Pioneers

The increasing demands of industry for dependable explosionproof lighting, motivated Baliga to pioneer the design and manufacture of a quality line way back in 1962, when the first Indian Standards were just being formulated. **“Quality”** and **“Dependability”** have been synonymous with Baliga products, ever since.

Ex-ENGINEERING

In order to maintain their poisition as market leaders, Baliga have a continuous program of value engineering and product development. This has ensured a continuous flow of new ideas and new products. A programe aided by the latest CAD, and photometric equipment.

Quality

Customers rely on Baliga as a very dependable source and for good reason since each product goes through regorous checks at every stage of manufacture with the results docmented for traceability. And ofcourse Baliga products have the stamp of approval of various certifying authorities.

Self Sufficient Factory

Quality can only be achieved with matching production facilities. Baliga products are manufactured in a completely self sufficient factory in Madras with over 35,000 sq.ft. of manufacturing space. A factory that houses a wide range of machine tools for machining, sheet metal fabrication and moulding of plastic components. In line with the polcy of continuous upgradation of technology, a sophisticated epoxy powder coating equipment was installed in 1982. And almost all operations are computerised, right from order processing, costing, production planning and designing. This gives the customer, high-quality products delivered on time.

Customer Service

Baliga is proud to offer their extensive experience in lighting hazarous areas, as another area of total commitment to the customer. A nationwide network of experienced agents and representatives are available to discuss any lighting or Exproblem and arrive at the ideal cost effective solution. Baliga – The name spells quality without a single compromise.

Introduction

It is an inevitable fact that the manufacture, processing and storage of petroleum products and chemicals in the liquid or vapour form, leads to the formation of highly explosive atmospheres due to the leakage of gases and vapours. When these combine with the oxygen in the atmosphere, potentially explosive mixtures comes into accidental contact with an electrical spark or hot surface, with the resulting explosion causing extensive damage to life and property. Explosion protection is therefore the science of designing and developing electrical products for safe use in these highly explosive areas.

Combustion Principles

Three basic conditions must be satisfied for a fire or explosion to occur :

1. A flammable, liquid, vapour or combustible dust must be present in sufficient quantity.
2. The flammable liquid, vapour or dust must be mixed with air or oxygen in the proportions required to produce an explosive mixture.
3. A source of energy must be applied to the explosive mixture.

The application of the above principles involves a clear understanding of the characteristics of the flammable gas or liquid and the source of ignition.

Flammable gas/vapour risk

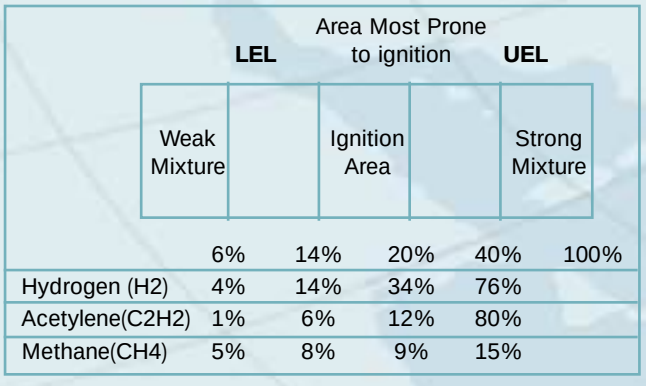
To design or select an equipment for hazardous areas, it is essential to understand the various parameters which affect the explosive characteristics of the flammable gas/air mixture.

The power of any explosion depends upon the inherent properties of the gas and its concentration in the atmosphere. Not all concentrations of the flammable gas in air will burn or explode.

The Lower Explosive Limit (LEL) is the lowest concentration of the gas in air which can cause an explosion.

The Upper Explosive Limit (UEL) is the maximum concentration of the gas in air beyond which no explosion can take place.

Upper and Lower Explosive Limits in Gases



	6%	14%	20%	40%	100%
Hydrogen (H2)	4%	14%	34%	76%	
Acetylene(C2H2)	1%	6%	12%	80%	
Methane(CH4)	5%	8%	9%	15%	

Flammable liquids generally have a low Flash Point. This is the lowest temperature at which vapour is given off at a sufficient rate to form an explosive mixture with air. Therefore liquids with flash points below ambient temperature will automatically release vapour in sufficient quantities to provide an explosive mixture.

Vapour Density is a measure of the density of the gas relative to air. A knowledge of this parameter is important as gases lighter than air tend to rise up from the point of escape and may therefore disperse easily. Heavier than air gases tend to sink and accumulate over a period of time to form concentrations between the LEL and UEL ready to explode as soon as a source of ignition is introduced.

When an explosive mixture of sufficient concentration has been developed, it can be ignited by a spark o sufficient energy or if it is exposed to a surface at a sufficiently high temperature. The lowest temperature which will cause the mixture to explode is called the **Ignition Temperature.**

Sources of Ignition

A source of energy is all that is required to touch off an explosion where flammable gases or combustible dusts are mixed in the proper proportion with air.

For ignition of gas mixture to take place, it is necessary that atleast a small portion of the mixture be raised to the ignition temperature. By the burning of this portion, sufficient heat will be evolved to cause the ignition of the whole volume. It follows from this that any ignition source has two essential characteristics.
They are :

Temperature : This must be equal to or higher than the ignition Temperature.

Energy : The source must supply sufficient energy at a high enough rate, to raise enough gas mixture to the ignition point to start a self sustaining explosion.

The different sources of energy can be effectively grouped into 3 categories.

a) Flames
b) Sparks - electric or percussive
c) Hot surfaces.

Flames

These usually have a temperature between 1000ºC and 2000ºC. They are also capable of supplying energy at a high rate and can therefore be effective sources of ignition.

Sparks

These have very high temperatures between 1000ºC and 3000ºC and are capable of supplying large amounts of energy over short periods of time.

One prime source of sparks is electricity. Equipment such as switches, motor starters and push button stations produce arcs and sparks during normal operation.

Another source of sparks is static electricity. Present wherever there is a flow of liquids & gases through hoses and pipelines, the static charge accumulated can over a period of time generate sparks of sufficient energy to initiate an explosion.

Non-electrical hazards such as sparking of metal can also easily cause an ignition. A hammer, file or other tools when dropped on masonry or on a ferrous surface can cause a spark with sufficient energy to trigger an explosion.

Conditions for explosion

It is therefore necessary that in order to ignite a given flammable atmosphere, sufficient energy has to be supplied to raise the temperature of gases locally to their ignition temperature. The minimum energy required to do this is dependant upon the gas present and varies widely from one gas to another. Because of this wide variation, it has been found convenient to determine the **Minimum Ignition Energy** for four gas groups classified I to IIC in the direction of their increasing sensitivity to spark ignition.

They are :

Gas	Group No.	Minimum ignition Energy
Methane	I	280 µ
Propane	IIA	260 µ
Ethylene	IIB	85 µ
Hydrogen	IIC	19 µ

Hot Surfaces

The third source of ignition is the surface temperature developed by the product during normal operation like in lighting fixtures or motors.

Here the surface temperature may exceed the safe limits of many flammable atmospheres, thereby initiating an explosion. Other components of the electrical system can also become potential sources of ignition in the event of insulation failures for example : in transformers, impedance coils, solenoids and in the basic wiring system.

Electrical safety therefore, is of crucial importance and the electrical installation must be designed to prevent the accidental ignition of flammable liquids, vapours and dusts released to the atmosphere.

Classification of Hazardous materials

The NEC has classified all materials capable of forming an explosive atmosphere into three major classes :-

Class I : A Class I atmospheric hazard is an area consisting of gases and liquids which have been further divided into 4 groups.

Class II : A Class II hazard covers 3 different groups of combustible dusts based upon their resistivity

Class III : A Class III hazard covers locations where combustible fibres or flyings are present.

Zone Classification

All hazardous areas can be classified into 3 zones according to the probability of there being an explosive gas air mixture present .

Zone O – Areas where an explosive gas atmosphere is continuously present.
Typical eg.: inside of containers or reactors.

Zone 1 – Areas where an explosive gas atmosphere is likely to occur under normal operation.
Typical eg.: areas surrounding Zone 0, areas surrounding drains, discharge equipment.

Zone 2 – Areas where an explosive atmosphere is not likely to occur in normal operation and if it does it is only for short periods.
Typical eg.: areas surrounding flanged gaskets, areas surrounding Zone 0 or Zone 1.

Gas Grouping

All gases and vapours can be classfied into 4 major gas groups. The classification criteria is based upon laboratory tests to determine the Maximum Experimental Safe Gap (MESG) and the Minimum Ignition Current (MIC). Gas group classification for typical gases will be :

Representative Gas	IS2206 EN 50018 BS 5501 Pt 5 IEC 79-1	USA UL 698
	GROUP	GROUP
Methane (mining Use)	I	D
Propane	IIA	D
Ethylene	IIB	C
Hydrogen	IIC	B
Carbon Disulphide*	IIC	–
Acetylene*	IIC	A

Gases belonging to the IIC group are the most dangerous with the severity decreasing down the scale to the IIA group. The performance and testing requirements of electrical equipment is consequently more stringent for applications in areas containing IIC gases that in areas consisting IIA gases.

*IS 2206 has not yet classified these gases.

Classification of flammable liquids

All flammable liquids vary in volatality and have a flash point below 93% and a vapour pressure not exceeding 2.81 kg/m^2. These liquids can be divided into 3 classes.

Class A : Flammable liquids having a flash point below 23˚C. These liquids produce large volumes of vapour when released in appreciable quantities to the open.

Class B : Flammable liquids having a flash point between 23˚ and 65˚C. These liquids are heavier and less volatile and have a flash point slightly below normal ambient temperature. At elevated temperatures, Class B liquids approach the characteristics of Class A liquids in vapour release.

Class C : Flammable liquids having a flash point between 65˚ and 93˚C. These liquids have a low degree of hazard because the rate of release is nil at normal ambient temperature. These include a broad range from cleaning solvents to heavy fuel oils in commercial grades.

Temperature Class

It is an essential requirement that for electrical equipment to work safely in an explosive atmosphere, the maximum surface temperature of the exposed surface of the equipment ust always be lower than the ignition temperature of the gas mixture.

In order to properly select electrical equipment with regard to the ignition temperature, all gases are classified according to a temperature classification scale shown below:

Maximum Surface Temperature ˚C	EN 50014 BS 5501 Pt 1 IS 8239 IEC 79-1	USA UL 698
450	T1	T1
300	T2	–
280	–	T2A
260	–	T2B
230	–	T2C
215	–	T2D
200	T3	T3
180	–	T3A
165	–	T3B
160	–	T3C
135	T4	T4
120	–	T4A
100	T5	T5
85	T6	T6

Any electrical equipment to be used in an hazardous area is also tested and rated for its maximum surface temperature. It now becomes relatively simple to ensure that the temperatre rating of the equipment is always compatible with temperature classification of the gas.

For example electrical equipment with a T5 rating can be used in all areas where gases have a temperature rating from T1 to T5 but not T6 cation.

IS 2206 currently requires temperature classification of Ex d luminaires as X, Y or Z being the temperature rise of 125˚C, 75˚C and 50˚C respectively at an ambinet of 30˚C. This standard is to be revised shortly.

Types of Protection

The basic principles of providing explosion protection requires the use of a number of techniques to prevent the simultaneous availability of a gas air mixture of sufficient concentration and volume and an ignition source with sufficient energy. Where this is unavoidable, then special measures are taken to contain any explosion.

Worldwide, seven different types of protection are currently recognised as effective techniques to prvent explosions. These types of protection are listed below.

1. Ex i : Intrinsic Safety
2. Ex d : Flameproof
3. Ex e : Increased Safety
4. Ex p : Pressurised
5. Ex o : Oil Immersion
6. Ex q : Powder filling
7. Ex n : Non sparking (basically in UK and India)

A new standard for providing protection using moulding techniques – Ex m is under preparation.

Each type of protection however, can be used only in specific Zones. In Zone 0 for example, apparatus with Ex is category of protection can only be used. Ex n category of apparatus cn be used only in Zone 2 areas.

An apparatus certified for use in Zone 0 can also be used in Zones 1 and 2. similarly those certified for use in Zone 1 areas can be used in Zone 2 areas, but not in Zone 0 areas.

Zone	Type of Protection
Zone 0	Ex ia
Zone 1	Ex ib Ex d Ex e* Ex p
Zone 2	Ex n Ex o Ex q

* As per IS 5572, Ex e equipment may be used in zone 2 areas only. As revision of this standard is under consideration.

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Types of Protection

Type of protection to IEC or European Standard	Basic principle	Schematic	Applications
flameproof enclosure **Ex 'd'**	A type of protection in which the parts, which can ignite an explosive atmosphere are placed in an enclosure, which can withstand the pressure developed during an internal explosion of an explosion mixture and which prevents the transmission of the explosion to the explosive atmospheres surrounding the enclosure.		Switchgear, control and indicating equipment, control boards, motors, transformers, light fittings and other spark-producing parts.
increased safety **Ex 'e'**	A type of protection in which measures are applied so as to prevent with a higher degree of safety the possibility of excessive temperatures and of the occurance of arcs or sparks in the interior and on the external parts of electrical apparatus, which does not produce them in normal service.		Terminal and connection boxes, control boxes housing Ex-modules (of a different type of protection) squirrel cage motors, light fittings.
pressurized apparatus **Ex 'p'**	A type of protection in which the entry of a surrounding atmosphere into the enclosure of the electrical apparatus is prevented by maintaining inside the said enclosure a protective gas (air, inert or other suitable gas) at a higher pressure than that of the surrounding atmosphere. The overpressure is maintained either with or without continuous flow of the protective gas.		as above, but especially for large equipment and complete rooms.
intrinsic safety **Ex 'i'**	A type of protection in which the electrical apparatus contains intrinsically safe circuits, which are incapable of causing an explosion in the surrounding atmospheres. A circuit or part of a circuit is intrinsically safe, when no spark or any thermal effect in this circuit, produced in the test conditions prescribed in the standard (which include normal operation and specific fault conditions) is capable of causing ignition.		Measurement and control equipment.
oil immersion **Ex 'O'**	A type of protection in which the electrical apparatus are immersed in oil in such a way that an explosive atmosphere, which may be above the oil or outside the enclosure cannot be ignited.		Transformers (only used rarely now)
power filling **Ex 'q'**	A type of protection in which the enclosure of electrical apparatus is filled with a material in a finely granulated state so that, in the intended conditions of service, any arc occuring within the enclosure of an electrical apparatus will not ignite the surrounding atmosphere. No ignition shall be caused either by flame or by excessive temperature of the surfaces of the enclosure.		Transformers, capacitors, heater strip connection boxes electronic assemblies.
encapsulation **Ex 'm'** (in preparation)	A type of protection in which the parts which can ignite an explosive atmosphere are enclosed in a resin sufficiently resistant to environmental influences in such a way that this explosive atmosphere cannot be ignited by either sparking or heating, which may occur within the encapsulation.		only small capacity switchgera, control gear, indicating equipment, sensors.

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IP Degree of Protection

All electrical apparatus, depending on the ultimate application, need to be protected to varying degrees from the effects of contact with foreign bodies, dust and water. This degree of protection is shown in the table below.

1st figure : protection against solid		2nd figure : protection against liquids		3rd figure : mechanical	
IP	**tests**	**IP**	**tests**	**IP**	**tests**
0	**No protection**	0	No protection	**0**	No protection
1	Protected against solid bodies larger than 50 mm (eg. : accidental contact with the hand)	**1**	Protected against vertically - falling drops of water (condensation)	**1**	Impact energy 0.225 joule
2	Protected against solid bodies larger than 12 mm (eg. : finger of the hand)	**2**	Protected against drops of water falling at up to 15° from the vertical	**2**	Impact energy 0.375 joule
3	Protected against solid bodies larger than 2.5 mm (eg. : tools wires)	**3**	Protected against drops of rain water at up to 60° from the vertical	**3**	Impact energy 0.500 joule
4	Protected against solid bodies larger than 1 mm (fine tools and small wires)	**4**	Protected against drops of rain water from all directions	**5**	Impact energy 2.00 joules
5	Protected against dust (no harmful deposit	**5**	Protected against jets of water from all directions	**7**	Impact energy 6.00 joules
6	Completely protected against dust	**6**	Protected against jets of water of similar force to heavy seas	**9**	Impact energy 20.00 joules
		7	Protected against the effects of immersion		
		8	Protected aginst prolonged effects of immersion under pressure		

The 3rd figure is specific to the French standard U.T.E. 20 010

Standard EN 500 14 defines the impact tests to be carried out according to materials used and the groups to which they belong.

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Selection of Electrical Equipment

A number of logical steps are involved in the proper selection of electrical equipment for hazardous areas.

Step 1 : Clearly identify the gas/vapour, its gas group and temperature class.

Setp 2 : Define the area Zone 0, 1, or 2

Step 3 : Select the type of protection appropriate to the Zone

Step 4 : For the given type of protection select the equipment keeping in mind the gas group and the temperature rating

Step 5 : Depending on whether the equipment is to be installed indoor or outdoor, ensure the correct IP protection for the equipment

Guide to certification code

Apparatus marking requirements normally include a certification code which includes the following elements.

a. Symbol fr the type of protection

b. The apparatus group

c. The temperature classification

EXAMPLE 1. Ex ‘d’ II B T5
This indicates a unit having flameproof type of protection ‘d’ suitable for apparatus gas group IIA and II B and having a maximum surface temperature classification of 100ºC (T5)

EXAMPLE 2. Ex. N II T6
This indicates a unit having non-sparking type of protection ‘N’ suitable for apparatus gas groups IIA, IIB and IIC (absence of letter indicates all gas groups) having maximum surface temperature classification of 85ºC (T6)

Inspection, maintenance and testing

The safe and satisfactory operation of electrical apparatus is dependant on a high standard of inspection, maintenance and testing by trained and competent personnel.

General recommendations for inspection, maintenance and testing given herein apply particularly to type of protection ‘d’ flameproof enclosures.

Initial and periodic inspections

All electrical apparatus, systems and installations should be inspected prior to commissioning and after replacement in accordance with the ‘initial’ column of the inspection schedule.

Following any repair, adjustment or modification, those parts of the installation that have been disturbed should be checked in accordance with the relevant items in the ‘initial’ column of the inspection schedule.

If, at any time, there is a change in the area classification or in the characteristics of the flammable material used in the area, or if the apparatus is moved from one location to another, a check should be made to ensure that the apparatus concerned has the correct apparatus subgroup and temperature class and that it complies with the relevant area classification.

A system should be established to record the results of all inspections and the action taken to correct defects.

Maintenance

No alteration that might invalidate the certificate or other document relating to the safety of the apparatus should be made to any apparatus without appropriate approval.

If replacement components such as cable glands, conduit or conduit accessories, are available only with thread forms which differ from those provided on the apparatus, suitable adaptors having component approval should be employed.

Checks should be made for obstructions around flanges of equipment. The dimensions of the gaps at flameproof joints should be checked periodically during maintenance to see that they do not exceed the maximum figure specified in IS-2148. At such intervals as experience may prove desirable, the flanged joints should be separated and the faces examined for possible defects resulting from corrosion, erosion or other causes. If flanges are to be sealed, then new nonsetting grease or tape should be used on reassembly.

Equipment enclosures and fittings should be examined to see that all stopping plugs and bolts are in position and tight. Locking and sealing devices should be checked to confirm that they are secured in the prescribed manner.

Replacement cover securing fasteners, nuts, studs and bolts should be types specified by the manufacturer for the particular apparatus.

No attempt should be made to replace or repair a glass in a flameproof enclosure e.g. in a luminaire or other enclosures, except by the complete assembly or part obtainable from the manufacturer, or complying with the flameproof certificate.

Repairs and refurbishing of apparatus with type of protection ‘d’ should be performed only by the original manufacturer, his authorised agents or a repairer who is conversant with the construction standards for flameproof equipment and demonstrates the ability to understand certification restraints.

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Sample Inspection Schedule

Check that	Inspection Category		Notes
	Initial	Periodic	
Apparatus is appropriate to area classification	A	B	
Surface temperature class is correct	A	B	
Apparatus subgroup is correct	A	A	
Apparatus carries the correct circuit identification	A	B	Apparatus should be positively identified with its circuit to ensure that correct isolation can be carried out.
Obstructions are not present near flanged joints	A	A	
Enclosures, glasses and glass/metal seals are satisfactory	A	A	
Gaps are free from corrosion, dirt and paint	A	B	
Dimensions of gaps are correct	A	B	
There are no unauthorized modifications	A	A	
Bolts, glands and stoppers are complete and tight.	A	A	
There is no undue accumulation of dust or dirt	B	B	Accumulation of dust or dirt can interfere with heat dissipation and result in surface temperatures higher than those permitted in the hazardous area.
All conduits runs and fittings are tight and free from corrosion	A	B	
Earthing is satisfactory	A	A	
Electrical connections are tight	A	B	
Motor fans and couplings are not rubbing on cowls/guards	A	A	
Lamp rating and type are correct	A	B	An initial inspection is necessary after relamping
Stopper boxes and cable boxes are correctly filled	A	B	
There is no leakage of compound from stopper or cable boxes	B	B	
There is no obvious damage to cables, cable sheats or cable glands	A	A	Particular attention should be paid to flexible cables used with portable apparatus.
Apparatus is adequately protected against corrosion, the weather, vibration and other adverse fators	A	A	
Guards, where used, are present and correctly located	A	B	

*Category A inspections should be carried out in all cases and, where periodic, at intervals not exceeding two years. More frequent and/or more detailed inspection will be necessary where there is corrosive or other adverse atmosphere, a high risk of mechanical damage or vibration, or where there are other onerous circumstances. The need for more frequent inspection may also be determined by operating experience.

The need for, the method, and the frequency of category B inspections is at the discretion of the engineer responsible. It is not intended that periodic inspections should incur undue disturbances of apparatus, unless considered necessary by the engineer responsible.

The above chart is reproduced from BS 5345 Part I.

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Indian Standards for Explosive Atmospheres / Areas

General specifications

IS4051/1967	–	Code of practice for installation & maintenance of electrical equipment used in mines.
IS 5571/1979	–	Guide for the selection of electrical equipments for hazardous areas.
IS 5572/1978 Part I	–	Classification of hazardous areas for electrical installation.
IS 7820/1975	–	Method of test for ignition temperatures.
IS 8239/1976	–	Classification of maximum surface temperatures of electrical equipment for use in explosive atmospheres.
IS 8240/1976	–	Guide for electrical equipment for explosive atmospheres.
IS 8241/1976	–	Method of marking for identifying electrical equipment for explosive atmospheres.
IS9570/1980	–	Classification of flammable gases according to their MESG/MIC
IS 9559/1980	–	Guide for selection of electrical & electronic equipment for coal mines.
IS 13408/1992 Part I	–	Code of practice for the selection, installation and maintenance of electrical apparatus for use in explosive atmospheres (other than mining applications).
IS 139417(Pt1)/1993	–	Ingners Protection

Specification for the types of protection

IS 13346 / 1992	–	General requirements for electrical apparatus for explosive atmospheres
IS 2148 / 1981	–	Specification for flameproof enclosures of electrical apparatus.
IS 5780 / 1980	–	Intrinsically safe electrical apparatus and circuits.
IS 6381 / 1972	–	Specification for construction & testing of electrical apparatus with type of protection ‘e’.
IS 7389 / 1976 Part I	–	Specification for pressurised enclosures of electrical apparatus for use in explosive atmospheres.
IS 7693 / 1975	–	Specification for oil immersed electrical apparatus for use in explosive gas atmospheres.
IS 7724 / 1975	–	Specification for sand filled protection of electrical equipment for use in explosive atmospheres.
IS 8289 / 1976	–	Specification for electrical equipment with type of protection ‘n’
IS 11005 / 1984	–	Specification for dust–tight ignition proof enclosures of electrical equipment

Product specifications

IS 2206/1984 Part I	–	Specification for FLP electric lighting fittings – Wellglass & Bulkhead
IS 2206 / 1976 Part II	–	Specification for FLP electric lighting fittings – using glass tubes
IS 2206 / 1987 Part IV	–	Specification for FLP electric lighting fittings – Portable flameproof hand lamps.
IS 4012 / 1967	–	Dust proof electric light fittings.
IS 4013 / 1967	–	Dust tight electric light fittings.
IS 4821 / 1968	–	Specification for cable glands and cable sealing boxes for use in mines.
IS 6539 / 1972	–	Intrinsically safe magneto telephones for use in hazardous atmospheres
IS 6789 / 1972	–	Bolted flameproof cable couplers & adaptors
IS 8224 / 1976	–	Specification for lighting fittings for Division 2 areas
IS 8945 / 1987	–	Specification for electrical measuring instruments for explosive gas atmospheres
IS 9099 / 1979 Part I	–	Performance testing of powered industrial trucks working in hazardous areas (IC – engine powered)
IS 9099 / 1980 Part II	–	Performance testing of powered industrial trucks working in hazardous areas (battery operated)
IS 9628 / 1980	–	Three phase induction motors with type of protection ‘n’