HAZARDOUS AREA STANDARDS AND APPROVALS

There are different standards used for hazardous areas and electrical equipment designed for use in those environments, depending upon where in the world they are to be used. In Europe EN standards are used to check compliance with the ATEX directive. In the USA the standard is NEC (National Electric Code), with a variant called CEC (Canadian Electric Code) used in Canada. In addition some countries have their own approval standards (e.g. GOST for Russia and the former Soviet States, TISI for Thailand, etc), however these are often based on EN standards.

To simplify matters an attempt is being made to harmonise all major standards for use in the IEC Ex scheme. The aim of the IECEx Scheme is to facilitate international trade in electrical equipment intended for use in explosive atmospheres (Ex equipment) by eliminating the need for multiple national certification while preserving an appropriate level of safety.

Whilst the standards used in Europe and America are intended to achieve the safe installation and operation of electrical equipment in hazardous areas, they are different in principles, classification and approach.

The purpose of the following guide is to detail some of the differences in the two approaches and to use a step-by-step process to select the correct type of luminaire or other electrical, equipment for use in a hazardous area.

THE CLASSIFICATION OF HAZARDOUS AREAS INTO ZONES IS GIVEN FOR GAS MIXTURES, IN IEC OR EN 60079-10 AND SELECTION IN IEC OR EN 60079-14.

FOR COMBUSTIBLE DUST HAZARDS THE EUROPEAN STANDARDS ARE EN 61241-10 AND EN 61241-14.

THE INFORMATION FOLLOWING IS GIVEN AS BACKGROUND TO THE USE OF THE ABOVE STANDARDS. THE APPLICATION OF THE STANDARDS AND ANY LOCAL REGULATION IS THE RESPONSIBILITY OF THE USER.

EUROPEAN HAZARDOUS AREA EQUIPMENT DIRECTIVE, STANDARDS AND APPROVALS

ATEX DIRECTIVE

The ATEX Directive 94/9/EC is a directive adopted by the European Union (EU) to facilitate free trade in the EU by aligning the technical and legal requirements in the Member States for products intended for use in potentially explosive atmospheres.

The Directive covers electrical and mechanical equipment and protective systems, which may be used in potentially explosive atmospheres (flammable gases, vapours or dusts.) It became mandatory at the end of June 2003 for Europe.

One of the significant changes that was introduced in the ATEX directive was the move away from defining types of equipment by their protection concept and using categories instead. These are in effect levels of safety. They are linked to the protection concept by the wording in the individual harmonised European standards. In fact the definition of the categories aligns the protection concept with it's traditional area of use. The directive for use is 99/92/EC.

The table below shows the relationship between the category and the expected zone of use.

It is very important to emphasise that the ATEX categories are levels of safety. The various types of protection are put into these categories of safety as shown in the EN equipment standards. The hazardous area classification into zones is entirely separate.

However, because the types of protection have been designed for use in particular hazardous areas and the application/installation standards give the basic suitability of types of protection for different zones, the ATEX categories align with the zone of use for practical purposes. This is provided that other attributes of the equipment or zone do not conflict and that the risk assessment for the zone does not dictate differently.

Category 1 - Zone 0

Category 2 - Zone 1

Category 3 - Zone 2

Category	Degree of Safety	Design Requirement	Application	Expected Zone of Use
1	Very high level of Safety	Two independent means of protection or safe with two independent faults	Where explosive atmospheres are present continuously or for lengthy periods	Zone 0 (gas) and Zone 20 (dust)
2	High level of Safety	Safe with frequently occurring disturbances or with a normal operating fault	Where explosive atmospheres are likely to occur	Zone 1 (gas) and Zone 21 (dust)
3	Normal level of Safety	Safe in normal operation	Where explosive atmospheres are likely to occur infrequently and be of short duration	Zone 2 (gas) and Zone 22 (dust)

Table 4 ATEX Categories and Applications

STEP BY STEP PRODUCT SELECTION GUIDE

STEP 1

Establish if the hazardous area is due to the presence of an explosive gas or an explosive dust.

EXPLOSIVE GASES

Using the table FIG. 1.0 below, ascertain first if the gas present is a group I or group II gas.

- Group I gases are firedamp methane gas.
- Group II gases are all other explosive gases as listed opposite with relevant subdivisions A, B or C according to the nature of the chemical content.

GROUP IIA				GROUP IIB	GROUP IIC
Hydrocarbons	**Mixtures of hydrocarbons:**	**Ketones:**	Chloroethylene (vinyl chloride)	***Hydrocarbons***	Hydrogen
Alkanes:	Industrial methane	Acetone	Benzyl trifluoride	Allylene (Propyn)	Acetylene
Methane	Turpentine	Ethyl-methyl ketone	Methylene chloride	Ethylene	Carbon disulphide
Ethane	Petroleum naphtha	Propyl-methyl ketone		Cyclopropane	
Propane	Oil naphtha	Butyl-methyl ketone	***Compounds containing***	Butadine	
Butane	Petroleum (including petroleum spirits)	Amyl-methyl ketone	**Oxygen:**	***Compounds containing***	
Pentane	Dry cleaning solvents	2,4-Pentanedione (acetylacetone)	Acetyl chloride	**Nitrogen:**	
Hexane	Fuel oil	Cyclohexanone	Chloroethanol	Acrylonitrile	
Heptane	Kerosene			Isopropyl nitrate	
Octane	Gas-oil	**Esters:**	***Compounds containing***	Hydrocyanic acide	
Nonane	Benzole for cars	Methyl formate	**Sulphur:**		
Decane		Ethyl formate	Ethyl mercaptan	***Compounds containing***	
Cyclobutane	***Compounds containing oxygen:***	Methyl acetate	Propyl mercaptan	**Oxygen:**	
Cyclopentane	**Oxides:** (including ethers):	Ethyl acetate	Thiophene	Mrthyl ether	
Cyclohexane	Carbon monoxide	Propyl acetate	Tetrahydrothiophene	Ethylmethyl ether	
Cycloheptane	Dipropyl ether	Butyl acetate		Ethyl ether	
Methylcyclobutane		Amyl acetate	***Compounds containing***	Butyl ether	
Methylcyclopentane	**Alcohols and phenols:**	Methyl methacrylate	**Nitrogen:**	Ethylene oxide (epoxyethane)	
Methylcyclohexane	Methanol	Ethyl methacrylate	Ammonia	Epoxy-propane	
Ethylcyclobutane	Ethanol	Vinyl acetate	Acetonitrile	Dioxoian	
Ethylcyclopentane	Propanol	Ethyl acetyacetate	Nitromethane	Dioxin	
Ethylcyclohexane	Butanol		Nitroethane	Trioxin	
Decahydronaphthalene (decaline)	Pentanol	**Acids:**		Butyl hydoxyacetate	
	Hexanol	Acetic acid	**Amines:**	Tetrahydrofurfuryl	
Alkenes:	Heptanol		Methylamine	Methyl acrylate	
Propene (propylene)	Octanol	***Compounds containing halogens***	Dimethylamine	Ethyl acrylate	
	Nonanol	**Compounds with no Oxygen:**	Trimethylamine	Furane	
Aromatic hydrocarbons:	Cyclohexanol	Chloromethane	Diethylamine	Crotonaldehyde	
Styrene	Methylcyclohexanol	Chlorethane	Propylamine	Acrolien	
Methylstyrene	Phenol	Bromoethane	Butylamine	Tetrahydrofuran	
	Cresol	Chloropropane	Cyclohexylamine		
Benzene and its derivatives:	Diacetone-alcohol	Chlorobutane	Monoethanolamine	**Mixtures:**	
Benzene		Bromobutane	Diaminoethane	Gas from a coke furnace	
Toluene	**Aldehydes:**	Dichlorethane	Anline		
Xylene	Acetaldehyde	Dichloropropane	Dimethylaniline	***Compounds containing***	
Ethylbenzene	Methaldehyde	Chlorobenzene	Amphetamine	**Halogens:**	
Trimethylbenzene		Benzyl chloride	Toluidine	Telrafluoroethylene	
Naphthalene		Dichlorobenzene	Pyridine	Propane, 1 chloro. 2,3 epoxy (epichlorohydrin)	
Cumene		Allyl chloride			
Cymene		Dichloroethylene			

FIG 1.0

COMBUSTIBLE DUSTS

If an area is classed as hazardous due to the presence of combustible dust, it is important to establish if it is a metallic or non metallic dust. The latest series of standards for electrical apparatus in the presence of combustible dust that will provide protection concepts, installation and selection requirements will be the EN/IEC 61241 series.

The most commonly used part of the EN 61241 series applicable to luminaires will be EN 61241-1: Protection by enclosures with marking "tD". It should be noted that this standard outlines to two techniques that provide equivalence in safety but different requirements in terms of selection and installation.

The two techniques are "Practice A" and "Practice B", practice B is principally a prescriptive based technique where practice A is performance based. Practice A is the most commonly used technique, where dust may form in layers up to 5mm thick and where a temperature difference of 75K is specified between the maximum surface temperature and the ignition temperature of the dust; the method of determining dust ingress is according to IEC 60529 the IP code. Practice A and Practice B apply to Zones 21 and 22. For clarity the zones for dust can be described as follows:

ZONE 21

Where a combustible dust, as a cloud, is likely to occur during normal operation in sufficient quantity to be capable of producing an explosive concentration of combustible or ignitable dust in mixture with air.

ZONE 22

In this zone, combustible dust clouds may occur infrequently, and persist for only a short time, or in which accumulation or layers of combustible dust may be present under abnormal conditions and give rise to ignitable mixtures of dust in air. Where following an abnormal condition, the removal of dust accumulations or layers cannot be assured, then the area shall be classified as zone 21.

STEP 2

Now having established which gas or dusts are present, the next thing to establish is the hazardous area category. FIG 1.1 below sets out the zone definitions to classify your area.

ZONE	TYPE OF PROTECTION ASSIGNED TO APPARATUS
Zone 0	An area in which an explosive atmosphere is continuously present or for long periods or frequently
Zone 1	An area in which an explosive atmosphere is likely to occur in normal operation occasionally
Zone 2	An area in which an explosive atmosphere is not likely to occur in normal operation and if it occurs it will exist only for a short time. (Zone 2 is often described as the 'remotely hazardous area'.)

TABLE 2 HAZARDOUS AREA CLASSIFICATION

FIG 1.1

Using the guide in FIG 1.1 you can now classify the hazardous area into a zone. If you are unsure as to which zone an area should be classified as, please refer to your local health and safety officer or your fire brigade for guidance. Victor Lighting or any other manufacturer of hazardous area equipment is not able to offer any advice in this respect.

STEP 3

Having now identified the zone and gas/dust present in the hazardous area, the ignition temperature of the gas/dust needs to be ascertained. For atmospheres containing explosive dust, the ignition temperature of the dust needs to established both when it is in a cloud and when it is in a layer. This information can be found from the table in FIG 1.2 below.

EXPLOSIVE GASES

GAS	IGNITION TEMP °C	GAS	IGNITION TEMP °C	GAS	IGNITION TEMP °C
Acetic acid (glacial)	464	Isopropyl ether	443	Vinyl chloride	472
Acetone	465	Mesityl oxide	344	Xylenes (o-xylene)	463
Acrylonitrile	481	Methane (natural gas)	537	Acrolein (inhibited)	220
Ammonia	651	Methanol (methyl alcohol)	385	Arsine	NA
Benzene	498	3-methyl-1-butanol (isoamyl alcohol)	350	Butadiene	420
Butane	287	Methyl ethyl ketone	404	Ethylene oxide	429
1-butanol (butyl alcohol)	343	Methyl isobutal keytone	448	Hydrogen	500
2-butanol (secondary butyl alcohol)	405	2-methyl-1-propanol (isobutyl alcohol)	415	Propylene oxide	449
N-butyl acetate	425	2-methyl-1-propanol (tertiary butyl)	478	Propylnitrate	175
Isobutyl acetate	421	Petroleum naphta	288	Ethylene	450
Sec-butyl alcohol	343	Pyridine	482	Ethylenmine	320
Di-isoutylene	391	Octanes	206	Ethyl mercaptan	300
Ethane	472	Pentanes	260	Ethyl sulfide	NA
Ethanol (ethyl alcohol)	363	1-pentanol (amyl alcohol)	300	Hydrogen cyanide	538
Ethyl acetate	426	Propane	432	Hydrogen sulfide	260
Ethylene diamine (anhydrous)	385	1-propanol (propyl alcohol)	412	Morpholine	310
Ethylene dichloride	413	2-propanol (isopropyl alcohol)	399	2-nitropropane	428
Gasoline (56-60 octane)	280	Propylene	455	Tetrahydrofuran	321
Hexanes	223	Styrene	490	Unsymmetrical dimethyl hydrazine (udmh 1. 1-dimethyl hydrazine	249
Heptanes	204	Toluene	480		
Isoprene	395	Vinyl acetate	402		

EXPLOSIVE DUSTS METALLIC

MATERIAL	CLOUD	LAYER
Aluminum	650	760
Magnesium	620	490
Titanium	330	510
Zinc	630	430
Bronze	370	190
Chromium	580	400
Tin	630	430
Cadmium	570	250

EXPLOSIVE FIBRES

MATERIAL	CLOUD	LAYER
Cotton lint	520	-
Flax	430	230
Rayon	520	250

EXPLOSIVE DUSTS NON METALLIC

MATERIAL	CLOUD	LAYER
Alfalfa	460	200
Cocoa	420	200
Coffee	410	220
Corn	400	250
Cornstarch	380	200
Malt	400	250
Skim milk	490	200
Rice	440	220
Sugar	350	400
Wheat	480	220
Coal (pittsburgh seam)	610	180
Wheat flour	380	360
Cellulose acetate	450	390
Ethyl acetate	450	390
Nylon	500	430
Polyethylene	450	380
Polystyrene	560	-
Epoxy	540	-
Polyurethane	550	390
Cork	490	280
Wood flour (white pine)	470	260

FIG 1.2

STEP 4

Knowing the ignition temperature of the explosive atmosphere, the zone and the gas grouping or dust type we are better able to decide upon the appropriate type of electrical apparatus required. It is important therefore to understand the certified protection concepts recognised for safe operation as used for an ATEX category and/or within a zone.

The category in ATEX links to types of protection listed below. If the ATEX categories are used as a cross reference to zones then the protection concepts listed apply

ATEX CATEGORY PROTECTION TYPE - STANDARDS AND PROTECTION METHODS

CATEGORY	PROTECTION TYPE	STANDARDS	PROTECTION METHOD
1	Ex 'ia' Intrinsic Safety.	EN 50020	Where the design limits the ignition spark energy to below that which will ignite the explosive gas. Safe even with two simultaneous faults.
	Special protection for Category 1 [and Zone 1]	EN60079-26	Special construction normally based on the use of two independent types of protection both individually suitable for Category 1.
2	Ex 'ia' Intrinsic Safety		All protection methods described above for Category 1 are also suitable for Category 2.
	Ex 'e' Increased Safety	EN 60079-7	Design prevents any ignition from occurring by ensuring no normally sparking components are used and other components reduce the risk of causing a fault that may cause an ignition. This is achieved by strictly controlling and limiting the temperature of components, ensuring adequate insulation is used, all electrical connections are true and the IP rating offers adequate protection against contamination.
	Ex 'd' Flameproof	EN60079-1	The components may produce sparks that could cause ignition of the explosive gas but which are housed in an explosive proof enclosure. The design of the enclosure may allows the gas to enter, but any explosion is contained within the enclosure.

CATEGORY	PROTECTION TYPE	STANDARDS	PROTECTION METHOD
	Ex 'ib' Intrinsic Safety	As Ex ia	As Ex ia but allows for the occurrence of only one component fault.
	Ex 'tD'	EN 61241-1	Design ensures dust ingress protection and surface temperature limitation to avoid ignition of dust layer or cloud.
	Ex 'm' Encapsulation	EN 60079-18	Integral components which can potentially ignite an explosive gas are encapsulated allowing the isolation of these components from the explosive atmosphere surrounding them. This allows the strict control of surface temperatures under normal and fault conditions.
	Ex 'p' Pressurised Apparatus	EN 60079-2	One type of pressurisation maintains a positive static pressure inside the apparatus to prevent entry of gas and another maintains a continuous flow of air or inert gas to neutralise or carry away any explosive mixture entering or being formed within the enclosure. Essential to these methods are continuous monitoring systems to ensure their reliability and purging schedules on installation and following opening.
	Ex 's' Special Protection		As special protection, Ex 's' is not subject to any formal standard as such. It is used where equipment does not comply exactly with standards but where its method of operation is proven to be safe in a hazardous area environment.
	Ex 'q' Powder filling	EN 50017	This technique involves the mounting of potentially incendive components in an enclosure filled with sand or similar inert powder. The sand prevents explosive ignition. It was originally developed to protect heavy duty traction batteries. It is now primarily of use where the incendive action is the abnormal release of electrical energy by the rupture of fuses or failure of components used in electronic apparatus. The likelihood of possible incendive failure of the components is assessed and precautions taken to minimise it. Usually Ex q is used for discrete sub-assemblies and components inside Ex e apparatus.
3			All protection methods described above for Category 1 & Category 2 are suitable for use in Category 3
	Ex 'n' non sparking	EN 60079-15	This is a method very similar to Ex 'e' increased safety although not as stringent. The components are designed so as not to produce any sparks or dangerous temperatures in operation.
	Ex 'nA' and Ex 'nR'	EN 60079-15	The Ex non sparking 'nR' denotes the use of a restricted breathing enclosure. This technique is used where internal components run hotter than the required T rating. The T rating is achieved by mounting the offending components in a sealed enclosure to prevent the explosive atmosphere contacting them. This technique by virtue incorporates high IP ratings of minimum IP65.
	Ex 'o' Oil Immersion	EN 50015	Ex 'o', involves the immersion of the sparking components in oil with controlled venting.

FIG 1.3

STEP 5

Now that you have clarified the gases/dusts present, their ignition temperature, the zone and applicable protection methods, the certified temperature codings must be understood for choosing the correct luminaire. Failure to understand the relationships could result in selecting an inappropriate luminaire for the zone and atmosphere. If the luminaires T rating code signifies the surface temperature of the equipment is greater than the ignition temperature of the gas/dust present, the luminaire will ignite the surrounding atmosphere causing an explosion.

Below FIG 1.4 shows the temperature codes related to surface temperatures. Using this table check the ignition temperature of the gas/dust present, as shown in FIG 1.2. This will then indicate the suitability of the equipment you have selected, or the temperature rating of the equipment you need to select.

TEMPERATURE CLASSIFICATION	MAXIMUM SURFACE TEMPERATURE OF EQUIPMENT (^{O}C)
T1	450
T2	300
T3	200
T4	135
T5	100
T6	85

FIG 1.4

STEP 6

The environment that the equipment will operate in is also important. Many environments are arduous and may involve the equipment being subject to the following:

TYPES OF ENVIRONMENT	EXAMPLES
Extreme high or low temperatures	Middle east/Norway
Arduous weather conditions	Offshore/Marine
Immersion in water	Dry docks
Subject to dusty atmospheres	Clean rooms/Grain silos

FIG 1.5

In order to ensure that the equipment selected will perform in the environment for which it is intended, the following factors of equipment performance need to be considered.

- Ambient temperature - Does the equipment have certification to operate within the minimum and maximum temperatures of the environment?
- How much dust/liquid etc will the equipment be subjected to and for how long?
- Will the equipment be subject to any likely impact during its service life?
- Are there any chemicals/vapours present that could attack luminaires with plastic enclosures?

When selecting equipment, the product information will state the certified operating temperature such as the example below. If in selecting equipment the product information contains no statement or reference to ambient temperature be very sceptical and do not assume. Always check and obtain written confirmation from the manufacturer.

Example Floodlight VL65A

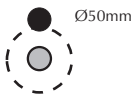
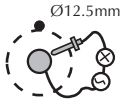
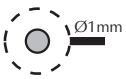
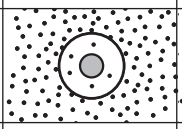
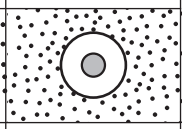
-50^{O}C to +55^{O}C

Always check that the ambient temperature certification is applicable to your relevant choice of product as maximum ambient performances are often quoted and may only be applicable to certain product variants.

If the environment will subject the equipment to any dust/fibres/liquids, ensure it is certified to an appropriate level of ingress protection. This can be done using the table below.

INDEX OF PROTECTION (IP XX)

IP** degree of protection of enclosures of electrical equipment in accordance with standards IEC 529, EN 60529 and NFC 20-010

1st figure: Protection against solid bodies							
IP	0	1	2	3	4	5	6
TESTS							
	No Protection	Protected against solid bodies of 50 mm and greater (e.g. accidental contact with the hand)	Protected against solid bodies of 12.5 mm and greater (e.g. finger)	Protected against solid bodies of 2.5mm and greater (e.g. tools, wires)	Protected against solid bodies larger than 1 mm (e.g. thin tools and fine wires)	Protected against dust (no harmful deposit)	Completely protected against dust

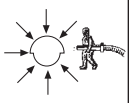
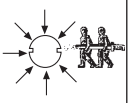
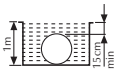
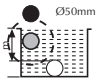
2nd figure: Protection against liquids									
IP	0	1	2	3	4	5	6	7	8
TESTS									
	No Protection	Protected against vertically falling drops of water (condensation)	Protected against drops of water falling up to 15° from the vertical	Protected against drops of water falling up to 60° from the vertical	Protected against splashing water from all directions	Protected against jets of water from all directions	Protected against powerful jets of water from all directions	Protected against the effects of temporary immersion in water	Protected against the continuous effects of immersion in water having regard to specific conditions

FIG 1.6

Example Floodlight VL65A
Ingress protection to IP66 and IP67

STEP 7... FINALLY

Having covered all the rules and safety considerations of the operation of electrical equipment in a hazardous area it is now possible to select a safe and appropriate product.

INTERNATIONAL STANDARDS AND APPROVALS

IECEx International Certification Scheme

"The aim of the IECEx Scheme is to facilitate international trade in electrical equipment intended for use in explosive atmosphere (Ex equipment) by eliminating the need for multiple national certification while preserving an appropriate level of safety."

"The final objective of the IECEx Scheme is worldwide acceptance of one standard, one certificate and one mark."

GOST-R (Russia)

Gosstandart of Russia is responsible for:

- establishment of the general rules and recommendations for certification of products, services (works) and systems of quality and production harmonised with international norms and rules;
- carrying out the State registration of the mandatory and voluntary certification systems and of the conformity marks.

Russia participates in the following international certification systems:

- System of the International Electrotechnical Commission (IEC) for tests of electrical equipment on conformity to the safety standards.

GGTN

Gosgortekhnadzor (GGTN) is the Federal Mining and Industrial Safety Supervisory Authority of Russia, and is responsible for the issue of permits and licenses for a broad range of machinery and equipment. As a separate entity to Gosstandart, GGTN requires product types that fall under its jurisdiction to undergo a further certification process.

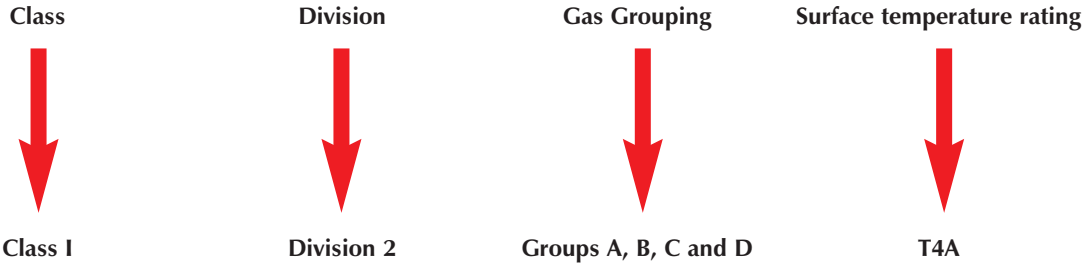
All potentially hazardous machinery and equipment, such as pressure vessels, boilers, burners, lifts and cranes is subject to GGTN approval, even if it has already obtained a GOST-R Coc.

In addition, any machinery to be used in hazardous or potentially explosive environments, such as oil or gas fields, refineries or chemical plants also require a separate GGTN permit. This applies even where the equipment itself would not normally require GOST-R approval.

NORTH AMERICAN STANDARDS AND APPROVALS

PRODUCT CODING

As in the European section, products are coded according to their certification for use in particular types of environments.



STEP I

As detailed in the European section in STEP 1 the gas/dust/fibre present in the hazardous area needs to be identified and classified under the CEC\NEC (North American) classifications detailed in FIG 1.9 below.

CLASS I (EXPLOSIVE GASES)

GROUP A ATMOSPHERE	
Acetylene	305

GROUP B ATMOSPHERE	
Acrolein (inhibited)	220
Arsine	NA
Butadiene	420
Ethylene oxide	429
Hydrogen	500
Propylene oxide	449
Propylnitrate	175

GROUP C ATMOSPHERE	
Ethylene	450
Ethylenmine	320
Ethyl mercaptan	300
Ethyl sulfide	NA
Hydrogen cyanide	538
Hydrogen sulfide	260
Morpholine	310
2-nitropropane	428
Tetrahydrofuran	321
Unsymmetrical dimethyl hydrazine (udmh 1. 1-dimethyl hydrazine	249

GROUP D ATMOSPHERE			
Acetic acid (glacial)	464	Mesityl oxide	344
Acetone	465	Methane (natural gas)	537
Acrylonitrile	481	Methanol (methyl alcohol)	385
Ammonia	651	3-methyl-1-butanol (isoamyl alcohol)	350
Benzene	498	Methyl ethyl ketone	404
Butane	287	Methyl isobutal keytone	448
1-butanol (butyl alcohol)	343	2-methyl-1-propanol (isobutyl alcohol)	415
2-butanol (secondary butyl alcohol)	405	2-methyl-1-propanol (tertiary butyl)	478
N-butyl acetate	425	Petroleum naphta	288
Isobutyl acetate	421	Pyridine	482
Sec-butyl alcohol	343	Octanes	206
Di-isoutylene	391	Pentanes	260
Ethane	472	1-pentanol (amyl alcohol)	300
Ethanol (ethyl alcohol)	363	Propane	432
Ethyl acetate	426	1-propanol (propyl alcohol)	412
Ethylene diamine (anhydrous)	385	2-propanol (isopropyl alcohol)	399
Ethylene dichloride	413	Propylene	455
Gasoline (56-60 octane)	280	Styrene	490
Hexanes	223	Toluene	480
Heptanes	204	Vinyl acetate	402
Isoprene	395	Vinyl chloride	472
Isopropyl ether	443	Xylenes (o-xylene)	463

CLASS II (EXPLOSIVE DUSTS)

GROUP E		
MATERIAL	CLOUD	LAYER
Aluminum	650	760
Magnesium	620	490
Titanium	330	510
Zinc	630	430
Bronze	370	190
Chromium	580	400
Tin	630	430
Cadmium	570	250

GROUP F		
MATERIAL	CLOUD	LAYER
Coal (Pittsburgh Seam)	610	180

MATERIAL	CLOUD	LAYER	MATERIAL	CLOUD	LAYER
Alfalfa	460	200	Wheat flour	380	360
Cocoa	420	200	Cellulose acetate	450	390
Coffee	410	220	Ethyl acetate	450	390
Corn	400	250	Nylon	500	430
Cornstarch	380	200	Polyethylene	450	380
Malt	400	250	Polystyrene	560	-
Skim milk	490	200	Epoxy	540	-
Rice	440	220	Polyurethane	550	390
Sugar	350	400	Cork	490	280
Wheat	480	220	Wood flour (white pine)	470	260

CLASS III (EXPLOSIVE FIBRES)

MATERIAL	CLOUD	LAYER
Cotton lint	520	-
Flax	430	230
Rayon	520	250

FIG 1.9

Using FIG 1.9 we can also ascertain the ignition temperatures of the identified gas/dust/fibre present.

STEP 2

Select the Gas/Dust/Fibre type present from FIG 1.9 and note:

- Material classification
  I = Gas
  II = Dust
  III = Fibre
- The material group
- If the material present is a dust or fibre and whether it forms a cloud or a layer on surfaces
- The ignition temperature of the material

STEP 3

Assess the hazardous area as in STEP 2 of the european section with regard to the potential frequency and longevity of an explosive atmosphere. This can be done using the classifications below.

DIVISION	CLASSIFICATION CRITERIA
1	Gas/dust/fibres normally present in explosive amounts during operation.
2	Gas/dust/fibres not normally present in explosive amounts during operation.

STEP 4

Now having defined the explosive gas/dust/fibres present, the nature of their presence, their ignition temperature and the classification of the hazardous area we, need to determine the temperature classifications to ensure the selection of equipment which will be safe in operation.

The classifications, which are similar to Europe, are further subdivided as follows

NORTH AMERICAN TEMPERATURE CLASSIFICATIONS

Temperature in Fahrenheit	Temperature in Celsius	North American Temperature code
842	450	T1
572	300	T2
536	280	T2A
500	260	T2B
446	230	T2C
419	215	T2D
392	200	T3
356	180	T3A
329	165	T3B
320	160	T3C
275	135	T4
248	120	T4A
212	100	T5
185	85	T6

FIG 2.0

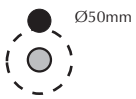
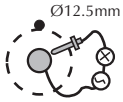
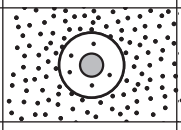
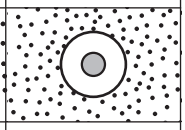
Product markings will often show the actual rated temperature in brackets next to the temperature code to make judgement and selection easier.

STEP 5

Finally we need to take cognisance of the environment in which the equipment will be operating with respect to the concentration of liquids/gas/dust/fibres and ambient temperature.

On establishing these operating conditions we can establish the desired ingress protection required of the equipment by using the table below.

INDEX OF INGRESS PROTECTION

1st figure: Protection against solid bodies							
IP	0	1	2	3	4	5	6
TESTS							
	No Protection	Protected against solid bodies of 50 mm and greater (e.g. accidental contact with the hand)	Protected against solid bodies of 12.5 mm and greater (e.g. finger)	Protected against solid bodies of 2.5mm and greater (e.g. tools, wires)	Protected against solid bodies larger than 1 mm (e.g. thin tools and fine wires)	Protected against dust (no harmful deposit)	Completely protected against dust

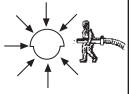
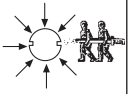
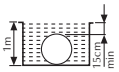
2nd figure: Protection against liquids									
IP	0	1	2	3	4	5	6	7	8
TESTS									
	No Protection	Protected against vertically falling drops of water (condensation)	Protected against drops of water falling up to 15° from the vertical	Protected against drops of water falling up to 60° from the vertical	Protected against splashing water from all directions	Protected against jets of water from all directions	Protected against powerful jets of water from all directions	Protected against the effects of temporary immersion in water	Protected against the continuous effects of immersion in water having regard to specific conditions

FIG 2.1

The ingress protection level is found by putting the first and second figure together e.g. IP67

A third figure is sometimes used in the index of protection. This relates to the degree of mechanical protection the equipment has been certified as having. This relates to the degree of impact energy the equipment will stand before its hazardous area and ingress protection certification is compromised. FIG 2.2 below details the levels of protection.

INDEX OF MECHANICAL PROTECTION

IK CODE	IK00	IK01	IK02	IK03	IK04	IK05	IK06	IK07	IK08	IK09	IK10
Impact energy Joule	a	0.14	0.2	0.35	0.5	0.7	1	2	5	10	20
[a] not protected to this standard											

FIG 2.2

Many manufactures do not display this protection figure so if no information is provided please contact the manufacturer direct. This is a valuable form of protection measurement if the equipment may be subject to any significant impact either accidental or during normal operation.

The environment will also be subject to ambient temperature fluctuations for both seasonal and day and night time variations. It is therefore important to establish what ambient temperatures the equipment is certified for use in. Ambient temperature operation is usually stated as the maximum temperature the equipment is certified for use in.

STEP 6 ..... FINALLY

We have developed the methodology to select the correct hazardous area type approved equipment that suits an environment by establishing as follows:

- Class I, II or III (Gas, dust or fibre present)
- Division 1 or 2 (Level of hazardous area)
- Ignition temperature of gas/dust/fibre present
- Max operating space temperature of equipment (T code)
- Ingress protection level of equipment
- Min and max ambient operating temperature of equipment

EUROPEAN V NORTH AMERICAN HAZARDOUS AREA CLASSIFICATIONS

TEMPERATURE RATINGS

Temperature in Fahrenheit	Temperature in Celsius	North American Temperature code	IEC Temperature code
842	450	T1	T1
572	300	T2	T2
536	280	T2A	T2
500	260	T2B	T2
446	230	T2C	T2
419	215	T2D	T2
392	200	T3	T3
356	180	T3A	T3
329	165	T3B	T3
320	160	T3C	T3
275	135	T4	T4
248	120	T4A	T4
212	100	T5	T5
185	185	T6	T6

Note Actual temperatures may be shown instead of T - codes in North America

HAZARDOUS AREA CLASSIFICATIONS

North American to IEC / CENELEC Zone method of protection usability chart.

(Use with caution: **most Category 1 products cannot be used in North American Class I Div. 1 Areas**)

North American Approval	CENELEC/IEC equivalent Zone
Class I, Division 1	Zone 1
Class I, Division 2	Zone 2

North American Gas & Vapour Groups	CENELEC/IEC Gas and Vapour classification
Group A	IIC
Group B	IIC
Group C	IIB
Group D	IIA

NOTES