MODULE III

Types of explosion protection of electrical equipment

Definition

Explosion-proof equipment -

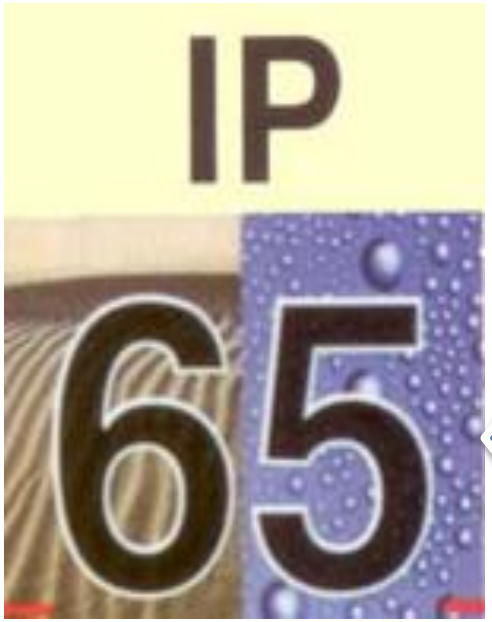
Special-purpose electrical equipment that is designed in such a way that the possibility of ignition of it and the surrounding explosive environment due to the operation of this equipment is eliminated or hindered.

Definition

IP degree of protection:

The measures applied to the cases of the devices provide, firstly, protection of people from contact with living or moving parts inside the case and protection from ingress of solid foreign bodies and, secondly, protection of the devices from ingress of liquids.

Protection against dust, water and solid objects



Protection against Solid Objects and Dust
7 levels: from 0 to 6

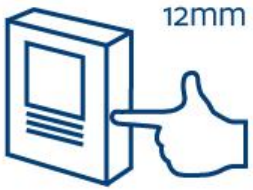
Protection against WATER
10 levels: from 0 to 9

Protection against dust and water

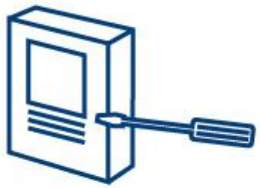
Protection against solids

1 Protected against a solid object greater than 50mm such as a hand.

2 Protected against a solid object greater than 12.5mm such as a finger.



3 Protected against a solid object greater than 2.5mm such as a screwdriver.



4 Protected against a solid object greater than 1mm such as a wire.

5 Dust Protected. Limited ingress of dust permitted. Will not intefere with operation of the equipment. Two to eight hours.

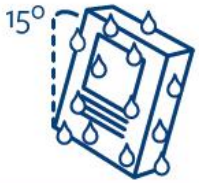
6 Dust tight. No ingress of dust. Two to eight hours.

Protection against water and dust

Protection against water

1 Protected against vertically falling drops of water.
Limited ingress permitted.

2 Protected against vertically falling drops of water with zenclosure tilted up to 15 degrees from the vertical. Limited ingress ermitted.



3 Protected against vertically falling drops of water.
Limited ingress permitted.

4 Protected against sprays of water up to 60 degrees from the vertical. Limited ingress permitted for three minutes.

5 Protected against jets of water. Limited ingress permitted.

6 Water from heavy seas or water projected in powerful jets shall not enter the enclosure in harmful quantities.

Protection against water and dust

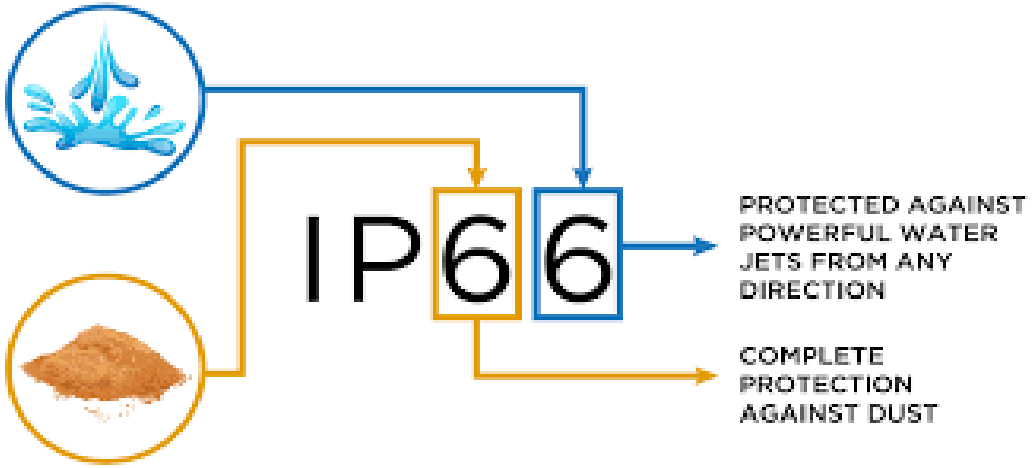
Protection against water

7	Protection against the effects of immersion in water between 15cm and 1m for 30 minutes.	
8	Protection against the effects of immersion in water under pressure for long periods.	
9	Protection against the effects of high pressure and temperature water jet.	

Protection against water and dust

Minimum IP rating for explosion proof equipment

IP rating for explosion-proof equipment commonly found



FGP is normally IP66 unless Engineering specify otherwise.

Protection against water and dust

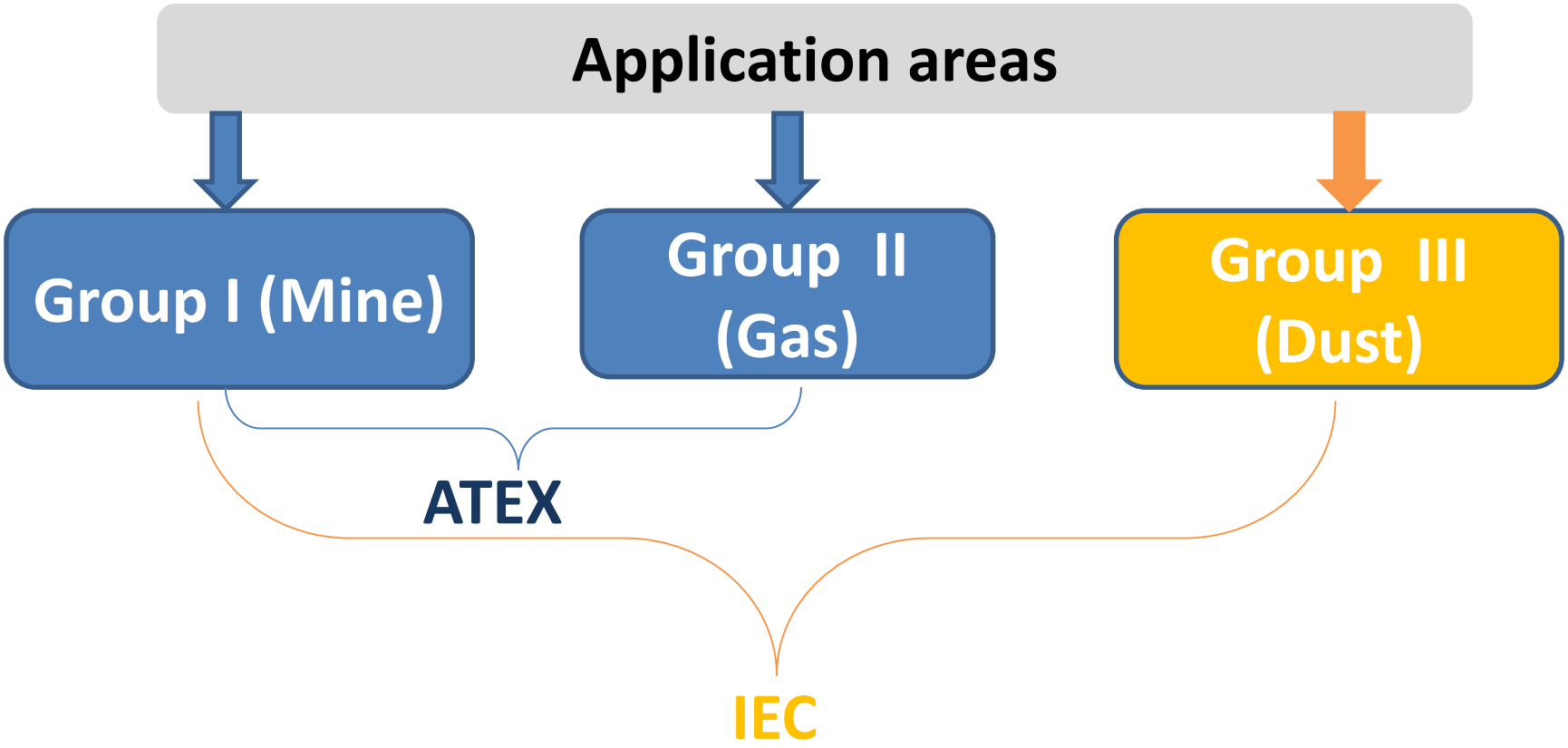
If either numeral is represented by an “X,” it means the product has not been tested in that category. It does not equate to a ranking of 0, but it does not guarantee any protection.

Protection against water and dust

Level	Protection against access to dangerous parts
A	Back of the hand
B	Fingers
C	Tool
D	Wire

Letter	Meaning
H	High-voltage equipment
M	Moving device in testing with water
S	Static device in testing with water
W	Environmental conditions

Classification of explosion-proof equipment



Classification of explosion-proof equipment

By category of explosive mixture (gas group)

Group I (Mine)

Group II (Gas)

- Sub group IIA
- Sub group IIB
- Sub group IIC

Group III (Dust)

- Sub group IIIA
- Sub group IIIB
- Sub group IIIC

ATEX

IEC

Classification of explosion-proof equipment

Equipment marked IIC or II can be used with gases in divisions IIC, IIB and IIA;

Equipment marked IIB can only be used with gases in divisions IIB and IIA;

Equipment marked IIA can only be used with gases in division IIA.

Classification of explosion-proof equipment

Equipment protection level

Group I			Group II			Group III	
Ma	M1	M 0	Ga	1G/D	0	Da	0
Mb	M2	M 1	Gb	2G/D	1	Db	1
			Gc	3G/D	2	Dc	2
ATEX			CU TR			IEC	

Equipment protection level

Very high

high

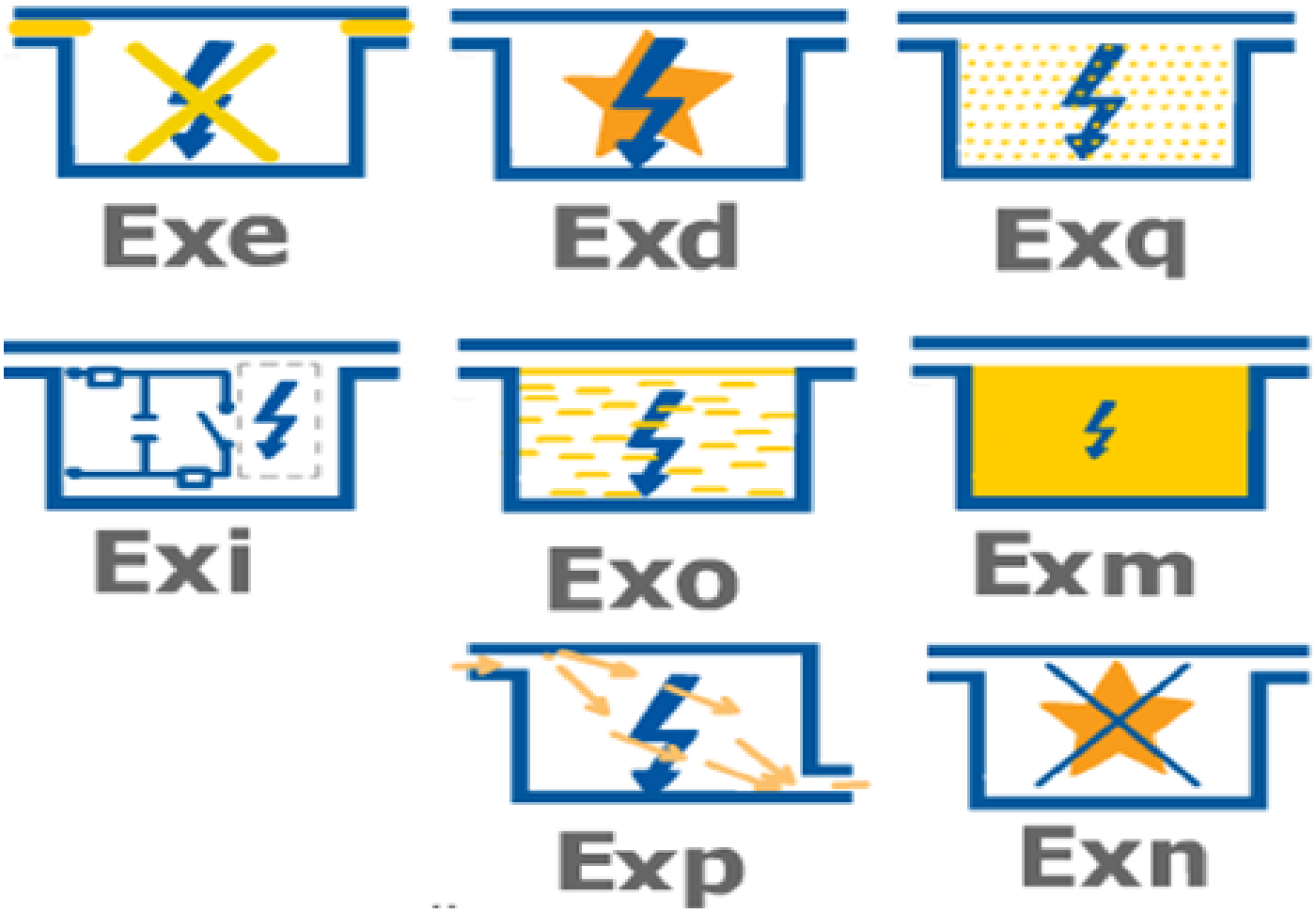
Normal

The level of explosion protection assigned to electrical equipment depending on the danger of becoming a source of ignition and the conditions of use in explosive gas, dust-air environments

Classification of explosion-proof equipment

Class of zone	ATEX (category)	IEC (EPL)	CU TR
0	1	a	0
1	1, 2	a, b	0, 1
2	1, 2, 3	a, b, c	0,1,2

Classification of equipment by type of protection



1
2
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Classification of equipment by type of protection

Flameproof enclosure Ex d

(The equipment contains sparks, arcs or high heat)

IEC 60079-1

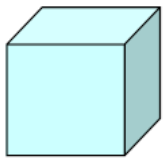
Flameproof enclosure Ex d

The equipment is of Solid and Robust construction. Usually 4 times the reference pressure of an internal explosion

TYPICAL MATERIALS :

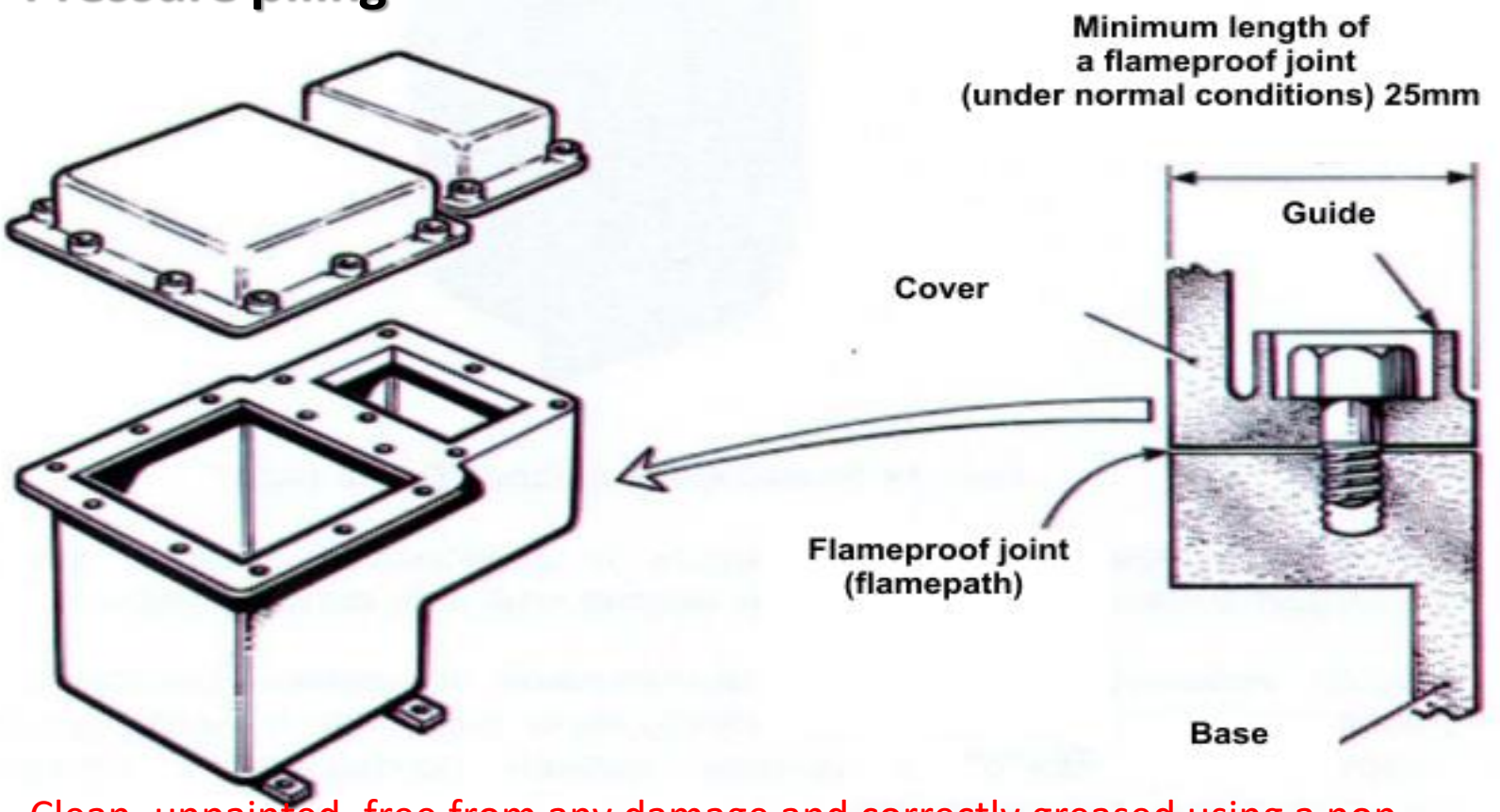
- Cast-iron
- Aluminium Alloys
- Gun Metal Bronze
- Phosphor Bronze
- Stainless Steel

PLASTICS - Can Be Used Where The Free Volume Does Not Exceed 10 cm^3



Flameproof enclosure Ex d

Pressure piling



Clean, unpainted, free from any damage and correctly greased using a non-setting grease (FGP specifies the use of HTL4 grease)

Flameproof enclosure Ex d

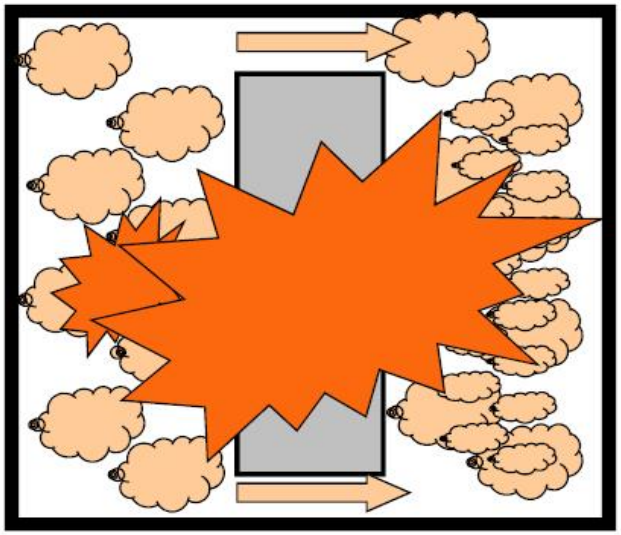
Pressure Piling

Pressure piling can result from **an uncontrolled** modification to the original designed **internal layout** or by connecting two items of Exd equipment together by a short piece of conduit.

A sub-division of the interior of a flameproof enclosure, prevents the natural development of an explosion.

The secondary explosion can reach an explosion pressure around three times that of the first or normal explosion pressure.

There should be adequate free space (typically 20 – 25% of the total cross-section) around any potential obstruction



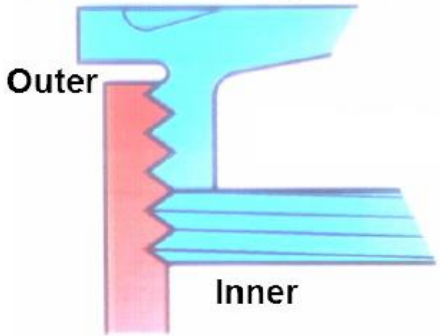
Example: Division of enclosure

HORIZON

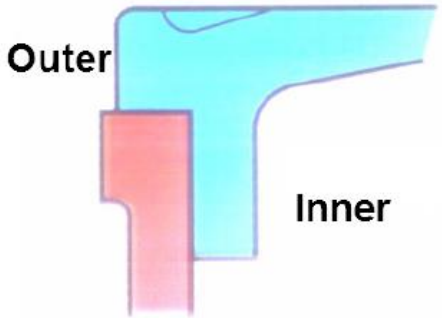
Flameproof enclosure Ex d

Flamepath Joints

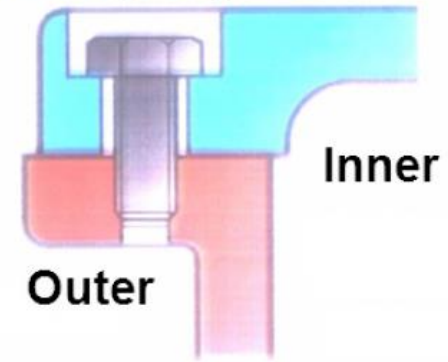
Threaded joint



Spigot joint

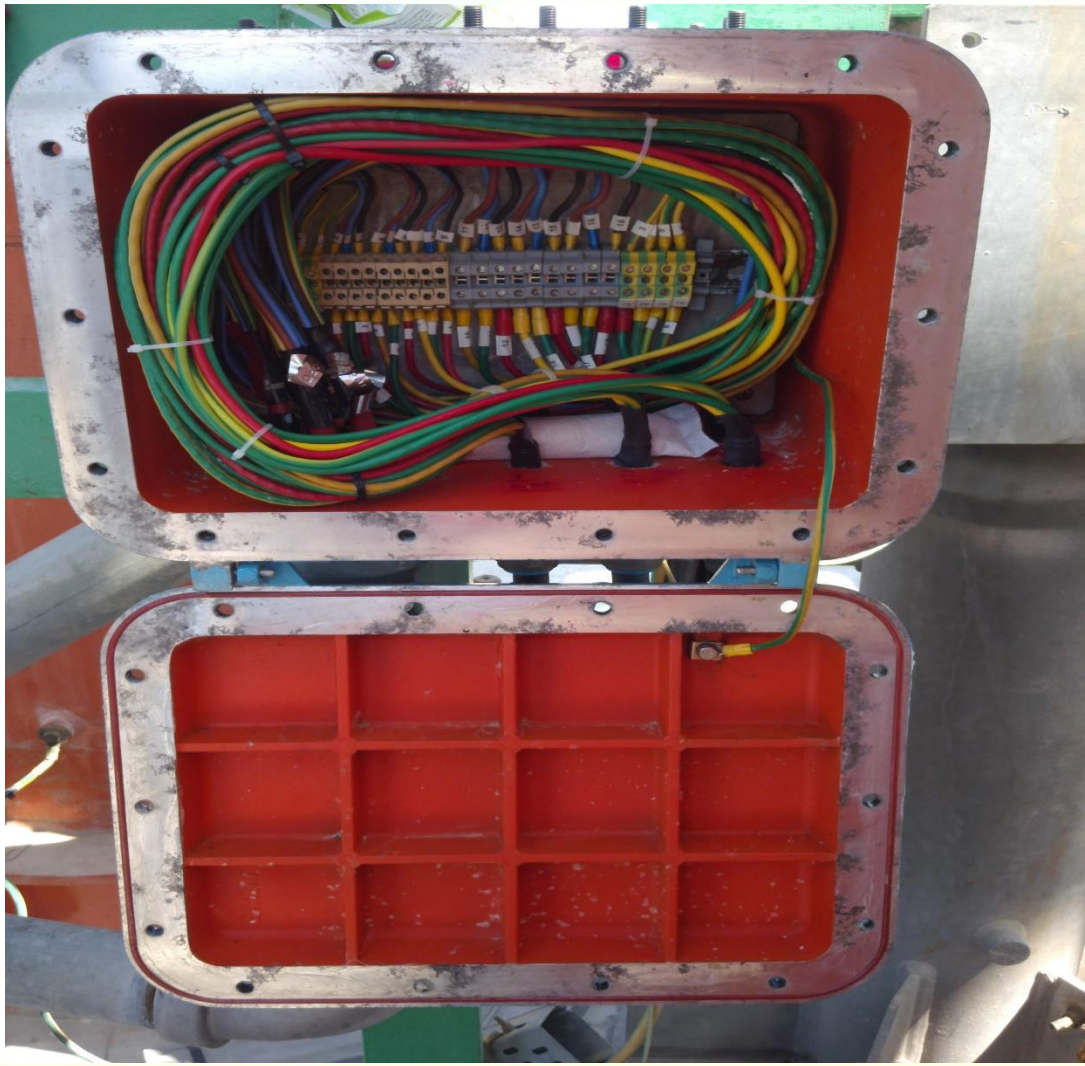


Flanged joint



Objective: To prevent the flames and "hot" gases of an internal explosion being transmitted to an external explosive atmosphere.

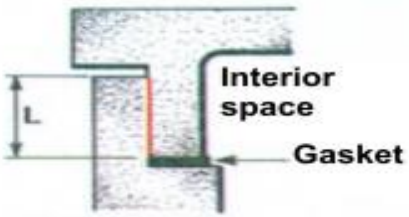
Flameproof enclosure Ex d



Flameproof enclosure Ex d

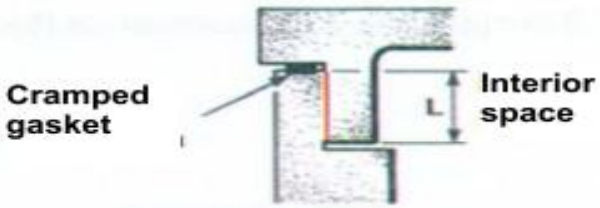
Gasket

Unsuitable for outdoor use of equipment

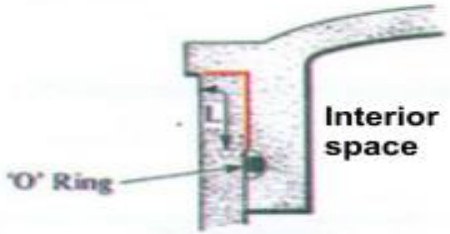


a) The gasket is set inside

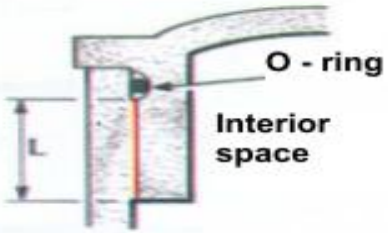
Suitable for outdoor use of equipment



b) The gasket is set outside

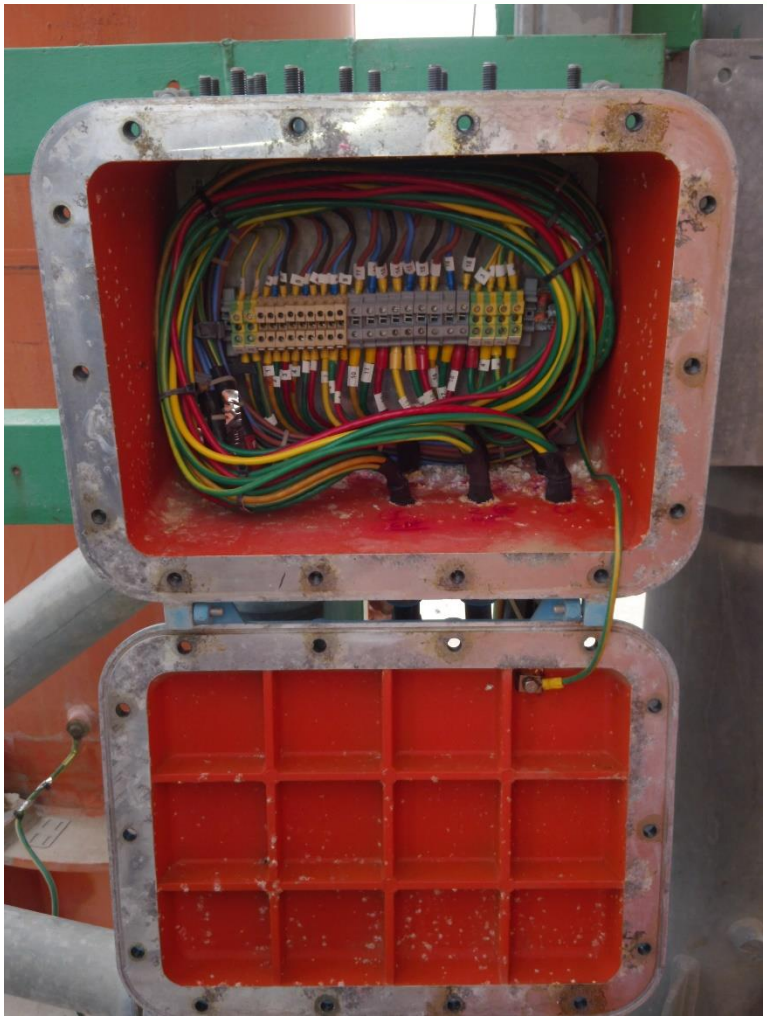


c) The gasket is set inside



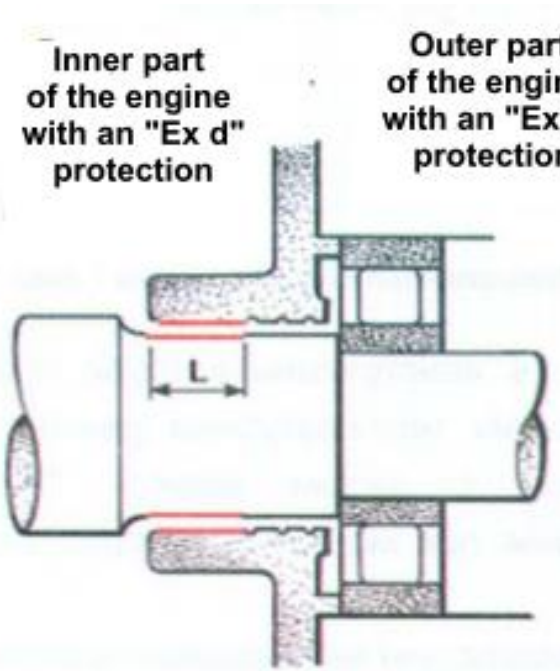
b) The gasket is set outside

Flameproof enclosure Ex d

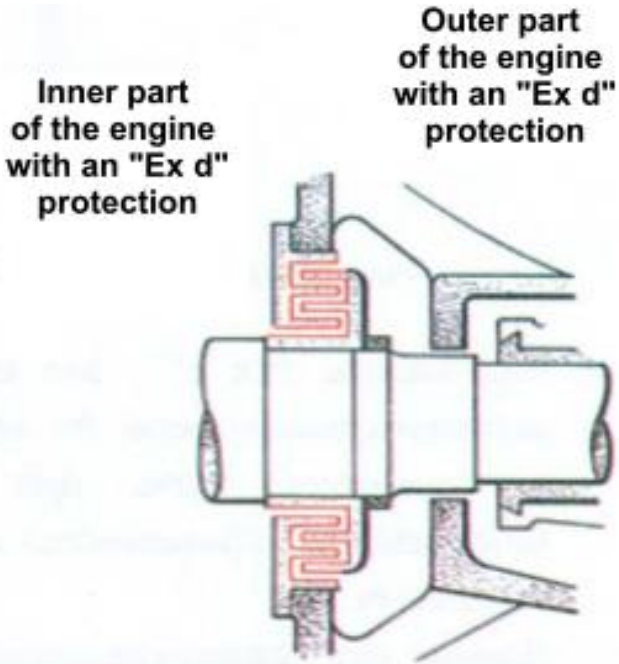


Flameproof enclosure Ex d

Types of sealing for electric motor shafts



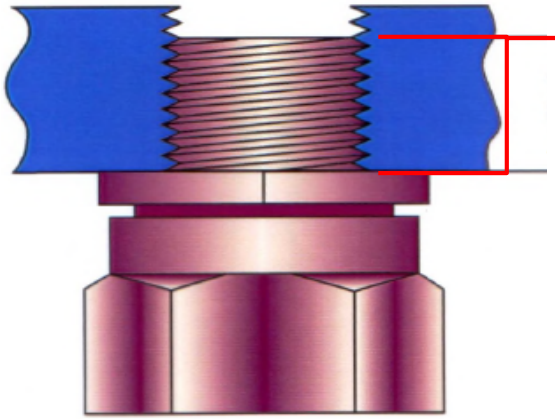
a) ROLLER BEARING



b) LABYRINTH SEAL OF A JOURNAL BEARING

Flameproof enclosure Ex d

Joints



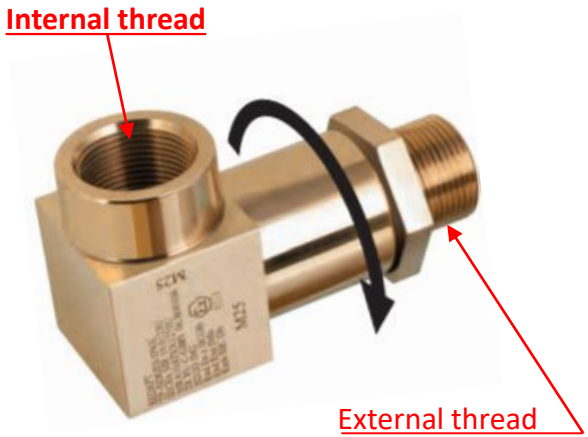
Parallel Thread Entries

Enclosure Entry not less than:

- 8 full Threads
- 8 mm Axial length

Gland Engagement:

- Not less than 5 full threads



IEC 60079-1 (Ex d) Section 13.1 General:

– **external metric threads** with a threaded part of at least 8 mm in length and at least eight full threads. If the thread is provided with an undercut, then a non-detachable and non-compressible washer or equivalent device shall be fitted to ensure the required length of thread engagement;

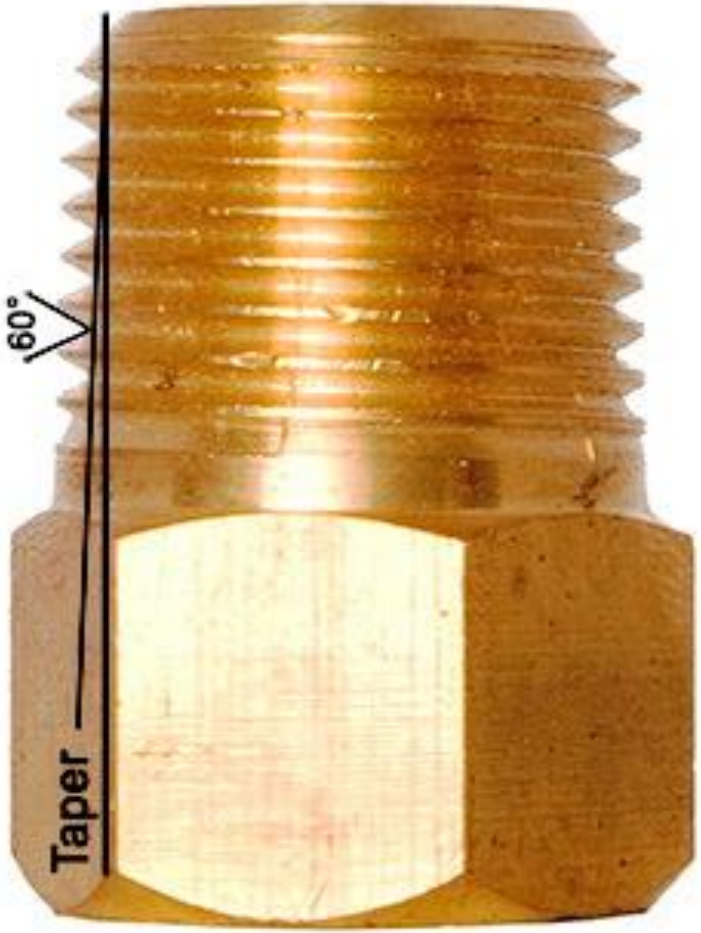
NOTE 1 The requirement for at least eight full threads is to ensure that at least five full threads will be engaged when the part is installed in a threaded entry – taking into account the presence of any chamfer or undercut.

Flameproof enclosure Ex d

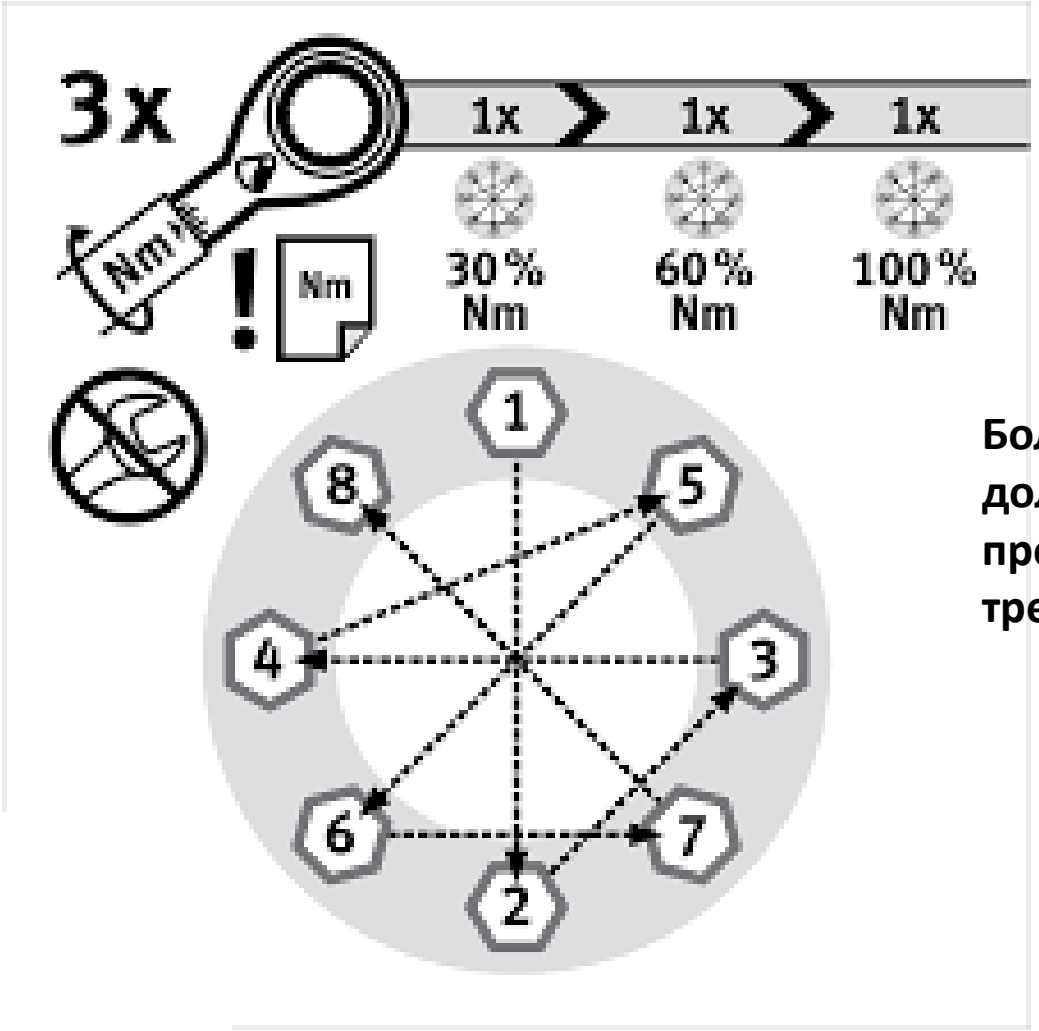
Joints

NPT

Needs to be fully wrench tightened!



Flameproof enclosure Ex d



Болты крышки оболочки должны быть смазаны и протянуты в соответствии с требованиями производителя

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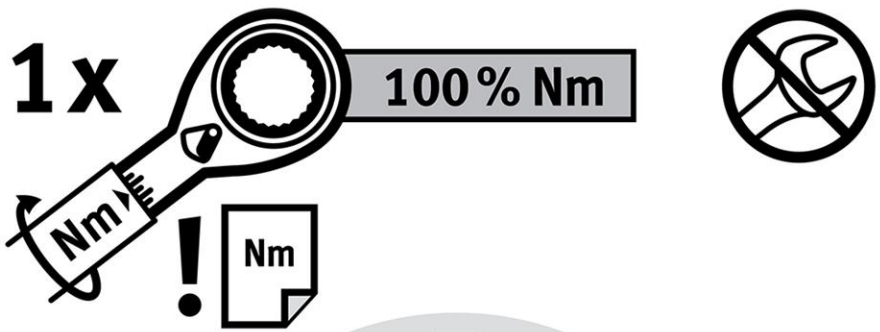
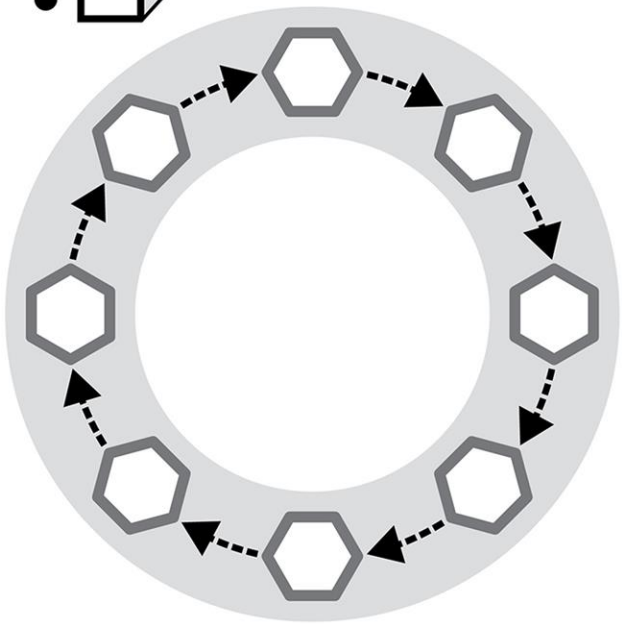
Flameproof enclosure Ex d





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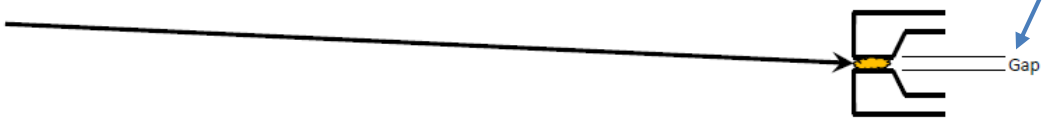
Flameproof enclosure Ex d

Weatherproofing

Equipment can have as part of their approved design, seals or gaskets to prevent the ingress of water and/or dust.



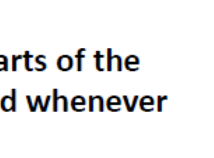
IIB gases gap between joint surfaces not to exceed 0.1mm.

The use of non-setting grease in the flamepath gap of the machined surfaces has two advantages

a. Additional level of ingress protection.
b. Inhibits formation of rust on these surfaces.

Non-hardening grease-bearing textile tape (Denso Tape) may be employed outside of a straight flanged joint with the following conditions:

- The tape should be restricted to one layer surrounding all parts of the flange joint with a short overlap; new tape should be applied whenever existing tape is disturbed;
- New tape should be applied whenever existing tape is disturbed;
- where the enclosure is used in conjunction with gases allocated to Group IIC, tape should not be applied.



Machined surfaces of flanged joints should not be painted.

Flameproof enclosure Ex d

Crouse Hinds - HTL 4

Lubricants, HTL Series

Item# HTL4 *- Thread Lubricant,High Temperature, 4oz Tube*

HTL Series Information

- Effective and Stable from -70
- Prevents Seizure, Galling, and Rust
- Stops Galvanic Action
- Maintains Grounding Continuity
- Effective Between Dissimilar Metals

Crouse-Hinds HTL is a high temperature, anti-seize, conductive thread lubricant. It is used on lighting fixture threaded joints and on threaded joir of the enclosures of any heat producting apparatus or control.

Approved for project!

Flameproof enclosure Ex d

Ex ‘d’ Maintenance Checklist

Enclosure:

- Damage to flamepaths.
- Obstruction of flamepaths. (Flange joints only)
- Glands/Stopping plugs/Adaptor are tight and certified.
- All cover bolts tool/spanner tight, check gap sizes.
- Corrosion prevention of flamepath grease/tape applied correctly.
- Weather protection O ring/gasket undamaged and in position.
- Earth Terminals – Corrosion Free.

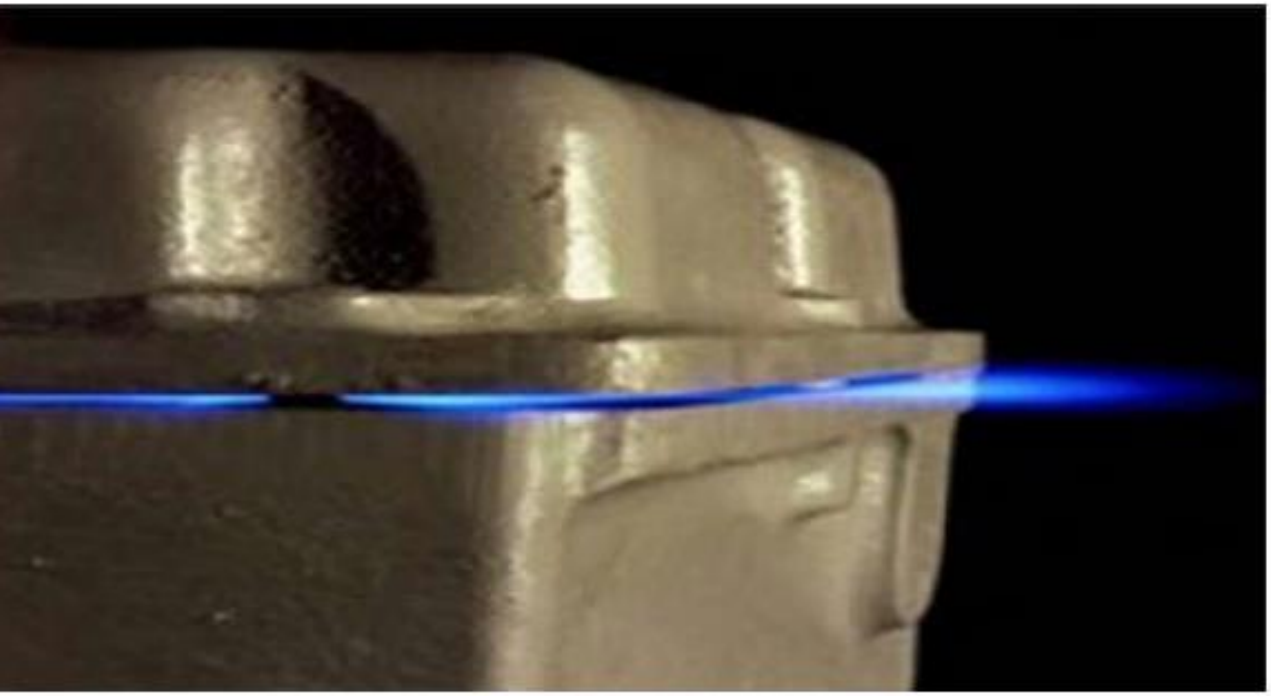
Flameproof enclosure Ex d

Ex ‘d’ Repair & Maintenance

If there was need to repair Ex d equipment situated in a hazardous area, for a wiring fault. It must be assumed that there is flammable gas present and so to test the equipment after completion of repair the cover must be fitted and ALL Bolts fitted tool/spanner tight. If the joint is a flange joint, the gap should also be checked before the tests begin.

Exd equipment only to be repaired in accordance with IEC 60079-19 so in all cases the manufacturer must be contacted.

Flameproof enclosure Ex d



The gap measurement is carried out by an appropriate verified measuring device

Flameproof enclosure Ex d

10 mm ↔ IIA

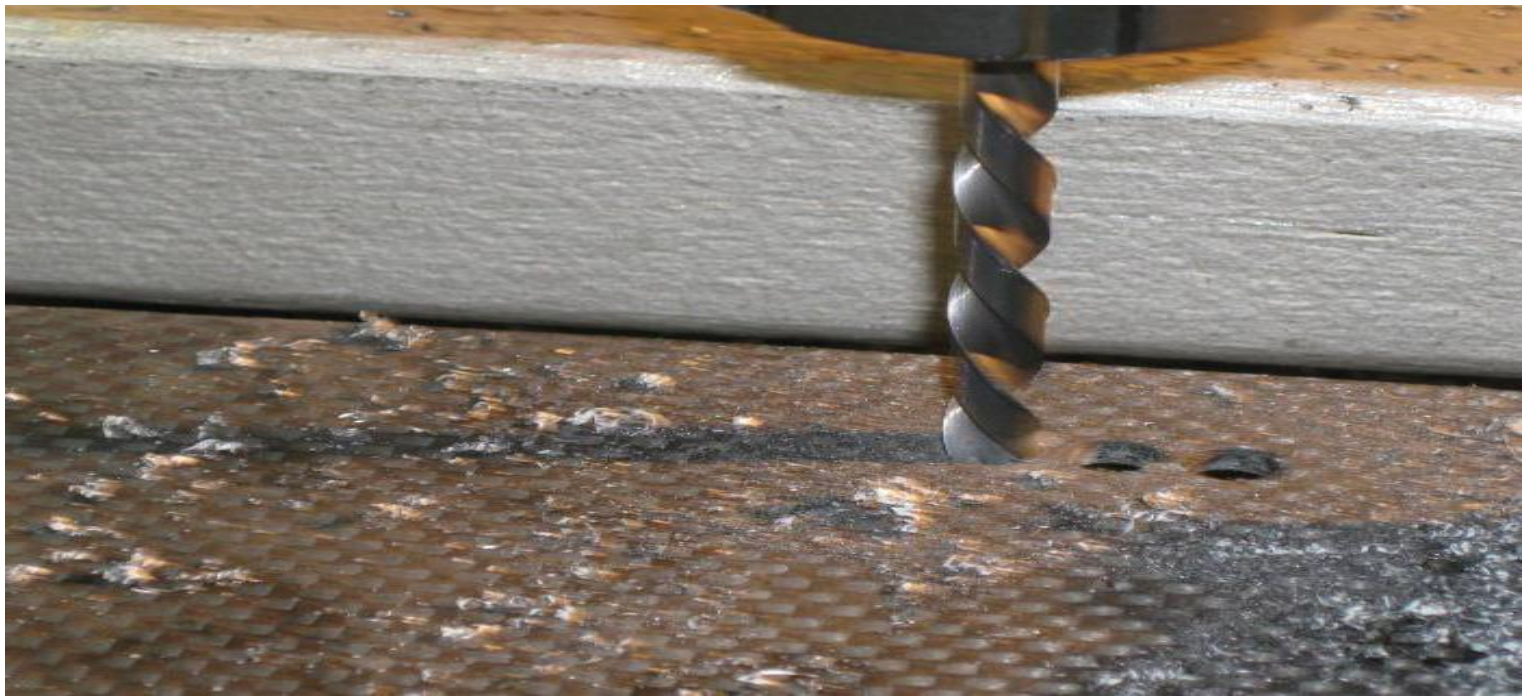
30 mm ↔ IIB

40 mm ↔ IIC

ROK for IIC required 50мм

Требования к монтажу видов защиты

Drilling additional holes



Drilling additional holes is not allowed for the type of protection Ex d

Increased safety Ex e

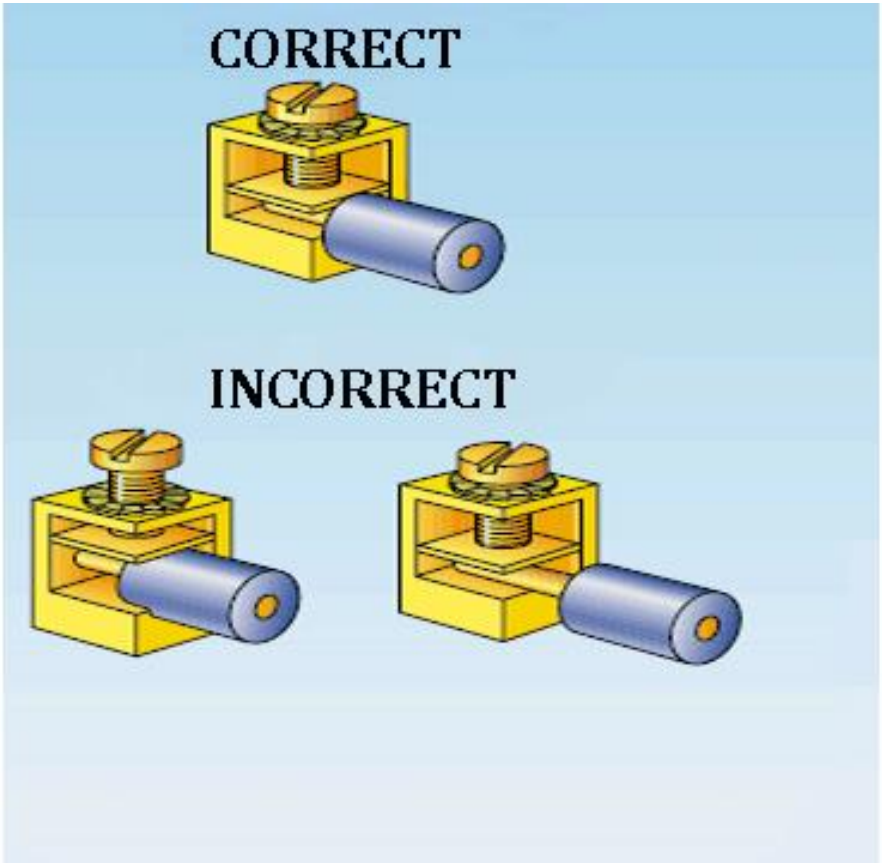
(NO ARCS, SPARKS OR HOT SURFACES)

Increased safety Ex e

"Ex e“ enclosures – key features

- Ingress protection IP54, normally > IP65
- Impact resistant per IEC 60079-0
- Solvent resistant
- Can be Plastic or metal

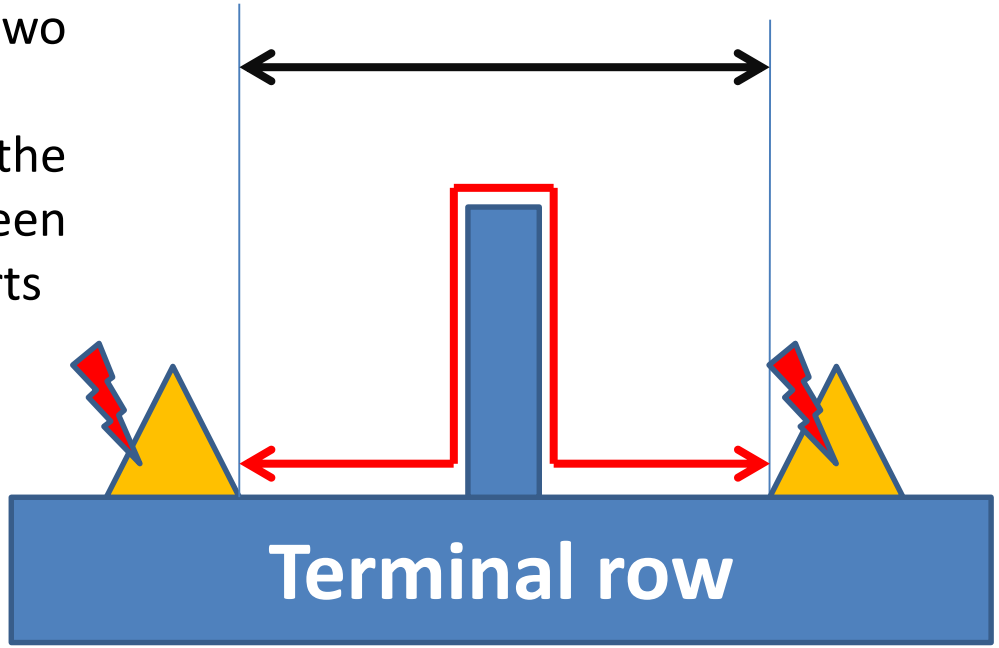
Increased safety Ex e



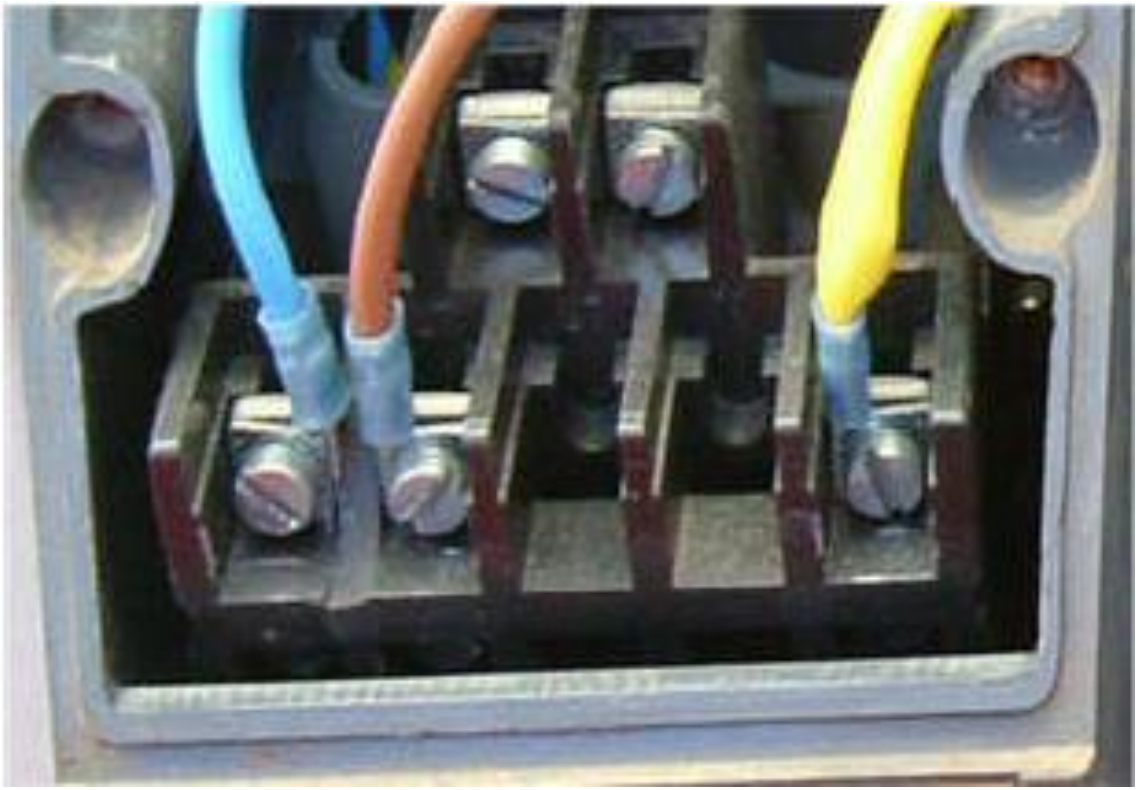
Increased safety Ex e

Creepage distance is the shortest distance along the surface of an insulating material between two electrically conductive parts

Clearance distance is the shortest distance in air between two electrically conductive parts



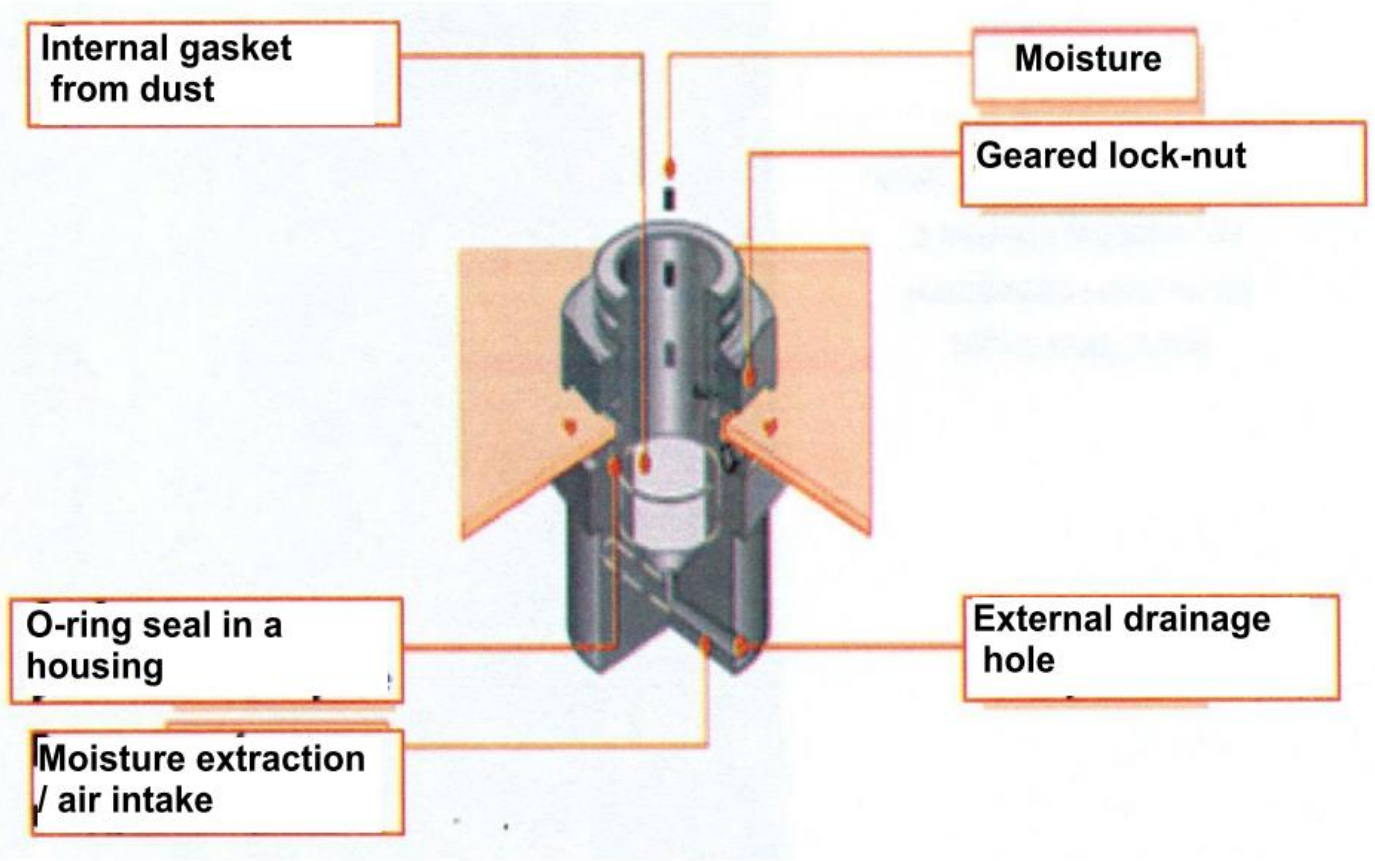
Increased safety Ex e



The partition between the terminals is broken

Increased safety Ex e

Enclosure with a drain hole



Increased safety Ex e

Bi-metallic corrosion.

Nickel-plated brass;
Stainless steel;
Plastic;
Cable entries of the alloy conforming to the alloy of the enclosure.

Increased safety Ex e

Increased safety Ex e

Increased safety Ex e

Ex e Installation and Maintenance

Enclosure content should not be modified. For all damages repair or allowed modifications it needs to be consulted with manufacturer documentation and technical representative.

Only specifically approved components should be fitted in enclosure

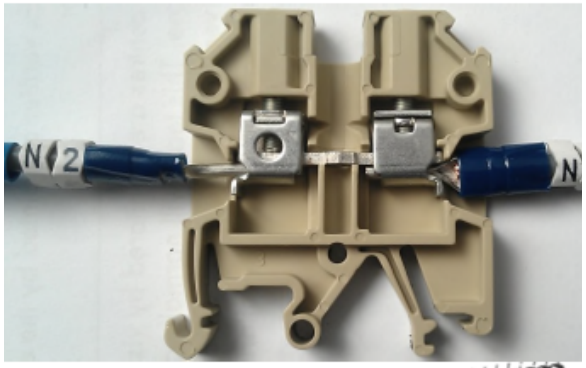
ALL terminals, used and unused, should be tightened!!!

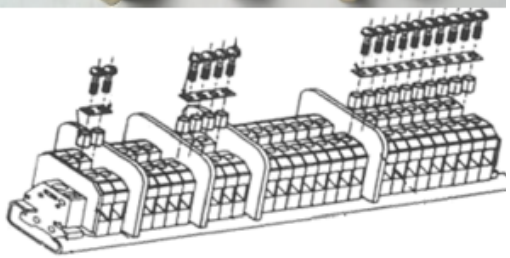
Conductor insulation should extend to within 1 mm from the metal throat of the terminal

Only one conductor should be fitted to each terminal side unless as specified in the documentation, of two conductors specified by documentation, special crimping ferrules reguared

Partitions should be fitted at either side of terminal linking assemblies

Grouping of more than 6 conductors is not recommended.

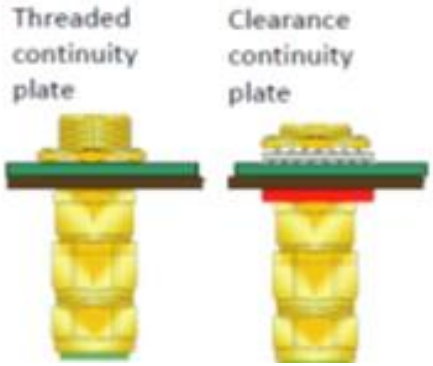




Increased safety Ex e

Increased safety Ex e

The individual earth continuity plates within plastic enclosures must be bonded together and locknuts used to secure glands to continuity plates. For clearance holes, serrated metal washers may be used between the locknut and the gland plate.



There must be adequate clearance between adjacent enclosures to allow proper installation of cables and glands.

All unused cable entries should be closed using appropriate certified plugs as of Jan 2008.

Cable glands or conduit entries must maintain the minimum ingress protection of enclosure

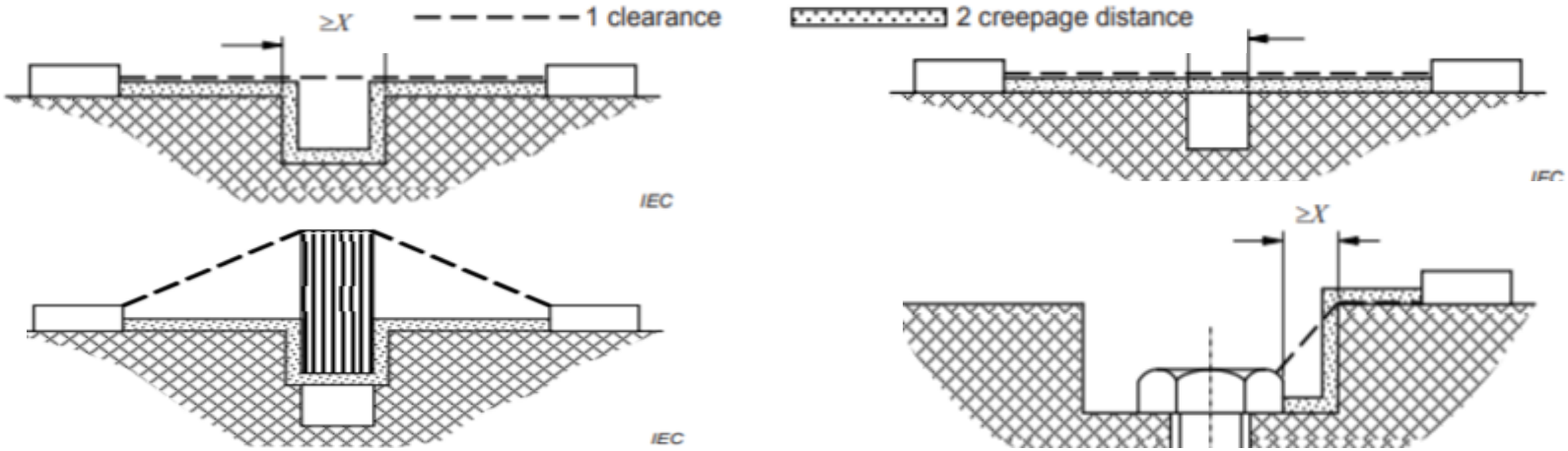
All lid and gland plate bolts must be tool tightened afte installation.

Cable glands or conduit entries must be acceptable by type of protection and minimal requirements of area of installation

Increased safety Ex e

Creepage distancess, clearances and separations

Voltage (see a and b) $U_{r.m.s.}$ a.c. or d.c. V	Minimum creepage distance mm								Minimum clearances and separations mm		
	Material group								Clearance		Distance under coating[d]
	I		II		IIIa		IIIb				
	"eb"	"ec"	"eb"	"ec"	"eb"	"ec"	"eb"	"ec"	"eb"	"ec"	"ec"
≤10 (see c)	1,6	1	1,6	1	1,6	1	-	1	1,6	0,4	0,3
≤ 12,5	1,6	1,05	1,6	1,05	1,6	1,05	-	1,05	1,6	0,4	0,3
≤ 16	1,6	1,1	1,6	1,1	1,6	1,1	-	1,1	1,6	0,8	0,3
≤ 20	1,6	1,2	1,6	1,2	1,6	1,2	-	1,2	1,6	0,8	0,3

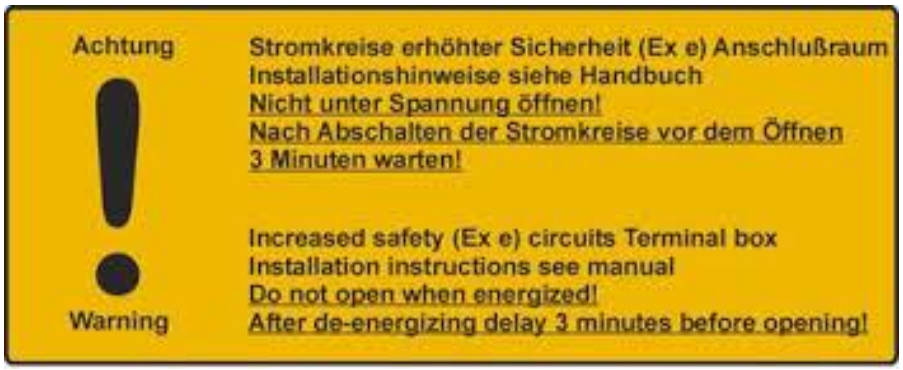


Increased safety Ex e

Ex e Installation and Maintenance

If Ex e enclosure contain any parts of IS system:

- Needs to be marked “WARNING – DO NOT OPEN WHEN NON-INTRINSICALLY SAFE CIRCUITS ARE ENERGIZED” or all non IS circuits needs to be covered by additional IP30 (minimum) protection. For this internal cover additional marking “WARNING – DO NOT OPEN WHEN ENERGIZED” needs to be done.
- On Main label needs to be mentioned that IS circuits inside enclosure have additional IP30 cover.
- IS and non-IS circuits needs to be segregated 50 mm minimum



Increased safety Ex e

Ex ‘e’ Installation and Maintenance (cont.)

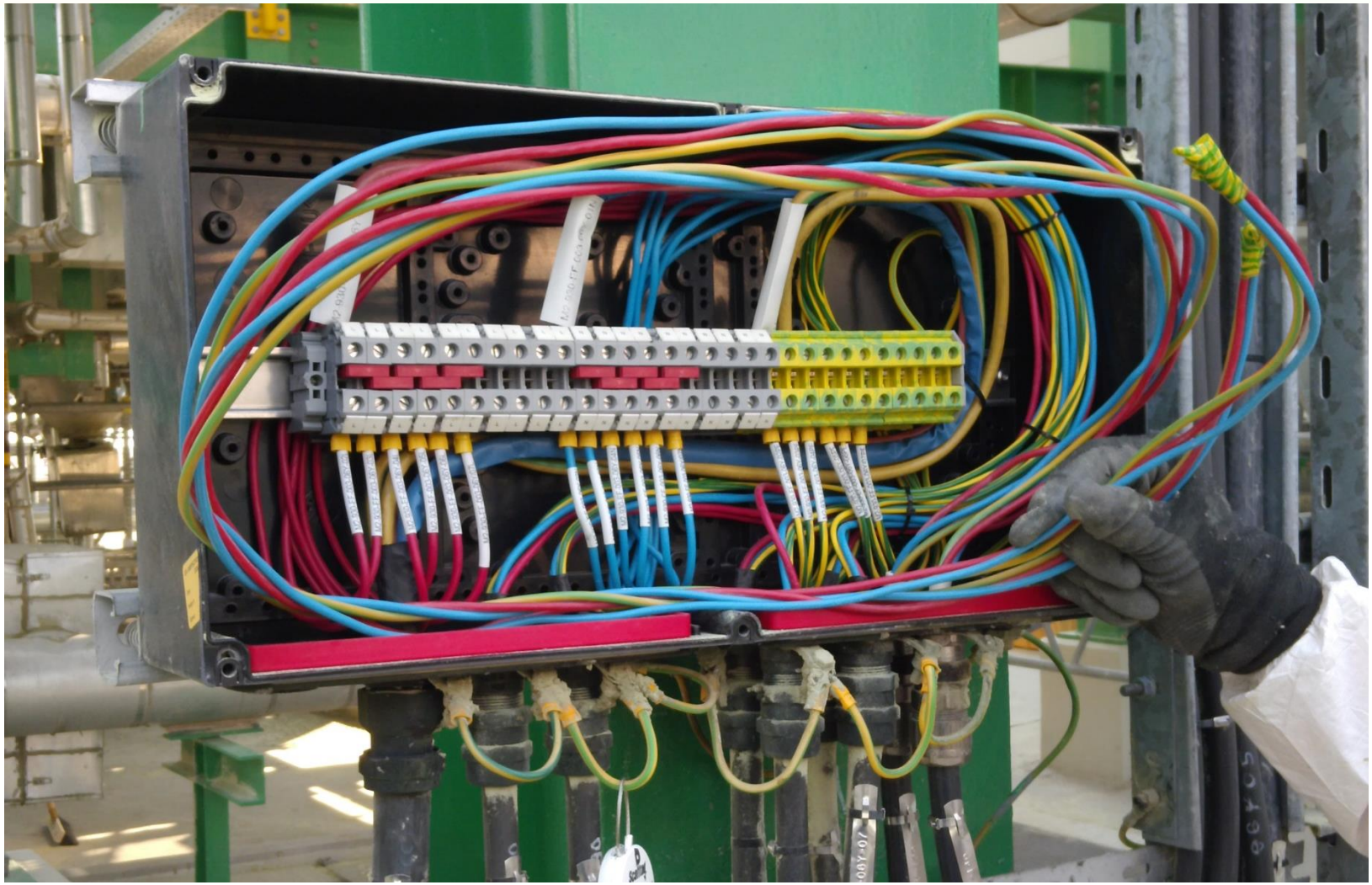
Keep the cores as short as possible as these long cores may cause the temperature to rise above the designated level marked on ex plate

Avoid grouping more than 6 cores together, it may cause the temperature to rise above the designated level marked on ex plate!!!

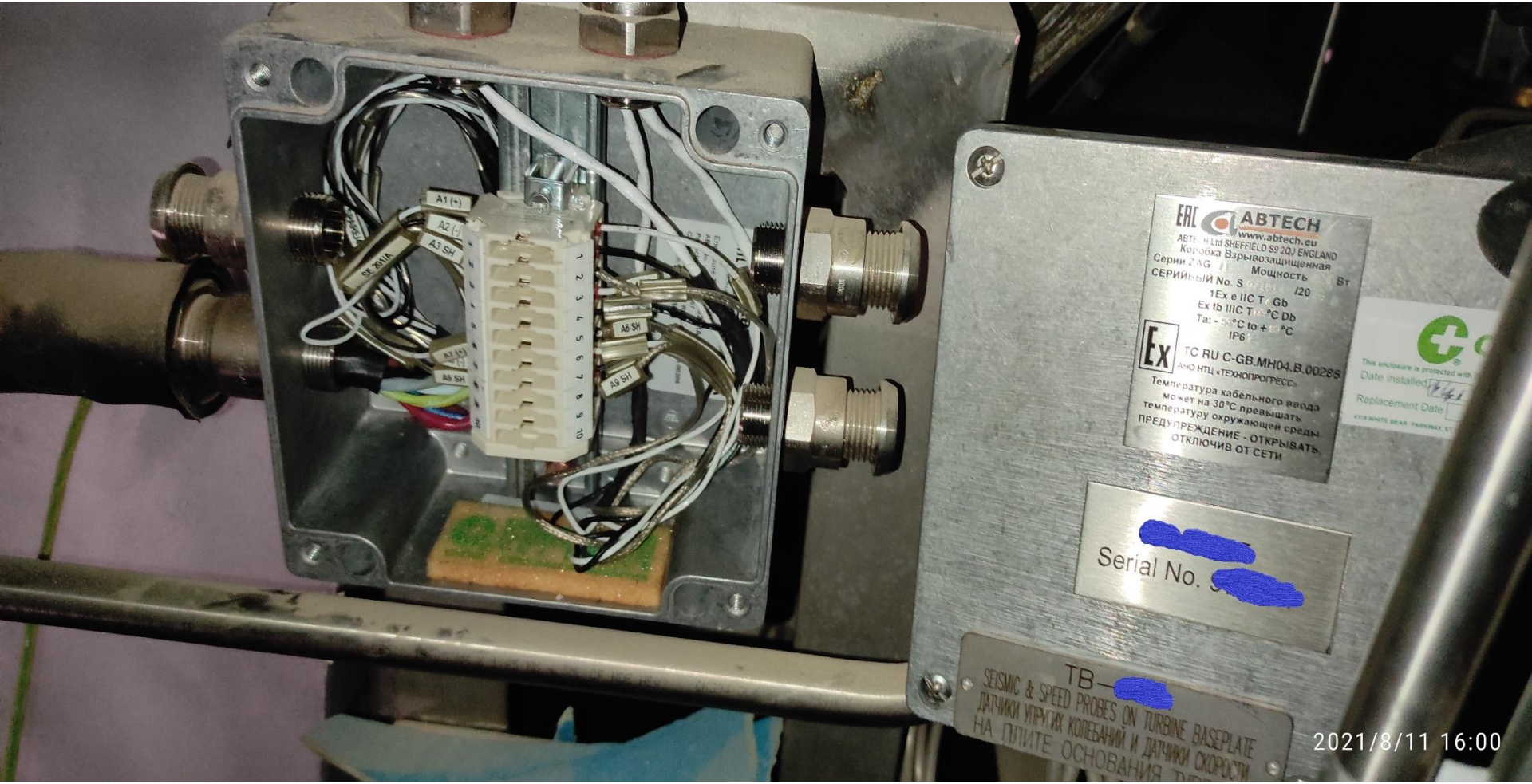
As the application of increased Safety 'e' Ex Components can often affect temperature rise and creepage/clearance, Ex Component certificates shall include the necessary technical information to allow the appropriate evaluation of the application of the Ex Component in equipment.

Ex Component
equipment intended to be part of Ex Equipment, marked with the symbol “U”, which is not intended to be used alone, and requires additional consideration when incorporated into Ex Equipment

Increased safety Ex e



Increased safety Ex e



Increased safety Ex e

The ending "U" in test certificates, such as PTB 09 ATEX 1107 U, means that the device in question is incomplete equipment. Such a partial certificate, which is issued, for example, for empty cases, does not certify complete devices, but only individual components. Why?

Increased safety Ex e

Increased Safety Ex ‘e’ Motors

(NOT DESIGNED TO WITHSTAND AN INTERNAL EXPLOSION)

PRINCIPAL DESIGN FEATURES

Special attention to air gap concentricity and clearance of all rotating parts

Impact testing of motor frame

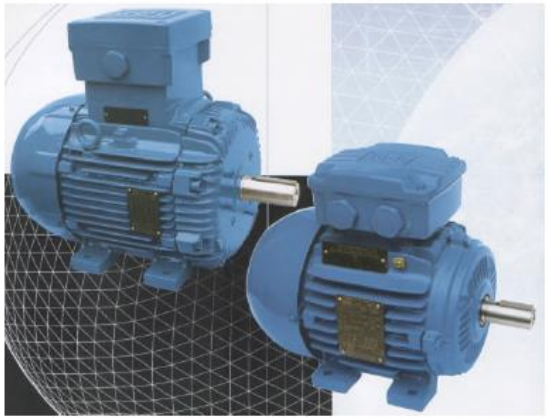
T2 or T3 surface temperature limitation

Special terminal block with specific clearance/creepage distances and locking devices on terminals

Minimum ingress protection to IP 54

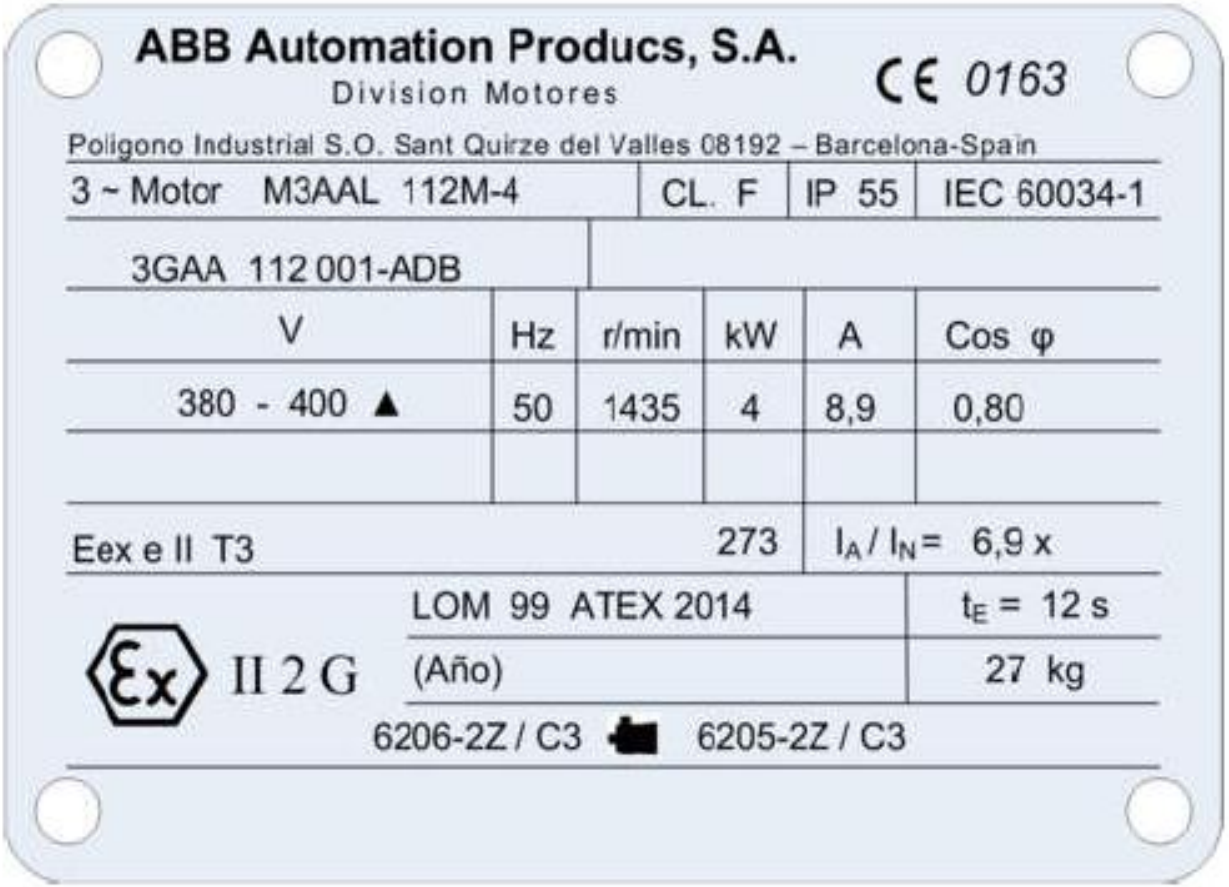
Compliance with ‘Te’ characteristic

Te time :
The motor control gear must disconnect the motor within Te time if the motor stalls after reaching its normal operating temperature.



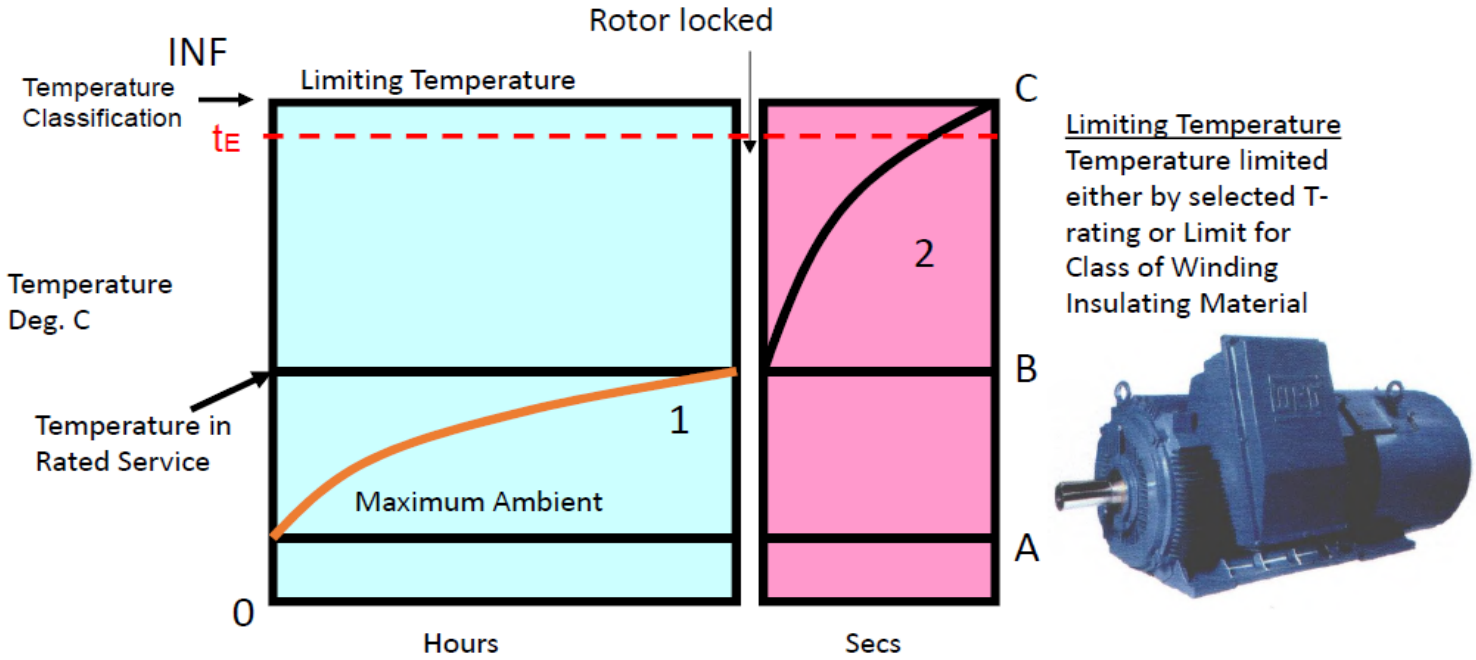
Increased safety Ex e

Время t_e



Increased safety Ex e

Determination of ‘tE’ Time (Motors)



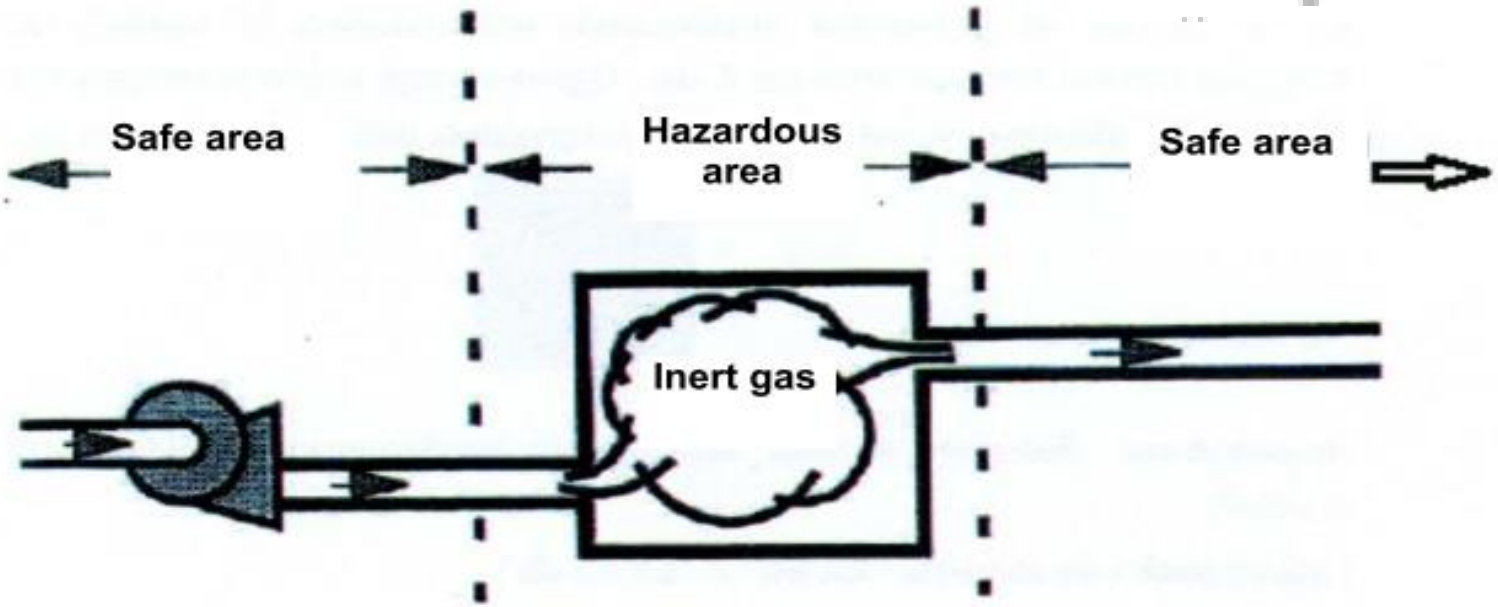
Limiting Temperature
Temperature limited either by selected T-rating or Limit for Class of Winding Insulating Material

A = Maximum ambient temperature
B = Maximum temperature at rated current
C = Limiting temperature (T rating)
0-INF = Temperature
1 = Temperature rise at rated current
2 = Temperature rise during locked rotor test
Te = Time for maximum temperature (B) at rated current to limiting temperature (C)

tE - The time to disconnection for a stalled motor when re-started from hot.

Pressurized equipment Ex p

Exp



Pressurized equipment Ex p

"WARNING! DO NOT OPEN IN AN EXPLOSIVE AREA“

Pressurized equipment Ex p

Ex px ATEX category **2** (EPL **Gb**)
Ex py ATEX category **2** (EPL **Gb**)
Ex pz ATEX category **3** (EPL **Gc**)

3 types of Pressurization:

- Static pressurization
- Constant flow
- Leakage compensation

Pressurized equipment Ex p

Pv

The PV protection method is reduced to protection by dilution and can be used in a non-hazardous area.

As a result, non-certified equipment is allowed to be used in ventilated, sealed rooms

However, it is necessary to take into account equipment with an internal gas source.

1
2
3
4
5

Pressurized equipment Ex p

Pressurized equipment Ex p

Flammable substance in a containment system	EPL/category of external area	Enclosure contains ignition-capable equipment	Enclosure does not contain ignition-capable equipment
No containment system(i.e no potential for an internal release)	Gb / 2	Type “px”	Type “py”
No containment system(i.e no potential for an internal release)	Gc /3	Type “pz”	No pressurization required
Gas / vapour	Gb / 2	Type “px”	Type “py”
Gas / vapour	Gc / 3	Type “px” (and ignition capable equipment is not located in the dilution area)	Type “py”
Liquid	Gb / 2	Type “px”(inert)	Type “py”
Liquid	Gc / 3	Type “pz”(inert)	No pressurization required

Pressurized equipment Ex p

Pressurised Equipment Ex ‘p’

Some factors need to be considered when selecting Ex p equipment:

- **Equipment Protection Level (EPL)required .**
- **Possibility of parts inside the enclosure creating ignition.**
- **Potential for internal release.**

Refer to: EN/IEC 60079-02

Outside Area - Zone, EPL/Cat	Inside Enclosure	
	Contains Ignition-capable apparatus	Does not contain ignition-capable apparatus
Zone 1 Gb/2G	Ex px	Ex py
Zone 2 Gc/3G	Ex pz	No Requirement

Ex ‘px’

Ex ‘py’

Ex ‘pz’

Pressurized equipment Ex p

Pressurised Equipment Ex ‘p’

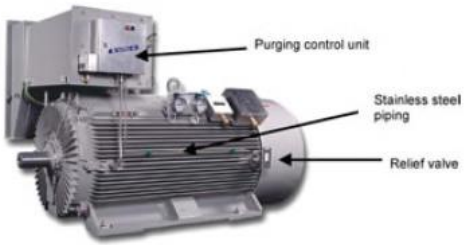
Typical Applications

1. **Transformer / Rectifier cabinets**

2. **Oil drilling control consoles**

3. **Visual Display Units (VDU’s)**

4. **Gas analysis equipment**

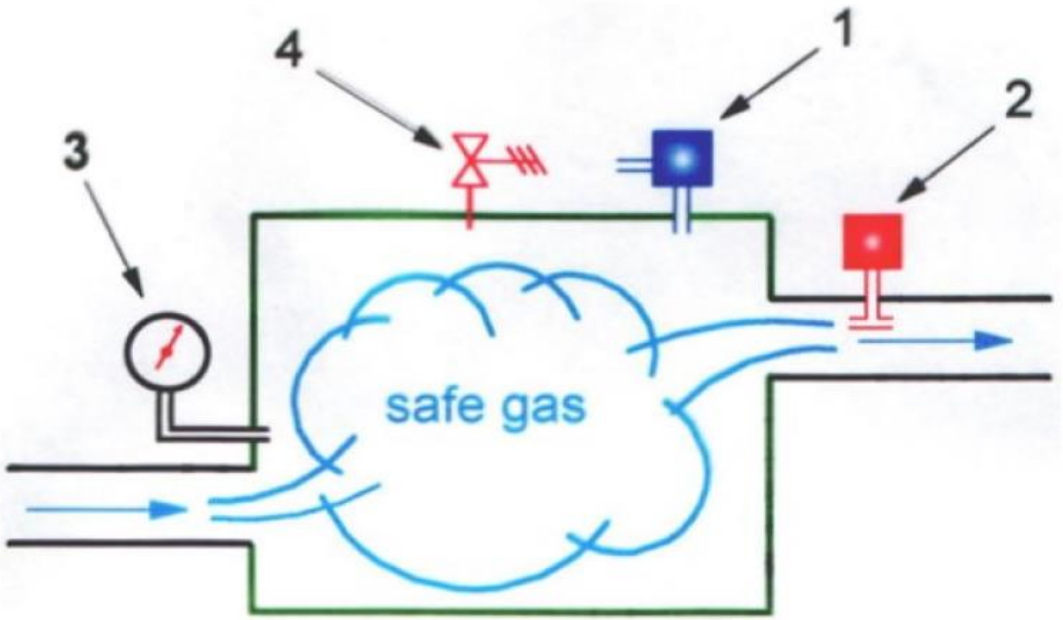


5. **Large rotating machines**

Pressurized equipment Ex p

Pressurised Equipment Ex ‘p’

Minimum control circuit & safety devices required

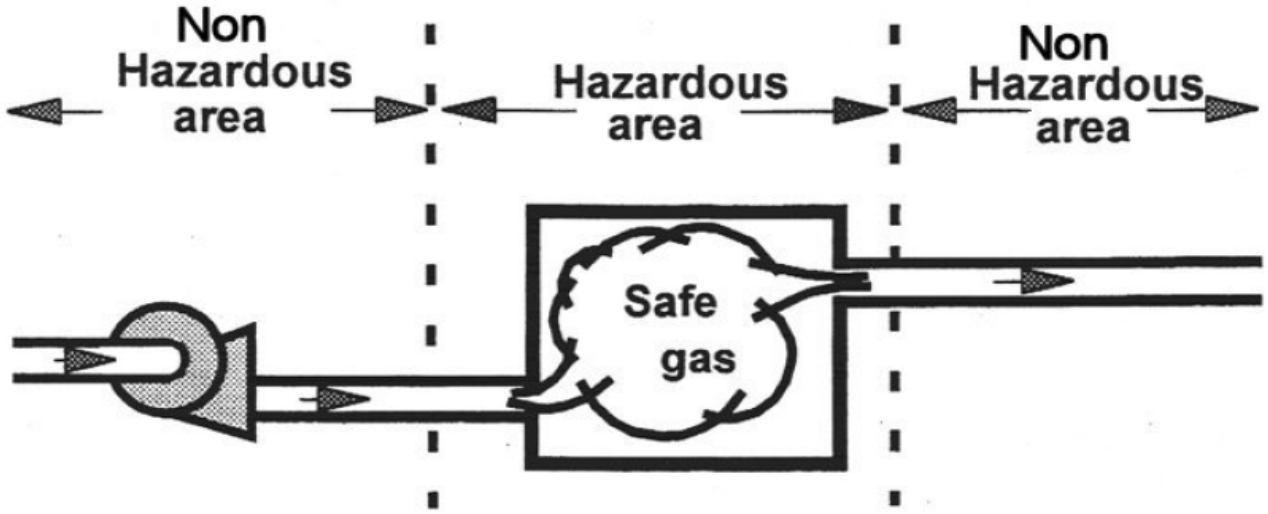


1. Over- pressure monitoring device
2. Protective gas flow-rate monitoring device
3. Pressure gauge
4. Pressure relief valve set to a defined value stated in the equipment instructions established by test or calculation.

Pressurised Equipment Ex 'p'

Pressurisation - Purge

During start up or after maintenance a purge cycle is required to clear-out unwanted flammable gas. This purge cycle shall be automatic for protection type Ex px, it will be timed and specified by the manufacturer, it may be based upon 5 times the enclosure full volume.



Pressurized equipment Ex p

Pressurised Equipment Ex ‘p’

Alarm and Control Safety Requirements if There is a Loss in Pressure:

Alarm Requirements - Immediate action should be taken when the alarm is activated.

Outside Area - Zone, EPL/Cat	Inside Enclosure	
	Equipment not meeting EPL ‘Gc’ requirements without pressurisation	Equipment meeting EPL ‘Gc’ requirements without pressurisation
Zone 1 Gb/2G	Alarm & Switch Off	Alarm
Zone 2 Gc/3G	Alarm	No Requirement

Refer to: EN/IEC 60079-14

Pressurized equipment Ex p

Ex ‘p’ Safe Gas

Protective or Safe gas either Air or Inert gas e.g.

- **Argon**
- **Nitrogen**
- **Carbon Dioxide**

Provided by either:

a. A motor driven fan/blower;

b. A compressor;

c. Compressed gas container

Air to be drawn from a defined non-hazardous area.

On entry to inlet duct:

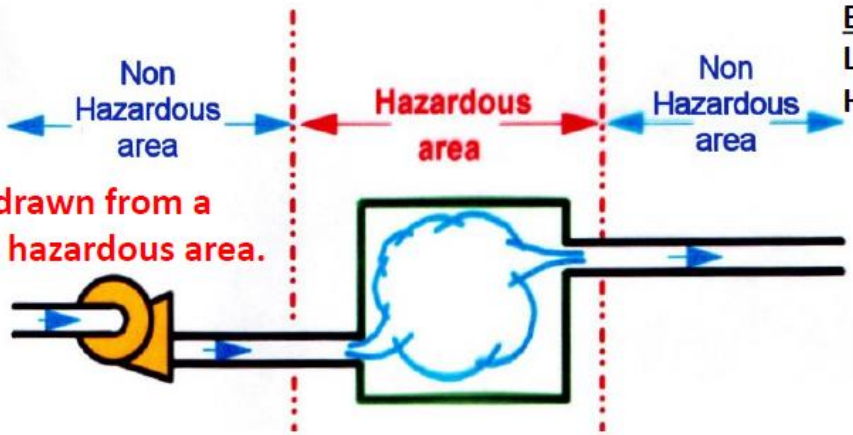
1. Temperature < 40 deg. C;
2. Air - Oxygen content not greater than 21%
3. Inert Gas - Oxygen content not greater than 1%
4. Free from moisture, oil, dust, fibres and chemicals

Pressurized equipment Ex p

Pressurised Equipment Ex 'p' Ducting

The ducts should have:

- Adequate mechanical strength
- Be properly supported
- Be located where accidental damage is unlikely
- Have adequate protection against corrosion



Inlet Duct:

Air shall be drawn from a defined non hazardous area.

Exhaust Duct:
Located in a Non Hazardous area.

Or:
Located in hazardous area if fitted with a spark/particle arrestor

Pressurized equipment Ex p

Pressurised Equipment Ex 'p'

Safety Requirements: Use of spark arresters

Conditions requiring use of a spark particle barrier on exhaust duct

Outside Area - Zone, EPL/Cat	Inside Enclosure	
	Ignition-capable apparatus	Does not contain ignition-capable apparatus
Zone 1 Gb/2G	Required *	Required *
Zone 2 Gc/ 3G	Required	No Requirement

Refer to EN/IEC 60079-14

* Hot surfaces within enclosure: A device is fitted to prevent rapid entry of gas on failure of pressurisation.

Pressurised Equipment Ex ‘p’

Pressurisation Techniques

1. Static pressurisation
2. Pressurisation with continuous flow
3. Pressurisation with leakage compensation
4. Pressurisation with continuous dilution

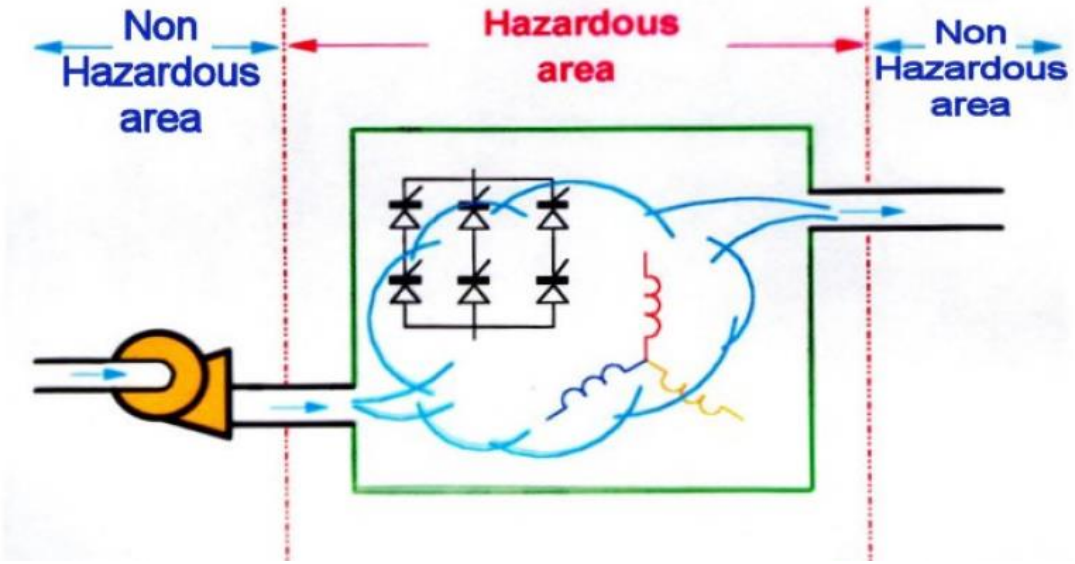
Pressurized equipment Ex p

Pressurised Equipment Ex 'p'

Continuous Flow

Flow rate of safe gas to:

1. Maintain overpressure
2. Cool internal hot surfaces

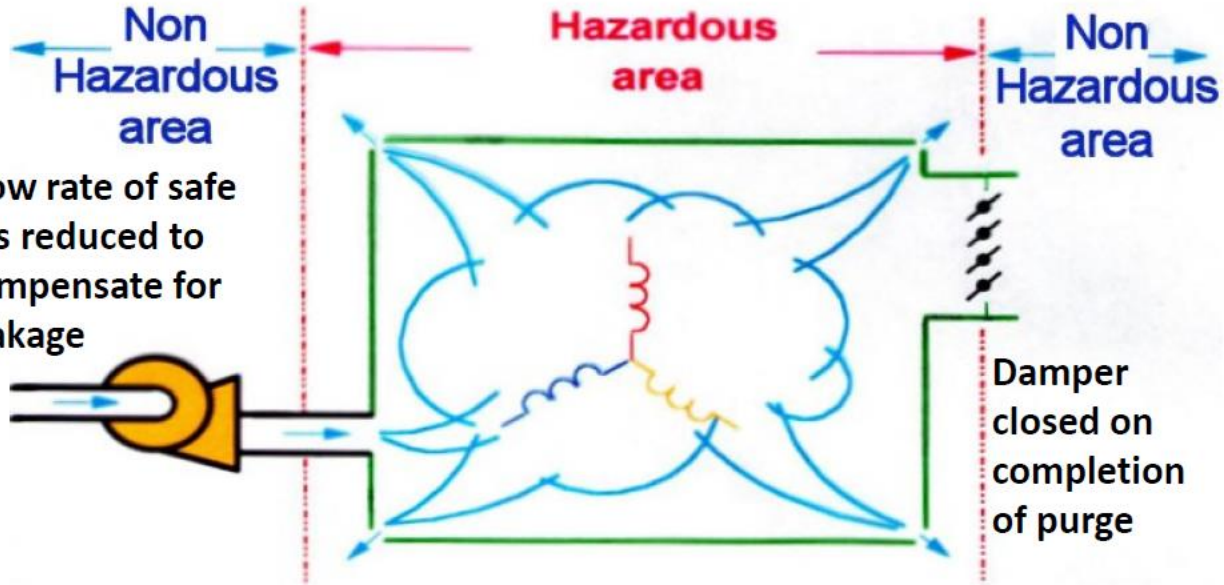


Pressurized equipment Ex p

Pressurised Equipment Ex ‘p’

Leakage Compensation

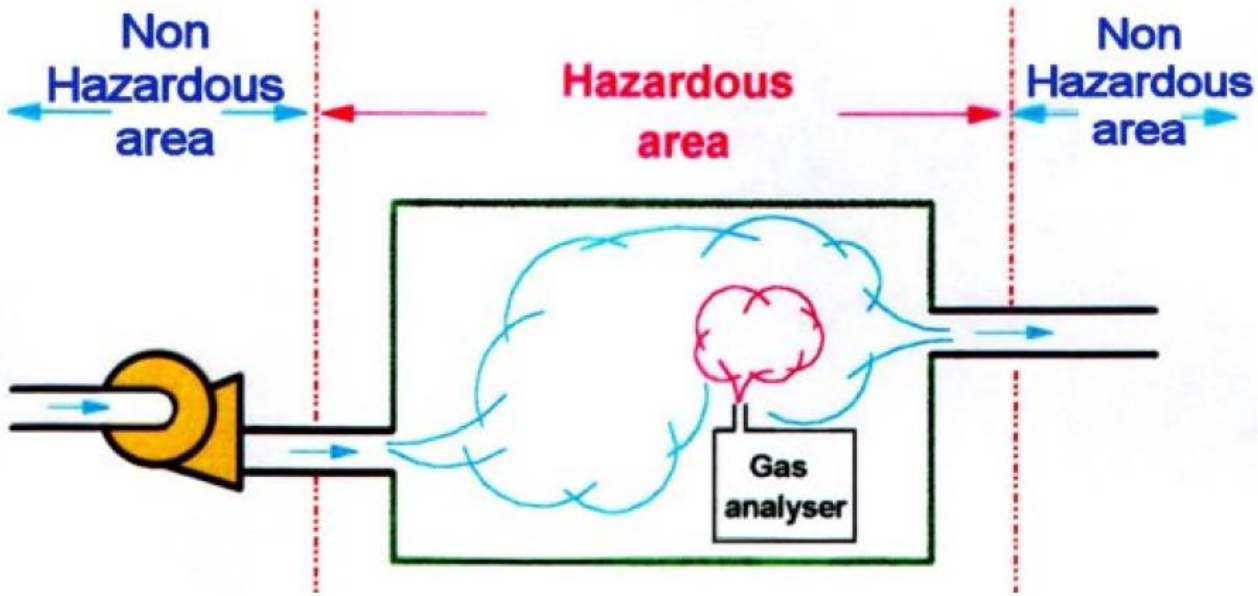
Utilised with poorly sealed enclosures



Purge cycle as normal

Pressurised Equipment Ex 'p'

Continuous Dilution



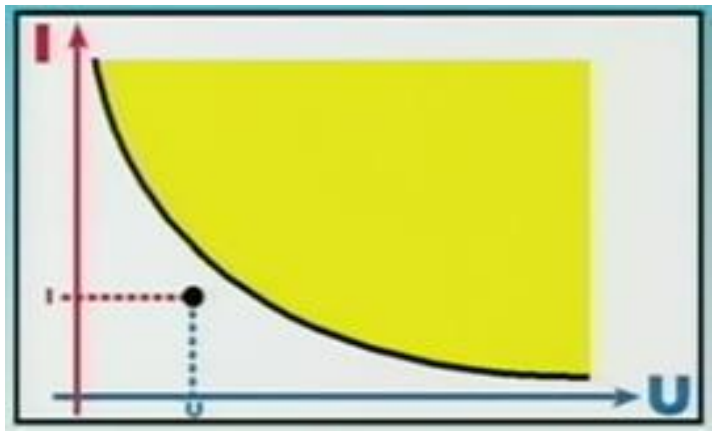
Flow rate of safe gas to:

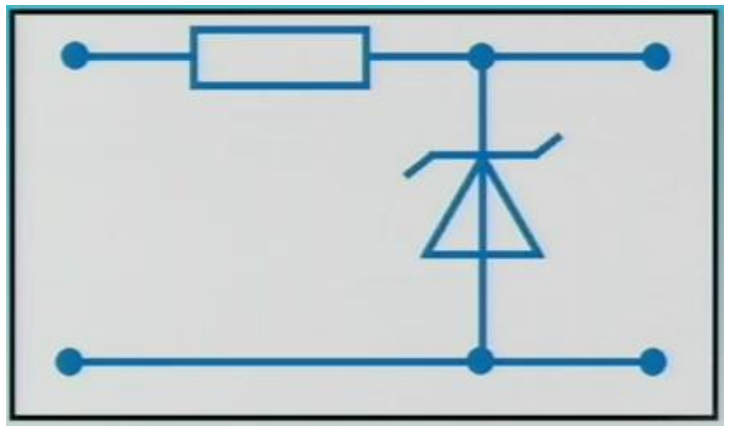
1. **Maintain overpressure**
2. **Dilute sample of flammable material, released from gas analyser, to at least 25% of LEL when the protective gas is air.**

Intrinsic safety Ex i

Exi

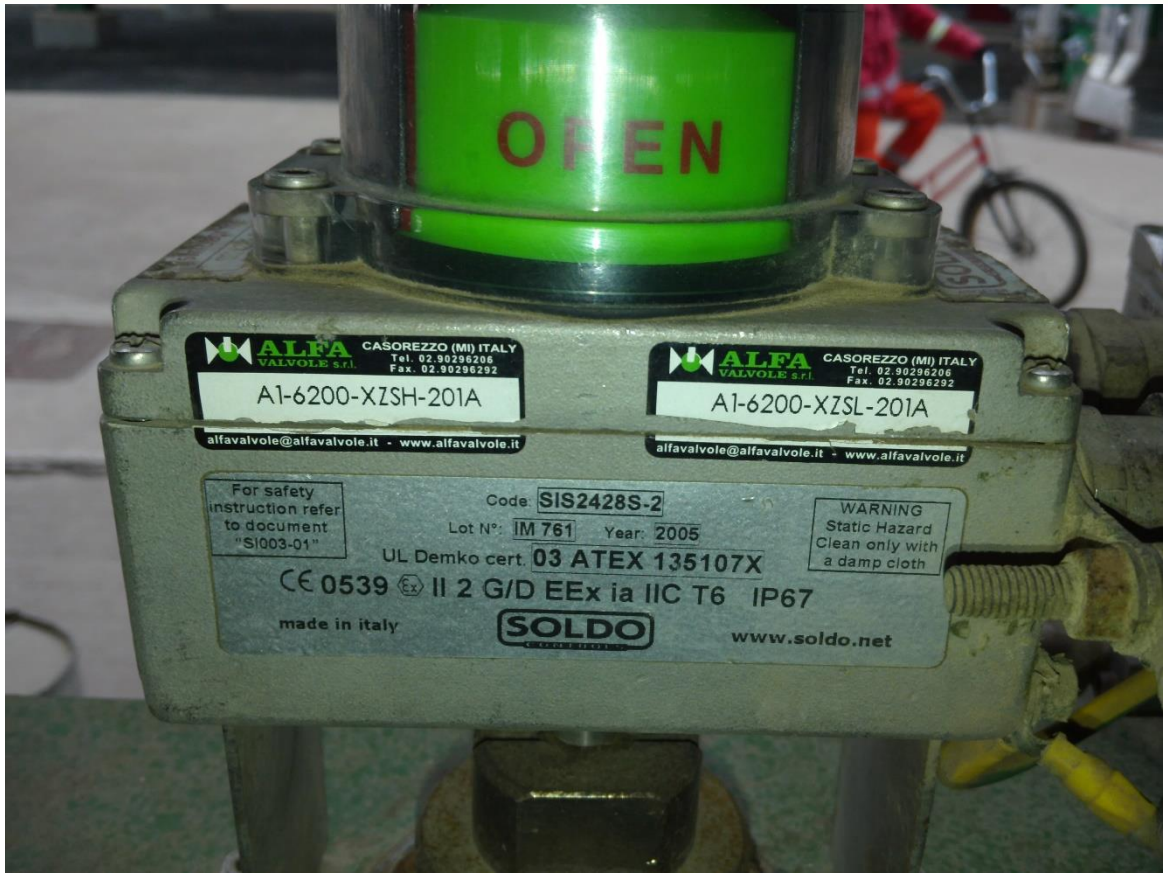
Exia, Exib, Exic





Intrinsically safe equipment falls into group II equipment , 1G (ia) EPL Ga or 2G (ib) EPL Gb or 3G (ic) EPL Gc categories

MODULE III
Types of Protection



Intrinsically safe equipment falls into group II equipment , 1G (ia) EPL Ga or 2G (ib) EPL Gb or 3G (ic) EPL Gc categories

MODULE III
Types of Protection

What is the Temperature class?

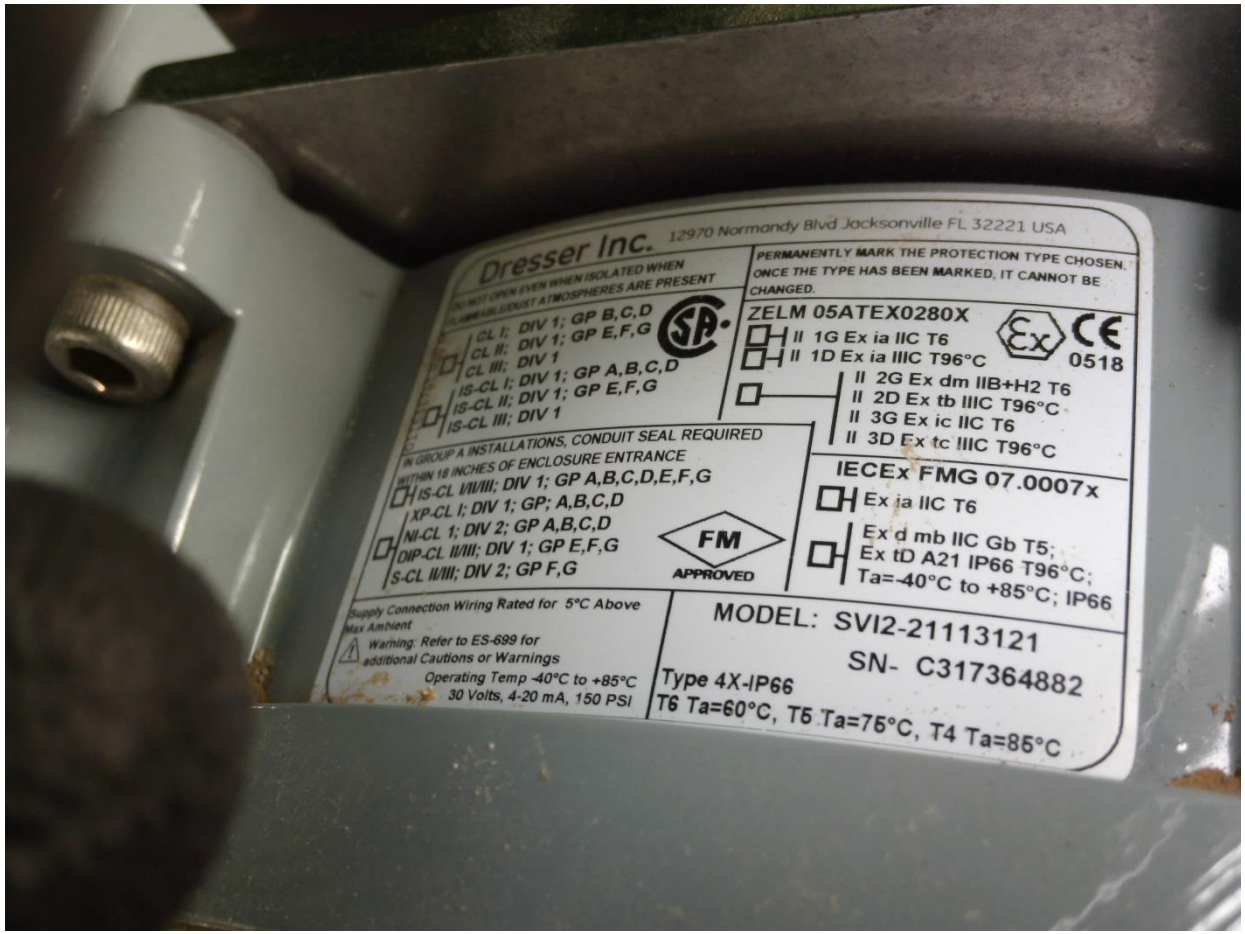
Intrinsic safety Ex i

Definition

A protection type in which the energy available in the hazardous area is limited to below that which could ignite a flammable atmosphere.

- Intrinsically safe apparatus is electrical equipment which is connected to intrinsically safe circuits.
- Associated apparatus is electrical equipment which is connected to both intrinsically safe circuits and non-intrinsically safe circuits and is constructed so that the non-intrinsically safe circuits cannot adversely affect the intrinsically safe circuits.

Intrinsic safety Ex i



What is the type of protection?

MODULE III
Types of Protection

Basic principles of IS:

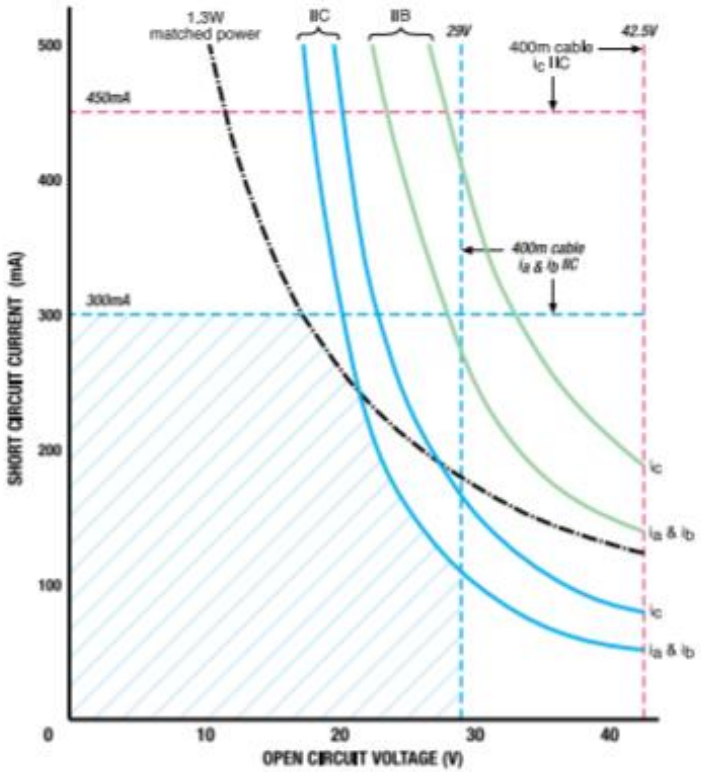
Low power levels

Limitation of current and voltage

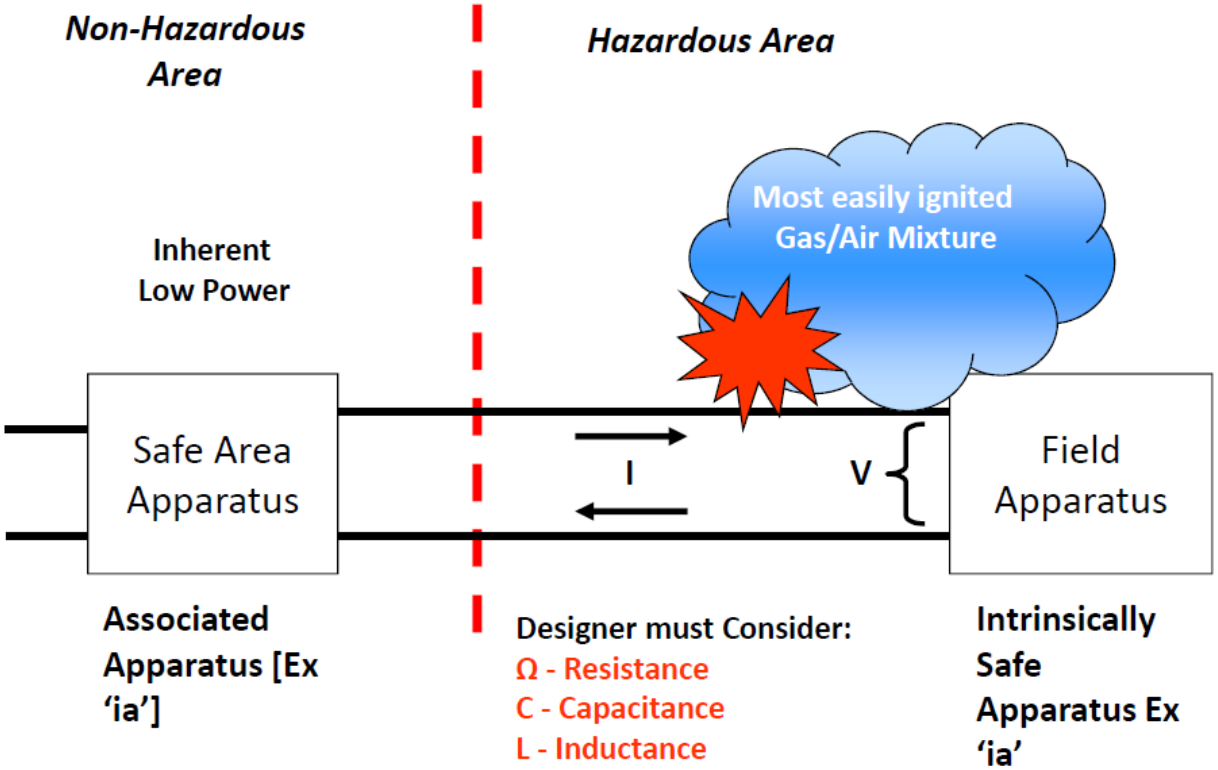
Resistance, inductance and capacitance are considered

No any hot surfaces, electrical sparks energy – insufficient to ignite flammable mixture

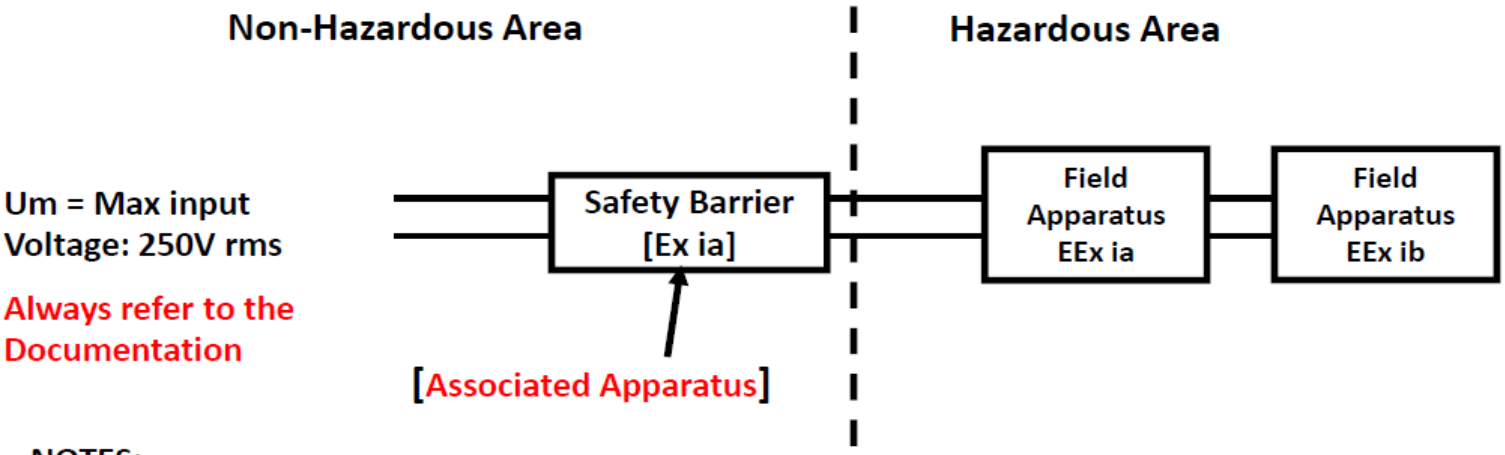
Advantages:
Safe – controlled low energy
Maintainable – without gas free certificates or isolatior
Cost effective
Useful for zone 0 (only Ex “ia”)



Intrinsic Safety Ex 'i'



Basic IS System Concept



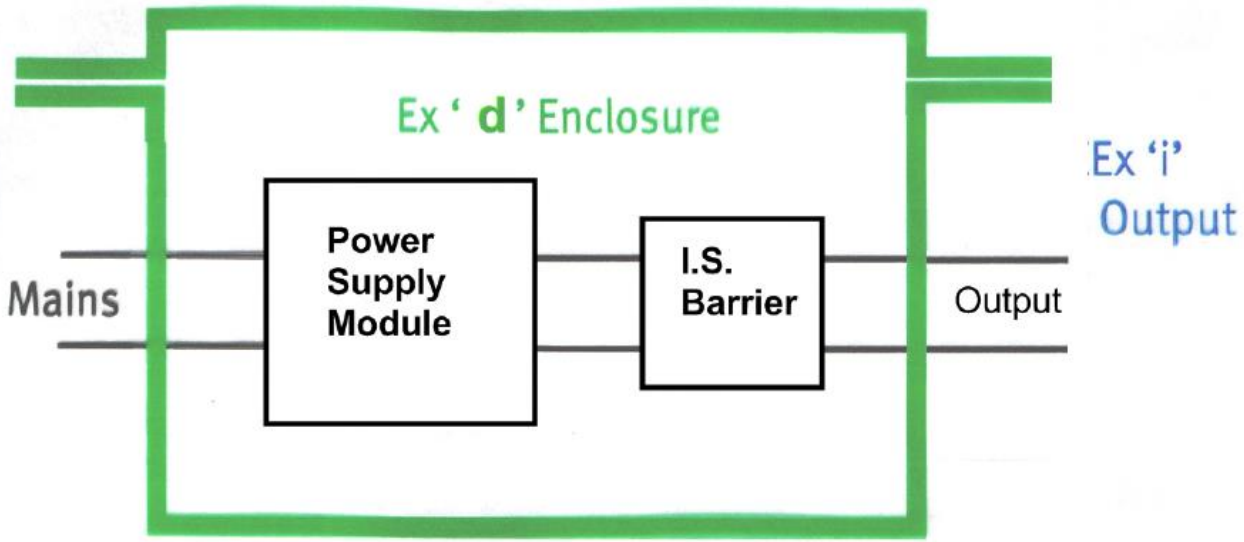
NOTES:

- The purpose of the safety barrier is to limit the energy into the hazardous area.
- Intrinsic Safety is a system concept which applies to the whole system and not to any one item only.
- Apparatus in the safe area connected directly to apparatus in the hazardous area is known as 'Associated Apparatus'.
- Only 'Associated Apparatus'." Certified Apparatus" and Simple Apparatus" specified in the documentation can be connected to a Intrinsic Circuit.

[Associated Apparatus]

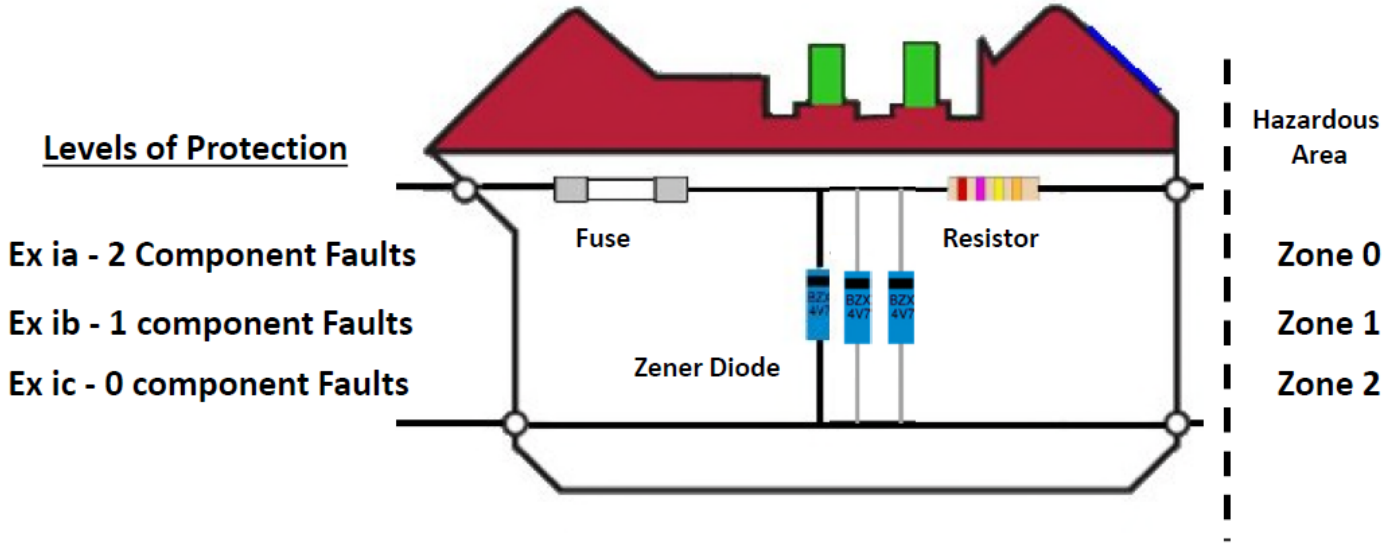
Associated intrinsically safe equipment, such as power supply modules and barriers, may be contained within an Ex d or Ex px or Ex pz protection enclosure in Zones 1 or 2.

Example: Ex d [ia]



MODULE III
Types of Protection

Safety Barrier - The Zener Barrier



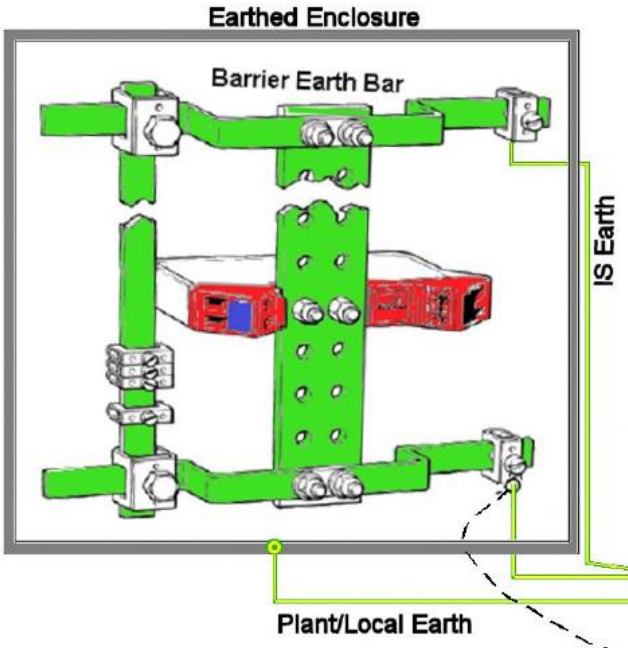
The zener barrier will limit the energy to the Hazardous are by using the resistor to limit the current.
The zener diode will be used to limit the input voltage to the hazardous area.

How would we test the zener barrier if we suspect it is faulty?

A. Disconnect from the circuit and measure the resistance between input and output.

MODULE III
Types of Protection

IS Earthing



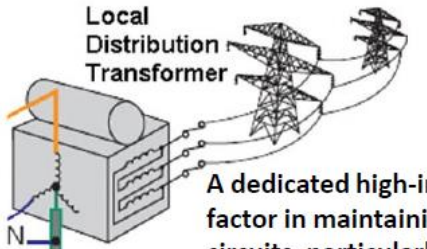
The dedicated high-integrity earth (IS Earth) should have appropriate cable sizes.

One core CSA greater than 4mm²

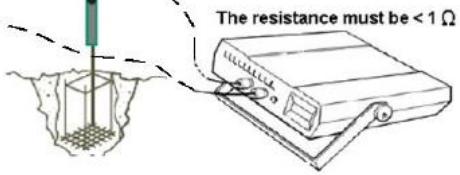
or

Two core CSA greater than 1.5mm²

Or as per the System Documentation



A dedicated high-integrity earth is a vital factor in maintaining the security of IS circuits, particularly when zener barriers are used.



The IS earth must be insulated from the surrounding metal work.ie plant earth

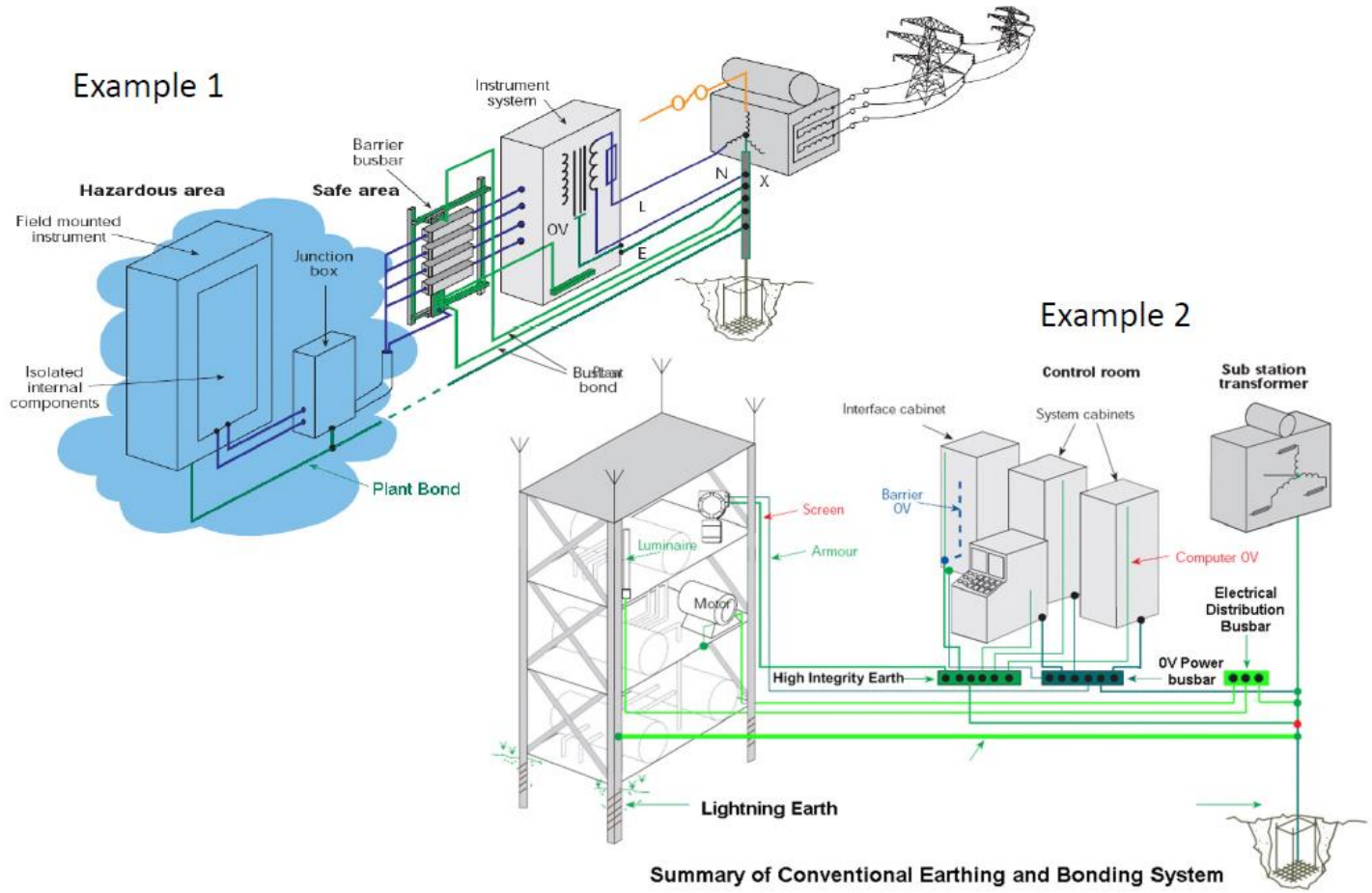
Live maintenance is possible.

The resistance of the High Integrity earth must be less than 1Ω.

Galvanic barriers, operate on a different principle which does not require a high-integrity earth, but earthing may be used for interference suppression.

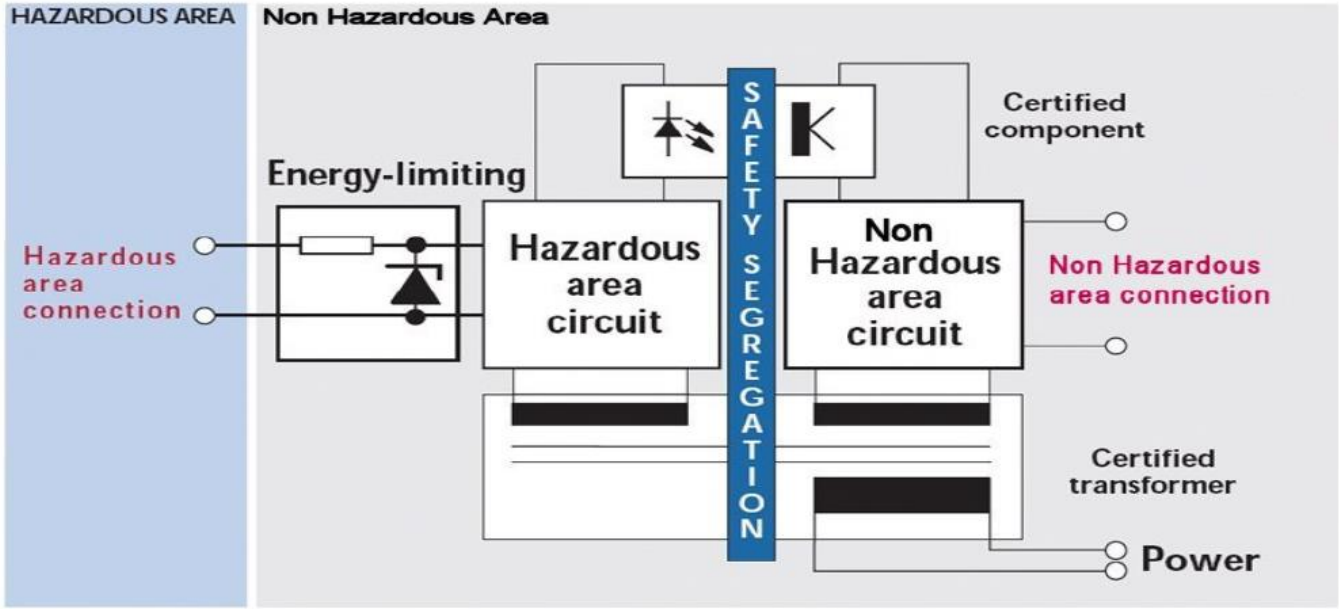
MODULE III
Types of Protection

Earthing Example

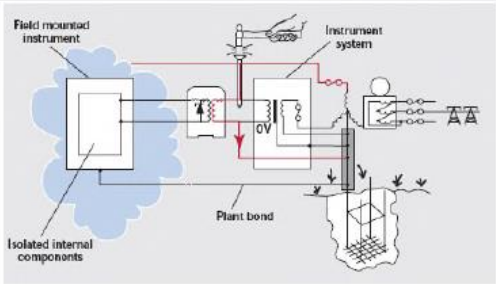


Summary of Conventional Earthing and Bonding System

Galvanic Isolation via an Optical Device



A major advantage of Galvanic isolation is that no dedicated IS Earth is required. An earthed system may be a requirement for practical reasons, e.g. where one side of a unit needs to be connected to process steelwork.



Galvanic Isolator Under Fault Conditions

MODULE III
Types of Protection

Enclosures

IP 20 minimum reguared, but environmental conditions may require higher rating

All enclosures and simple apparatus should be marked that “contain IS circuits”

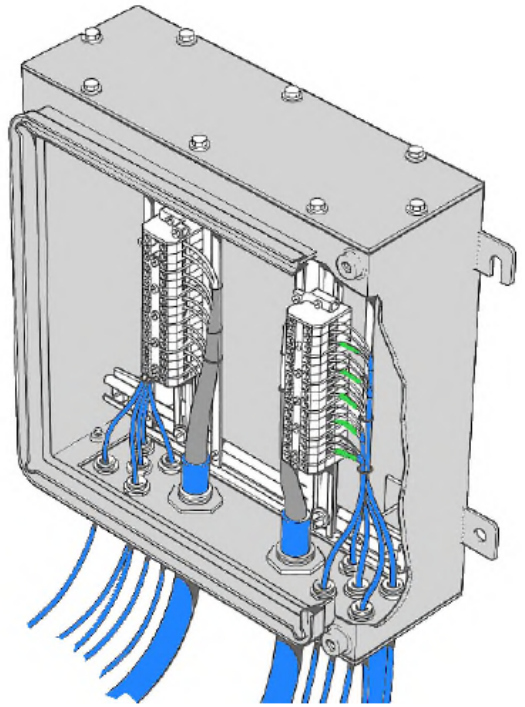
Cable glands needs to be suitable for enclosure

MODULE III
Types of Protection

Apparatus Connected to an IS Barrier

The only types of apparatus the installer can connect are;

- **Simple Apparatus and Intrinsically safe apparatus as detailed in the system documentation.**
- **Since 'Simple Apparatus' is not required to be certified, justification for it's use must be included in the system documentation.**
- **Cables conforming to the system requirements.**
- **Test instruments need to be approved before use on the IS circuit.**

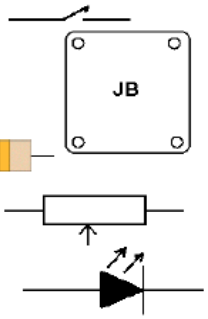


Simple Apparatus

Definition - Any device which is resistive by nature and non-energy storing may be added to the circuit without jeopardising the integrity of intrinsic safety.

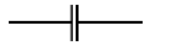
Passive Components:

- Switches
- Junction Boxes
- Resistors
- Potentiometers
- Diodes or LED's



Low Energy Sources:

- Capacitors
- Inductors



Well defined parameters

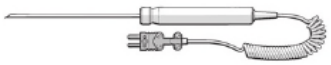
Is a battery considered Simple?

NO

Sources of Low Generated Energy:

Typically thermocouples and photocells, providing they do not generate more than:

1.5 V
100 mA
25 mW



MODULE III
Types of Protection

Passive field equipment does **not** have to be certified
However, the design **shall** comply with requirements of IEC 60079- 11.

- Is **independent of** EPL.
- Shall be clearly identifiable by durable labelling.
- Labelling may be done by any party:
  the manufacturer, an expert or the installer.
- Any marking or code preference is permitted, provided that it is clearly recognisable as a simple apparatus.
- Additional information, such as a reference to the instrument loop number for the identification of simple apparatus can be considered.

MODULE III
Types of Protection

For simple apparatus the maximum temperature can be determined from the values of P_o of power to obtain the temperature class .

The maximum surface temperature shall be calculated in accordance with formula:

$$T = P_o R_{th} + T_{amb}$$

T = surface temperature
P_o = the power marked on associated apparatus
R_{th} = the surface temperature rise (K/W) (*specified by the component manufacturer*)
T_{amb} = the ambient temperature

The simple apparatus with a total surface area above 20mm^2 may be assigned a temperature class T4 if the maximum power supplies does not exceed the values in Table below

Maximum power dissipation – Equipment Group II						
Max. Ambient temperature	°C	40	50	60	70	80
Maximum power dissipation	W	1.3	1.25	1.2	1.1	1.0

MODULE III
Types of Protection

Small components may be assigned to the temperature class T4 of T5 as per following limitation:

Component surface	Temperature class	Maximal temperature
≤ 20 mm^2	T4	≤ 275 °C
> 20 - ≤ 1000 mm^2	T4	≤ 200 °C
< 1000 mm^2	T5	≤ 150 °C

Note: Cannot be applied for Group III.

- Terminal boxes and switches in IS circuits:
  temperature rise < 40 K;
  and temperature classification:

Temperature class	Ambient temperature
T6	≤ 40 °C
T5	≤ 55 °C
T4	≤ 80 °C

Energy Storage

Energy can be stored in devices over a period of time and then released in a surge of greater amplitude at, for example, a break in the IS cable due to a fault or live disconnection at terminals. This could occur regardless of the limits on voltage and current, causing the ignition of a surrounding flammable gas atmosphere.

Measures must be applied to counteract this problem at the design stage. Field apparatus which have energy storage capability, i.e. They have some internal Inductance (L) and Capacitance (C), are termed 'non-simple' and are required to be certified.

CABLES - Long runs will have appreciable L and C. Energy will be stored under normal operation, but will be greater under fault conditions

VOLTAGE - At around 5V, the Inductance is predominant. At 28V, the Capacitance will be predominant.

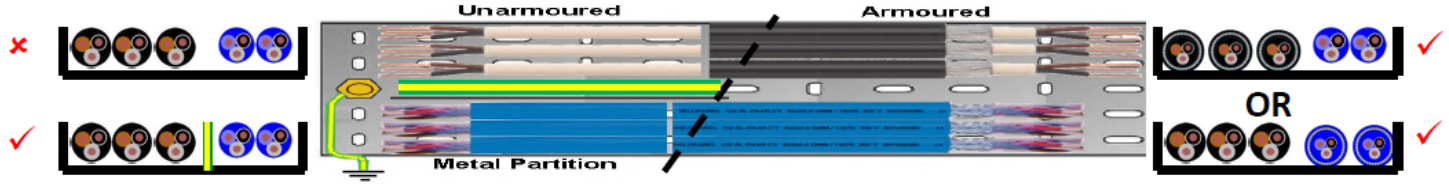
Installation of Apparatus

The apparatus which makes up an IS installation, i.e. field apparatus, associated apparatus and interface units, are required to be certified to relevant standards and installed to manufacturers recommendations.

Cables

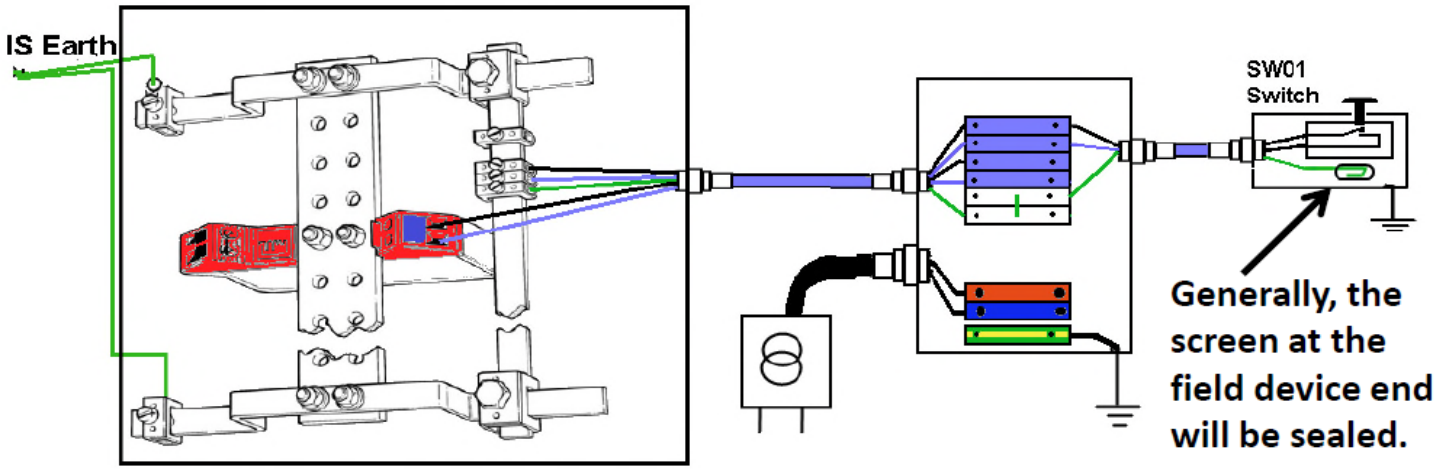
The conductors of IS cables are required to be insulated with elastomeric or thermoplastic insulation. Only insulated cables whose conductor-earth, conductor-screen and screen-earth have passed a Insulation Resistance test where voltages are at least 500 VAC or 750 VDC should be used in intrinsically safe circuits.
Multi-stranded cables are preferred to be ferruled.
Though not a mandatory requirement, the colour for IS cables and terminals is preferred to be light blue.
The armouring of cables should be securely bonded to the plant earth.

Where IS cables run with other cables (non-IS), provided that the IS or non-IS cables are armoured, metal sheathed or screened this is acceptable.



Cable Screens

Where the interconnecting cables of IS circuits have overall screens, or groups of conductors with individual screens, the screens are required to be earthed at one point only, usually the barrier earth bar or as per loop or hook-up diagram.



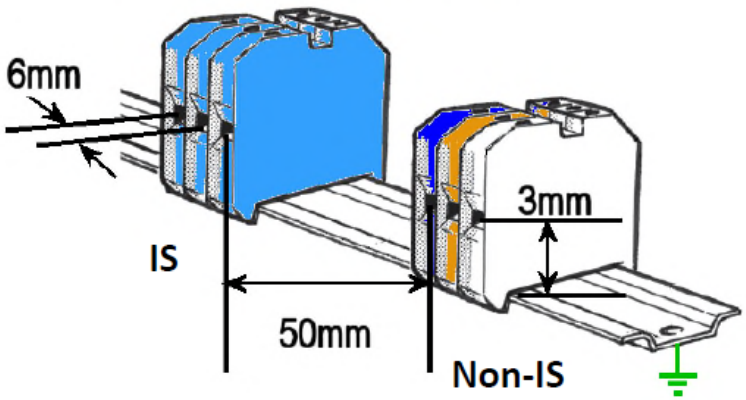
Unused Cable Cores

Generally, unused cable cores should be connected to the IS earth at the interface, and insulated elsewhere by means of connection to terminals which are identified in the documentation.

Clearance Distances

Peak Voltage (v)	Between terminals of separate circuits (mm)	between terminals and earth (mm)
0 - 90	6	3

Minimum Clearance Distances



Where IS circuits and non-IS circuits share the same enclosure, for example measurement and control cabinets, adequate segregation must exist between the two sets of terminals. This can be achieved by means of a 50mm gap. Segregation also applies to the cables of the two types of circuit.

IS and non-IS cables should not be able to reach the terminals of each other

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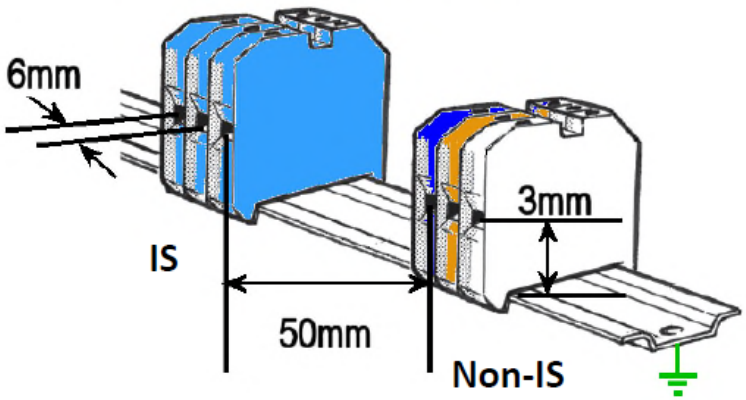
Minimum Clearance Distances



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IS and non-IS cables should not be able to reach the terminals of each other

Maintenance and Testing of IS Systems

Live maintenance is possible on an IS circuit, in a hazardous area.

This meter is marked CE 1180 Ex II 1 G Ex ia IIC T4
Can I use it on an IS circuit in a Zone 2/EPL Gc?

No This instrument needs to be 'Authorised' for use on the appropriate IS circuits.

If test equipment is to be used on an IS circuit in a hazardous area, it must be approved for use on the circuit being tested.

If testing an interface unit such as a Zener barrier for a blown fuse.

Disconnect the unit from the circuit, then measure resistance from the input to output.

Never bridge between the input and output terminals while connected.

Oil immersion Ex o

- Have a volume resistivity at 25 ° C, equal to $1 \cdot 10^{12}$ Ohm
- A flash point (in a closed cup) of at least 200 ° C
- An ignition temperature not less than 300 ° C
- Have a puncture strength of not less than 27 kV for voltage above 1000V and at least 10 kV for voltage up to 1000 V
- A pour point of not more than -30 ° C

Oil Immersion Ex 'o'

Key Points:

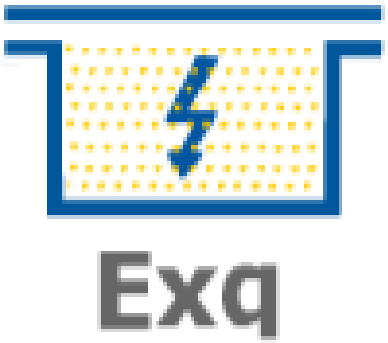
- Oil is used to completely cover components
- Advantage - Circulation of oil, dispersing hot-spots and Oil quenches arcs at contacts where mineral oil is used.
- Revised standards have stricter specification and now may be used in Zone 1 as well as Zone 2.
- Enclosure ingress protection IP66.
- Sealed enclosures to be fitted with pressure-relief device.
- Non-sealed enclosures to be fitted with an expansion device which incorporates a mechanism for automatic tripping on detection of gas evolution from liquid.

Powder filling Ex q

The maximum gap in the enclosure with quartz filling «q» shall be less than the minimum size of the filling material by not less than 0.1 mm.

Equipment that is immersed in powder refers to equipment of group II, category 2G (Zone 1) / Gb.equipment protection level.

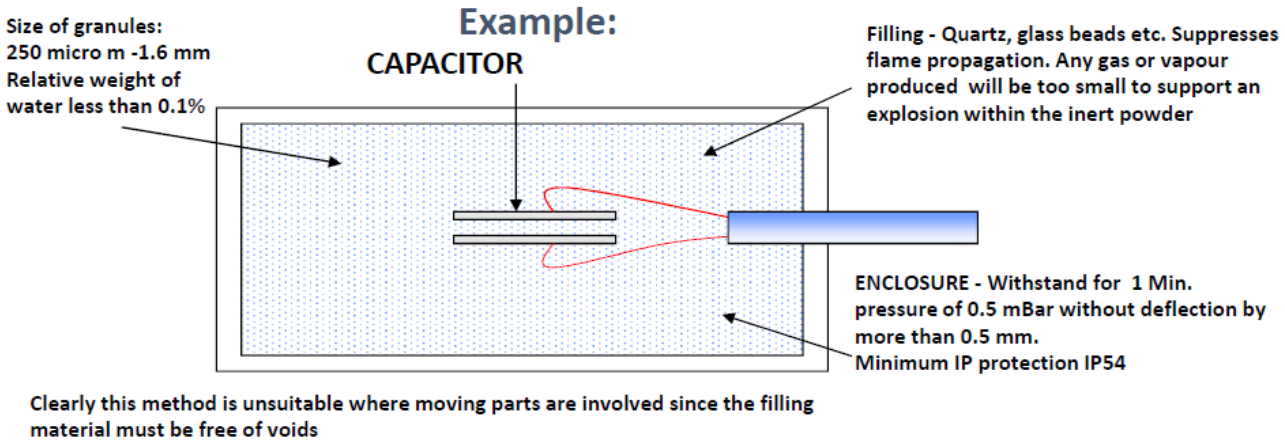
IP 54



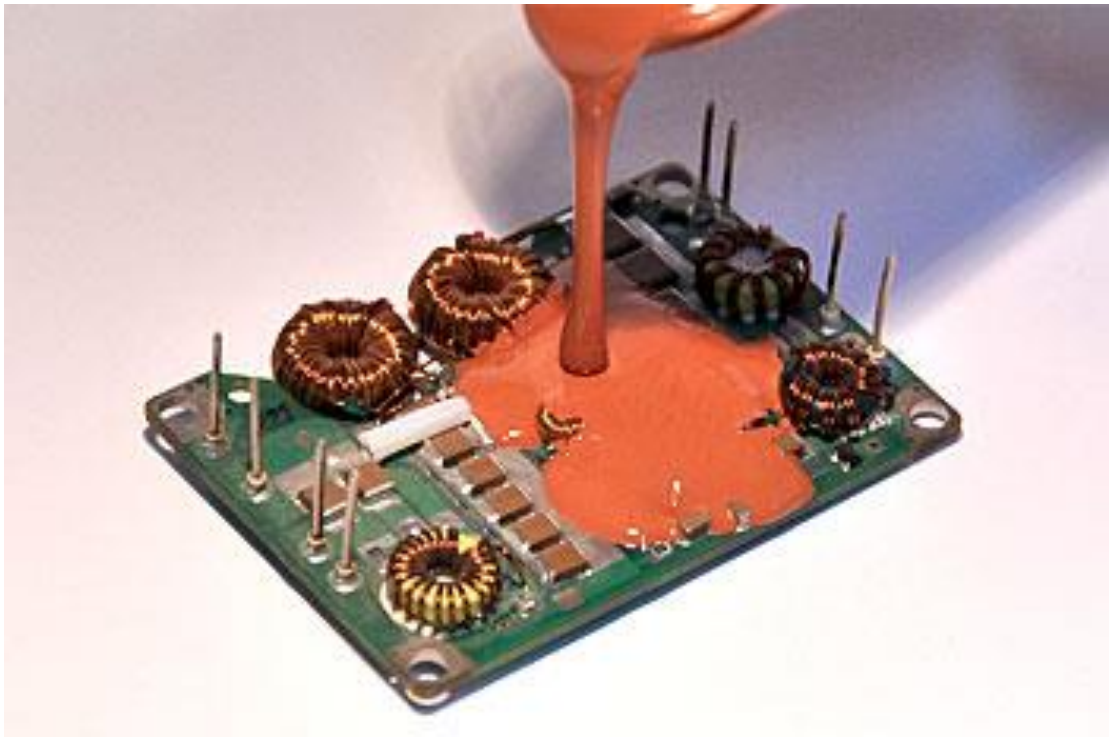
Definition

A type of protection in which the enclosure of electrical apparatus is filled with a material in a finely granulated state so that, in the intended conditions of service, any arc occurring within the enclosure of an electrical apparatus will not ignite the surrounding atmosphere. No ignition shall be caused either by flame or by excessive temperature of the surfaces of the enclosure.

This type of protection is not widely used and typical applications are, for example, capacitors in Increased Safety Ex 'edq' lighting fittings, and telecommunications in some European countries.



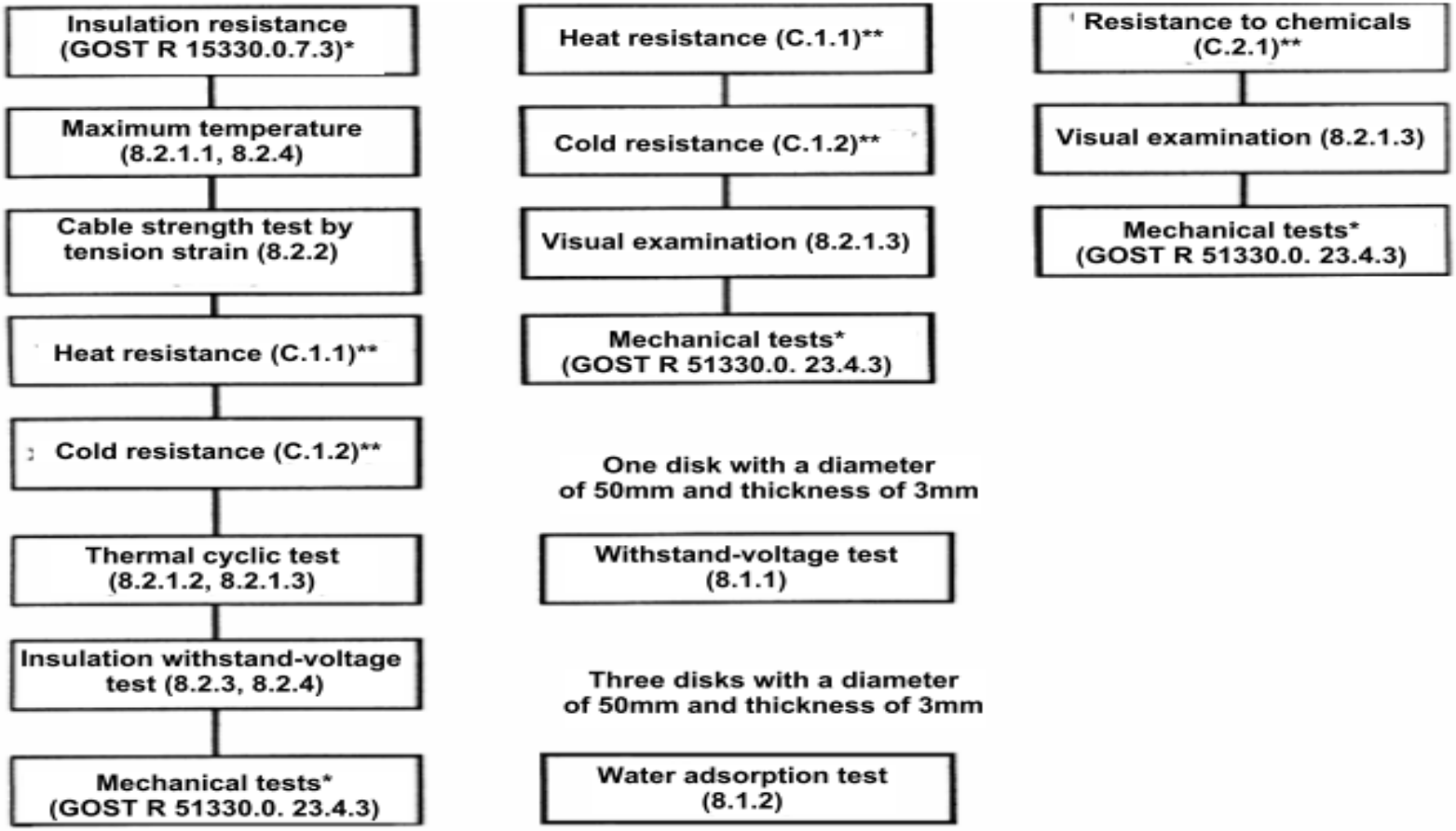
Encapsulation Ex m



Encapsulation Ex m

Rated insulation voltage *(effective value)*, V	Minimum distance, mm
380	1,0
500	1,5
660	2,0
1000	2,5
1500	4,0
3000	7,0
6000	12,0
10000	20,0

Encapsulation Ex m



Encapsulation Ex 'm'

Definition:

A type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited.

Three levels of protection are considered: 'ma', 'mb' and 'mc'. The essential difference between the three levels of protection lies in component integrity and in the means adopted to ensure that, even if components do fail, safety is ensured.

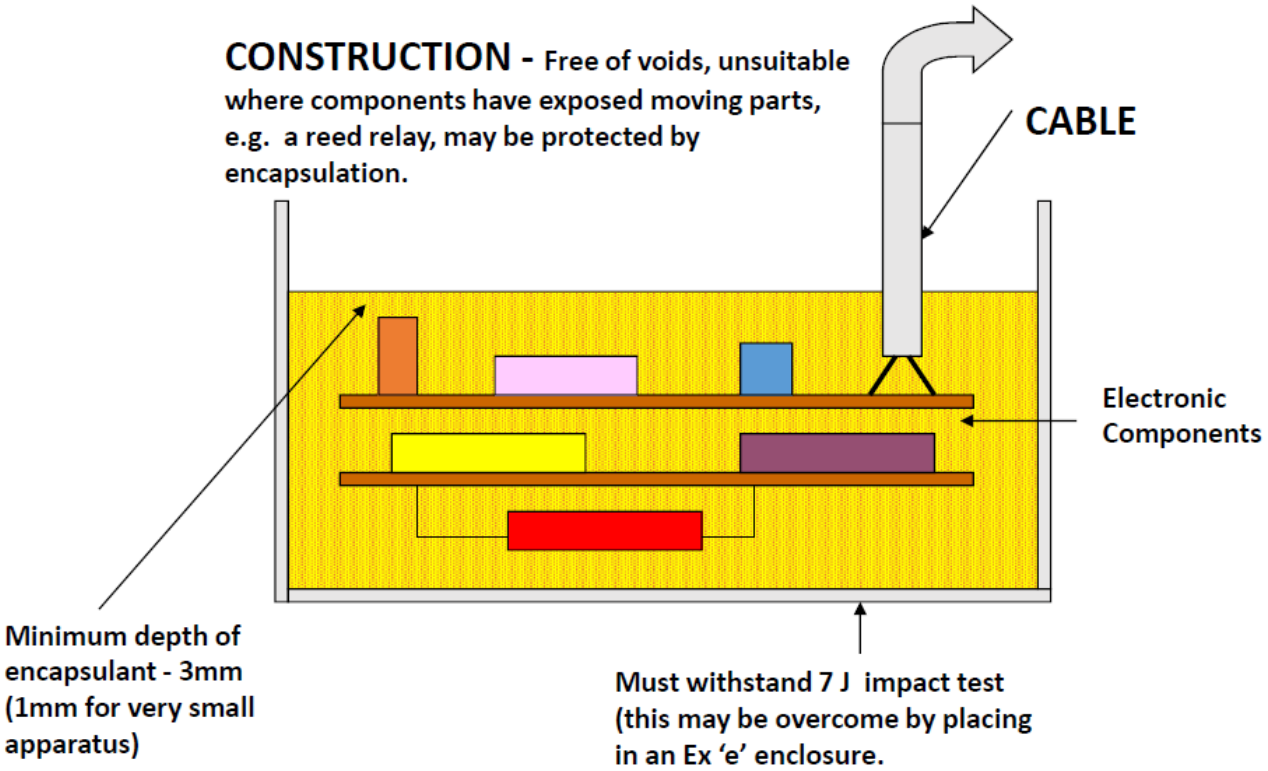
Ex ma – Suitable for use in zones 0 or less onerous duties.
Will remain safe with 2 component failures

Ex mb – Suitable for use in zones 1 or less onerous duties.
Will remain safe with 1 component failures

Ex mc – Suitable for use in zone 2 only
no component failures are considered.

Encapsulation Ex 'm'

Example:



MODULE III
Types of Protection

Reduced risk Ex n

Ex n

- not causing arcing device
- causing arcing device

Definition Ex 'n'

A type of protection applied to an electrical apparatus such that, in normal operation and in certain specified abnormal conditions, it is not capable of igniting a surrounding explosive atmosphere, and a fault capable of causing ignition is not likely to occur.

Additional Protection Measures

CENELEC Marking	Apparatus Variations
nA	Non Sparking Device;
nC	Sealed Devices - Hermetically, Encapsulated, Enclosed Break;
nR	Restricted Breathing Enclosure;

Note:

nL Energy Limited Apparatus – Protection Ex ic can be used to replace Ex nL equipment/components.

Ex n not permitted on FGP/ WPMP per specification.

MODULE III
Types of Protection

Principle Design Features

1. Mechanically strong enclosure resistant to impact.
2. Ingress protection against solid objects and water - at least IP 54 for internal bare live parts.
3. The use of certified Ex e, Ex nR glands as of January 2008.
4. Luminaries – Lamps that have non conductive end caps with a conductive coating are prohibited unless they have been tested with the equipment.
5. Terminals manufactured from high quality insulation material.
6. Specified creepage and clearances incorporated in design of terminals.
7. Terminal locking devices to ensure conductors remain secure in service.
8. The use of certified de-rating terminals as of 2008.

MODULE III
Types of Protection

Principle Design Features

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MODULE III
Types of Protection

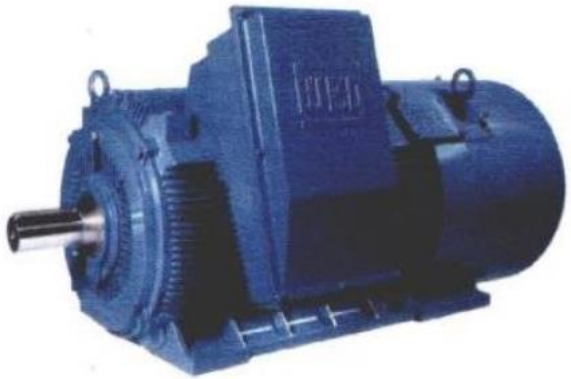
Ex ‘nA’ – Non Sparking

This equipment is constructed to minimize the risk of occurrence of arcs or sparks capable of creating an ignition hazard during normal use conditions.

Junction Box - Example Label

Does this equipment have special conditions? No

Example Equipment
Ex nA Motor



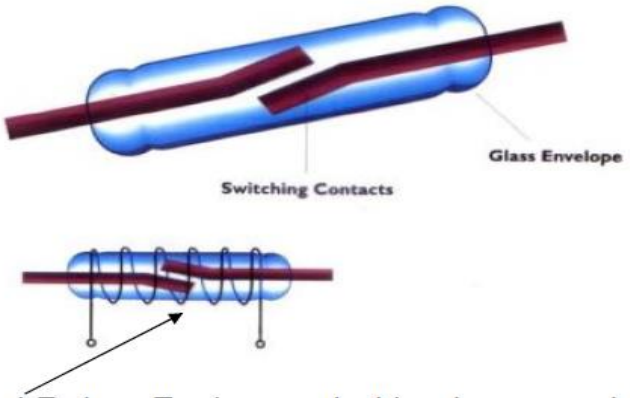
If JB or motor is installed today then the gland we use to enter the connection box must be certified.

MODULE III
Types of Protection

Ex ‘nC’ Type Protection

This equipment is constructed to minimize the risk of arcs or sparks capable of creating an ignition hazard using other methods of protection.

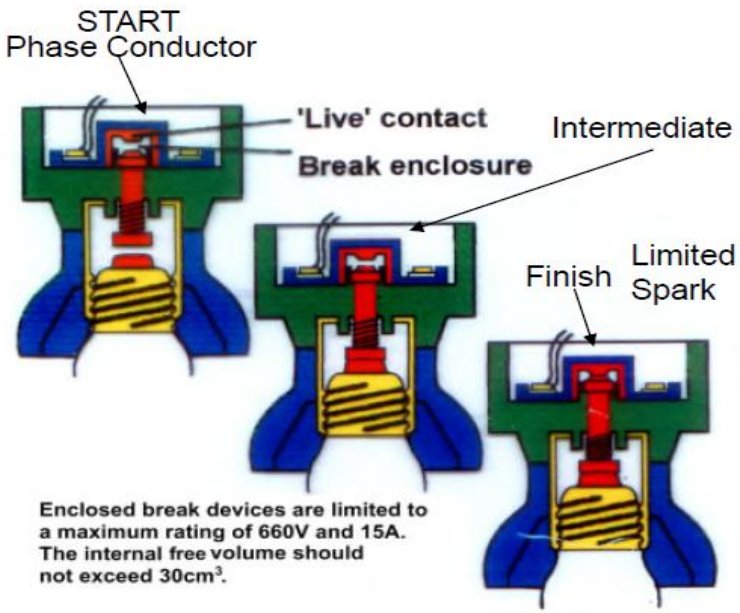
Hermetically Sealed Device



Reed Relay: Fusion sealed in glass envelope

A device which prevents an external gas or vapour gaining access to the interior by sealing of joints by fusion, e.g. welding, soldering, brazing or fusion of glass to metal.

Enclosed-Break Device



Enclosed break devices are limited to a maximum rating of 660V and 15A. The internal free volume should not exceed 30cm^3.

MODULE III
Types of Protection

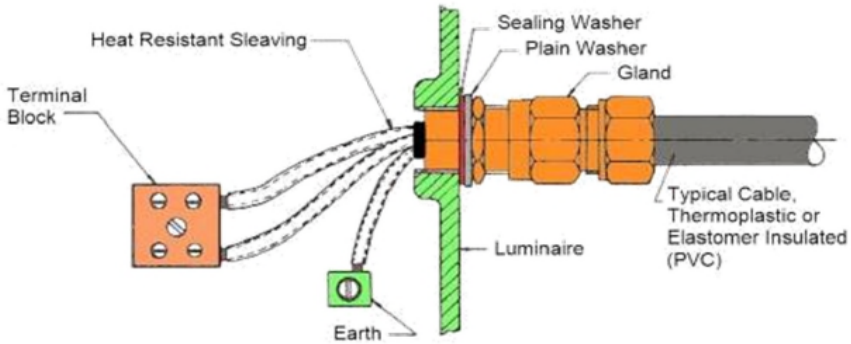
Ex ‘nR’ Protection (Restricted Breathing Device)

Restricted breathing is a protection technique which will restrict the entry of explosive gases or dusts. A low rate of leakage is allowable providing the requirements of the standard are met.

Example of Ex nR Equipment

The explosion protection is Ex nR will have a restricted breathing seal on the enclosure.

Ex nR - Glanding & Incoming Cable Arrangements



The use of a certified gland with an appropriate seal should be used for a Restricted breathing enclosure.

The manufacture may recommend the use of an external sealing washer.

MODULE III
Types of Protection

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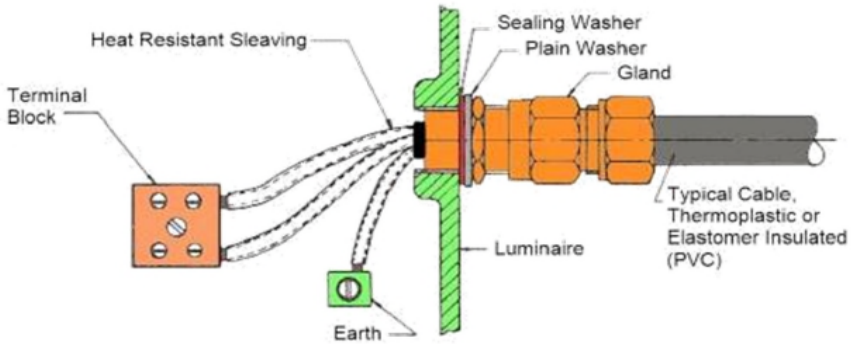

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The manufacture may recommend the use of an external sealing washer.

MODULE III
Combined Protection

Combined Protection Types

PYROBAN
Leaders in Hazard Protection

Pyroban Ltd, Endeavour Works
Dolphin Road, Shoreham-by-Sea,
West Sussex, BN43 6QG
United Kingdom.
Tel: +44 (0) 1273 466200
Fax: +44 (0) 1273 465313

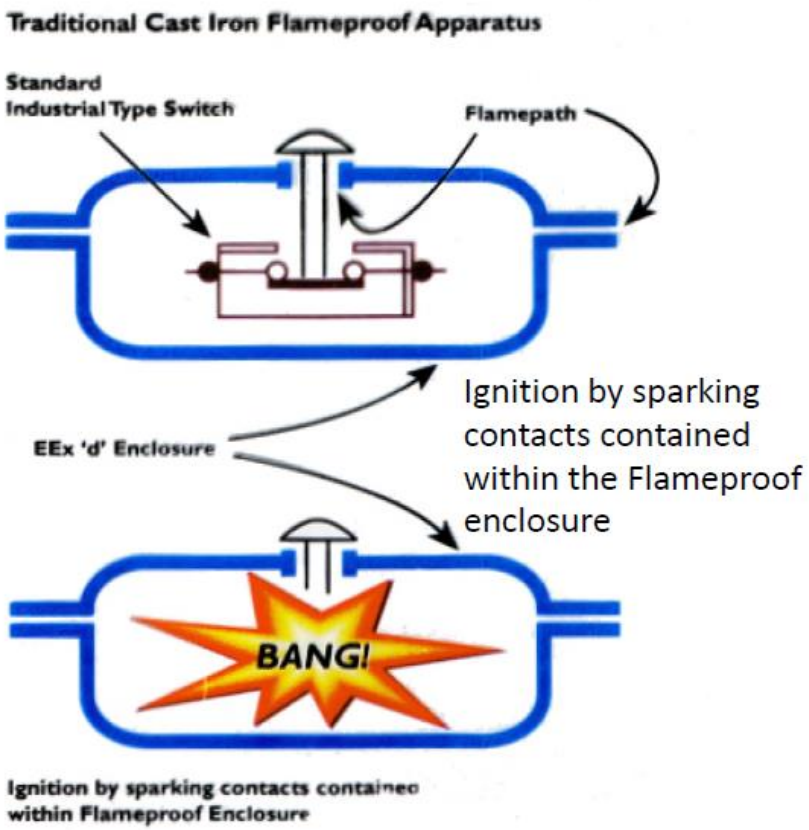
Systeem / System / Système: Euromech 2G™	
Third Party Certificate No: SEV 07ATEX0104 08.IK-10100.075	
Bouwjaar / Boujahr / Annee de le fabr / Manufacturing Date: 04/2008	Serienr / Seriennr / No de serie / Serial No: D09287A 08054/OR
Gasgroep / Zuendgruppe / Group de gaz / Gas Group: IIA & IIB	Categorie / Kategorie / Categorie / Category: II 2G
Temp. klasse / Temp klasse / Classe de Temp / Temp class: T 3	Zone / Zone / Zone / Zone: 1
Voertuig / Fahrzeug / Vehicule / Vehicle	Motor / Motor / Moteur / Engine
Merk / Marke / Marque : / Manufacturer: MITSUBISHI	Merk / Marke / Marque : / Manufacturer: MITSUBISHI
Type / Typ / Typ : / Type: FD50K2	Type / Typ / Typ : / Type: S6S
Serienr / Seriennr / No. de serie / Serial No.: EF28B50860	Serienr / Seriennr / No. de serie / Serial No.: 060104

MODULE III
Combined Protection

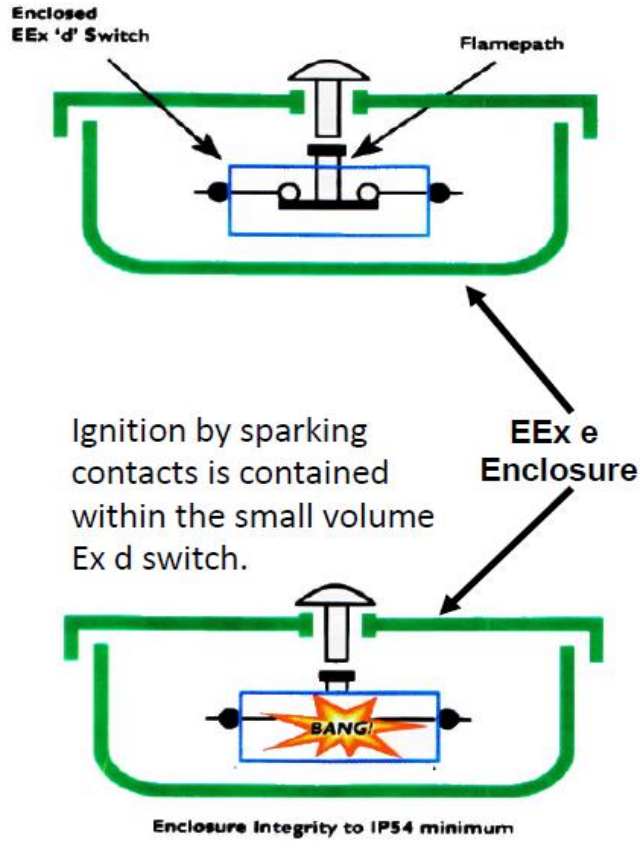
Electrical equipment may be manufactured with more than one method of explosion protection. Equipment of this type has combined methods of protection but may also be known as a *hybrid*. Such an approach combines the best features of each type of protection into one piece of equipment for both economic and practical purposes.

MODULE III
Combined Protection

Traditional Cast Iron Flameproof Apparatus



Ex e Enclosure with small volume Ex d switch fitted internally



MODULE III
Combined Protection

Ex de

All parts what can be possible sources of ignition

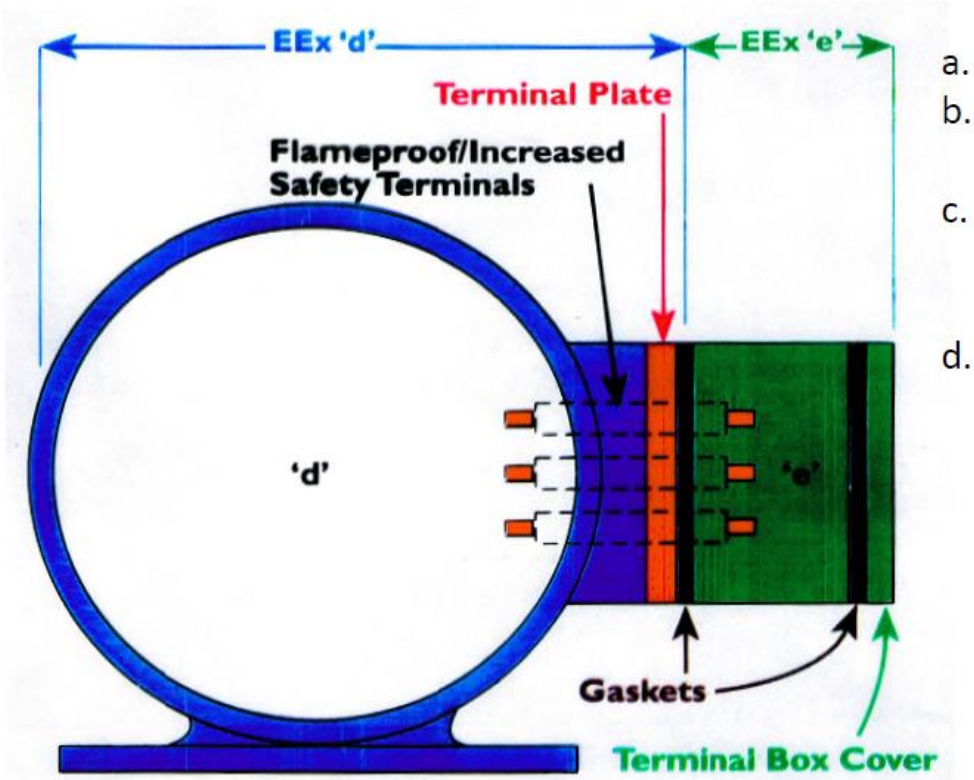
Unmaintainable joint

Maintainable termination

MODULE III
Combined Protection

Combined Types Ex 'de'

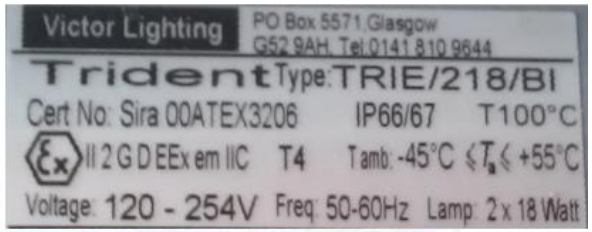
If this motor was installed today what gland would I fit to attain the minimum standard?



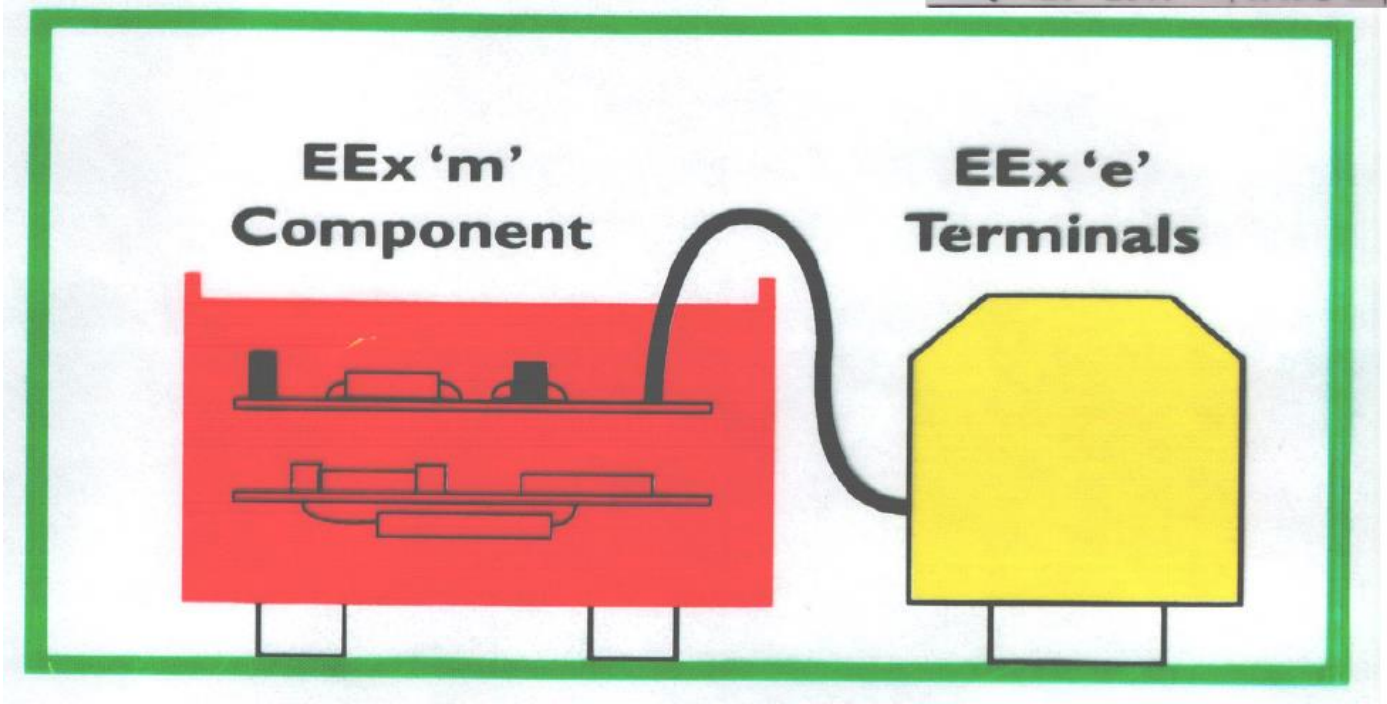
a. Ex d Barrier
b. Ex e gland that meets 60079-0 Standard
c. Non certified that meets IP and impact Std
d. Ex d

MODULE III
Combined Protection

Combined Types Ex 'em'



EEx 'e' Enclosure



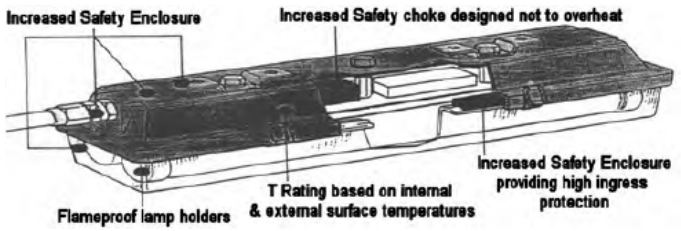
Combined Types of Protection

Where different types of protection are employed for different parts of electrical equipment or an Ex component, the Ex marking would include the symbols for all of the types of protection employed. The symbols for the types of protection would appear in alphabetical order, with small separating spaces.

Note: Earlier versions of IEC 60079-0 required that the types of protection were marked with the major type of protection first, e.g. an Ex e enclosure with an Ex d switch inside was marked Ex ed.

When associated apparatus is incorporated, the symbols for the type of protection, including the square brackets as applicable, follow those symbols of the type of protection for the equipment.

Old Marking
Lighting Fitting
Ex 'edqm'



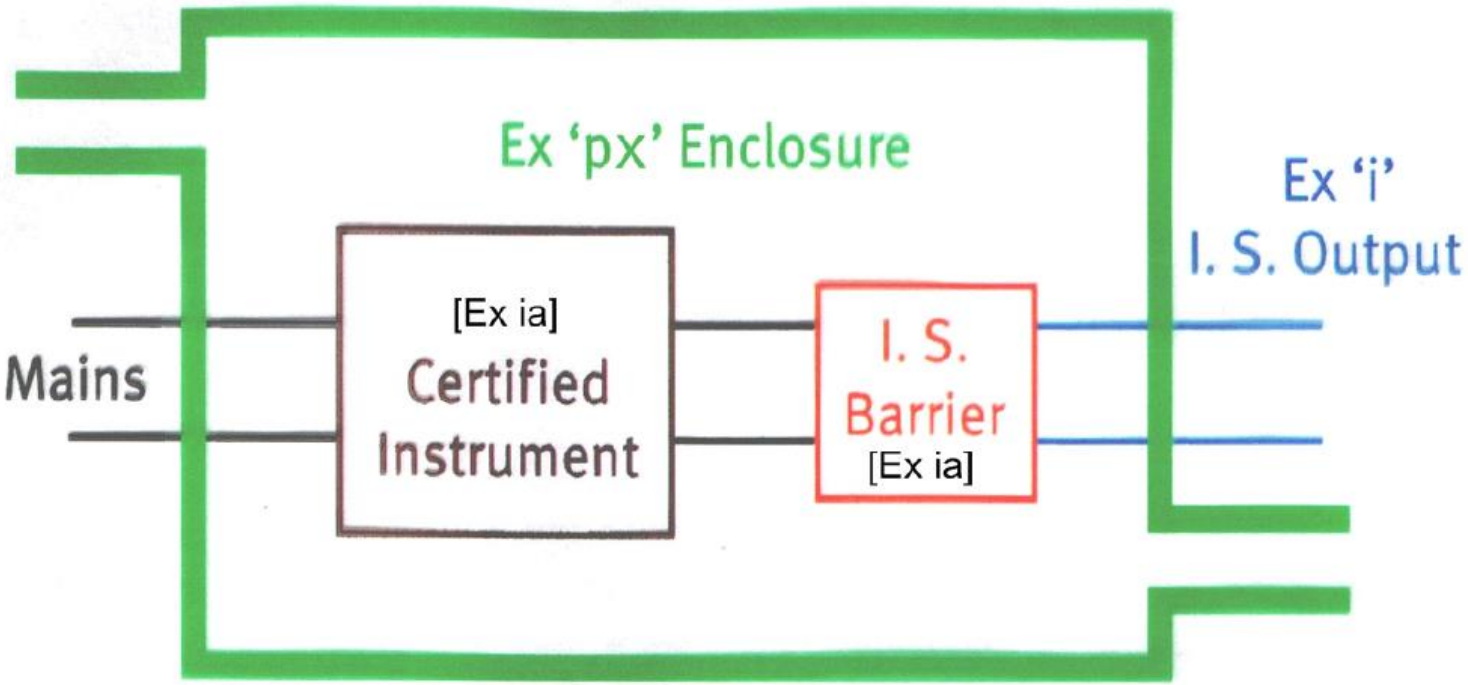
New Marking
Lighting Fitting
Ex 'demq'

MODULE III
Combined Protection

Combined Types Ex 'px' [ia]'

Ex Marking — Ex px [ia Ga] IIC T4 Gb — EPL Marking

ATEX Marking — II 2(1) G — Zone 1 IIC T4

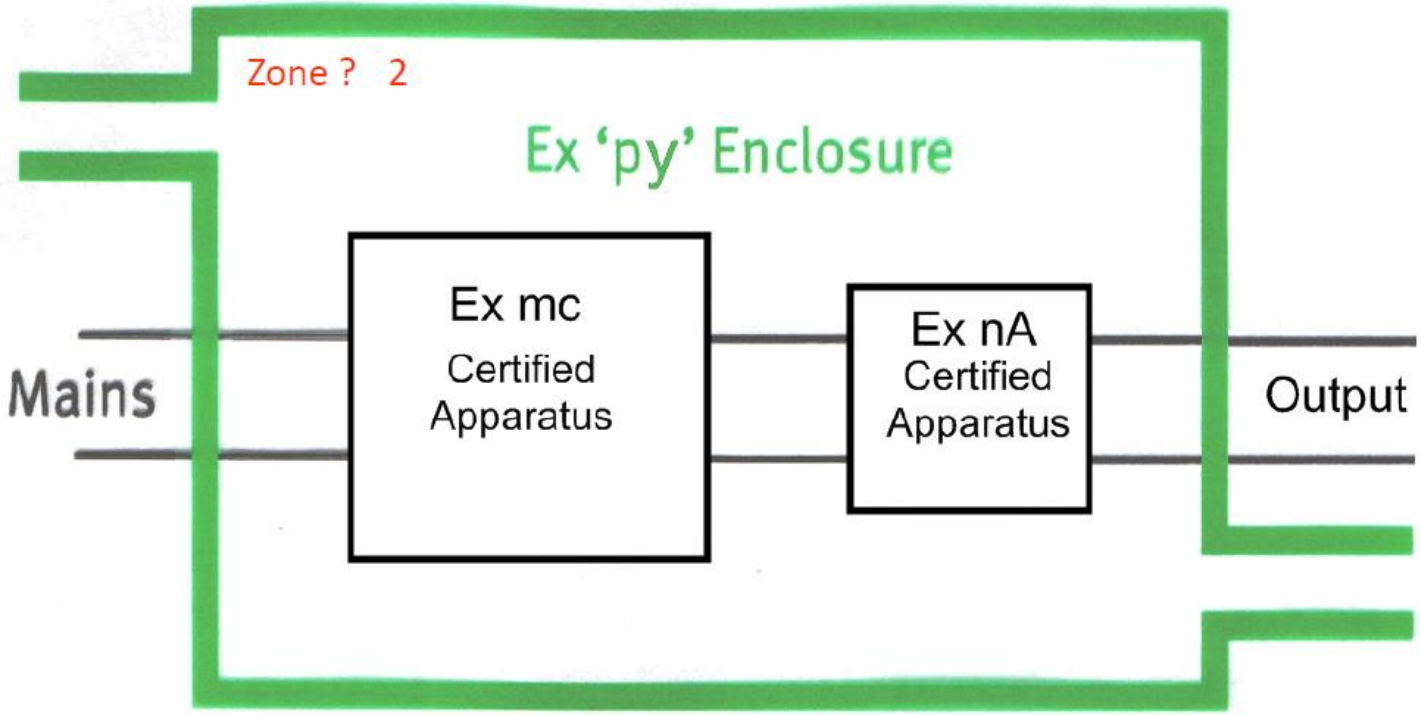


MODULE III
Combined Protection

Combined Types Ex 'py'

Ex Marking Ex mc nA py IIC T4 Gb EPL Marking

Zone 1 IIC T4

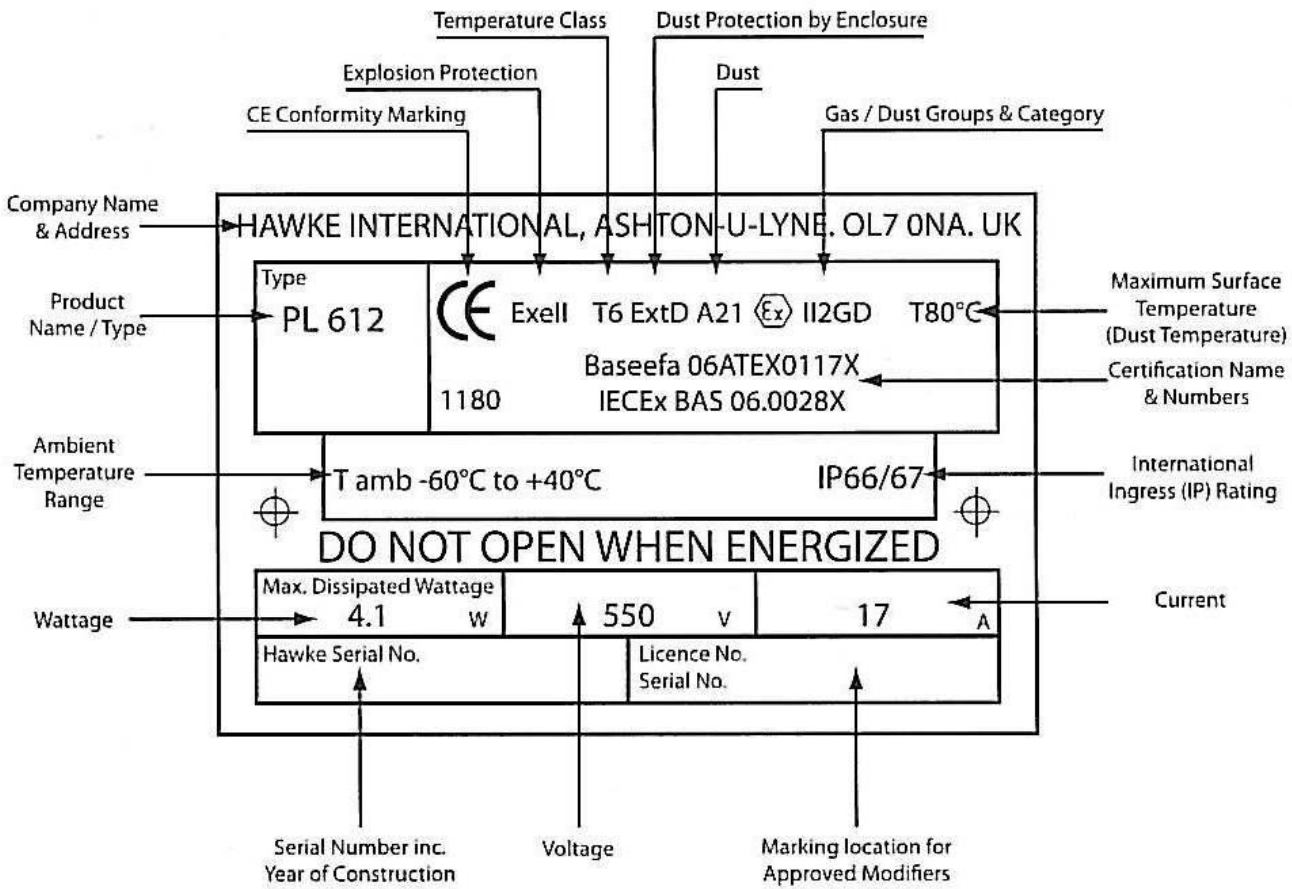


MODULE III
Types of Protection

Certification Marking Summary

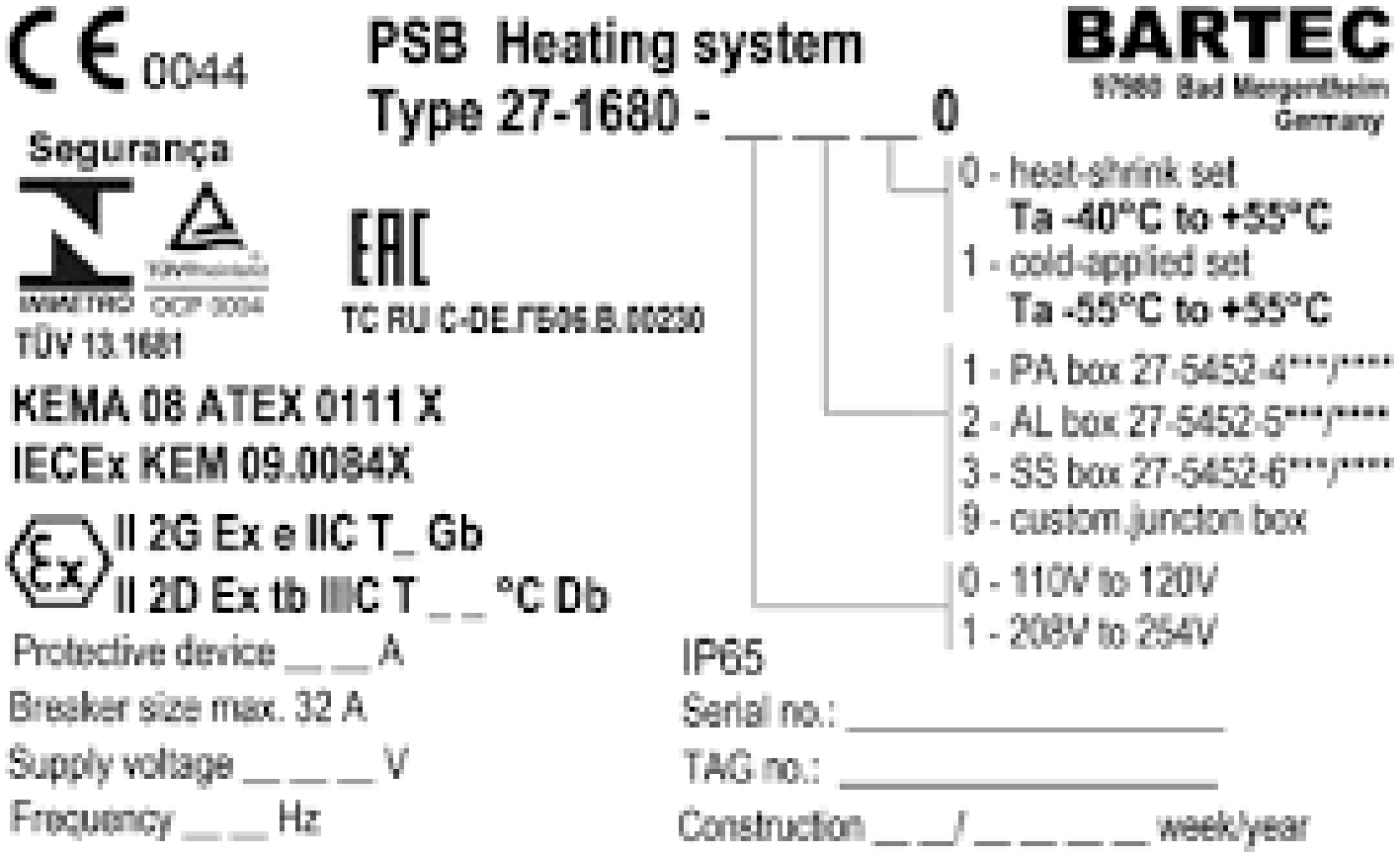
Method of Protection	Ex code	Permitted in:		
		Zone 0	Zone 1	Zone 2
Encapsulation	ma	✓	✓	✓
	mb		✓	✓
Oil immersion	o		✓	✓
Powder filling	q		✓	✓
Pressurisation	p		✓	✓
Flameproof	da	✓	✓	✓
	db		✓	✓
	dc			✓
Intrinsic safety	ia	✓	✓	✓
	ib		✓	✓
	ic			✓
Increased safety	e		✓	✓
Type of protection "n"	nA			✓
	nR			✓
	nC			✓

MODULE III
Ex certification plate



EAC Certification details is mandatory to be showed on certification plate for RoK

MODULE III
Ex certification plate



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