SVF FLOW CONTROLS

Understanding Hazardous–Area Classification for Successful Equipment Selection

The term hazardous location once meant a place within a petrochemical or some other equally volatile plant. Today, hazardous manufacturing processes include coatings, adhesives, and flammable liquids in parts-cleaning tanks and dry-cleaning plants. Even food processing and other agricultural-related industries are becoming familiar with hazardous designations by the nature of the processes involved, such as grain elevators or flour and feed mills. Textile mills and any plant that creates sawdust also fall into the hazardous category.

Selecting equipment that may be used in such locations requires an understanding of how hazards are classified. The NEMA, Underwriters' Laboratories, and the National Fire Protection Association have categorized hazardous environments by the following classes with divisions similar to European ATEX zones.

Classification of hazardous areas varies slightly between the United States and other countries. The European classification of hazardous areas generally follows that of the International Electrotechnical Commission (IEC)/ATEX <note: I will use this IEC/ATEX relationship to reflect the harmonization of their work> and is affiliated with the International Organization for Standardization (ISO), as its electro-technical division. The IEC classifications are as follows. A hazardous area is divided into zones:

Ex Zone Definitions:	
Gas, Mists or Vapors	***Dusts***
• Zone 0 - An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is present frequently, continuously or for long periods.	• Zone 20 - An atmosphere where a cloud of combustible dust in the air is present frequently, continuously or for long periods.
• Zone 1 - An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is likely to occur in normal operation occasionally.	• Zone 21 - An atmosphere where a cloud of combustible dust in the air is likely to occur in normal operation occasionally.
• Zone 2 - An atmosphere where a mixture of air and flammable substances in the form of gas, vapor or mist is not likely to occur in normal operation but, if it does occur, will persist for only a short period.	• Zone 22 - An atmosphere where a cloud of combustible dust in the air is not likely to occur in normal operation but, if it does occur, will persist for only a short period.

Two other safety aspects are commonly included in the classification of devices for use in hazardous areas—gas groupings and temperature classification. The gas grouping takes account of the maximum amount of energy which can be released under operating or fault conditions, whereas the temperature classification is concerned with the maximum temperature which can be attained by the external surface of the device.

Temperature classification

Gas-air mixtures can be ignited by contact with a hot surface. Consequently all electrical equipment used in hazardous atmospheres must be classified according to its maximum surface temperature. The table on the following page shows the ignition temperature to be taken into consideration in Europe (EEC) and the United States (NEC) for the gases and vapors stipulated there.

All temperature classifications, unless otherwise specified, are assessed with reference to a maximum ambient temperature of 40°C (104°F). If the equipment is used in a temperature higher than this, then its temperature classification should be reassessed.

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In general hazardous locations in North America are separated by classes, divisions, and groups to define the level of safety required for equipment installed in these locations.

Classes

The classes defines the general nature of hazardous material in the surrounding atmosphere.

Class	Hazardous Material in Surrounding Atmosphere
Class I	Hazardous because flammable gases or vapors are present in the air in quantities sufficient to produce explosive or ignitable mixtures.
Class II	Hazardous because combustible or conductive dusts are present.
Class III	Hazardous because ignitable fibers or flying's are present, but not likely to be in suspension in sufficient quantities to produce ignitable mixtures. Typical wood chips, cotton, flax and nylon. Group classifications are not applied to this class.

Divisions

The division defines the **probability** of hazardous material being present in an ignitable concentration in the surrounding atmosphere.

Division	Presence of Hazardous Material
Division 1	The substance referred to by class is present during normal conditions.
Division 2	The substance referred to by class is present only in abnormal conditions, such as a container failure or system breakdown.

Groups

The group defines the hazardous material in the surrounding atmosphere.

Group	Hazardous Material in Surrounding Atmosphere
Group A	Acetylene
Group B	Hydrogen, fuel and combustible process gases containing more than 30% hydrogen by volume or gases of equivalent hazard such as butadiene, ethylene, oxide, propylene oxide and acrolein.
Group C	Carbon monoxide, ether, hydrogen sulfide, morphline, cyclopropane, ethyl and ethylene or gases of equivalent hazard.
Group D	Gasoline, acetone, ammonia, benzene, butane, cyclopropane, ethanol, hexane, methanol, methane, vinyl chloride, natural gas, naphtha, propane or gases of equivalent hazard.
Group E	Combustible metal dusts, including aluminum, magnesium and their commercial alloys or other combustible dusts whose particle size, abrasiveness and conductivity present similar hazards in connection with electrical equipment.
Group F	Carbonaceous dusts, carbon black, coal black, charcoal, coal or coke dusts that have more than 8% total entrapped volatiles or dusts that have been sesitized by other material so they present an explosion hazard.
Group G	Flour dust, grain dust, flour, starch, sugar, wood, plastic and chemicals.

Group A, B, C and D apply to class I locations. Group E, F and G apply to class II locations.

Temperature Classes					
IEC/ATEX		NEC			
Temperature Class	Max. surface temperature, °C	Temperature identification number	Max. surface temperature		Ignition temperature of gases or vapors °C
			°C	°F	
Tl	450	Tl	450	842	>450
T2	300	T2	300	573	>300
		T2A	280	536	>280
		T2B	260	500	>260
		T2C	230	446	>230
		T2D	215	419	>215
T3	200	T3	200	392	>200
		T3A	180	356	>180
		T3E	165	329	>165
		T3C	160	320	>160
T4	135	T4	135	275	>135
		T4A	120	248	>120
T5	100	T5	100	212	>100
T6	85	T6	85	185	> 85

Example of gases	IEC	North America (group)
Hydrocarbons such as alkenes, including propane, benzenoids, alkenes, gasoline	IIA	D
Oxygen compounds such as carbon monoxide, alcohols and phenols, some aldehydes, ketones, esters		
Halogens		
Nitrogen compounds such as ammonia, amines, amides		
Natural gas	IIB	C
Hydrocarbons such as ethylene propylene		
Oxygen compounds such as ethyl ether, aldehydes *Hydrogen sulfide*		
Hydrogen Carbon disulfide	IIC	B
Acetylene (with special material limitations)	IIC	A
*Note: These are approximate correlations.		

Gas or apparatus grouping
The same gas groupings are used for flameproof and intrinsically safe equipment, and tables are available showing the equipment classification which can be used with particular groups of gases. The table below gives some examples with the IEC and North American classifications. Gas groups E, F, and G (not shown) are concerned with hazards associated with the presence of dust.

The overall term used in Europe covering all methods of protection is explosion-proof, and the symbol Ex is used. In the United States engineers tend to use the term explosion-proof as being synonymous with the European term flameproof and this often causes confusion.

Methods for Safe Control
Understanding design methods for operating equipment in hazardous areas starts with the **combustion triangle**. Fuel, oxygen, and a source of ignition {spark or temperature) must be present at the same time (and in the necessary proportions) for combustion to occur.

One approach to creating a safe environment for hazardous areas is confinement; isolating the area reduces the possibility of accidents. Isolation involves removing or confining any possible element which could create a spark and ignite an explosion. There are three common methods of providing safety within a hazardous location, categorized by the power technology used; (1) pneumatic, (2) explosion-proof, and (3) intrinsically safe systems.

Pneumatic systems
Pneumatic systems are, by their nature, a safe means of control because they are powered by air. Pneumatic systems are generally clean and easy to service, but the number of control operations performed by pneumatic sequencers is limited. This can be augmented by an electro pneumatic interface which enables pneumatics to be controlled by a Programmable Logic Controller.

The drawbacks to pneumatic systems are in distance and reaction times. Where installations are spread over a wide area, the slow reaction time of pneumatic systems increases control reaction time. The length of control circuits in a total

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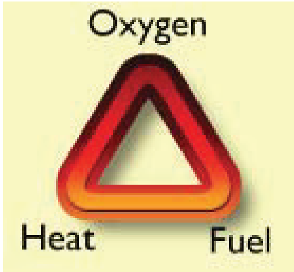
Methods of Explosion Protection	
Type of Protection	**Method**
Ex d Flameproof Enclosure	Designed to prevent any ignition from spreading
Ex q Powder Filling	
Ex i Intrinsic Safety	Designed to limit the ignition energy of the circuit
Ex e Increased Safety	Designed to prevent any ignition from arising
Ex N or Ex nA Non Sparking	
Ex m Encapsulation	Designed to prevent the flammable mixture reaching a means of ignition
Ex p Pressurisation	
Ex o Oil immersion	
Ex N or Ex nR Restricted Breathing	



Explosion-proof housings… NEMA classifications

Explosion-proof housings provide a simple means to adapt electric and electromechanical and electro-pneumatic controls to hazardous locations, Explosion-proof housings are designed to withstand the explosion of a mixture inside the enclosure and to prevent the spread of the flame to the outside.

These enclosures are effective, especially for interrupting high currents to motors using limit switches. However, this method lacks flexibility in the use of sensing techniques because of the size of the devices. In addition to the space required for explosion-proof devices, material and labor costs for installation and service may be high.

NEMA classifications	
I	**General purpose**
	Protects againstindirect splashing of dust and light butis not dusttight; primarily prevents contact with live parts; used in-doors and under normal atmospheric conditions.
II	**Driptight**
	Similar to type I, with addition of drip shields or equivalent; used where condensation may be severe as in cooling rooms and laundries.
III	**Weather resistant**
	Protects against weather hazards such as rain and sleet; used outdoors on ship docks, for construction work, and in tunnels and subways.
IV	**Watertight (weatherproof)**
	Must exclude at least 65 gal/min (247 L/m) of water from 1-in (25-mm) nozzle delivered from a distance of not less than 10 ft (3 m) for 5 min. Used outdoors on ship docks, in dairies, and in breweries.
V	**Dusttight**
	Provided with gaskets or equivalentto exclude dust; used in steel mills and cement plants.
VI	**Submersible**
	Design depends on specified conditions of pressure and time; used for submersion in water, as in quarries, mines, and manholes.
VII	**Hazardous location (explosive gas or vapor)**
	Meets application requirements class I of National Electrical Code; conforms with specifications of Underwriters' Laboratories, Inc.; used for atmosphere containing gasoline, hexane, naphtha, benzine, butane, propane, acetone, benzol, lacquer, solvent vapors, and natural gas.
Type 8 enclosure	**Hazardous locations (oil-immersed)**
	Type 8 enclosures are for indoor or outdoor use in locations classified as class I, Groups A, B, C, or D as defined in the National Electrical Code.
Type 9 enclosure	**Hazardous locations (dust-ignition proof)**
	Type 9 enclosures are for use in indoor locations classified as class II, groups E, F,or G, as defined in the National Electrical Code
IX	**Hazardous locations (combustible dust)**
	Meets application requirements class II of National Electrical Code; conforms with specifications of Underwriters' Laboratories, Inc.; used for atmospheres containing metal dusts, carbon black, coal or coke dust, flour, starch or grain dusts.

Ingress Protection (IP) ratings-specifying the environmental protection the enclosure provides. This is not a system of hazardous area classification.

The IP rating normally has two numbers:

1. Protection from solid objects or materials
2. Protection from liquids (water)

IP (Ingress Protection) & NEMA Protection Rating Information

An IP number contains two numbers (i.e. IP65) in most instances which relate to the level of protection provided by an enclosure or housing.

The first number relates to protection from solids as follows:	The second number relates to protection from liquids as follows:
0: No Special Protection	**0**: No special protection
1: Protected against solid objects up to 50 mm in diameter	**1**: Protected against dripping water
2: Protected against solid objects up to 12 mm in diameter	**2**: Protected against dripping water when tilted up to 15° from normal position
3: Protected against solid objects up to 2.5 mm in diameter	**3**: Protected against spraying water
4: Protected against solid objects up to 1 mm in diameter	**4**: Protected against splashing water
5: Dust protected	**5**: Protected against water jet spray
6: Dust tight	**6**: Protected against heavy jet spray
	7: Protected against the effects of immersion
	8: Protected against submersion

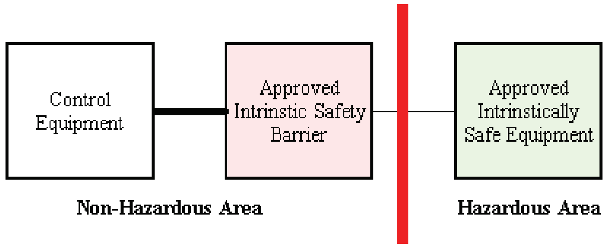
Example: IP66 = Dust tight and protected against heavy water jet spray

NEMA (National Electrical Manufacturers Association) ratings can be approximately compared to those of the IP
Other factors such as corrosion protection are also involved in the NEMA system, please refer to official

NEMA 1 = IP10	NEMA 4X = IP66
NEMA 2 = IP11	NEMA 6 = IP67
NEMA 3 = IP54	NEMA 12 = IP52
NEMA 4 = IP56	NEMA 13 = IP54

Intrinsic safety

Intrinsic safety implies that there is insufficient electric energy in a circuit to ignite the most readily flammable mixture of a gas and air. As mentioned in relation to classification, the energy can appear as a spark resulting from its sudden release or in thermal form from the temperature rise of a surface. The equipment design must consider fault conditions as well as normal operation.



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According to the National Electrical Code, "Intrinsically safe equipment and wiring shall not be capable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific flammable or combustible atmosphere mixture in its most easily ignitable concentration."

There is a fundamental difference between intrinsic safety and the other equipment application techniques. None of the others aims at preventing release of energy at a dangerous level. Instead they avoid the possible effects in a number of ways:

1. Ensuring that when a spark occurs, it is prevented from reaching an explosive mixture
2. Ensuring that any explosion is contained
3. Reducing the hazard by diluting the gas mixture to a safe level
4. Protecting against excessive temperature or spark which occurs exceptionally

Intrinsic safety, on the other hand, deals with the root cause and ensures that there is insufficient energy available, whatever happens, to cause an explosion. It is, therefore, considered by some to be the safest and most technically elegant approach. It has a number of practical advantages, offering compact design, reliability, low cost, simple installation and the possibility, not available with flameproof equipment, of on-line maintenance, if required. The principal disadvantage is the relatively low amount of power available, although this has been largely overcome by a growing range of specially designed components and equipment. For all practical purposes, intrinsic safety is the only safe technique suitable for zone 0 and is often the preferred approach for zone 1 (division 1).

There are two standards on intrinsic safety in IEC countries,

- "ia" being the higher standard where safety is maintained with up to two faults and
- "ib" where safety is maintained with up to one fault

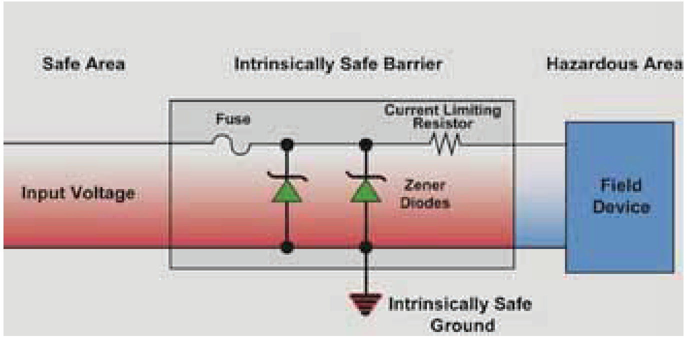
Equipment certified to "ib" standards is generally acceptable in all zones except zone 0, and "ia" equipment is suitable for use in all zones. In America there is only one standard, and all hazardous area equipment must maintain safety with up to two component faults.

Intrinsically safe elements in an automated valve package

Background. Pneumatic actuators for process valve automation are well suited for low-power or intrinsically safe system integration. Where electric motors or other high-power devices do not directly interface with today's computer-controlled systems, pneumatic actuators when properly sized and fitted with compatible control accessories can satisfy a variety of computer-direct process control requirements. When used in an intrinsically safe system, pneumatic actuator control accessories must be connected to a properly selected and approved barrier.

What are intrinsic safety barriers? Intrinsic safety barriers are current-and voltage-limiting assemblies which are designed and constructed to requirements as described by ANSI/UL 913 (formerly NFPA 493) in the United States and CSA 22.2 number 157M in Canada.

When operating conditions are abnormal, the intrinsic safety barriers circuit is designed to divert excessive current to ground. This diversion is accomplished by the Zener diodes, while current limiting is provided by a resistor. If voltage higher than the maximum allowed by the safety barrier is applied across the barrier, the Zener diode would then conduct that excess current to ground. Should current continue to increase, the fuse will open the circuit arresting current flow altogether.



Advantages of low power. All other methods of protection—e.g., pressurization, use of explosion-proof enclosures, or oil filling—rely on the maintenance of a physical barrier between the explosive atmosphere and the electric circuit. Out on the plant and difficult to monitor, a hazardous area enclosure has only to be breached at one point for protection to become nonexistent. In contrast, intrinsically safe elements provide inherent protection by restricting the energy at its source and as a result offer some advantages that include

- Economy. Enclosures are lighter, less cumbersome, and economical. Costly screwed conduits can be replaced by ordinary wiring. Thermocouples, resistors, switches, and other non-energy storing field equipment can be constructed to ordinary (weatherproof) specifications.
- Live maintenance. It is not necessary to cut power before calibrating or otherwise adjusting field equipment. Glanded or magnetically coupled controls through flameproof housings are not needed.
- Reliability. The system remains safe if seals fail, cables are severed, or the covers of enclosures or conduit boxes are improperly replaced. Switches do not require long, thin flame-retarding air gaps which are prone to corrosion and seizure.
- Safety. Personnel cannot be harmed by the low voltages used in intrinsically safe circuits.

There are three common electric components that are used with pneumatic valve actuators: the solenoid valve, limit switch, and transducer (or electro-pneumatic positioner). Each of these devices is manufactured in a version that allows them to be classified as low-power and are therefore appropriate elements for use in an intrinsically safe system.

It must be emphasized that a component with an intrinsically safe approval will only be safe either when installed within the terms of the approval documents and of the relevant codes of practice or when the system configuration has been given prior expert approval.

Typically, the cost of an intrinsically safe component is comparable or slightly higher than the standard explosion-proof device. When one considers that explosion-proof fittings and conduits are no longer needed, on the average the installed system may be less costly for intrinsically safe devices. Also, operating costs are lower as power consumption is negligible. Plus, an intrinsically safe system can be serviced in hazardous areas while the power is on, something which cannot be done with standard explosion-proof devices.

Finally, when an intrinsically safe system is installed correctly, it is always explosion-proof. When standard explosion-proof housings are damaged or there are errors in installation that allow a flame path to develop, the system is no longer explosion-proof. Some insurance companies have rewarded companies who install intrinsically safe systems by charging them lower premiums.