

## Session 12 – Ex Protection Concepts



# Ex Protection Concepts

## Electrical

Electrical	Symbol	Typical IEC EPL	Typical Zones	IEC Standard	Basic concept of protection
Increased safety Type 'n' (non-sparking)	e nA	Gb Gc	1,2 2	IEC 60079-7 IEC 60079-15	No arcs, sparks or hot surfaces. Enclosure IP54 or better
Flameproof Type 'n' (enclosed break)	d nC	Gb Gc	1,2 2	IEC 60079-1 IEC 60079-15	Contain the explosion, quench the flame
Quartz/sand filled	q	Gb	1,2	IEC 60079-5	Quench the flame
Intrinsic safety	ia	Ga	0,1,2	IEC 60079-11	Limit the energy of sparks and surface temperatures
Intrinsic safety	ib	Gb	1,2	IEC 60079-11	
Intrinsic safety	ic	Gc	2	IEC 60079-11	
Type 'n' (energy limitation)	nL	Gc	2	IEC 60079-15	
Pressurised (up to 2007)	p	Gb	1,2	IEC 60079-2	Keep the flammable gas out
Pressurised	px	Gb	1,2	IEC 60079-2	
Pressurised	py	Gb	1,2	IEC 60079-2	
Pressurised	pz	Gc	2	IEC 60079-2	
Type 'n' (sealing & hermetic sealing)	nC	Gc	2	IEC 60079-15	
Type 'n' (restricted breathing)	nR	Gc	2	IEC 60079-15	
Type 'n' (simple pressurised)	nZ	Gc	2	IEC 60079-15	
Encapsulation	ma	Ga	0,1,2	IEC 60079-18	
Encapsulation	mb	Gb	1,2	IEC 60079-18	
Oil immersion	o	Gb	1,2	IEC 60079-6	

# Ex Protection Concepts

## Non-Electrical

Non-electrical	Symbol	Typical IEC EPL	Possible Zone(s)	EN Standard	Basic concept of protection
Flow restricted enclosure Flameproof enclosure	fr d	- -	2 1,2	EN 13463-2 EN 13463-3	Relies on tight seals, closely matched joints and tough enclosures to restrict the breathing of the enclosure
Inherent safety	g	-	0,1,2	prEN 13463-4	Low potential energy (draft standard)
Constructional safety	c	-	0,1,2	EN 13463-5	Ignition hazards eliminated by good engineering methods
Control of ignition sources	b	-	0,1,2	EN 13463-6	Control equipment fitted to detect malfunctions
Pressurisation	p	-	1,2	EN 13463-7	Enclosure is purged and pressurised to prevent ignition sources from arising
Liquid immersion	k	-	0,1,2	EN 13463-8	Enclosure uses liquid to prevent contact with explosive atmospheres



# Ex Protection Concepts

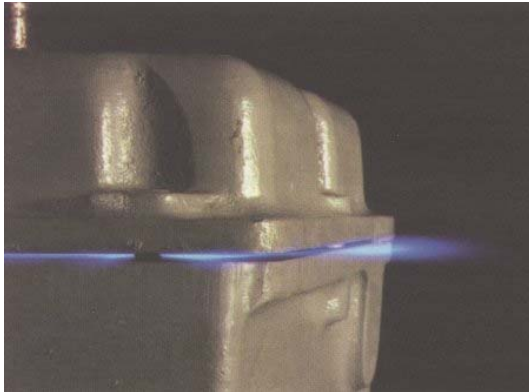
## Dust Protection Electrical

Dust Protection (Electrical)	Symbol	Typical IEC EPL	Typical Zone(s)	IEC Standard	Basic concept of protection
Enclosure	t	Da, Db, Dc	20	IEC 60079-31	Standard protection for dusts, rugged tight enclosure
Intrinsic safety	i		21	IEC 60079-11	Similar to t, but with some relaxations if circuit inside is intrinsically safe
Encapsulation	m		22	IEC 60079-18	Protection by encapsulation of incendive parts
Pressurised	p	Db,Dc	21,22	IEC 60079-2	Protection by pressurisation of enclosure

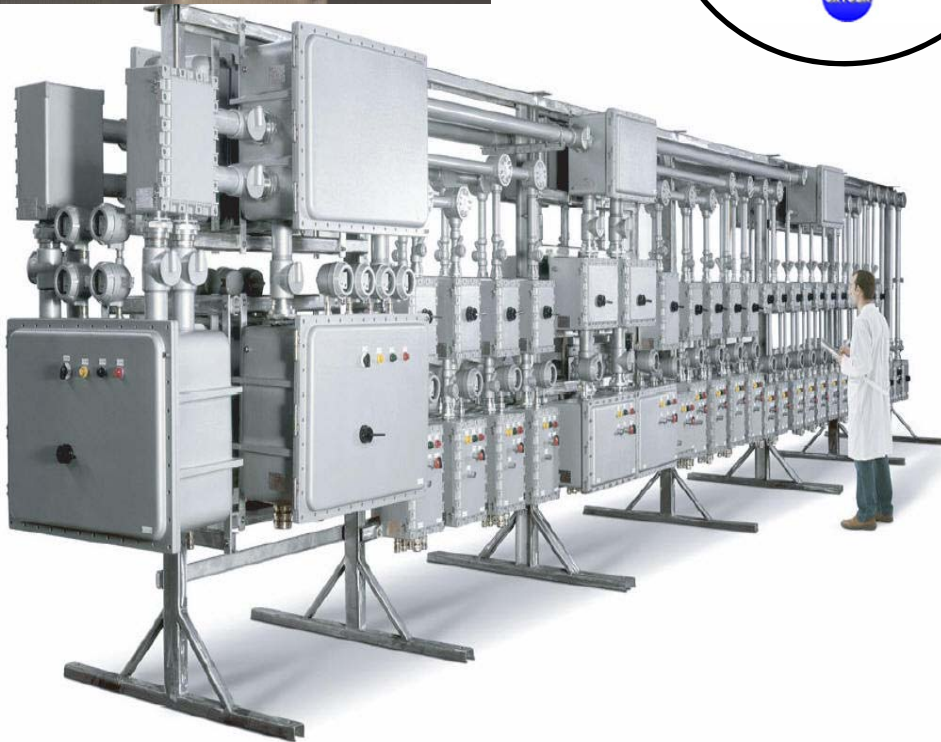
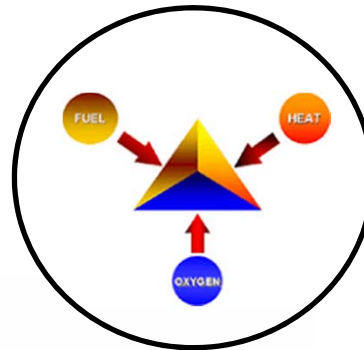


SOURCE IEx

# Ex d – Flameproof AS/NZS/EN/IEC 60079-1



Zone 1 & 2 Suitable

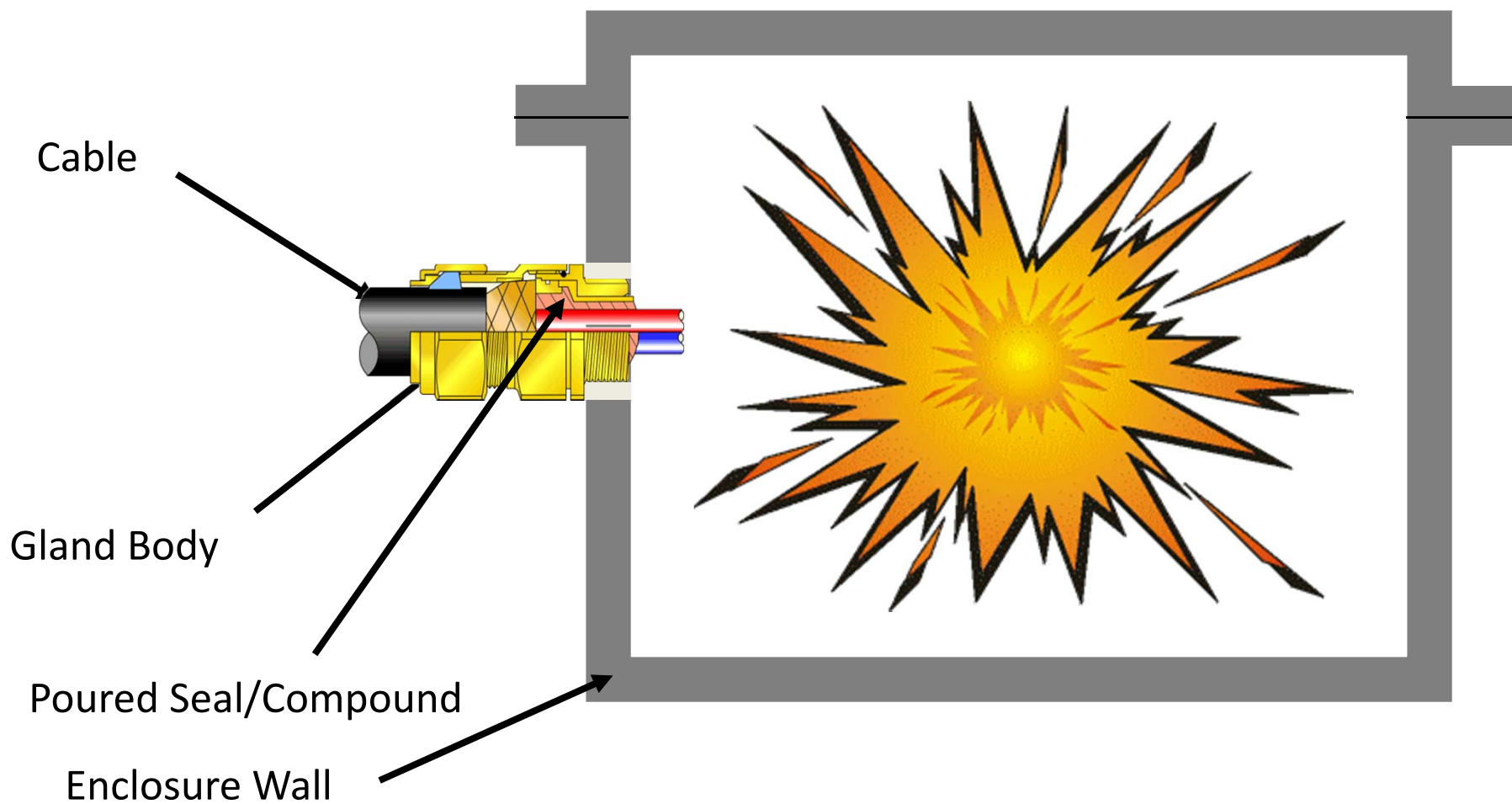


## Ex d – Flameproof Concept

- Lamps, circuits and sparking devices are contained within flameproof enclosure.
- Wiring enters enclosure via flameproof cable gland or flameproof barrier.
- Joints on covers or openings are protected by the 'flamepath'.
- Does not prevent explosion occurring but contains the explosion and prevents ignition of surrounding atmosphere.

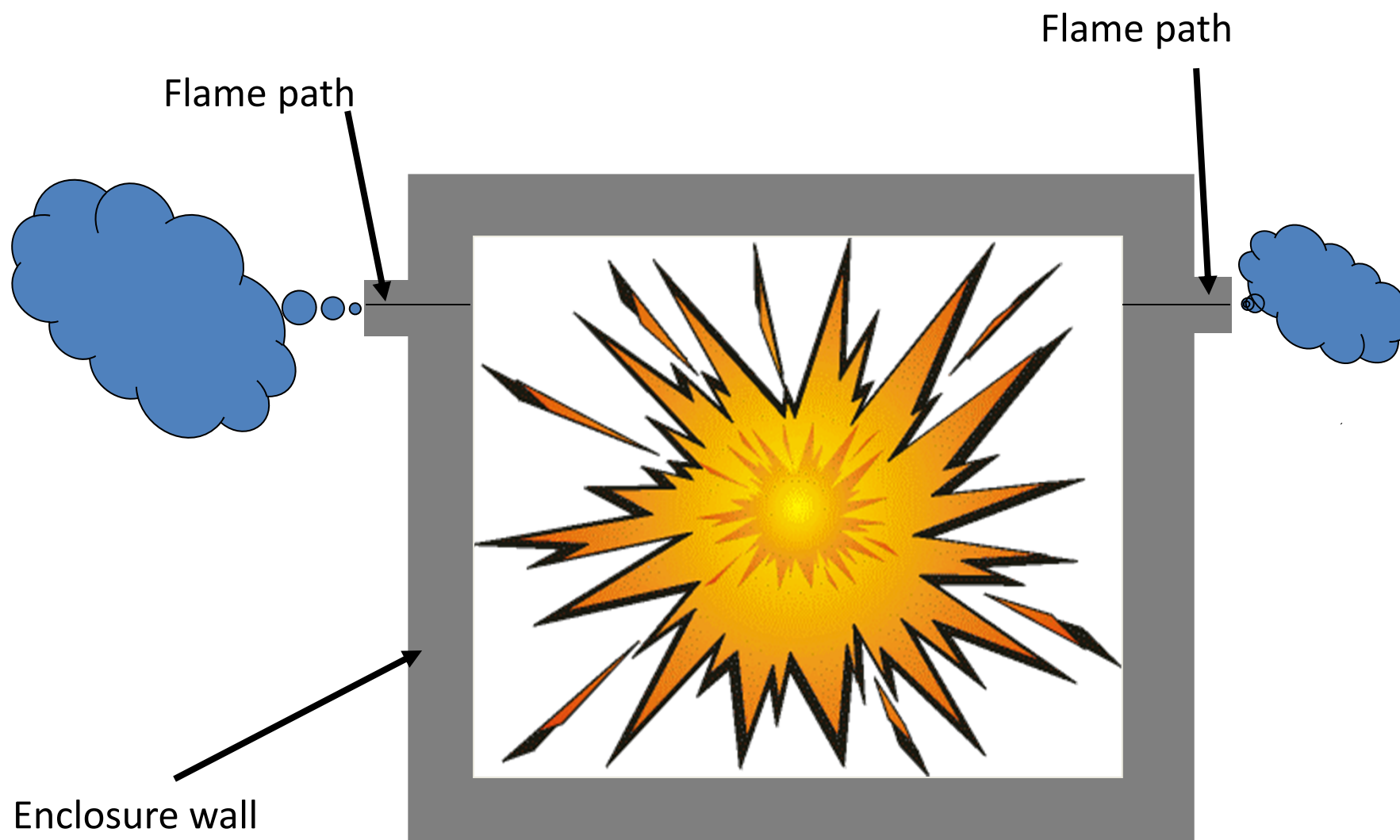


## Ex d – Flameproof Barrier



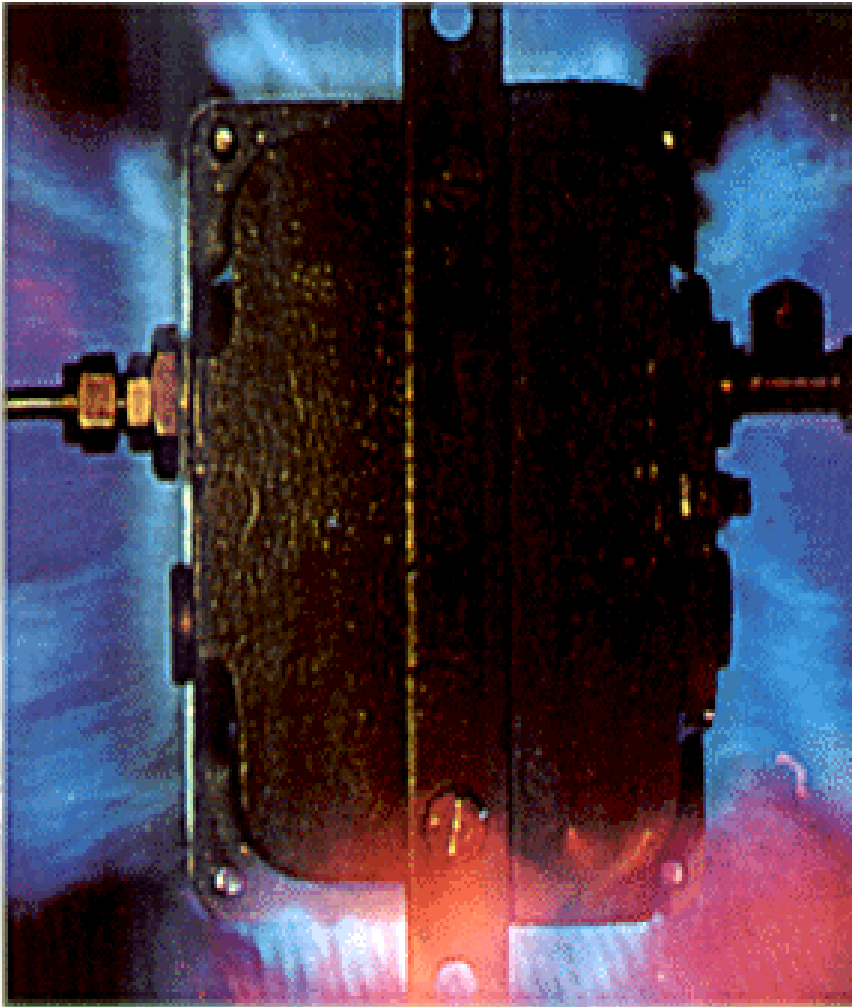


## Ex d – Flame Path Flanged Design





## Flameproof vs. Explosion Proof



Difference between Flameproof & Explosion proof boxes

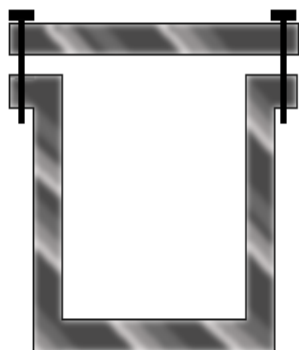
- Enclosure must have recessed screws or bolts for access
- 1.5 safety factor vs. 4 times
- Typically must be machined and fabricated at the factory vs. the field
- Most Ex 'd' enclosures individually tested

**SOURCE** IEx

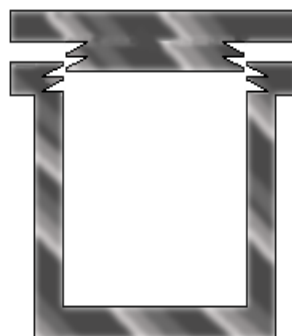
## Flameproof Testing



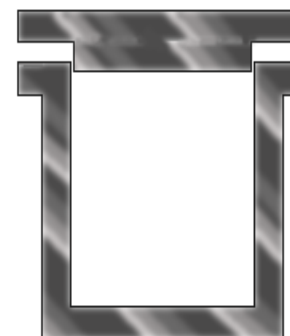
## Ex d – Flameproof 3 types of joints



Flanged Joint



Threaded Joint



Spigot Joint

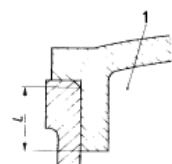


Figure 1

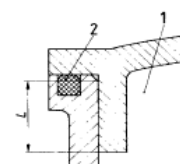


Figure 2

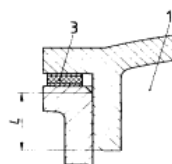


Figure 3

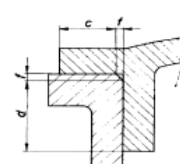


Figure 4

1 Interior of enclosure  
2 Sealing gasket  
3 Metal or metal-clad compressible sealing gasket

Figures 1 to 4. Spigot joints for Group IIC enclosures

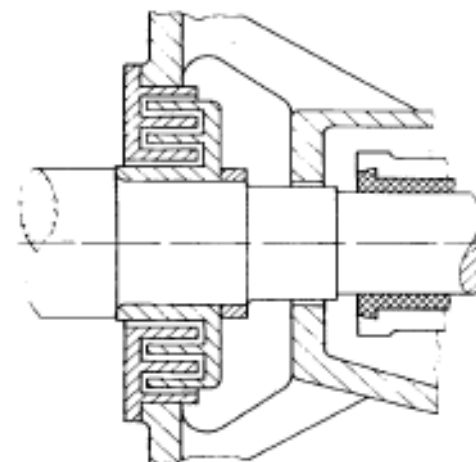


Figure 18. Example of labyrinth joint for shaft of rotating electrical machine

## Field Modification of Ex 'd' Equipment

Flameproof enclosures are normally supplied complete with all internal components fitted and certified as a single entity by a recognized test authority. The testing procedure will take into consideration the free internal volume after all the components have been fitted, the temperature rise, creepage and clearance distances and the rise in pressure as a result of an internal explosion using a gas/air mixture in its most explosive proportions.

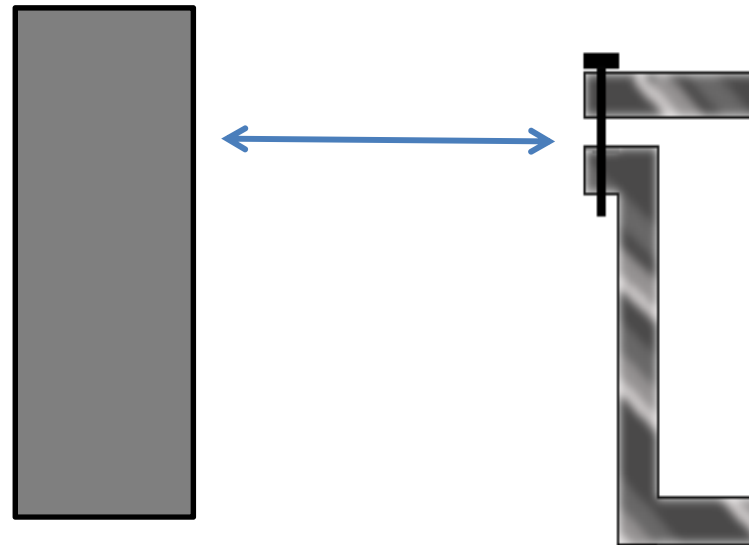
- Replacement components should be the same as the original components. For example, a component larger or smaller than the original will affect the internal geometry of the enclosure. Pressure piling is a possibility if a larger component is fitted and increased volume will result if a smaller component is fitted.
- Drilling and tapping of the entries should only be carried out by the manufacturer of the enclosure or his approved agent. The threads of the entries are required to be compatible with those of the cable glands or conduit in terms of type of thread, thread pitch and clearance tolerance since flamepaths exist at these points.
- Gaskets can only be replaced, they must not be added retrospectively if not included as part of the original design.



## Obstruction of Flamepath

A solid obstruction such as a wall, steelwork, conduit, brackets or weatherguards or other electrical equipment in close proximity to the opening of the joint can, in the event of an internal explosion, reduce the efficiency of the flamepath to the extent that ignition of the external gas or vapor could occur. Minimum distances between the flamepath opening and an obstruction as specified in IEC 60079-14

Group	Distance
IIA	10mm
IIB	30mm
IIC	40mm



## Ex d IIB vs. Ex d IIC Construction

Can you spot the difference in construction?...



Flanged designed enclosures are not designed for IIC applications. However, you can find certain flanged enclosures suitable for IIB+H2

## Ex 'd' Flameproof Conduit Systems

Although, conduit is not widely used in Northern Europe, this technique is included in the CENELEC standard and the IEC standards as one of the entry methods into flameproof enclosures. The design and testing requirements are contained in the CENELEC and IEC Standard IEC 60079-1. Either tapered (NPT) or parallel (straight or metric) threads are acceptable. The conditions are:

- The Ex d enclosure must be certified.
- Only the manufacturer can make the drilled and tapped entries into the Ex d enclosure.
- All conduits or cable glands entering the enclosure must be sealed by an approved method.

From the area beyond the enclosure seal, all of the wiring methods and fittings are considered installation materials and not subject to any certificate or approval. Thus, getting fittings certified to the ATEX directive would not be a common practice. The correct use of conduit installation is spelled out in the installation standards EN 60079-14 and IEC 60079-14.





## Weatherproofing Ex 'd' Equipment

In general, the use of Ex 'd' flameproof equipment without the use of gaskets or seals will only provide protection up to IP54. For applications requiring higher levels of IP protection, the use of gaskets integrated within the flamepath is a common option to consider. Other weatherproofing materials considered and commonly used are non-hardening grease bearing textile tape in the UK and non-setting grease or compounds.

The use of non-setting grease on machined surfaces of flamepaths has two advantages since in addition to providing an additional level of ingress protection, it also inhibits the formation of rust on these surfaces. Silicone based greases require careful consideration in order to avoid possible damage to the elements of gas detectors.

In general, consult with the manufacturer of Ex 'd' equipment for recommendations involving lubricants and tapes to be sure.



## Flameproof Ex 'd' Quiz

- Components which arc or spark in normal operation are permitted with Ex 'd' enclosures **True**
- Gaps at flamepaths are not necessary **True**
- An enclosure marked Ex 'd' IIA is suitable for all subgroups **False**
- It is acceptable for one fixing screw to be left out of a flameproof enclosure cover **False**
- It is not acceptable to remove an unused component from within a flameproof enclosure **True**

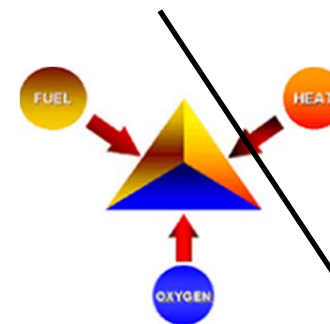
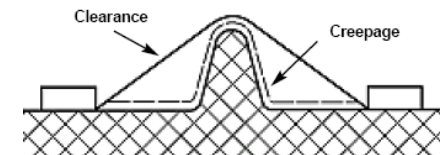
## Ex e – Increased Safety (AS/NZS/EN/IEC 60079-7)

Junction boxes and terminal enclosures for use in hazardous areas mainly contain non incandive devices i.e. terminals. For Ex 'e' certified apparatus there are two main criteria when specifying the apparatus.

1. Are the components acceptable for use in the enclosure i.e. non sparking, and
2. Will any components or wiring be hotter than the temperature classification of the apparatus allows.

By knowing the total current through the enclosure and the total resistance of the terminals and wiring, using Ohms Law it is possible to calculate the dissipation power of the circuit

**Zone 1 & 2 Suitable**



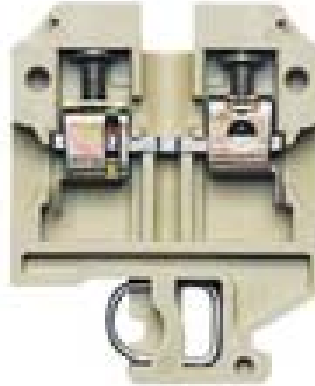
## Ex e – Increased Safety (AS/NZS/EN/IEC 60079-7)

- Cage Type
- Post Type
- Screw Type

All are suitable and have various advantages and disadvantages...

Post terminals are easy to use but provide a safety hazard as they are potentially exposed during maintenance.

Wire terminals have been widely used and are the most common form of terminal rated EEx e...



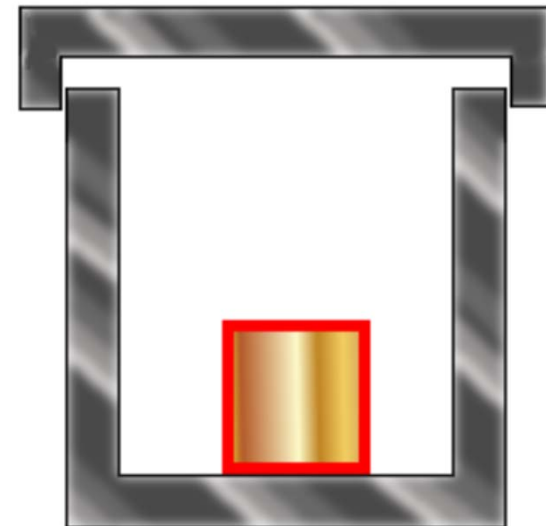
## Ex e – Increased Safety the principle..

General requirements for increased safety, Ex-e, enclosures are: ingress protection to at least IP 54 and additional tests for nonmetallic parts including thermal endurance, resistance to solvents, ultraviolet light, surface conductivity and mechanical resistance to impact of either 4 or 7 joules depending on the size of the enclosure.

General requirements for terminals are:

- They must be designed to allow the conductor to be easily inserted and clamped, so that contact pressure is maintained without reducing the cross sectional area of the conductor and shall incorporate a positive locking device to prevent conductors working loose by vibration.
- Specified creepage distances as detailed EN/IEC 60079-7 for the grade of insulation material (CTI) and subsequent maximum voltage rating.
- Temperature limitation
- Current de-rating of the terminals (and conductors) of 50%

Ex certified electrical components  
(with electrical connections that cannot loosen by themselves)









## Ex e – Increased Safety

### Example based upon design limits..

#### Example #1

Enclosure with Qty. 24 - 10mm<sup>2</sup> terminals:

The max. number of terminals for the equipment (physical dimensions) results from the maximum equipment length of 252 mm. The width of the terminal blocks for 10mm<sup>2</sup> is 10.2mm. This allows the equipment with 24 terminals (252 : 10.2 = 24 terminals )

Equipment according to heat computation:

1) Full use of all 10mm<sup>2</sup> conductors with 16 A:

max. equipment is possible, as the values are within the green fields

2) Full use of the conductors with 50 A:

9 conductors are permissible (10mm<sup>2</sup>)

10.20		10 A 10 mm <sup>2</sup>															
		290	252	1	25 mm <sup>2</sup>	*	*										
				1,5	2,5	4	6	10	16	25	35	50	70	95			
				120	96	80	60	24	20								
				2	2	2	2	1	1								
Example 1.1 ->	6																
	10	35	63														
	16	13	24	39													
	20	5	14	25	42												
	25			7	15	25											
	35					4	11	23	19								
	50									10							
	63									4							
	80									3							
	100									1							
Example 1.2 ->	125																
	160																
	200																
	225																
	250																
	315																
	400																
	500																

M	A		C		PG
	B	D			
12	17,25	42	18	7	17,25
16	25,30	20	7	9	21,85
20	27,60	17	6	11	25,30
25	37,95	7	4	13,5	27,60
32	48,30	5		16	31,05
40	60,95			21	37,95
50	69,00			29	48,30
63	74,75			36	60,95
				42	69,00
				48	74,75

## Ex e – Increased Safety

### Example based upon design limits..

#### Example #2

Enclosure with

Qty. 8 - 2.5mm<sup>2</sup> terminals with 10 A

Qty. 3 - 4mm<sup>2</sup> terminals with 20A

Qty. 3 - 16mm<sup>2</sup> terminals with 50A

Cross section/mm<sup>2</sup>      Current/amps

2.5

10A

Number / utilisation

8 / (of 31) = 25 %

4

20A

3 / (of 12) = 25 %

16

50A

3 / (of 9) = 33 %

Sum = 83% < 100 %, therefore, this means, that on technical heat grounds this equipment is permitted.

		1,5	2,5	4	6	10	16	25	35	50	70	95
290		120	96	80	60	24	20					
252		2	2	2	2	1	1					
1		6										
25 mm <sup>2</sup>		10	35	63								
v		16	13	24	39							
v		20	5	14	25	42						
N		25	7	15	25							
N		35		4	11	23						
N		50				9	19					
N		63				3	10					
A		80					4					
A		100										
A		125										
A		160										
A		200										
A		225										
A		250										
A		315										
A		400										
A		500										

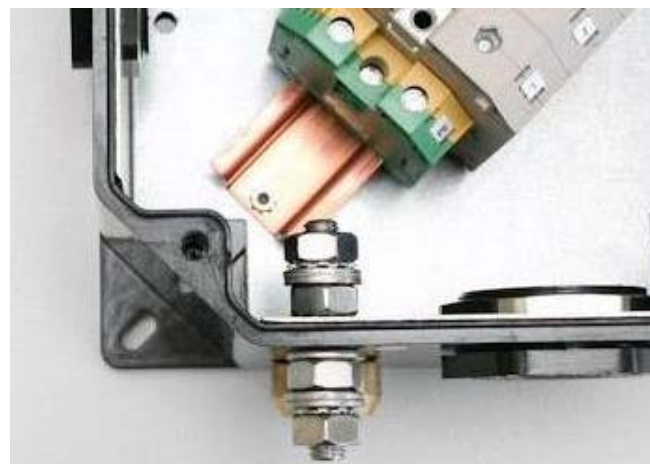
  

M	A	B	C	D	PG
12	17,25	42	18	7	17,25
16	25,30	20	7	9	21,85
20	27,60	17	6	11	25,30
25	37,95	7	4	13,5	27,60
32	48,30	5		16	31,05
40	60,95			21	37,95
50	69,00			29	48,30
63	74,75			36	60,95
				42	69,00
				48	74,75

## Ex e – Increased Safety Installation Details

Certified Ex-e terminal boxes must be provided with an internal or external ground connection of an adequate size for the wiring configuration. (Ex-e terminal boxes are not designed to carry earth fault currents.) The main internal/external ground connection must be connected to the main system earth with the correct coded wire of adequate size but not less than 4mm<sup>2</sup>. All exposed metal parts must be grounded together and to the main ground terminal.

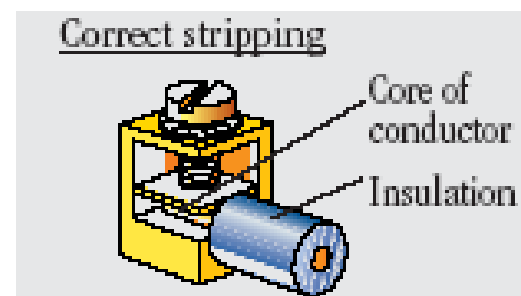
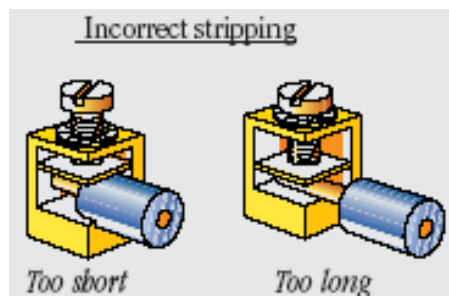
IEC 60079-14 (Installations), subclause 9.1.2 states “In hazardous areas each unused core in multi-core cables shall either be connected to earth or be adequately insulated by means of suitable terminations. Insulation by tape alone is not recommended.” Terminating the spare conductor onto an Ex-e terminal is recommended since the conductor could be used later as an active terminal.



## Ex e – Increased Safety Installation Details

### Important considerations for use of EX Terminals

- Use conductors of the appropriate size as designated by the terminal. E.g. for a 2.5mm<sup>2</sup> terminal, the maximum conductor size is 2.5mm<sup>2</sup>. Normally, the manufacturers also advise the AWG size of the conductor that is 28-12 AWG for 2.5mm<sup>2</sup>. If a larger conductor is used, the creepage & clearance distances could be reduced.
- The conductor insulation must be carried right up to the terminal throat within 1 mm of the clamp.
- Normal industrial ratings of the terminal and conductor are de-rated.
- Unless otherwise specified, only one conductor per terminal clamp is permitted.
- If flexible, fine stranded conductors are used, care must be taken to avoid whiskering of the strands that can reduce the creepage and clearance distances. The use of ferrules is recommended to avoid this problem.



## Increased Safety Ex 'e' Quiz

- Ex 'e' designed apparatus is suitable for use in Zone 0 **False**
- Increased safety enclosures must always withstand the pressure caused by an internal explosion **False**
- Ex 'e' equipment is mechanically strong to withstand damage from impact **True**
- Ex 'e' terminals are de-rated from their standard industrial rating **True**
- Ex 'e' terminal boxes can be used in conjunction with Ex 'd' equipment **True**

# Ex ia, ib – Intrinsic Safety (AS/NZS/EN/IEC 60079-11)

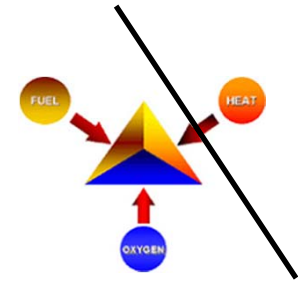
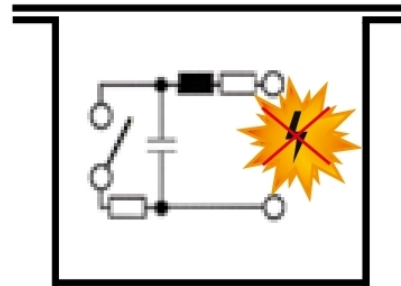
Zone 0, 1 & 2 Suitable

Circuit is controlled to reduce potential spark energy to below that which would ignite any flammable gas present.

I.S. barriers are used to protect the field circuit from non protected circuits

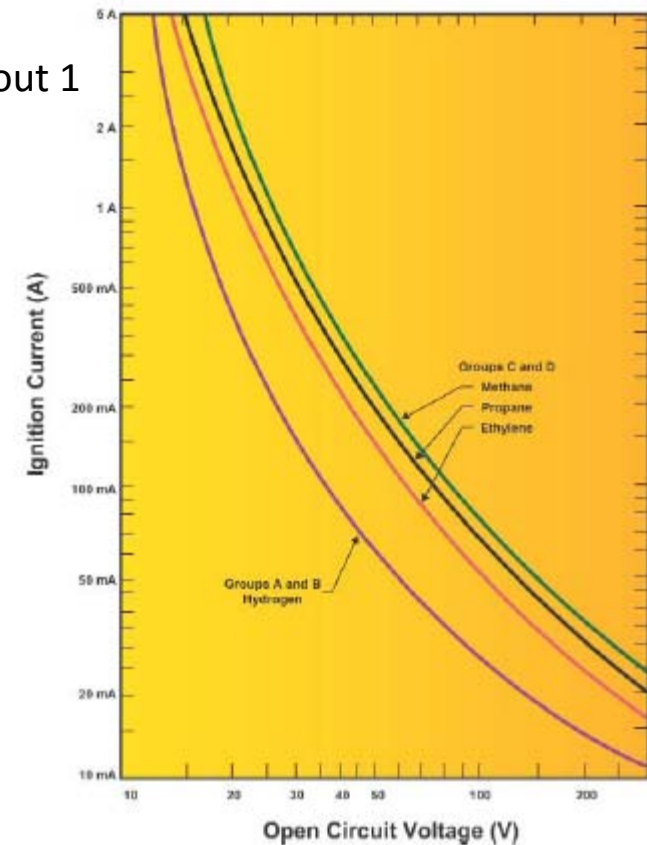
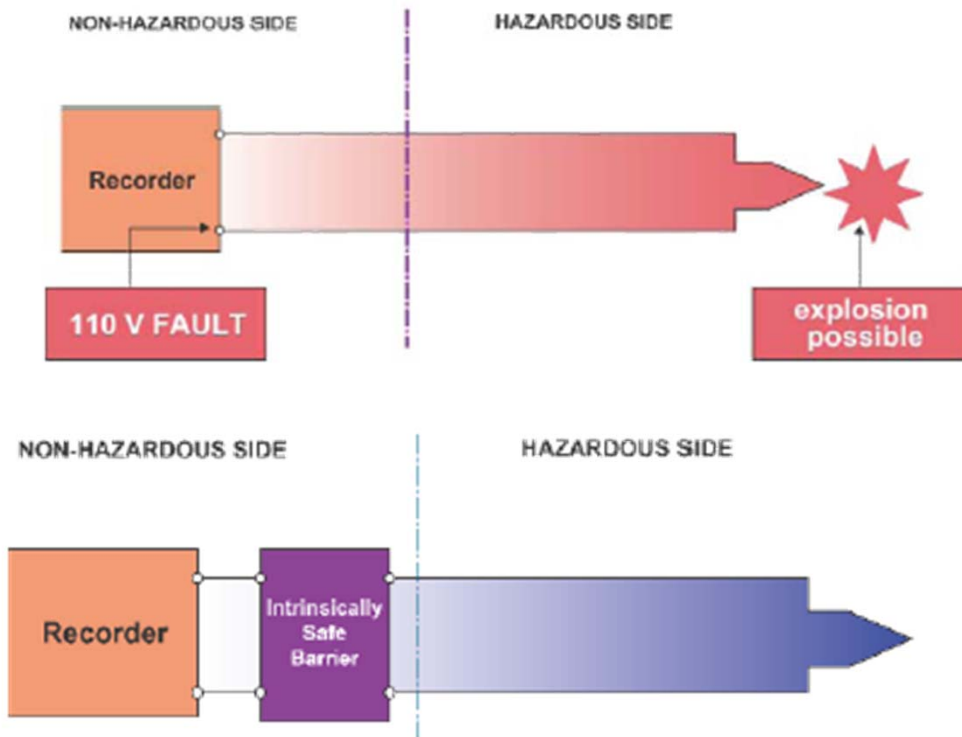
This includes the occurrence of:-

- ia - 2 fault conditions (Equal to NA Division 1 barrier (Zone 0))
- ib - 1 fault condition



## Ex ia, ib – Intrinsic Safety (EN/IEC 60079-11)

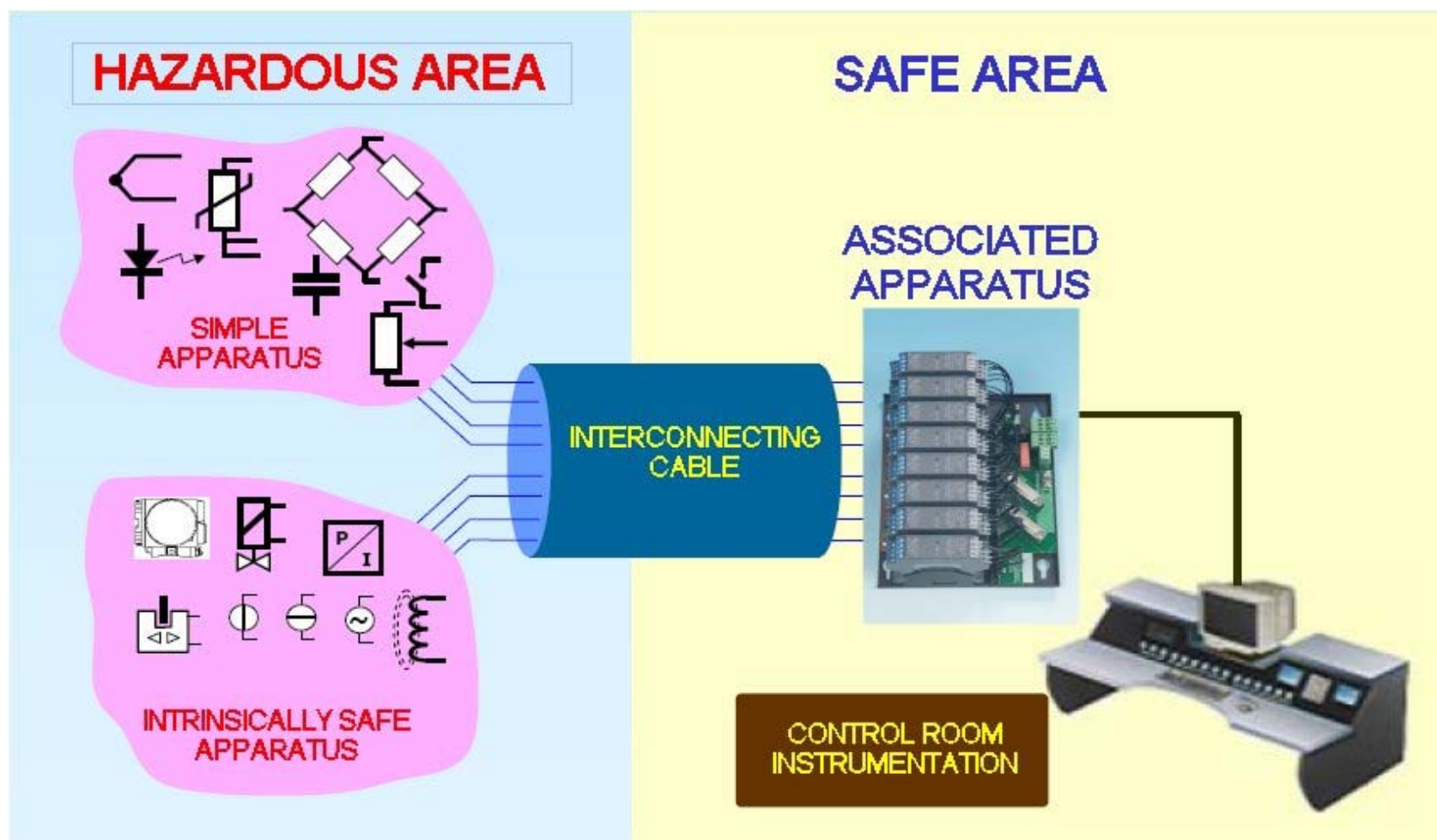
Where the problem comes from... During a potential fault, excess energy could be transmitted to the hazardous area and if a spark occurs could create an explosion. IS zener barriers drive excess energy to ground or by other means protect the device in the hazardous area from ever creating an explosion. Limited to about 1 watt or less in most instances.



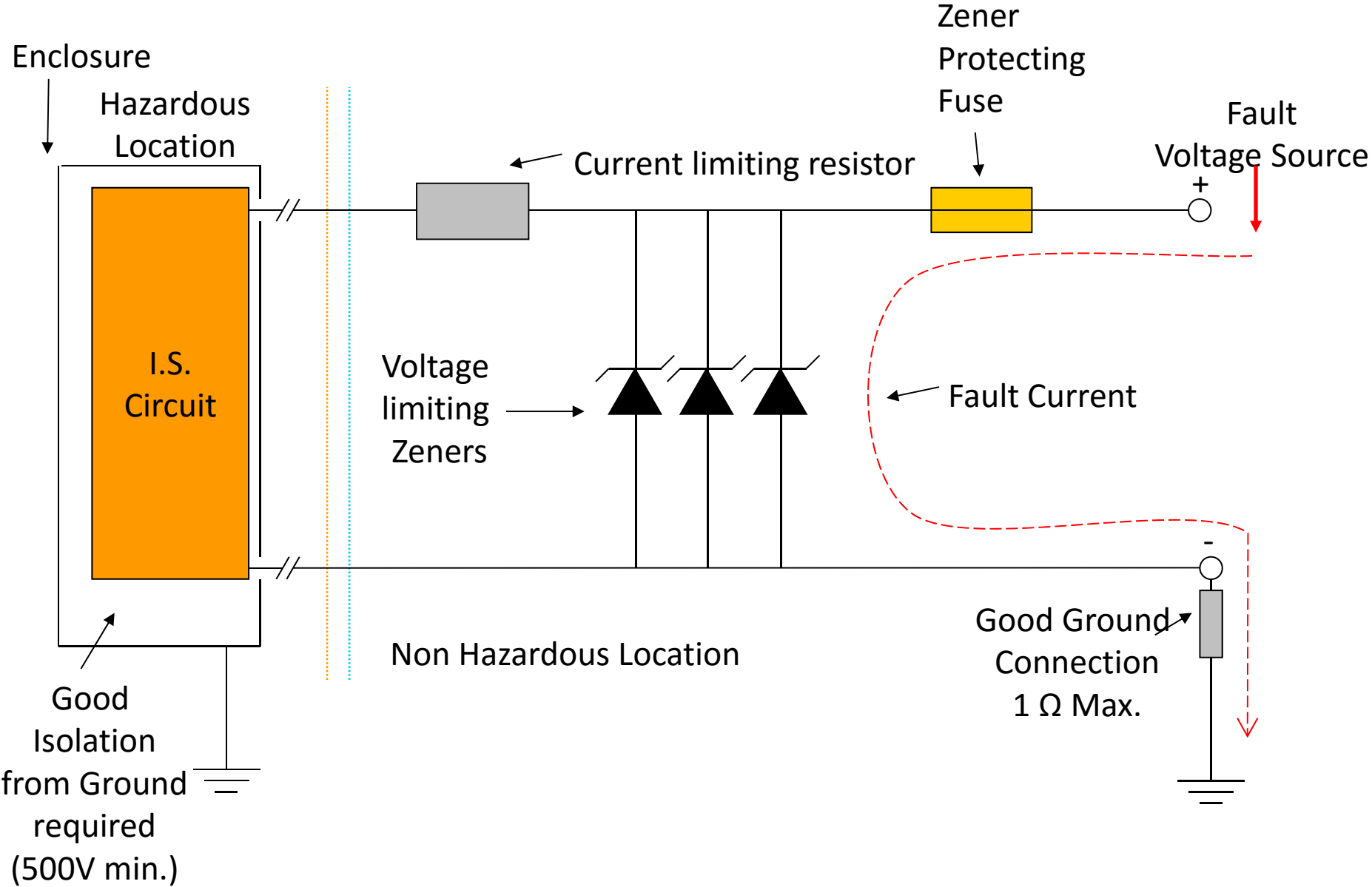
Typical Ignition Curves for I.S.



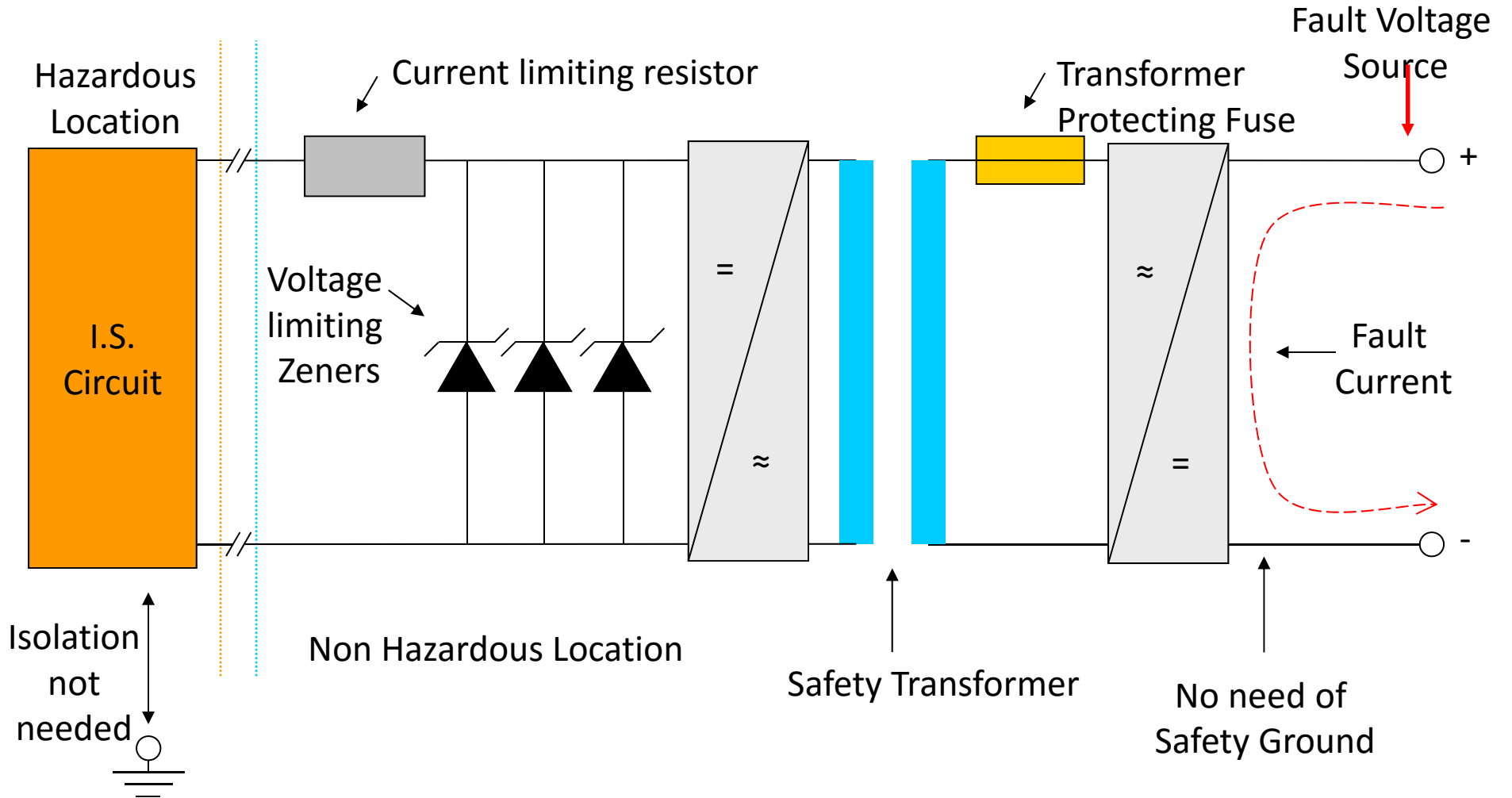
# Ex ia, ib – Intrinsic Safety Loop Concept



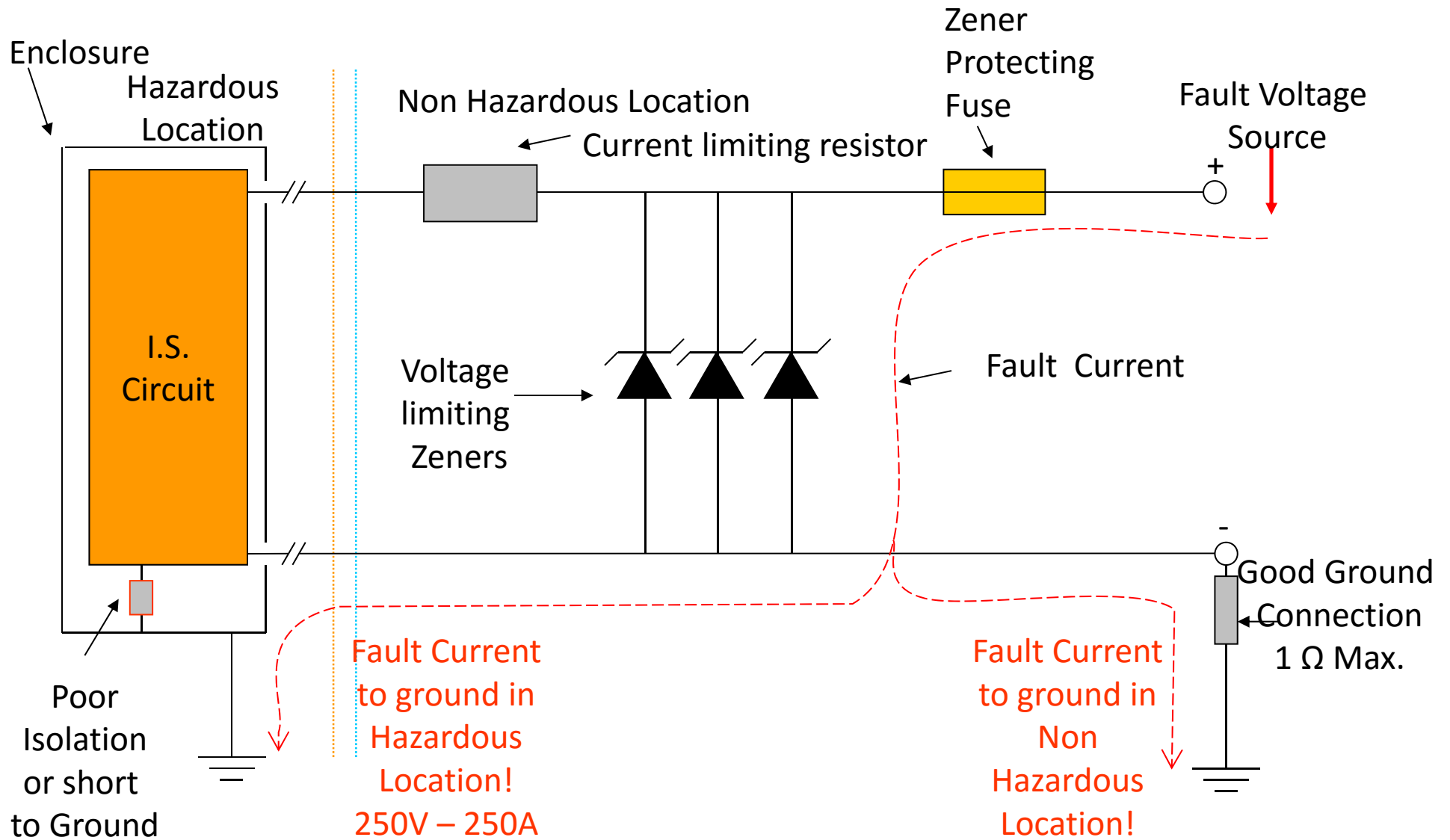
# Zener Barriers - Concept



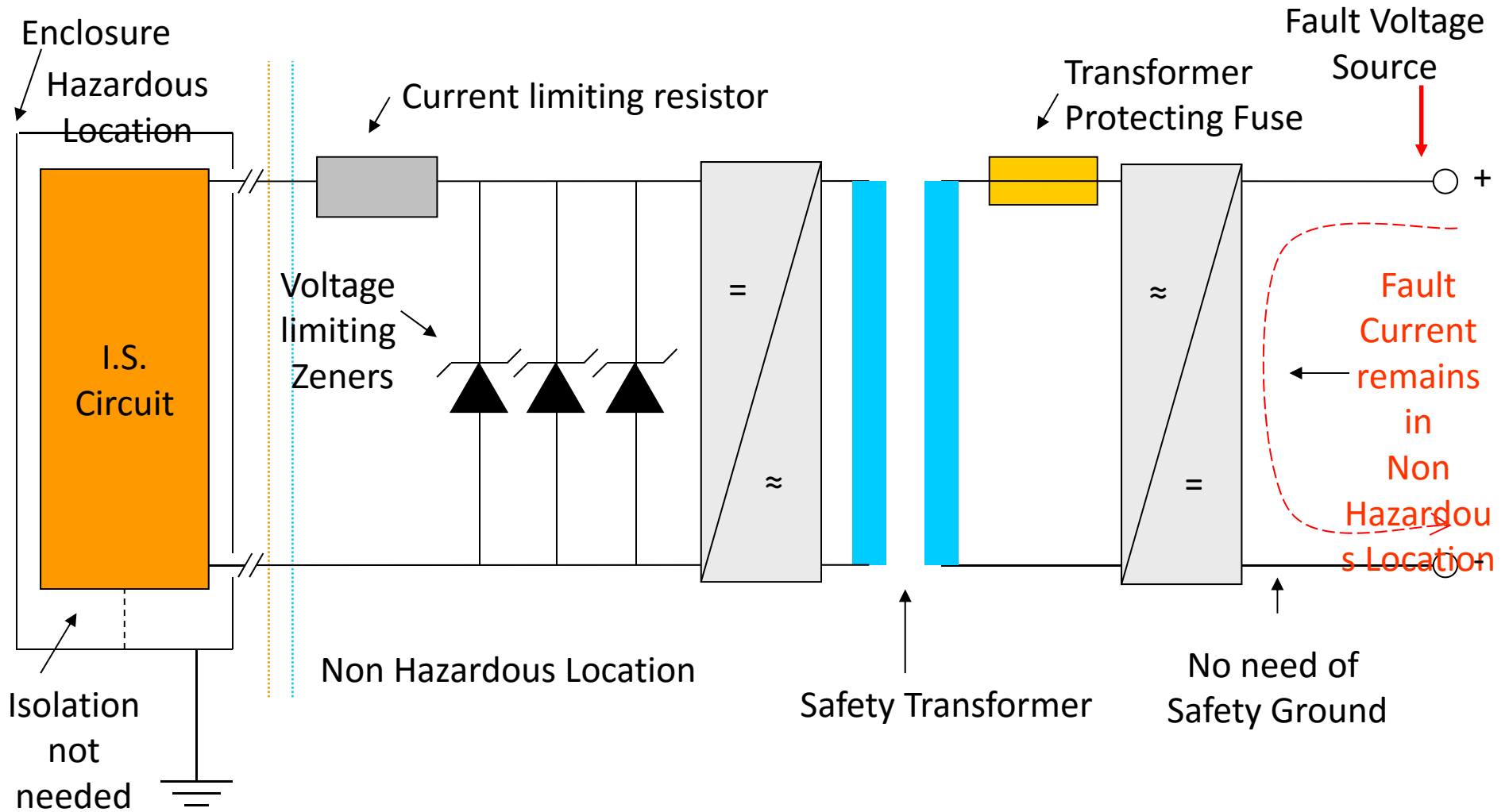
# Galvanic Isolated Barriers - Concept



# Protection Under Fault Condition – Zener Barriers



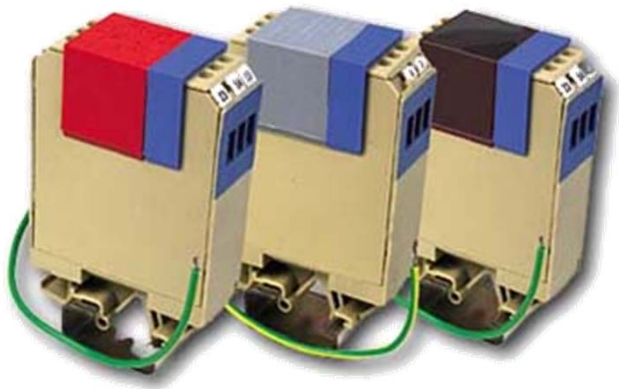
# Protection Under Fault Condition – Isolated Barriers



# Zener Barriers

## Advantages

- Lower parts cost
- Elementary three components device



## Disadvantages

- Dedicated Safety Ground Cost
- Safety Depends on
  - Good Safety Ground
  - Good Lines Isolation
- Voltage Drop across Resistor
- Zeners leakage Infl. accuracy
- Isolation of lines Infl. Accuracy
- Requires routine Checks.
- Grounded non linear semi-conductor (Zener) reduces immunity to interferences (common mode rejection)
- Applicable only with sensors that are well isolated from ground (500 V)

# Galvanically Isolated Barriers

## Advantages

- No Safety Ground requirement (No cost / No maintenance)
- Safety not impaired by a fault to ground.
- Full voltage availability.
- Better overall accuracy
  - Zener Leakage does not affect accuracy
  - Isolation of lines does not affect accuracy
- Higher common mode rejection and immunity to interferences
- Allows the use of grounded or poorly isolated sensors

## Disadvantages

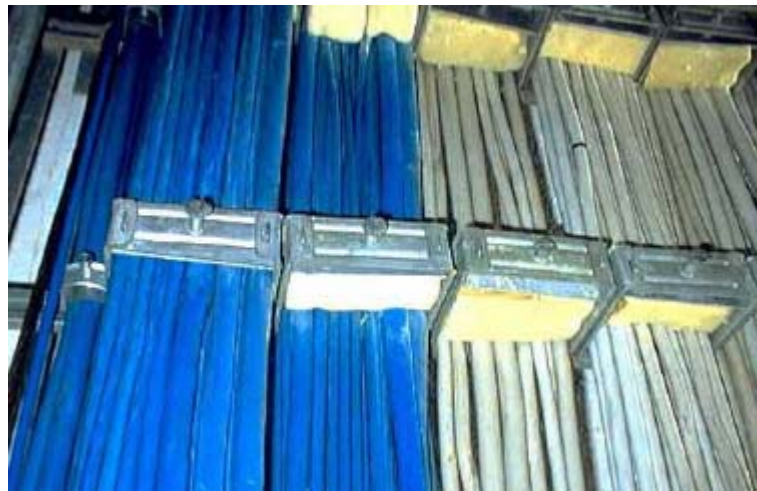
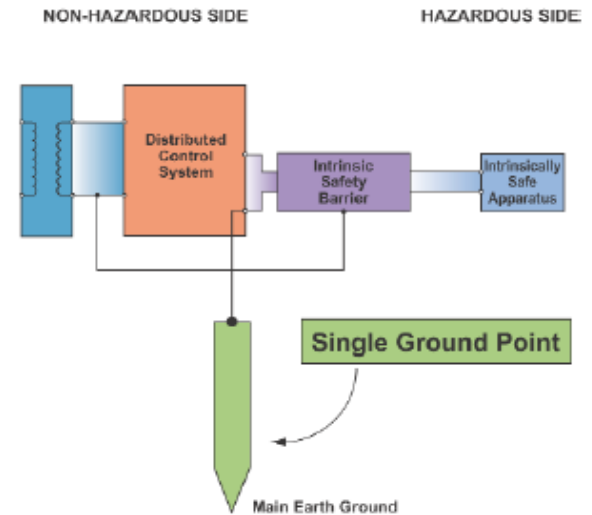
- Higher part cost



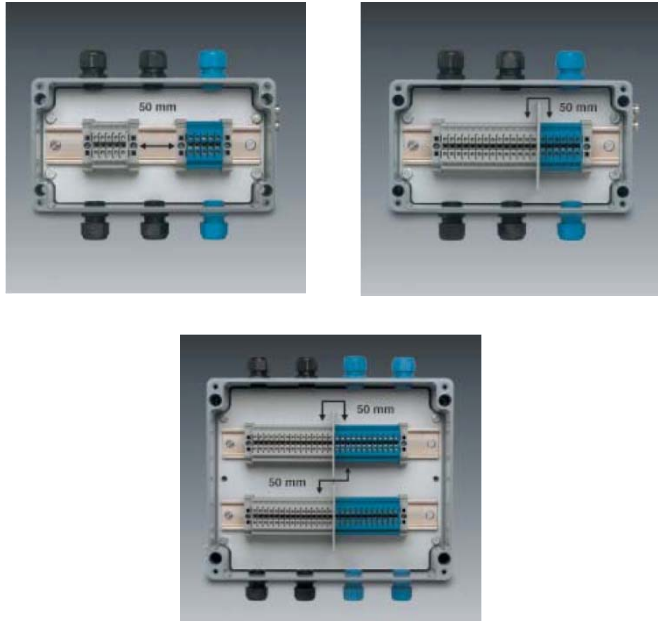


## Intrinsic Safety Wiring Methods

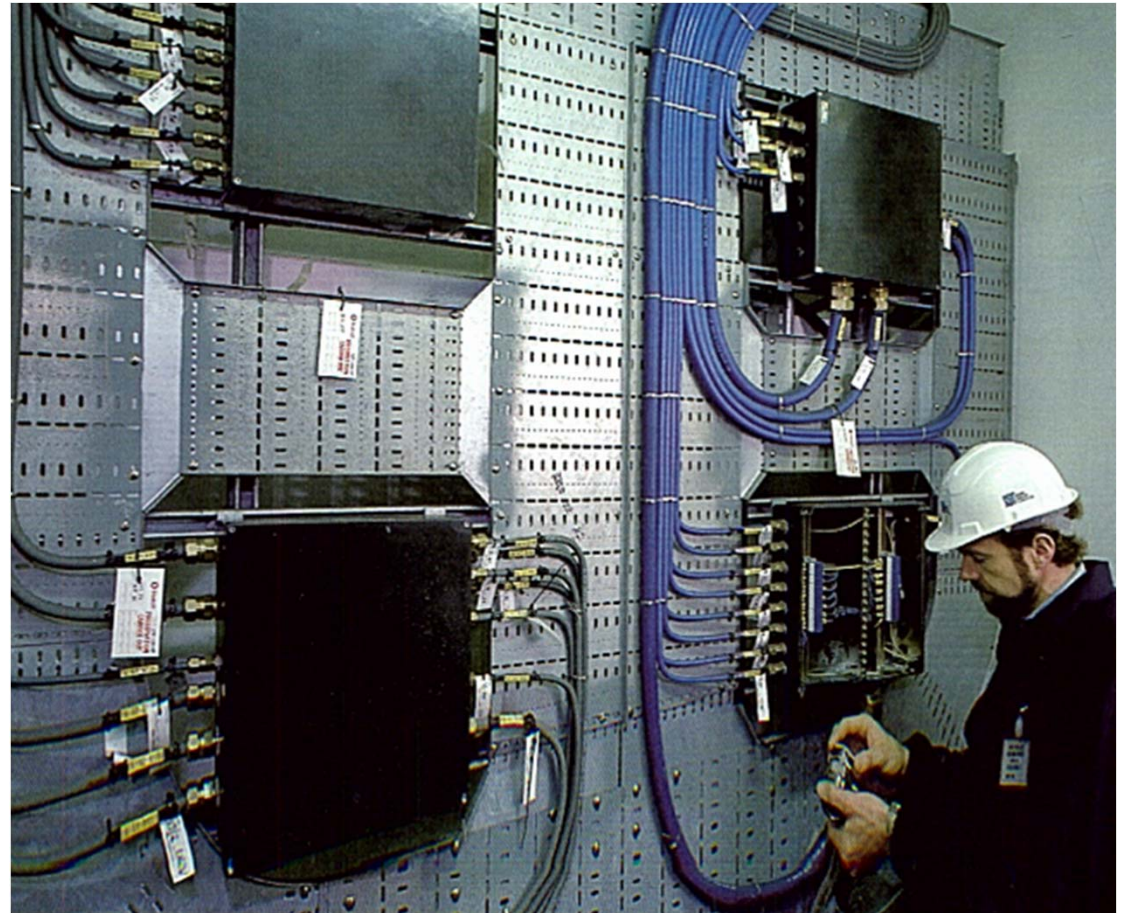
Intrinsically safe circuits may be wired in the same manner as comparable circuits installed for unclassified locations with two exceptions summarized as separation and identification. These wiring practices are simple and clear; however, they often are overlooked and are the source of potential problems. The intrinsically safe conductors must be separated from all other wiring by placing them in separate conduits or by a separation of 2 inches of air space. Within an enclosure the conductors can be separated by a grounded metal or insulated partition.



## Intrinsic Safety Wiring Methods



Combining wiring for IS and non-IS circuits can also be combined in single enclosures as long as proper segregation and identification methods are employed....

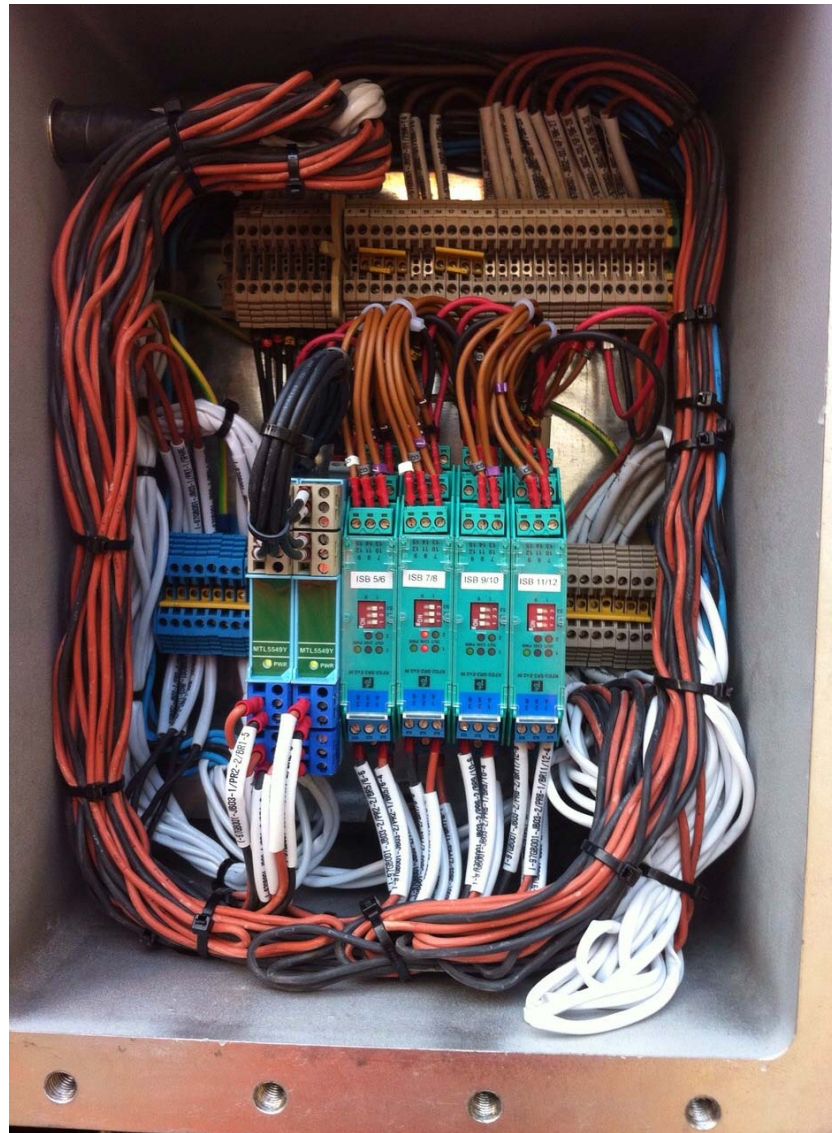




## Remember.....

The requirements for 50mm segregation applies not just to the terminals but also all of the interior wiring.

Keep this in mind when installation of I.S. and non-I.S. circuits within the same enclosure.



## Intrinsic Safety Ex 'i' Quiz

- The minimum required protection for intrinsically safe equipment is IP55 **False**
- Terminals for intrinsically safe circuits must be at least 50mm from terminals or un-insulated conductors of any non-intrinsically safe circuits **True**
- Ex 'n' cannot be designed for apparatus gas grouping IIC **False**
- Intrinsically safe equipment marked (Ex ia) IIC is designed to be installed in a hazardous area **False**
- Equipment marked Ex 'ib' IIC T4 is suitable for installation in a Zone 0 area **False**

## Intrinsic Safety Ex 'i' Quiz

- It is permissible to work on an intrinsically safe circuit without a gas free certificate **True**
- The insulation resistance between an intrinsically safe and non-intrinsically safe circuit must be capable of with standing a minimum of 500VDC **True**
- Intrinsically safe and non-intrinsically safe cables may be run in the same cable tray if the cables are armoured **True**
- You cannot use any terminal color but blue for terminals containing only intrinsically safe circuits **False**

**SOURCE IEx**

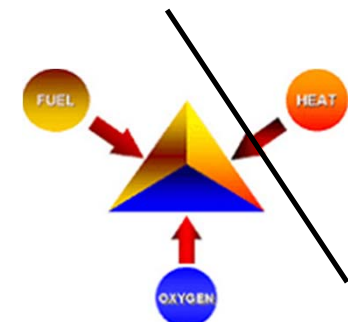
## Ex nA – Non-Sparking (AS/NZS/EN/IEC 60079-15)

Ex nA Non-Sparking is a lesser degree of protection than EEx e, where as standard industrial equipment that under normal operation will not produce arcs, sparks or surface temperature high enough to cause ignition of the surrounding gas vapor mixture. Typical products include Zone 2 lighting fixtures and certain enclosures...

**Zone 2 Suitable**



Electric motors (Squirrel cage motors), terminal boxes, fuses, LEDs, transformers, apparatus requiring low energy, plug connectors, cells, batteries, etc.

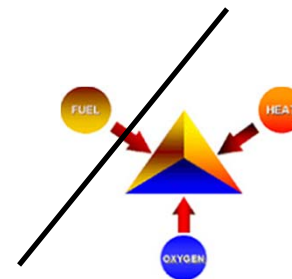
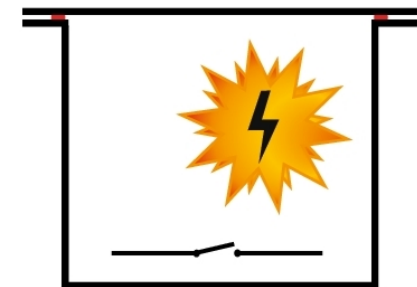


## Ex nR – Restricted Breathing (AS/NZS/EN/IEC 60079-15)

### Zone 2 Suitable

This provides the customer the ability to use arcing components in a Zone 2 environment w/o the need for flameproof equipment

Enclosures, Glands & Cable must be suitable. In this, the product is subject to temperature rise tests and ingress tests to determine the amount of “breathing” can take place. If during the operation, the product through tight gasketing or sealing has been found to restrict the air flow both in and out of the product, it is determined to be restrictive breathing.





## Ex nR – Restricted Breathing (EN/IEC 60079-15)

### Restricted Breathing

Better gasketing restricts fixture's "breathing"

Cable entries must be sealed

maintains Integrity of fixture

Only Exterior Temperatures Considered

Big difference In T-Codes

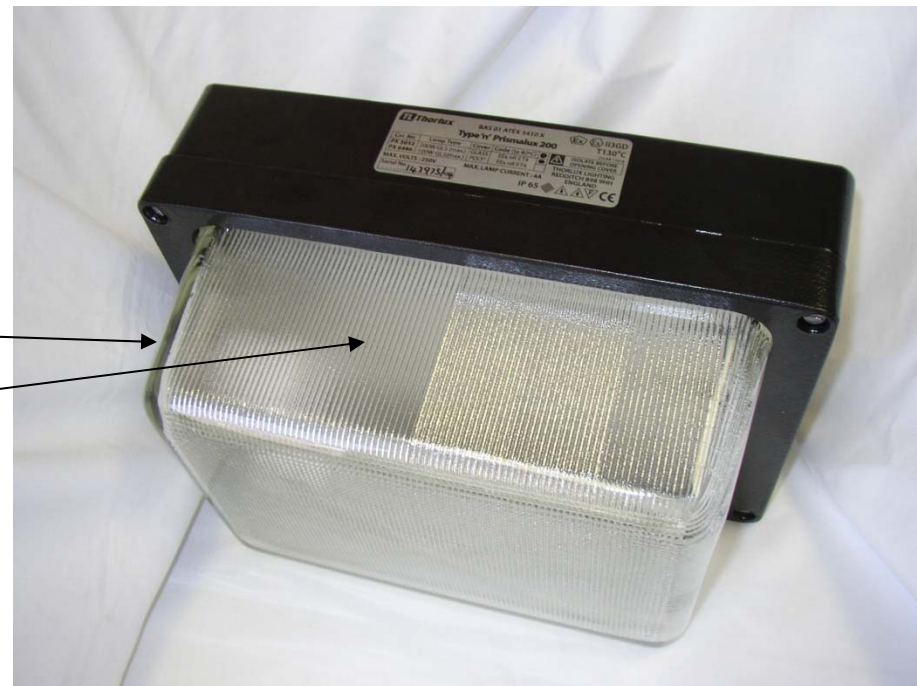
Permits Use of Higher Wattages

Allows Flexibility in Lighting Design



Temperature based  
upon external hot spot

Enclosed and gasketed fixtures  
based upon lamp surface  
temperature, significant  
difference





## EX nR vs. Division 2 Lighting Example (NEC)

High Pressure Sodium (SON)			
Wattage	Div. 2 Unit T-Code	Ex nR Unit T-Code	Change
400 Watt	T-2A	T-3C	120°C
250 Watt	T-2A	T-3C	120°C
150 Watt	T-2B	T-3C	100°C
100 Watt	T-3	T-4A	80°C
70 Watt	T-3	T-4A	80°C

Implication for lighting design is the use of higher wattage fixtures and using fewer of them for particular areas most notably for floodlights and wellglass applications...

In the IEC world, it means that more Zone 2 HID can be used since the T-Ratings are comparable to Zone 1 lights, i.e. with no intermediate T Identification numbers, HID for Zone 2 almost always needed a Zone 1 type construction.

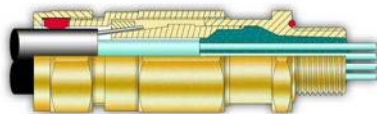


## Ex nR – Restricted Breathing (EN/IEC 60079-15)

Cable Gland Issues.... Per SIRA, a Notified Body in the UK

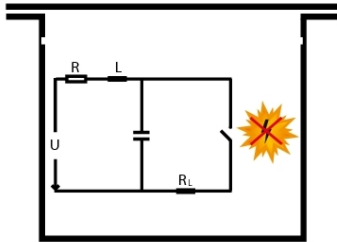
"Ex nR glands are a recent creation and no such thing existed until recently. If the glands have been tested and certified as 'Ex' cable glands then they are equipment and don't, in their own right, need to be re-assessed in order to fit. However, the interface does need re-assessing, just like 'Ex e' glands. This is because the gland to enclosure interface needs to maintain the sealing for the restricted breathing. Whilst we could test the sealing, say an 'O' ring or flat seal on an example enclosure, we can't be sure that the actual enclosure to which it is fitted will affect the same sealing. For example it may be a round enclosure and therefore wouldn't seal. For this reason, a condition of certification is imposed related to the interface having to be re-assessed, but this is really the only assessment required (other than temperature limits perhaps)."

Per 90079-0, all glands to be used in conjunction with Ex nR equipment must be suitable and certified Ex nR

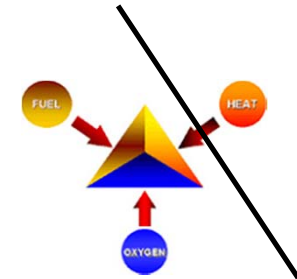
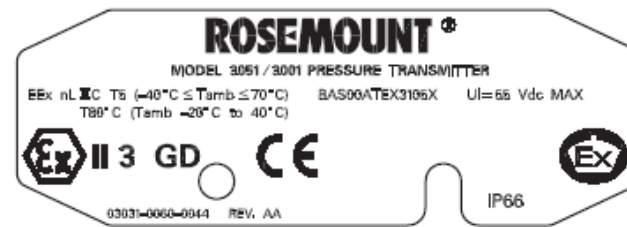


SOURCE IEx

## Ex nL – Energy Limitation (AS/NZS/EN/IEC 60079-15)



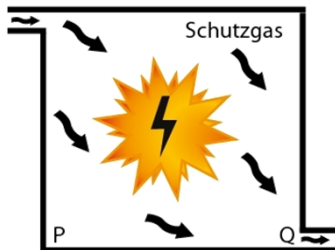
Zone 2 Suitable



Ex nL is a lower form of protection than I.S. and is typical used in circuits in individual components based upon spacing of circuits and other protection concepts.

## Ex nP – Pressurized (AS/NZS/IEC 60079-15)

Zone 2 Suitable



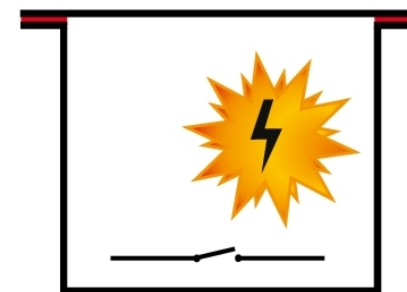
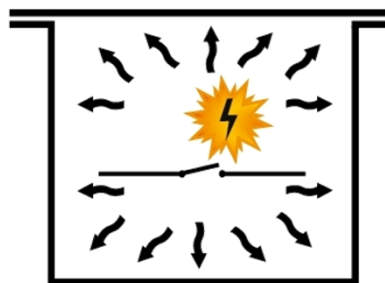
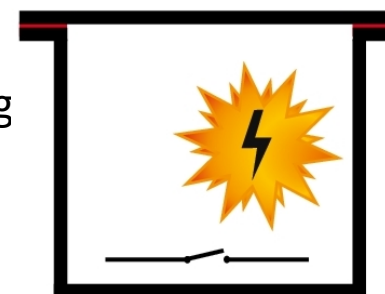
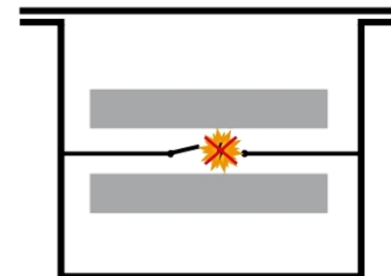
Pressurized enclosure, not subject to purging, in which faults are indicated by a drop in the pressure. However, the system need not be switched off immediately. A good example of this is a Zone 2 purge indicator that does not control the equipment being protected, but merely provides indication that the equipment is being protected. Ex P requires de-energization of the panel being protected.



## Ex nC – Enclosed Break (AS/NZS/EN/IEC 60079-15)

### Basic "Encapsulation"

- enclosed device
- non-ignitable component Contact mechanism or housing designed such that ignition is avoided.
- hermetically sealed device Sealing by means of a fusing process such as soft soldering or brazing, welding or fusing of glass in metal
- sealed device so constructed, that it cannot be opened during normal operation.
- encapsulated device completely enclosed in an encapsulating compound.



## Non-Incendive Ex 'n' Quiz

- A certified gland must always be used for an Ex 'n' application **True**
- For Ex n standards, hermetic sealing of enclosure can be satisfactory achieved by the use of 'O' rings and/or gaskets **True**
- Ex 'n' cannot be designed for apparatus gas grouping IIC **False**
- The Temperature classification for an Ex n standard must always take into consideration the external and internal surface temperature **True**
- Live working is not permitted on Ex n type equipment **True**

## Ex p – Pressurized (AS/NZS/EN/IEC 60079-2)

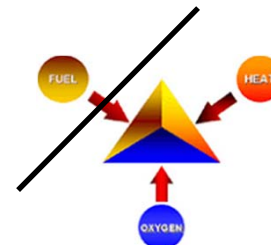
Entire rooms or buildings can be pressurized as well as enclosures.

Zone 1 & 2 Suitable

The requirements of IEC 60079-13 must meet the following:

- Positive pressure must have sufficient capacity to maintain pressure of at least 25 Pa (2.5mm water gauge) in the room and the room must have either air locks for the doors or the outward velocity must be at least 0.305 m/s with all doors and any openings simultaneously opened.
- Pressurizing gas must be air (containing at least 19.5% Oxygen by volume)
- When the pressurizing system fails, any equipment such as lights that cannot be switched off must be protected by other means suitable for the location.

One note: the NFPA requires 25 Pa internal pressure for enclosures, while the IEC requires 50 Pa for enclosures in Zone 1 and 25 Pa for pressurized rooms.

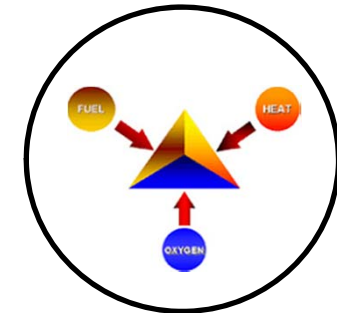


## Ex q – Powder Filled (AS/NZS/EN/IEC 60079-5)

Powder filling originated in France where it has been used for many years. IEC Standard 79-5 introduced in 1967 established this concept as an international method of protection.

This protection concept is normally suitable up to and including Group IIC gases and The original IEC standard referred to 'sand filled' but has been changed to 'powder filled'. the T6 temperature classification, in Zone 1 or 2 hazardous area locations. The enclosure construction requirements are a pressure test of 0.5 bar (1 bar = 14.5 psi) over-pressure for 1 minute and, if not protected by another enclosure, a minimum Ingress Protection of IP 54, the same requirement for Ex-e enclosures. If the component is protected by another enclosure (e.g. a capacitor in the type of protection "q" built into a light enclosure) then no specific requirements for the type of IP protection is required. When the enclosure is filled with the "q" medium (quartz sand, powder or glass beads) there must be no voids in the enclosure. The maximum distance from live parts of electrical components to earth fitted inside the metal enclosure or metal screen is specified and, depending on the applied voltage, can vary from 10 mm at 250 volts to 50 mm at 6,600 volts. If the enclosure is permanently factory sealed and the voltage does not exceed 500 volts, the minimum distance between live parts or live parts to earth can be reduced by 5 mm.

Zone 1 & 2 Suitable



## Ex m – Encapsulation (AS/NZS/EN/IEC 60079-18)

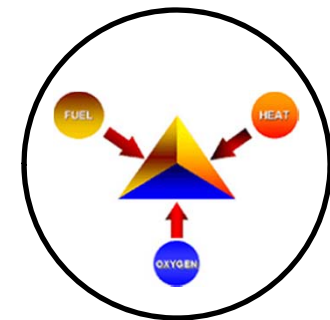
### Zone 1 & 2 Suitable

Encapsulation is a type of protection whereby parts that are capable of igniting an explosive atmosphere, by either sparking or heating, are enclosed in a compound in such a way that the explosive atmosphere cannot be ignited under operating or installation conditions. The selected compound must be in line with the requirements given in IEC 60079-18 and may be any thermosetting, thermoplastic, epoxy, resin (cold curing) or elastomeric material with or without fillers and/or additives, in their solid state. The temperature range must satisfy the requirements of an appropriate standard for this type of protection.

(Thermal stability at maximum operating temperature.) When considering the safety aspects of Ex-m encapsulation, the design must account for:

- Resistors, capacitors, optoisolators, diodes etc., must not operate at more than 2/3 of their rated voltage.
- The temperature rise of components and wiring must be limited.
- Voids and air pockets other than those for relays or other devices must be avoided.
- The effect of a component's short-circuit during fault conditions.

The Ex-m encapsulation protects electronic circuit relays, timers, lamp test devices and components in Zones 1 or 2 hazardous areas. Encapsulation is finding increased usage for printed circuit boards that are assembled in small rail-mounted housings similar to terminals.





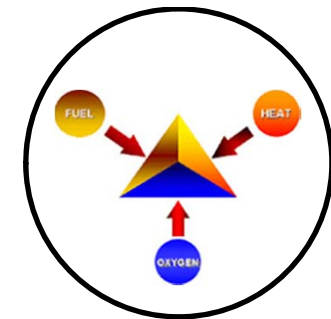
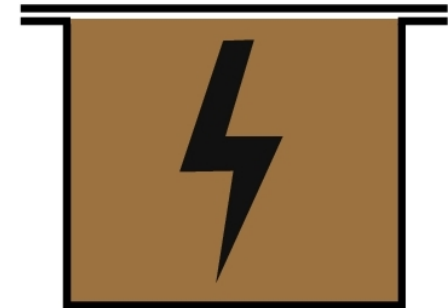
## Ex o – Oil Immersion (AS/NZS/EN/IEC 60079-6)

Zone 1 & 2 Suitable

In 1968, IEC subcommittee 31E wrote IEC Standard 79-6 which was recognized by many countries for use in Zone 1 locations. The Oil Immersion Ex-o concept has historically been used for heavy duty switchgear, motor starters and transformers.

The basic principle as shown above is to immerse the electrical parts in mineral oil, which will prevent any exposure of the arcing or sparking to the an explosive atmosphere. It will also quench arcs and limit the temperature rise on electrical q p parts. Standards for oil immersion protection, Ex-o, require that all parts capable of producing arcs or sparks must be immersed in the oil at a depth not be than 25 mm. A method to check the oil level must be provided, e.g., by a sight glass or by some other reliable method.

Some mineral oils used in switchgear apparatus produce acetylene and hydrogen gas when arcing occurs. Because of the risk of fire or an explosion with oil immersion, this application for apparatus in hazardous areas has been generally restricted. In the Petro-Chemical industries there are very few examples of Ex-o certified products installed in hazardous areas even though the standards permit its use in Zones 1 and 2.

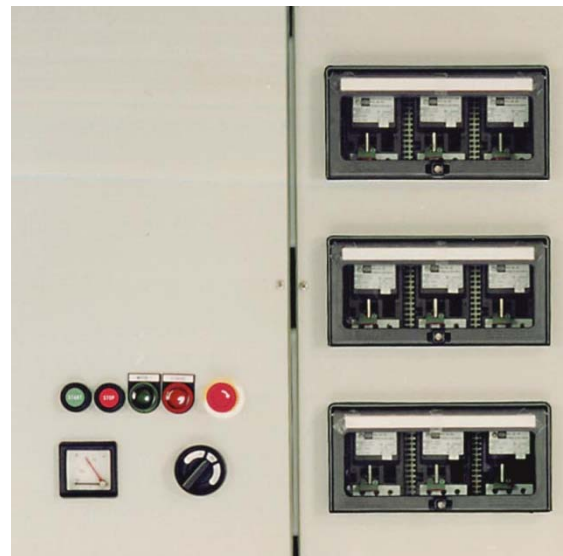
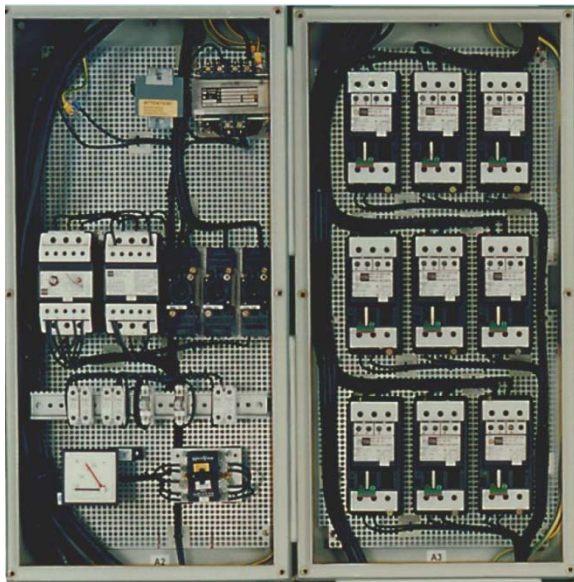


## Hybrid Ex Protection Techniques

It is very common to use a variety of protection concepts in a single product... Shown below are two examples.

The light fitting is rated Ex dem using Ex e Increased safety for the housing & terminal, Ex d flameproof for the disconnect switch and lamp holders and Ex m for encapsulation of the ballast.. Final product rated Ex edm

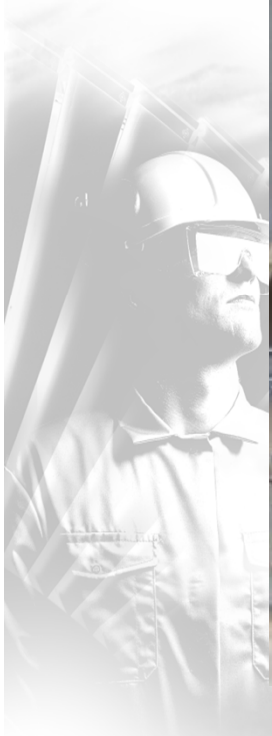
The control panel below is using Ex e increased safety for the housing and terminals and Ex d for flameproof operators... Final product rated Ex de...



## Hybrid Ex Protection Techniques



316SS Ex d & Ex e Enclosures





SOURCE IEx

## Examples of Ex components potentially inside Ex e enclosures



Question: ATEX "U" or "X" designation.  
Assembly, Component Certification

## Hybrid Protection Techniques

These products also use hybrid technologies to reach the same effect but in different ways...

The enclosures below are rated either Ex d flameproof or Ex e increased safety with the arcing components housed in the 'd' chamber, while the 'e' terminals are in the attached 'e' enclosure separated with the use of line bushings that provide a flameproof barrier between the two enclosures.

While previously, the order of the protection letters was deemed to indicate the primary means of protection first with secondary protection second and so on, the latest version of 60079 states that the protection concepts should be in alphabetical order.



**Arcing/Sparking**



**Non Arcing/Sparking**



## Hybrid Ex Protection Techniques

How many protection techniques can you find in this picture?  
Hint: Total of five methods

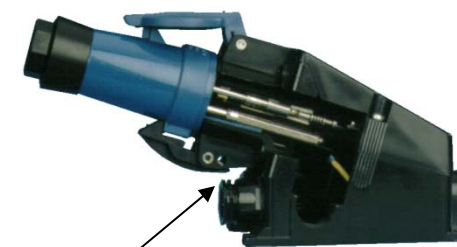
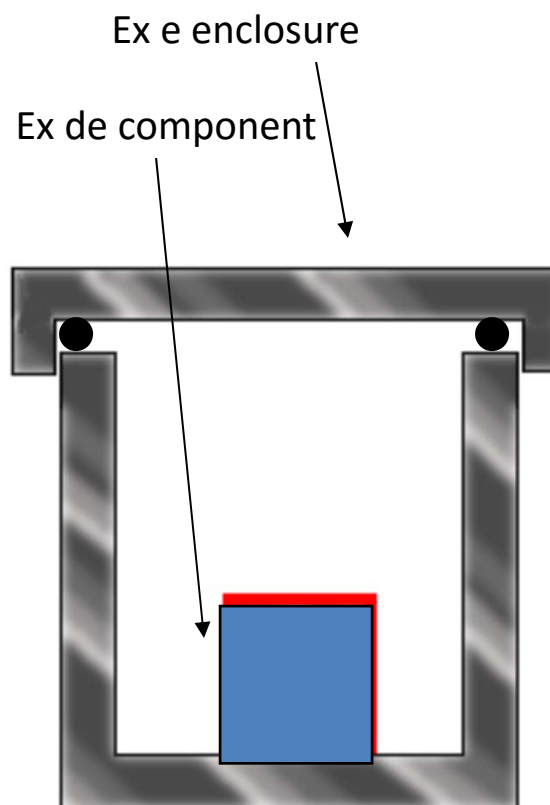
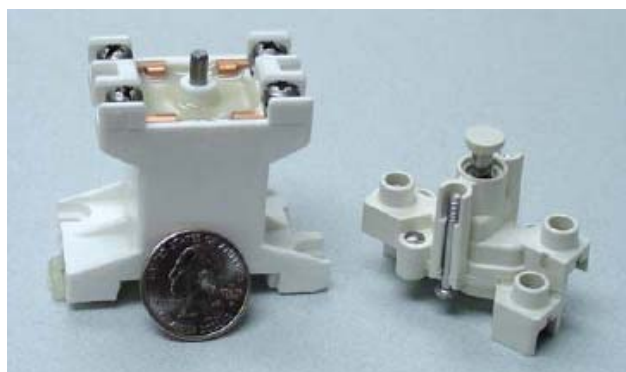


What Zone is this enclosure suitable for???

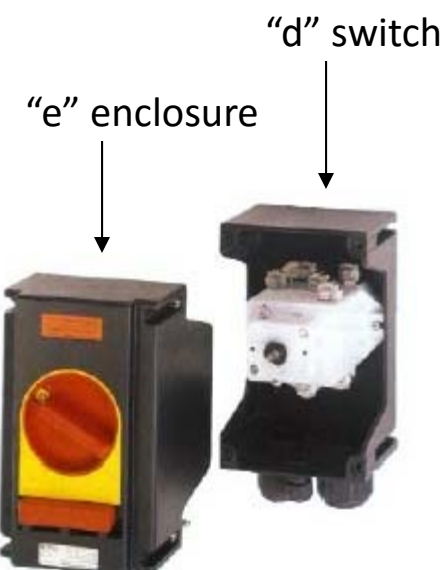
**Zone 2**

## Hybrid Ex 'd' & 'e' Protection

"e" & "d" electrical components:  
the contacts make and break  
in a flameproof "d" chamber



"d" switch or contacts  
"e" enclosure



In general, many of the latest developments of products for hazardous locations involve the combining of various protection techniques. As long as combination of protection techniques are all suitable for the same Zone or Category of hazard, the product is suitable for that hazard. Example, both 'e' & 'd' protection techniques are suitable for Category 2 (22) or Zone 1 hazardous areas.

## Which EX protection method is the most cost effective solution?

### Generalities – If Zone 1 locations...

- Ex 'e' Increased Safety is typically the way to go if at all possible due to weight, cost and ease of maintenance
- Ex 'd' used when 'e' protection is not practical, i.e. Motor Starters, Circuit Breakers, etc.
- Hybrid 'e' & 'd' usually the best concept where you take the best of both and combine the two.
- Lighting – Zone 1 HID lighting is going to always be Ex 'd' construction, where fluorescents are more likely to be Ex 'e' plastics. LED's have have been designed using both protection concepts. For low mounting applications, fluorescents are usually a most cost effective solution. To minimize fixture count, higher wattage HID's in Zone 2 or non-hazardous locations with intermixed Fluorescents has been the trend.
- Instrumentation circuits for Zone 1 are typically I.S.



### Generalities – If Zone 2 locations....

- More protection concepts are available such as Ex nR lighting, Ex nA lighting, Ex nC non-sparking, etc. The major area of potential savings is Zone 2 lighting HID, restricted breathing vs. Flameproof Ex 'd' construction. The component issues with glands and enclosures for the most part will not change from Zone 1 construction, i.e. brass glands, fiberglass enclosures, etc.

In general, look at Ex 'e' construction wherever possible, minimize the Ex 'd' wherever possible