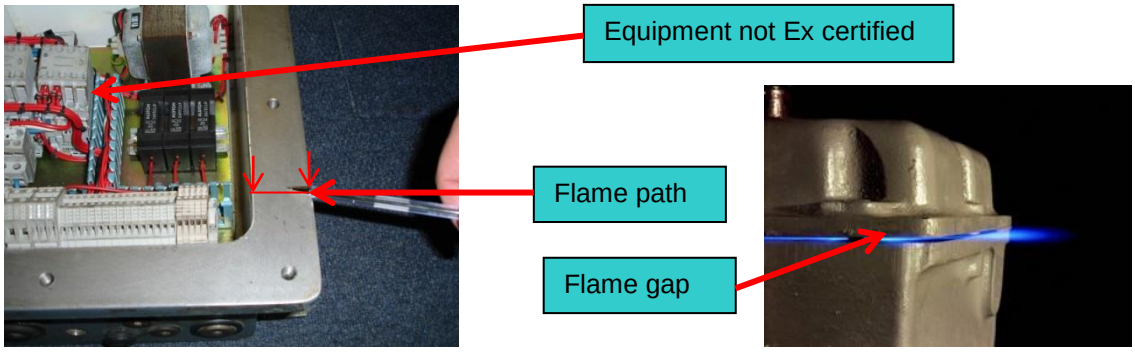



**Figure 1:**Flame proof enclosure

**Characteristics:**

- Use non certified equipment inside enclosure – can cause a spark.
- Explosions may occur inside enclosure
- Enclosure contains the explosion.
- Withstand the pressure during internal explosion – build strong enough
- Flame path prevent that hot gas or flames exit the enclosure prevent ignition of the external atmosphere.

**Temperature class:**

- Measure on outside of equipment.

## Different types of Flame proof joints:

The flame path as well as the flame gap of any flameproof equipment are very important and must be well maintained. Damage to flame paths and flame gaps can cause fires and explosions.

- The first requirement is that the joint must be robust and be of an approved design.
- Secondly, the joints must absorb the heat of the flame or hot gas of an explosion, as it escapes from the enclosure and thereby preventing it from igniting the surrounding atmosphere.
- Thirdly, joint surfaces must mate as closely as the method of manufacture allows. The maximum gap allowed for Class A enclosures is 0,5 mm provided that the joint is at least 25 mm wide.
- A complete table of flameproof paths and permissible gaps or clearances is given in “Standard Specifications for Enclosures for Electrical Apparatus” (SANS 60079-1)

**Maximum experimental safe gap (MESG)**

**Definition:**

The maximum gap of the joint between the two parts of the interior chamber of a test apparatus which, under specified conditions, when the internal gas mixture is ignited, prevents ignition of the external gas mixture by flame propagation through a joint measuring 25 mm in length.

**Table 2:** MESG

| Group | Safe gap in mm | MIC ratio |
|---|---|---|
| II A | > 0,9 | > 0,8 |
| II B | 0,5 up to 0,9 | 0,45 up to 0,8 |
| II C | < 0,5 | < 0,45 |

**NOTE:** Internal fire or explosion must be “contained” such that it does not ignite the surrounding hazardous atmosphere.

**There are four types of approved joints in flameproof enclosures, namely**

- Internal flange joints,
- External flange joints
- Spigot joints
- Screwed joints

**Figure 2:** Internal flange joints

**Figure 3:** External flange joints

**Figure 4:** Spigot joints

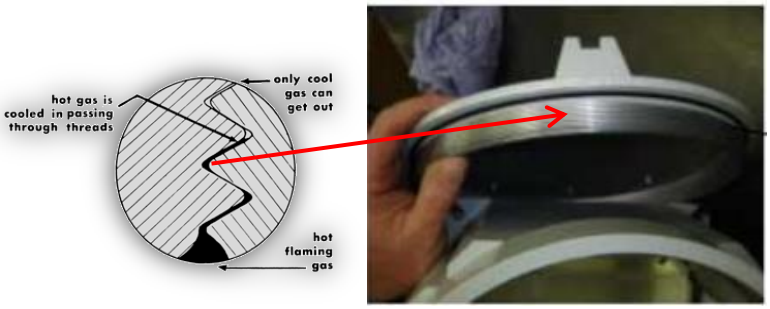



**Figure 5:** Screwed joints

## Installations methods of Ex d enclosures

In principle there are three methods of providing electrical connections:

- Cables system with indirect cable entry, through separate Connection Boxes
- Cables system with direct entry
- Conduit Systems

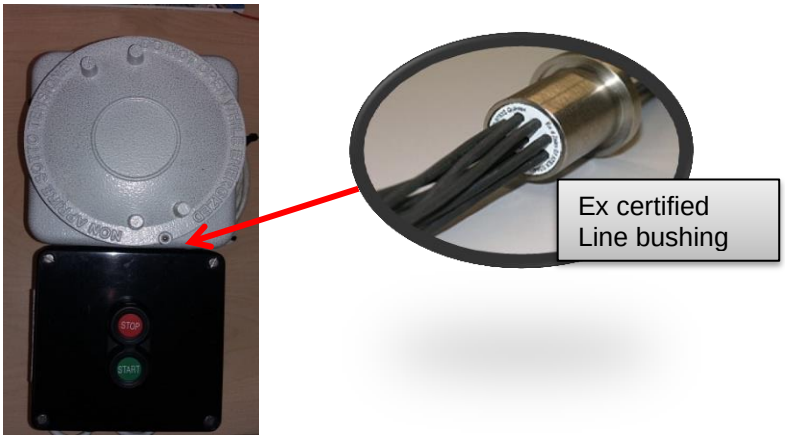



**Figure 6: Cable system with indirect entry;**

- Ex line bushings are used to electrically connect equipment in potentially explosive atmospheres. The connection is established either between a flameproof enclosure and an enclosure of another type of protection and in accordance with SANS 60079-0.

- Combination of Exd and Ex e enclosure (figure 6)


**Figure 7**: **Cable system with direct entry**

- Appropriated glands must be used – Ex d or a barrier gland as required by SANS 60079-14.

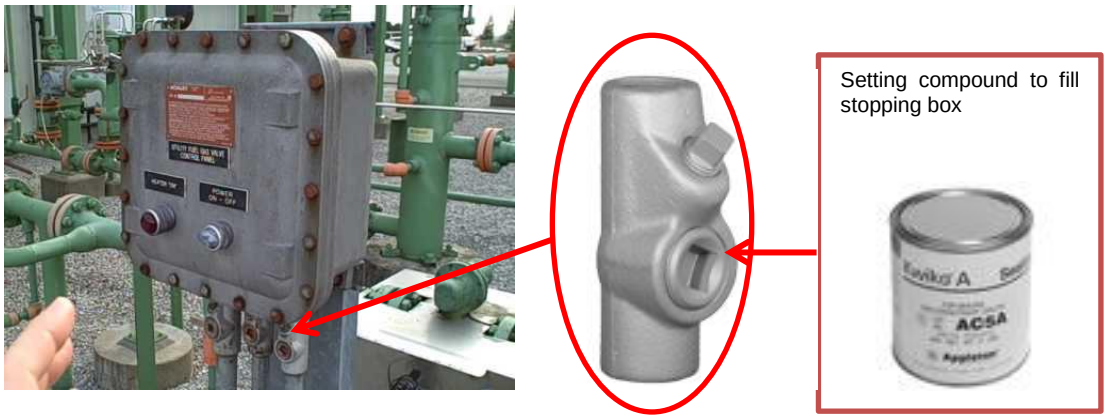



**Figure 8: Conduit system with stopping box and setting compound**

- A sealing device such as a stopping box with setting compound shall be provided, either as part of the flameproof enclosure or immediately at the entrance thereto.

- Direct conduit or tubing entry is not permitted on any Ex d enclosure

## Maintenance of joint surfaces

Although faces are machined flat, there will be a slight gap between the flanges when they are bolted together.

**Rust on the surfaces of the flanges**

- When approved flameproof enclosures are used for a considerable period of time where the conditions are moist, rust may form on the surfaces of the flanges. This rust must not be removed with any sharp tools, sandpaper or files which can increase the size of the flame gap. Only a fine steel brush should be used.

- No copper coating or any metal inhibited (impregnated) grease should ever be used to prevent rust between two opposing faces of any approved flameproof enclosure.

- It has been proved that copper coating or similar materials diminished the cooling effect of the flame path.

**Prevention of rust between opposite faces**

- To prevent rust between opposing faces a very thin layer of non-flammable grease can be used. No solid setting sealant (Silicon rubber) may be used on flameproof joints. A thin layer of petroleum jelly is normally used.

- After maintenance a feeler gauge should be used to make sure that the gap is still within the specified limits.

**Procedure if heat damage is suspected**

- If it is suspected that heat damage has occurred, flanges should be checked on a surface table or with a straight edge.

**Figure 9: Checking flange faces with a straight edge**

**Damage to flameproof enclosure during operation**

- In the event of a flameproof enclosure or cover becoming cracked during operation, the cover or enclosure must be replaced. Welding is not permitted on flameproof covers or enclosures, since the metal normally warps when welded.

**Note:** If the gap between the flanges becomes too large, the respective flange faces must be re-machined. However any machining which might affect the structural strength of the enclosure must be followed by a hydraulic overpressure test as per SANS 60079-1.

## Types of bolts approved for securing joints

The requirements for bolts, screws and studs used in the construction of a flameproof enclosure.

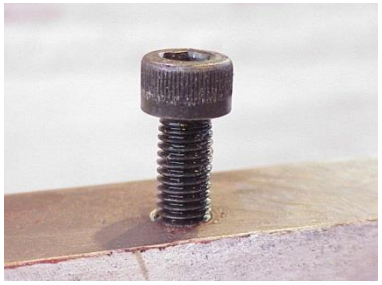


**Figure 10: Bolt used in flame proof enclosure**

All bolts, screws and studs used in the construction of a flameproof enclosure must meet the following requirements:

- Have non-slotted heads – bolts cannot be tightened properly with a screwdriver.
- Be of the correct length, nominal diameter and thread form for the tapped hole because it is possible that the wrong length, diameter or thread form bolt could be used in a hole, which may affect the compliance of the enclosure.

  Wrong thread form on a bolt may strip threads in a hole. Wrong length of bolt may either have too few threads engaged or if too long could bottom in the hole, thus preventing the cover to be pulled down properly or perhaps pushing a hole into the casing.
- Be present and tight – this is the most important requirement to make any flameproof enclosure flameproof, because if all bolts are not tight and present, the specified air gap may be increased during an internal explosion. Every time a flameproof enclosure is assembled, the bolts and studs and holes should be inspected for damaged threads.
- Remove any dirt from the bottom of a blind hole before refitting bolts, otherwise the bolt may bottom in the hole, thereby not correctly securing the cover or perhaps pushing a hole into the enclosure.

# Factors to consider when installing in hazardous areas:

### Problems with cable construction

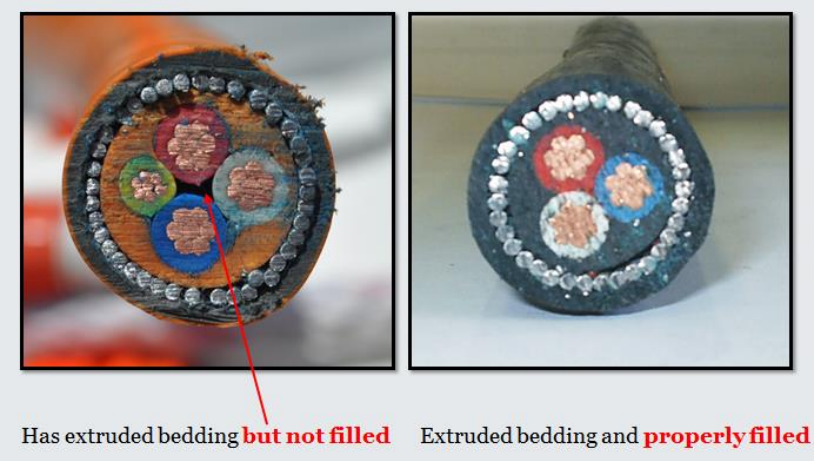



**Figure 11: Cable: Non-hygroscopic/not filled and Hygroscopic/filled**

### Why use a Barrier Gland ?

- Cables are hygroscopic instead of non-hygroscopic.
- A Barrier gland must be used where the construction of a Cable is such that a standard Exd gland with seals will not adequately maintain the integrity of the Exd equipment.
- A Barrier gland stops gas and/or explosions bypassing the inner elastomeric seal of a gland and propagating down the interstices of the cable.


**Figure 12: Cable (Unround / filled)**

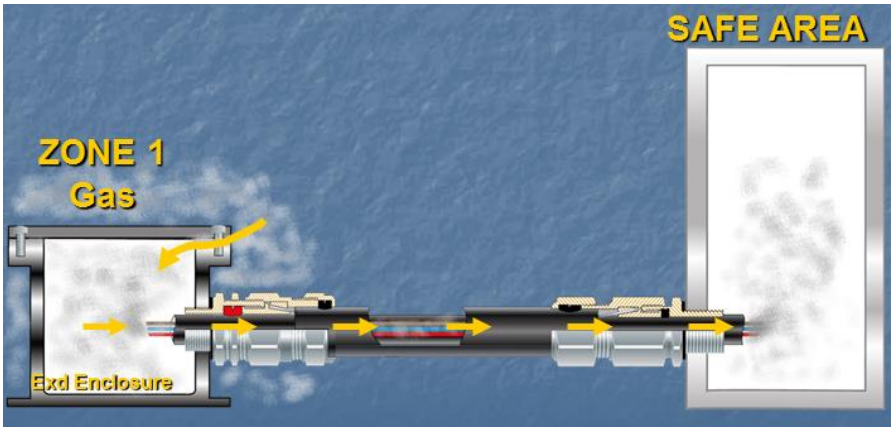



**Figure 13: Explosive environment transfer through cable**

**Dangers of gas propagation from a hazardous area to a safe area through unfilled cable:**

**Glands:**

- Only Ex d or flameproof glands are allowed for Gas groups IIA, IIB and IIC gasses in Zone 2 locations if the cable meets the requirements according to the standards. This also applies for fire damp in mines.

- No direct entry of an Ex d gland is permitted in a Zone 1 location with Gas Group IIC present as well as IIA and IIB Gasses under certain conditions.(The Ex de combination must be applied as per figure 6).

- Indirect Cable Entry into Ex d Enclosures by making use of Ex e and Ex d enclosures

- The two enclosures are connect by certified bushings

- Ex line bushings are used to electrically connect equipment in potentially explosive atmospheres. The connection is established either between a flameproof enclosure and an enclosure of another type of protection and in accordance with SANS 60079-0.

**Types of Ex d enclosures:**

- Luminaires

- Motors

- Actuators

- Control stations

## Common drawbacks

Knowledge of relevant standards and education are fundamental. Mistakes occur due to lack of knowledge or inexperience. The most common mistakes by end users are:

- Many end users replace faulty components with smaller components that will increase the volume of the enclosure. The results of the flame transmission test performed during the test laboratory type examination procedure could be negatively affected and a possible internal ignition will not be safely controlled by the existing flameproof enclosure from the external explosive atmosphere.

- Drilling new cable gland entries into an Ex d enclosure after or prior to installation.

- Fit additional components into the enclosure such as a switch or a component. This type of modification can have an impact on the temperature class rating of the equipment's enclosure and can become a source of ignition.

- Modifying an Ex d enclosures include accidentally damaging the flameproof gap where the end user scratch or damage the flanges.

**Figure 14: Damaged flame path**

The certification of the equipment is no longer valid if any modification is carried by the end user

Therefore, if any modifications are made to an Ex d enclosure and these are not within the responsibility and agreement of the equipment manufacturer, only two options exist:

- Ex d enclosure must be send back to the OEM for recertification by an ATL.
- The end user takes full responsibility which means they also become responsible for any subsequent failures of the enclosure that could lead to serious health and safety risks.

The relevant standard to consult is IEC/SANS 60079-19 that provides end users with technical instructions on the repair, overhaul and modification of equipment designed for use in explosive atmospheres.

**Painting of flame proof enclosures**

Painting an Ex d enclosure can cause the following problems:

- paint gets in and around the flame gap, can adversely affect the certification
- screws that are painted over can prevent access to the enclosure
- paint is typically non-conductive that can also lead to electrostatic hazards and introducing an ignition source .

## Objectives of Ex inspection

- To confirm the integrity and properties of Ex equipments in the Hazardous area.
- To ensure the suitability of Ex equipments in the particular Hazardous location.
- To meet national standards, regulations and company safety guidelines.

## Types of inspection

**Initial Inspection** is necessary to check that the selected type of protection is appropriate for the hazardous area installation before commissioning.

**Periodic Inspection** is a routine inspection that applies to existing installations. It monitors the effects of deterioration or change. The intervals between periodic inspections should not exceed two years

## Conclusion

All employees working in hazardous locations should first ensure that they understand and recognise the relevant standards and read the instruction manual provided by the manufacturer before starting any work on an Ex d enclosure.