Hazardous Area

In industries such as oil and gas installations, petrochemical, chemical plants, grain storage, coal handling and refuelling areas there is often a hazard resulting from flammable gases, vapours, mists and dusts which can produce explosive mixtures with air.

The electrical equipment installed in these potentially hazardous areas must be designed to provide protection against the possibility of gas or dust ignition. In this section we offer two solutions to this problem, namely flameproof equipment certified Exd and intrinsically safe equipment certified Exi. An explanation of both is given later.

All equipment for use in a hazardous area is classified according to the following:

IEC 60079-10-1: Classification of areas – explosive gas atmospheres

IEC 60079-10-2: Classification of areas – combustible dust atmospheres

HAZARDOUS ZONES

The likelihood of an ignition of gas occurring depends on the probability of an explosive mixture of gas being present at the same time as the electrical apparatus produces an ignitable source (i.e. a spark or a hot surface).

Hazardous areas are therefore classified into zones according to the likelihood of a flammable gas or dust mixture being present:

Group II flammable gases, vapours and mists

Zone 0 - area in which explosive mixture exists more or less continuously.

Protection technique allowed- Ex ia intrinsically safe.

Zone 1 - area in which gas is not normally present but is likely to occur from time to time.

Protection technique allowed-
- Ex ib intrinsically safe
- Ex d flame proof
- Ex de
- Ex e increased safety
- Ex p pressured or purged
- Ex v ventilation
- Ex s special protection

Zone 2 - area in which an explosive mixture is likely only in abnormal conditions and for short periods.

Protection technique allowed - Ex n non sparking.

Group II flammable dusts and powders

Zone 20 - area where an explosive atmosphere exists in the form of combustible clouds of dust in the air, either permanently, for long periods or frequently.

Protection technique allowed - Ex ia

Zone 21 - area where an explosive atmosphere exists in the form of combustible clouds of dust in the air during normal operation occasionally.

Protection technique allowed-
- DIP IP6x
- Ex tD –A21-IP6x

Zone 22 - area where an explosive atmosphere in the form of combustible clouds of dust in the air is unlikely to occur during normal operation but, if it does occur, it is only for a short period.

Protection technique allowed-

Non-conductive dusts - Ex tD-A22 -IP5x

Conductive dust - Ex tD-A21 - IP6x

It is clear that equipment for use in a Zone 0 area should offer a greater degree of protection than equipment for use in Zone 2 area. This does not mean that the equipment in Zone 2 area is any less safe, since it is the combination of an explosive mixture and an ignition source which is to be avoided. Obviously Zone 0 equipment would also be suitable for use in Zone 1 and Zone 2 areas.

GAS GROUPING

There are so many gaseous mixtures that to ensure by testing that equipment is safe in all gases would be very time consuming. It can be shown by test that gases may be grouped such that if the equipment passes the prescribed tests relative to one gas (known as the test gas for that group) the equipment will be safe for use in all gases in that group (and, if applicable in any other less stringent group).

The four groups into which gases have been categorised are as follows:

Group 1
For mining applications specifically underground mining.

Test Gas – Methane

Group II
For general industry

IIA Test Gas – Propane

IIB Test Gas – Ethylene

IIC Test Gas – Hydrogen

Of these, group IIC gases are the most easily ignited, followed by IIB, IIA. Similarly group IIC gases have flame propagation properties necessitating the most stringent design requirements. If equipment has been shown to be safe in the group IIC gases, then it will also be safe for group IIB and IIA. Equipment suitable for group IIB gases will also be suitable for group IIA.

Hazardous Area

CLASSIFICATION OF THE MORE COMMON COMBUSTIBLE GASES AND VAPOURS ACCORDING TO TEMPERATURE CLASS AND GROUP

Group	Temperature classes					
	T1	T2	T3	T4	T5	T6
I	Methane (firedamp)					
IIA	Acetic acid Acetone Ammonia Benzoyl Benzene Butanone Carbon monoxide Ethane Ethyl acetate Ethyl Chloride Methane Methanol Methyl acetate Methyl alcohol Methyl Chloride Naphthalene Propane Toluene Xylene	Acetic anhydride I amyl acetate n butane n butyl alcohol Amylic alcohol Butyl acetate Cyclohexanon Ethyl alcohol Iso butylic alcohol Liquefied gas Natural gas Propyl acetate	Cyclohexane Cyclohexanol Decane Diesel fuels Gasoline Heating oil Heptane Hexane Jet fuels Pentane Petroleum*	Acetaldehyde Ether		
IIB	Coke-oven gas	1, 3 - butadiene Ethylene Ethyl benzene Ethylene oxide	Hydrogen sulphide Isoprene Petroleum*	Ethyl ether		
IIC	Water gas	Acetylene				Carbon disulphide Ethyl nitrate

* depending on composition

TEMPERATURE CLASSIFICATION

To further streamline safety assessment, equipment is given one of six temperature classifications, based on a reference ambient of 40°C as shown in the table below:

Temperature Class	Maximum temperature of surfaces freely accessible to surrounding atmosphere (°C)	Minimum ignition temperature (°C)	
		Gas	Dust
T1	<450	>450	>500
T2	<300	>300	>350
T3	<200	>200	>250
T4	<135	>135	>185
T5	<100	>100	>150
T6	<85	>85	>135

Devices with a temperature class T6 can be used with gases or dusts with a temperature class of T6 or lower, similarly devices with T5 temperature class can be used with gases or dusts with a lower temperature class

Hazardous Area

FLAMEPROOF EQUIPMENT

Flameproof equipment is designed to withstand an internal explosion and prevent the ignition of external gases. It is basically a mechanical form of protection which works on the basis that as a flame (explosion) attempts to spread from the inside to the outside of an enclosure it is cooled to such an extent that any gas surrounding the enclosure will not be ignited. All flame proof enclosures must comply with certain dimensional requirements applicable to the particular gas group to be covered. Flameproof equipment is generally accepted for use in Zone 1 areas.

INTRINSICALLY SAFE EQUIPMENT

Intrinsically safe equipment is essentially equipment which is designed and operated so that any electrical sparking which may occur during normal operation, or during a fault, is incapable of causing an ignition of the prescribed flammable gas. This form of protection is more suited to low voltage equipment as the ability of a spark to ignite the gases increases rapidly with rising supply voltage. Intrinsically safe equipment can be used in Zone 1 areas and are usually suitable for use in Zone 0 areas.

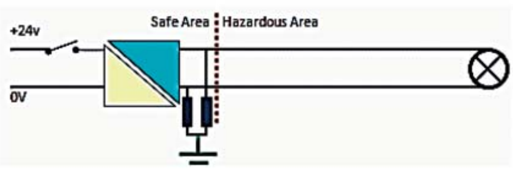
INTERFACE SELECTION: ZENER BARRIERS OR ISOLATION INTERFACES

The decision between these two types of interface will normally be down to site preferences and both have advantages and disadvantages.

Zener barriers are much simpler than isolation interfaces and tend to be more flexible in application. Generally zener barriers can be used in different circuits. Isolation interface's tend to be designed for a specific application and are limited in the way they are used.

Earthing with Zener barriers is perceived to be difficult as they have a strict Earthing requirement although in practice this is rarely a problem. Maintaining an intrinsic safety earth is not as difficult as some believe but, particularly when only a few zener barriers are used, it can introduce extra complication and cost.

Isolation interfaces (also known as Galvanic Isolators) do not require the same degree of integrity on the Earth as zener barrier interfaces. However to avoid the risk of cables charging to uncontrolled potentials and so acquiring stored capacitive energy which may be incendive, a discharge path to Earth should be provided. This would typically be between 200kΩ and 1MΩ and is not deemed to be earthing in terms of the instrumentation loop.



SELECTING AN INTRINSIC SAFETY INTERFACE

The associated apparatus (intrinsic safety interface) preserves the integrity of the field device such as E2S sounder or beacon. It can only do this if it limits the energy by way of voltage and current to a level below the maximum permitted by field device.

These values are the **entity parameters** (often referred to as safety parameters) and consist of voltage current power capacitance and inductance. All of these may not always be specified if they are irrelevant or can be derived directly from the other parameters.

The E2S sounders and beacons main terminals all have the same entity parameters (The suffix "i" denotes input characteristics)		
Ui = 28v	Ii = 93mA	Pi = 660mW

I.S. equipment must, be operated via a shunt zener diode safety barrier or galvanic isolator.

Protection Mode	Area Classification
Flameproof Ex d	Zone 1 & 2
Increased safety Ex e	Zone 1 & 2
Intrinsically safe Exia	Zone 0, 1 & 2
Intrinsically safe Exib	Zone 1 & 2
Special protection Ex s	Zone 0, 1 & 2
Oil immersion Ex o	Zone 1 & 2
Pressurised Ex p	Zone 1 & 2
Powder filling Ex q	Zone 1 & 2
Encapsulation Ex m	Zone 1 & 2
Non sparking Ex N	Zone 2
Ventilation Exv	Zone 1 & 2
Dust Ignition proof DIP	Zone 20, 21 & 22
Intrinsically safe Exi	Zone 20, 21 & 22
Pressurised Ex p	Zone 20, 21 & 22
Encapsulation Ex m	Zone 20, 21 & 22

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Hazardous Area

INTERFACE SELECTION: ZENER BARRIERS OR ISOLATION INTERFACES (CONT.)

This means that the integrity of the apparatus is maintained, i.e. is it is safe, providing these figures are not exceeded. Therefore the associated apparatus (barrier) must have parameters of less than or equal to these figures.

Note that the power figure is not the direct calculation based on Voltage and Current; these are entity or safety parameters not actual working values.

The capacitance and inductance figures	
Ci = 0µF	Li = 0mH

Refer to the capacitance or inductance that the apparatus contributes to the circuit. In the case of E2S sounders and beacons this is zero which simplifies the safety assessment of the circuit.

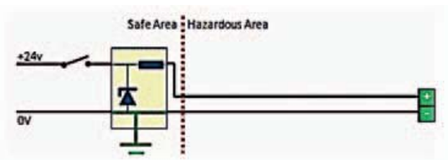
A suitable barrier would have entity parameters of		
Uo ≤ 28v	I o ≤ 93mA	P o ≤ 660mW

Please refer to the relevant certification prior to use. As all E2S sounder and beacons have the same entity parameters in most circuits different E2S intrinsically safe field apparatus may be used providing it has the relevant input feature.

The basic installation is straight forward on/off control using a zener barrier with entity parameters 28v 93mA (often referred to as 28v 300Ω) which is an industry standard barrier (Power driver).

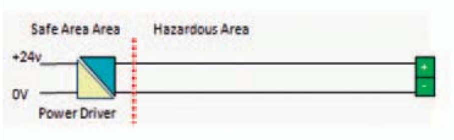
This is suitable for all E2S Intrinsically safe sounders and beacons.

ZENER BARRIERS



Any Interface with parameters		
Uo ≤ 28v	I o ≤ 93mA	P o ≤ 660mW
or for the Diode return channel		
Uo ≤ 28v	I o ≤ 0mA	

ISOLATION INTERFACE



A suitable barrier would have entity parameters of		
Uo ≤ 28v	I o ≤ 93mA	P o ≤ 660mW