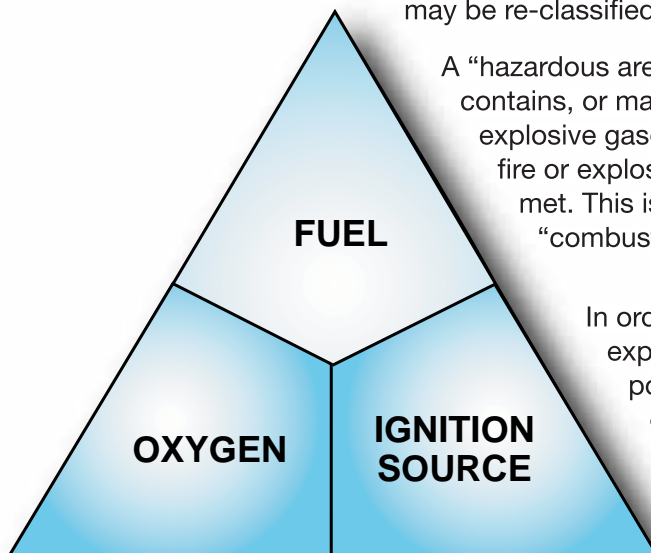




## HAZARDOUS AREA TECHNICAL GUIDE

The Redapt Hazardous Area Technical Guide provides an overview for the design and use of equipment used within potentially explosive atmospheres created by gases, vapours and ignitable dusts or fibres.

Typically this includes such installations as oil/gas rigs, processing refineries, chemical production facilities, flammable liquids storage facilities, fuel transportation, petrol stations, paint production, paper production etc, however this list is not exhaustive and many new areas may be re-classified as hazardous.



A “hazardous area” is defined as an area in which the atmosphere contains, or may contain in sufficient quantities, flammable or explosive gases, dusts or vapours. In such an atmosphere a fire or explosion is possible when three basic conditions are met. This is often referred to as the “hazardous area” or “combustion” triangle.

In order to protect installations from a potential explosion a method of analysing and classifying a potentially hazardous area is required. The purpose of this is to ensure the correct selection and installation of equipment to ultimately prevent an explosion and to ensure safety of life. The methods used to classify an installation can vary depending upon which part of the world it is located, but generally there are two main types of classification. In countries that have

adopted the IEC (International Electrotechnical Commission) philosophy this is referred to as Zoning whilst in North American installations are classified by Classes, Divisions and Groups to ascertain the level of safety required.



## SECTION 1

### Classification -IEC and ATEX Standards

A Hazardous Area is defined by three main criteria, these being:

The type of hazard (groups)

The auto-ignition temperature of the hazardous material (temperature or "T" rating)

The likelihood of the hazard being present in flammable concentrations (zones)

#### The Type of Hazard

The type of hazard will be in the form of either a gas or vapour or a dust or fibre.

The classification of these hazardous is primarily divided into two groups depending on whether it is in a mining or above surface industry. These are defined below:

**Group I** -electrical equipment for use in mines and underground installations susceptible to firedamp Group II and Group III -electrical equipment for use in surface installations

**Groups II & III** are further sub-divided depending upon the hazard. Group II gases are grouped together based upon the amount of energy required to ignite the most explosive mixture of the gas with air. Group III dusts are subdivided according to the nature of the explosive atmosphere for which it is intended.

Mining	Surface Industry			
Group I	Group II		Group III	
Electrical equipment for mines susceptible to firedamp	Electrical equipment for places with an explosive gas atmosphere		Electrical equipment for places with an explosive dust atmosphere	
	Sub-Division	Ignition Energy	Sub-Division	Explosive Atmosphere
	IIA	260 Microjoules	IIIA	Combustible flyings
	IIB	95 Microjoules	IIIB	Non-conductive dust
	IIC	18 Microjoules	IIIC	Conductive dust

## Auto Ignition Temperature or “T” Rating

The hazard level of the gases increases from gas group IIA to IIC with group IIC being the most severe. Substances in this group can be ignited very easily with Hydrogen being the most at risk to ignition. The temperature class is based on the auto-ignition temperature of the gas, details of which are given below.

*Apparatus Groups and Temperature Classes for Common Flammable Gases and Vapours – Group II*

Gas Group	Temperature Class					
	T1	T2	T3	T4	T5	T6
I	Methane					
IIA	Acetone	Ethanol	Diesel fuel	Acetaldehyde		
	Methane	Cyclohexane	Aircraft fuel			
	Ethane	Propanol 2	Fuel oil			
	Benzene	N-Butyl alcohol	N-Hexane			
	Methanol	N-butane	Heptane			
	Toluene		Kerosene			
	Propane					
	Acetic Acid					
	Ammonia					
IIB	Coal Gas	Ethylene	Ethylene glycol	Ethyl Methyl Ether		
		Ethylene oxide	Hydrogen Sulphide			
		Propanol 1	Tetrahydrofuran			
		Methyl Ethyl Ketone				
IIC	Hydrogen	Acetylene				

### Temperature Class Rating for Group II Electrical Apparatus

Group II Temperature Class		
T Code	Maximum Surface Temperature	Ignition temperature
T1	450°C	> 450°C
T2	300°C	> 300°C ≤ 450°C
T3	200°C	> 200°C ≤ 300°C
T4	130°C	> 130°C ≤ 200°C
T5	100°C	> 100°C ≤ 135°C
T6	85°C	> 85°C ≤ 100°C



If a hazardous is present the equipment used within the installation must be given an appropriate "T" classification in order to maintain the integrity. If that hazardous is, say, hydrogen, then all equipment used must meet the "T6" rating. This means that all equipment used must not have a surface temperature of greater than 85°C. Any equipment used that can generate a hotter surface temperature of greater than 85°C must not be used as this will then increase the likelihood of an explosion by igniting the hydrogen in the atmosphere.

### Apparatus Groups and Temperature Classes for Common Flammable Dusts and Fibres – Group III

When considering installations that are at risk of a potential explosion due to dust ignition, the equipment used is classified in much the same way as with gases. No equipment should be installed where the surface temperature of the equipment is greater than the ignition temperature of the given hazard. Below are some common dust hazardous and their minimum ignition temperature.

Ignition Temperatures for Common Flammable Dusts and Fibers		
Material	Ignition Temperature	
	Cloud	Layer
Coal Dust	380°C	225°C
Polythene	420°C	(melts)
Methyl Cellulose	420°C	320°C
Starch	460°C	435°C
Flour	490°C	340°C
Sugar	490°C	460°C
Grain Dust	510°C	300°C
Phenolic Resin	530°C	> 450°C
Aluminium	590°C	> 450°C
PVC	700°C	> 450°C
Soot	810°C	570°C

### The Likelihood of the Hazard

The likelihood of the hazard being present in a concentration high enough to cause an ignition will vary from location to location. For most installations this risk is dependant upon how long the hazard (gas, vapour, dust or fibre) is present. In order to classify this danger an installation is divided into areas of risk depending upon the amount of time the hazardous is present. These areas are referred to as Zones.





For gases and vapours and dusts and fibres there are three zones:

Gas	Dust	Hazardous Area Characteristics
Zone 0	Zone 20	A hazardous atmosphere is highly likely to be present and may be present for long periods of time (>1000 hours per year) or even continuously
Zone 1	Zone 21	A hazardous atmosphere is possible but unlikely to be present for long periods of time (>10 <1000 hours per year)
Zone 2	Zone 22	A hazardous atmosphere is not likely to be present in normal operation or infrequently and for short periods of time (<10 hours per year)

## Protection Concepts

There are varying types of equipment that can be used within these zones to ensure that the potential for an explosion is removed or greatly reduced. This equipment must be designed and manufactured in accordance with particular construction parameters known as protection concepts. Essentially these concepts fall under four main methods. These methods are detailed below along with a brief description of some of the concepts:

Type of Protection Method	Equipment Code	Description	International Standard	Suitable for Zones
Intended to prevent a potential ignition arising	Ex e	Increased safety	IEC 60079-7	1, 2
	Ex nA	Type -n protection	IEC 60079-15	2
Intended to limit the ignition energy of the equipment	Ex ia	Intrinsic safety 'ia'	IEC 60079-11	0, 1, 2
	Ex ib	Intrinsic safety 'ib'	IEC 60079-11	1, 2
	Ex ic	Intrinsic Safety 'ic'	IEC 60079-11	2
	Ex nL	Type -n protection	IEC 60079-15	2
Intended to prevent the explosive atmosphere contacting the ignition source	Ex p	Purge/pressurized protection	IEC 60079-2	1, 2
	Ex px	Purge/pressurized protection 'px'	IEC 60079-2	1, 2
	Ex py	Purge/pressurized protection 'py'	IEC 60079-2	1, 2
	Ex pz	Purge/pressurized protection 'pz'	IEC 60079-2	2
	Ex m	Encapsulation	IEC 60079-18	1, 2
	Ex ma	Encapsulation	IEC 60079-18	0, 1, 2
	Ex mb	Encapsulation	IEC 60079-18	1, 2
	Ex o	Oil immersion	IEC 60079-18	1, 2
	Ex nR	Type -n protection	IEC 60079-15	2
Intended to prevent an ignition from escaping outside the equipment	Ex d	Flameproof protection	IEC 60079-1	1, 2
	Ex q	Sand / powder (quartz) filling	IEC 60079-5	1, 2
	Ex nC	Type -n protection	IEC 60079-15	2
Special	Ex s	Special protection	See IEC 60079-0	0, 1, 2



## **Ex i Intrinsic Safety**

A protection concept in which the electrical energy within the equipment is restricted to a level which is below that what may cause an ignition or to limit the heating of the surface of the equipment. There are two main sub types to Ex i protection, these being "ia" and "ib".

Type "ia" protection allows for the occurrence of two faults during operation

Type "ib" protection allows for the occurrence of one fault during operation.

## **Ex d Flameproof**

The equipment that may cause an explosion is contained within an enclosure which can withstand the force of an explosion and prevent transmission to the outside hazardous atmosphere. This method of protection also prevents the hazardous atmosphere from entering the enclosure and coming into contact with equipment.

## **Ex m Encapsulation**

A protection concept where by equipment that could potentially cause an ignition is encapsulated within a compound or resin so as to prevent contact with the explosive atmosphere. The concept also limits the surface temperature of the equipment under normal operating conditions.

## **Ex e Increased Safety**

Precautions are applied to the installation to ensure increased security against the possibility of excessive temperatures and sparks from electrical equipment. Equipment that normally causes sparks is excluded from use within this method of protection.

## **Ex p Pressurised**

One process ensures that the pressure inside an enclosure is sufficient to prevent the entrance of a flammable gas, vapour, dust, or fibre and prevent a possible ignition. Another process maintains a constant flow of air (or an inert gas) to dilute to take away any potentially explosive atmosphere.

## **Ex o Oil Immersion**

All equipment that has the potential to arc and potentially cause an ignition is immersed in a protective liquid or oil. The oil provides an insulating method to prevent ignition.

## **Ex q Powder Filling**

All equipment that has the potential to arc is contained within an enclosure filled with quartz or glass powder particles. The powder filling prevents the possibility of an ignition.



## Ex n Non-Sparking

A type of protection where precautions are taken so that electrical equipment that has the potential to arc is not capable of igniting a surrounding explosive atmosphere. This can be further categorised as follows: Ex nA -Where components used in construction are non-sparking Ex nC -Where components used in construction are non-incendive Ex nR – Where components used are tightly enclosed to restrict the breathing and prevent ignition Ex nL -Where components used in construction do not contain enough energy to cause an ignition

## Ex s Special

This method of protection, as its name indicates, has no specific parameters or construction rules. In essence it is any method of protection which can provide a pre-determined level of safety to ensure that there is no potential for an ignition. As such it does not fall under any specific protection method and may in fact be a combination of more than one.

## Ingress Protection

Another consideration in the protection of equipment in hazardous areas is the safeguarding against the ingress of solid foreign objects and water. This is known as the degree of ingress protection and is commonly referred to as the IP Code. The relevant standard for the degree of ingress protection is IEC 60529. An overview of the IP code as defined in the standard is detailed below:

1st Numeral	Degree of Protection	2nd Numeral	Degree of Protection
0	No protection at all against solid objects	0	No protection at all against the ingress of water
1	Protection against solid objects greater than 50 mm in diameter	1	Protected against falling water drops
2	Protection against solid objects greater than 12.5 mm in diameter	2	Protected against falling water drops at an angle of up to 15°
3	Protection against solid objects greater than 2.5 mm in diameter	3	Protected against sprayed water at an angle of up to 60°
4	Protection against solid objects greater than 1.0 mm in diameter	4	Protected against the splashing of water from any direction
5	Protected against the ingress of dust in such an amount that it will not interfere with the operation of the equipment	5	Protected against water jets from any direction
6	Total protection against the ingress of any dust	6	Protected against powerful water jets from any direction
		7	Protected against the ingress of water when temporary immersed between 0.15 m and 1 m
		8	Protected against the ingress of water when continuously immersed to a specified depth



## Operational Temperatures

All equipment used within hazardous areas has an operational temperature band or limit. This is often referred to as the "Tamb" and defines the upper and lower ambient temperatures of which the equipment is approved for use in. As defined in IEC 60079-0 the standard limits are – 20°C to +40°C. Where the operation temperatures of the equipment fall between these parameters no additional marking is required. However, if they are outside these parameters then the specific temperatures need to be identified.

## Marking of Hazardous Area Equipment

All equipment for use in hazardous areas should be marked as prescribed in 60079-0. As a general rule this includes, where appropriate, such information as:

- Company/Manufacturers name and address
- Hazardous area certificate number(s)
- Protection concept -Gas group(s)
- Temperature class
- Ambient temperature range
- Product identification
- Serial number and year of manufacture
- Electrical parameters
- CE marking and ATEX notified Body ID number
- ATEX coding -IP code





## SECTION 2

### Classification – North American Standards

In North American installations, hazardous areas are defined by classes, divisions, and groups to classify the level of safety required for equipment installed in these locations.

Classes define the type of hazard in terms of whether it is a gas or vapour, a combustible or conductive dust or an ignitable fibre or flying.

Divisions define the probability of the presence of the hazard being present during normal or abnormal conditions.

Groups classify the exact type and nature of the hazardous substance.

An overview of this classification system can be defined as follows:

#### Classes

Class	Definition
I	A location in which a flammable gas or vapour is or may be present in sufficient quantity to cause an explosive atmosphere
II	A location in which a conductive or combustible dust is or may be present in sufficient quantity to cause a fire or an explosive hazard.
III	A location in which easily ignitable fibres or flyings are present in sufficient quantity to present a serious risk of fire

#### Classes

Class	Definition
1	The defined hazard is present during normal operational conditions
2	The defined hazard is present only during abnormal conditions such as equipment failure.

#### Groups

Class	Representative Hazard
A	Acetylene
B	Hydrogen
	Ethylene
D	Propane
E	Metal Dust
F	Coal Dust
G	Grain Dust



## Marking of Hazardous Location Equipment

The marking of hazardous location equipment varies in accordance with the relevant Electrical Code. As a general rule equipment should be marked as follows:

- Company/Manufacturers name
- Class I, II and/or III
- Division 1 and/or 2
- Group A, B, C, D, E, F and/or G
- Approving NRTL (Nationally Recognized Testing Laboratory) logo
- Product identification
- Serial number
- Other relevant safety information
- Enclosure Type Rating

## Basic UL / CSA / NEMA Enclosure Types

### Type 3

An enclosure which is intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, sleet and damage from external ice formation

### Type 3R

An enclosure which is intended for outdoor use primarily to provide a degree of protection against falling rain and damage from external ice formation

### Type 3S

An enclosure which is intended for outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust, and to provide for operation of external mechanisms when ice laden

### Type 4

An enclosure which is intended for indoor or outdoor use primarily to provide a degree of protection against windblown rain and dust, splashing water, hose directed water and damage from external ice formation

### Type 4X

An enclosure which is intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown rain and dust, splashing water, hose directed water and damage from external ice formation

### Type 6

An enclosure which is intended for indoor or outdoor use primarily to provide a degree of protection against falling dirt, hose directed water, the entry of water during occasional temporary submersion at a specified depth and damage from external ice formation.



## Type 6P

An enclosure which is intended for indoor or outdoor use to primarily to provide a degree of protection against falling dirt, hose directed water and the entry of water during prolonged submersion at a specified depth and damage from external ice formation.

This information has been compiled for guidance purposes only for equipment intended for use in potentially explosive atmospheres. This guide was assembled based on available technical knowledge at time of compilation. However regulations and legislations are subject to updates and the information provided within this guide may have been superseded. All equipment must be designed, selected and installed in accordance with appropriate regulations and governing legislation appropriate to its use.

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