Hazardous Area Classifications and Protections

The intent of this document is to provide a broad overview of hazardous area classifications and the types of protection techniques involved. The information provided in this bulletin is for educational purposes and should not be used in place of any other source or governing documents.

Not all approvals are covered in this bulletin. Contact your Emerson Process Management sales office for information on approvals not covered in this bulletin.

Contact your Emerson Process Management sales office for product specific hazardous area approval information or visit our website at www.Fisher.com.

Hazardous Area Classifications

When electrical equipment is used in, around, or near an atmosphere that has flammable gases or vapors, flammable liquids, combustible dusts, ignitable fibers or flyings, there is always a possibility or risk that a fire or explosion might occur. Those areas where the possibility or risk of fire or explosion might occur due to an explosive atmosphere and/or mixture is often called a hazardous (or classified) location/area. Currently there are two systems used to classify these hazardous areas; the Class/Division system and the Zone system. The Class/Division system is used predominately in the United States and Canada, whereas the rest of the world generally uses the Zone system. However, the United States and Canada are trending more towards the Zone System.

Class/Division System

Hazardous locations per the Class/Division system are classified according to the Class, Division, and Group.

1. Class—The Class defines the general nature (or properties) of the hazardous material in the surrounding atmosphere which may or may not be in sufficient quantities.

    a. Class I—Locations in which flammable gases or vapors may or may not be in sufficient quantities to produce explosive or ignitable mixtures.

    b. Class II—Locations in which combustible dusts (either in suspension, intermittently, or periodically) may or may not be in sufficient quantities to produce explosive or ignitable mixtures.

    c. Class III—Locations in which ignitable fibers may or may not be in sufficient quantities to produce explosive or ignitable mixtures.

2. Division—The Division defines the probability of the hazardous material being able to produce an explosive or ignitable mixture based upon its presence.

    a. Division 1 indicates that the hazardous material has a high probability of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.

    b. Division 2 indicates that the hazardous material has a low probability of producing an explosive or ignitable mixture and is present only during abnormal conditions for a short period of time.

3. Group—The Group defines the type of hazardous material in the surrounding atmosphere. Groups A, B, C, and D are for gases (Class I only) while groups E, F, and G are for dusts and flyings (Class II or III).

    a. Group A—Atmospheres containing acetylene.

    b. Group B—Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor whose MESG is less than 0.45 mm or MIC ratio is less than 0.40.

Typical gases include hydrogen, butadiene, ethylene oxide, propylene oxide, and acrolein.

c. Group C—Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor whose MESG is greater than 0.45 mm but less than or equal to 0.75 mm or MIC ratio is greater than 0.40 but less than or equal to 0.80. Typical gases include ethyl either, ethylene, acetaldehyde, and cyclopropane.

d. Group D—Atmospheres containing a flammable gas, flammable liquid-produced vapor, or combustible liquid-produced vapor whose MESG is greater than 0.75 mm or MIC ration is greater than 0.80. Typical gases include acetone, ammonia, benzene, butane, ethanol, gasoline, methane, natural gas, naphtha, and propane.

e. Group E—Atmospheres containing combustible metal dusts such as aluminum, magnesium, and their commercial alloys.

f. Group F—Atmospheres containing combustible carbonaceous dusts with 8% or more trapped volatiles such as carbon black, coal, or coke dust.

g. Group G—Atmospheres containing combustible dusts not included in Group E or Group F. Typical dusts include flour, starch, grain, wood, plastic, and chemicals.

Zone System

Hazardous locations per the Zone system are classified according to its Zone which can be gas or dust. For gas atmospheres electrical equipment is further divided into Groups and Subgroups.

Zone—The Zone defines the probability of the hazardous material, gas or dust, being present in sufficient quantities to produce explosive or ignitable mixtures.

1. Gas

a. Zone 0—Ignitable concentrations of flammable gases or vapors which are present continuously or for long periods of time.

b. Zone 1—Ignitable concentrations of flammable gases or vapors which are likely to occur under normal operating conditions.

c. Zone 2—Ignitable concentrations of flammable gases or vapors which are not likely to occur under normal operating conditions and do so only for a short period of time.

2. Dust

a. Zone 20—An area where combustible dusts or ignitable fibers and flyings are present continuously or for long periods of time.

b. Zone 21—An area where combustible dusts or ignitable fibers and flyings are likely to occur under normal operating conditions.

c. Zone 22—An area where combustible dusts or ignitable fibers and flyings are not likely to occur under normal operating conditions and do so only for a short period of time.

Group—Electrical equipment is divided into three groups .

- Group I—Equipment intended for use in mines susceptible to firedamp (flammable mixture of gases naturally occurring in a mine).

- Group II—Equipment intended for use in places with an explosive gas atmosphere other than mines susceptible to firedamp. Group II equipment is subdivided into three subgroups.

  - Group IIA—Atmospheres containing propane, or gases and vapors of equivalent hazard.

  - Group IIB—Atmospheres containing ethylene, or gases and vapors of equivalent hazard.

  - Group IIC—Atmospheres containing acetylene or hydrogen, or gases and vapors of equivalent hazard.

- Group III—Equipment intended for use in places with an explosive dust atmosphere. Group III equipment is subdivided into three subgroups.

  - Group IIIA—Atmospheres containing combustible flyings.

  - Group IIIB—Atmospheres containing non-conductive dust.

  - Group IIIC—Atmospheres containing conductive dust.

Protection Techniques and Methods

Various protection techniques and methods have been developed and employed, thus reducing or minimizing the potential risks of explosion or fire from electrical equipment located in hazardous locations. Not all methods are listed.

Class/Division system

- Explosion-proof—A type of protection that utilizes an enclosure that is capable of withstanding an explosive gas or vapor within it and or preventing the ignition of an explosive gas or vapor that may surround it and that operates at such an external temperature that a surrounding explosive gas or vapor will not be ignited thereby.

- Intrinsically Safe—A type of protection in which the electrical equipment under normal or abnormal conditions is incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentration.

- Dust Ignition-proof—A type of protection that excludes ignitable amounts of dust or amounts that might affect performance or rating and that, when installed and protected in accordance with the original design intent, will not allow arcs, sparks or heat otherwise generated or liberated inside the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust.

- Non-incendive—A type of protection in which the equipment is incapable, under normal conditions, of causing ignition of a specified flammable gas or vapor-in-air mixture due to arcing or thermal effect.

Zone system

The below concepts are high-level protection concepts. There are also sub-levels of protection that may or not be applicable to each type. Also, some equipment may combine multiple types of protection.

- Flame-proof—A type of protection in which an enclosure can withstand the pressure developed during an internal explosion of an explosive mixture and that prevents the transmission of the explosion to the explosive atmosphere surrounding the enclosure and that operates at such an external temperature that a surrounding explosive gas or vapor will not be ignited there. This type of protection is referred to as “Ex d”.

- Intrinsically Safe—A type of protection in which the electrical equipment under normal or abnormal conditions is incapable of releasing sufficient electrical or thermal energy to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentrations. This type of protection is referred to as “Ex i”.

- Increased Safety—A type of protection in which various measures are applied to reduce the probability of excessive temperatures and the occurrence of arcs or sparks in the interior and on the external parts of electrical apparatus that do not produce them in normal service. Increased safety may be used with flame-proof type of protection. This type of protection is referred to as “Ex e”.

- Type n—A type of protection applied to electrical equipment such that in normal operation it is not capable of igniting a surrounding explosive atmosphere. This type of protection is referred to as “Ex n”.

- Type t—A type of protection in which the electrical equipment is equipped with an enclosure providing dust ingress protection and a means to limit surface temperatures. This type of protection is referred to as “Ex t”.

Equipment Protection Level (EPL) Markings

The EPL marking indicates the level of protection that is given to equipment based on the likelihood of its becoming a source of ignition and distinguishing the difference between explosive gas atmospheres, explosive dust atmospheres, and the explosive atmospheres in mines susceptible to firedamp.

Temperature Code (T Code)

A mixture of hazardous gases and air may be ignited by coming into contact with a hot surface. The conditions under which a hot surface will ignite a gas depends on surface area, temperature, and the concentration of the gas. The same can be said about combustible dusts. The T code of a product denotes the maximum surface temperature that a given product will not exceed under a specified ambient temperature. For example, a product with a T code of T3 means that its maximum surface temperature will not exceed 200°C provided it is operated in a ambient temperature defined by the manufacturer.

Nomenclature

Class/Division system

Approved equipment is marked according to which Class (I, II, or III), Division (1 or 2), Group (A, B, C, D, E, F, or G), and temperature code (T1 through T6) that it is rated for. For intrinsically safe equipment the words “Intrinsically Safe” or “IS” will precede the actual approval marking to indicate it as being intrinsically safe. Examples are listed below:

Class I Division 1 Group B,C,D T5
CL I Div 2 GP ABCD T5
IS CL I,II,III Div 1 GP ABCDEFG
CL II,III Div 1,2 GP EFG T4

Zone system

Approved equipment is marked according to the protection concept for which it has been designed (Ex i, Ex d, Ex n, and etc.), the group (I, IIA, IIB, IIC, IIIA, IIIB, or IIIC), and temperature code (T1 through T6) that it is rated for. For the United States it will be preceded by which Class and Zone it is approved for. Examples are listed below:

Ex ia IIC T5
Ex d IIB+H2 T6
Ex nA IIC T6
Class I Zone 2 AEx nC IIC T5

Additional Terminology

Although the following terminology is not permitted for markings it is commonly used to describe the various types of approvals or when speaking of them.

XP—Flameproof approval for Class I Division 1
EXP—Flameproof approval for Class I Division 1
NI—Non-incendive approval for Class I Division 2
DIP—Dust Ignition Proof approval for Class II Division 1
S—“Suitable For” for Class II Division 2
IS—Intrinsically Safe

Approval Agencies

Generally speaking, most countries require that products intended for installation in a hazardous location be approved by a recognized authority or approval agency (governmental or independent) which that country has established by various laws, regulations, or codes. See table 1 for an overview of approvals and approval agencies.

North American Approvals

Of the 15 national testing laboratories (NRTL's) in the United States, only a few are qualified to approve products for use in hazardous locations. Two such agencies are; Factory Mutual (FM) and Underwriters Laboratories (UL). In Canada, products are approved by the Canadian Standards Association (CSA).

European Approvals

Each country belonging to the European Union has established one or more “Notified Bodies” for product approval. Notified Bodies not only approve products for use within their own country, commonly called national certifications/approvals, but also for any other country within the union, known as CENELEC certifications/approvals. CENELEC is the acronym for European Committee for Electrotechnical Standardization. A product which has been CENELEC certified or approved by any of the Notified Bodies is automatically accepted for use within all of the participating union countries. In July 2003 a European Directive, called the ATEX Directive, which pertains to equipment for explosive atmospheres, was adopted. All equipment intended for use in explosive atmospheres must comply with the ATEX Directive in order to be sold into the European Union.

International Approvals

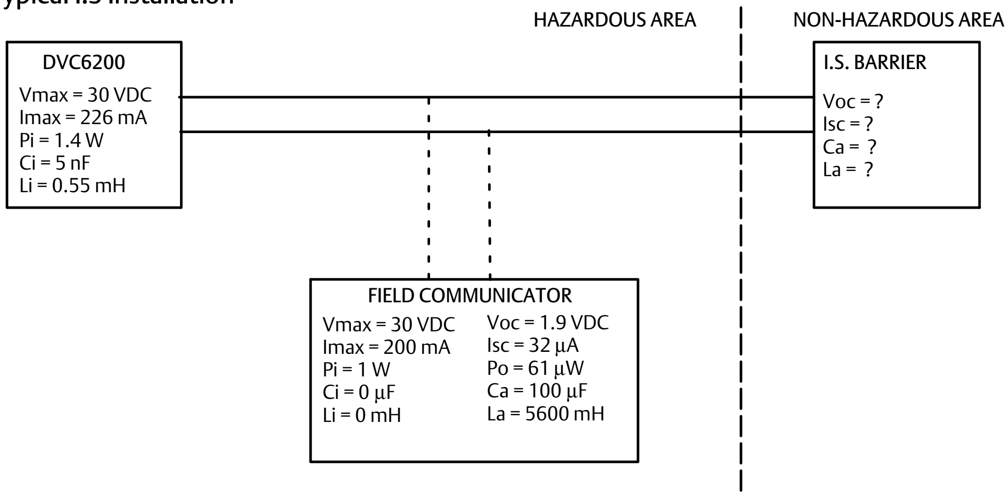
Countries participating in the IECEx Scheme (International Electrotechnical Commission on explosion protected equipment, known as “Ex”) can issue either an international certification or a national certification of explosion protected equipment. Each country within the IECEx scheme establishes an ExCB (Ex Certification Body) which can approve products. ExCB's can issue the national certification for their country based upon the IECEx standards (including any national deviations) and the international certification. Currently, Australia is the only country accepting international certifications for use in their country.

Table 1. Approval Agencies

Approvals[1]	Approval Agencies Used[2]	Approvals Accepted
FM	FM—Factory Mutual	North America
CSA	CSA—Canadian Standards Association	North America
ATEX	Baseefa—British Approvals Service for Electrical Equipment in Flammable Atmospheres KEMA—NV tot Keuring van Elektrotechnische Materialen LCIE—Laboratorie Central des Industries Electriques	European Union
IECEx	CSA—Canadian Standards Association Baseefa—British Approvals Service for Electrical Equipment in Flammable Atmospheres	International
SAA	SAA—Standards Association of Australia	Australia
NEPSI	NEPSI—National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation	China
TIIS	TIIS—Technology Institution of Industrial Safety	Japan
INMETRO	INMETRO—National Institute of Metrology, Quality and Technology	Brazil
CUTR	FGUP Certification Centre: SC VSI VNIIFTRI Certification Body: OS VSI VNIFFTRI	Russia, Belarus, Kazakhstan, and Armenia

1. Fisher™ products may carry additional approvals. Contact your Emerson Process Management sales office for additional approval information.
2. Fisher product approvals may be certified by other agencies. Contact your Emerson Process Management sales office for additional information.

Figure 1. Typical I.S Installation



Guidelines for Selecting Intrinsic Safety Barriers Using Entity Ratings

Selecting an intrinsic safety barrier with the required entity ratings depends upon the combined effects of the instrument, its cabling, and any instrument accessories such as the 475 Field Communicator. Determine the barrier entity ratings using the following guidelines:

$V_{oc} \leq V_{max}$
$I_{sc} \leq I_{max}$
$C_a \geq C_i + C_{cable}$
$L_a \geq L_i + L_{cable}$

where:

V_{oc} = Barrier open circuit voltage

V_{max} = Instrument Vmax

I_{sc}= Barrier short circuit current

I_{max} = Instrument Imax

C_a = Barrier acceptable connected capacitance

C_i = Instrument total unprotected internal capacitance

Ccable = Signal cable total capacitance

L_a = Barrier acceptable connected inductance

L_i = Instrument total unprotected internal inductance

L_{cable} = Signal cable total inductance

The values V_{oc}, I_{oc}, C_a, and L_a are specified by the barrier manufacturer for any given barrier. The values of C_{cable} and L_{cable} for the signal cable must be determined for the specific cable used.

Example barrier entity ratings calculation

A system is comprised of a FIELDVUE™ DVC6200 digital valve controller (FM approved), a Field Communicator (FM approved), and 1000 feet of cable with 60 pF/ft capacitance and 0.2 µH/ft inductance. Calculate the barrier entity ratings.

Figure 1 shows a typical I.S. installation.

Calculate C_{cable} and L_{cable}

C_{cable} = 60 pF/ft x 1000 ft

= 60 nF

L_{cable} = 0.2 µH/ft x 1000 ft

= 0.2 mH

Determine C_a and L_a for the barrier

$C_a \geq C_{i(DVC6200)} + C_{i(475)} + C_{cable}$

$\geq$ 5 nF + 0 nF + 60 nF

$C_a \geq$ **65 nF**

$L_a \geq L_{i(DVC6200)} + L_{i(475)} + L_{cable}$

$\geq$ 0.55 mH + 0 mH + 0.2 mH

$L_a \geq$ **0.75 mH**

Determine V_{oc} and I_{sc} of the barrier. Note that in this example the output of the 475 ($V_{oc(475)}$ and $I_{sc(475)}$)

must also be considered because it can also add energy to the loop besides just the barrier itself. V_{oc} of the barrier plus any additional voltage that could be added to the loop from each device must be subtracted from V_{max} for each device. I_{sc} of the barrier plus any additional current that could be added to the loop from each device must not exceed I_{max} for each device.

Voc of the barrier must meet all of the following conditional requirements.

1) $V_{oc} \leq V_{max(DVC6200)} - V_{oc(375)} \rightarrow 30$ VDC - 1.9 VDC $\rightarrow 28.1$ VDC

2) $V_{oc} \leq V_{max(DVC6200)} \rightarrow 30$ VDC

3) $V_{oc} \leq V_{max(475)} \rightarrow 30$ VDC

$V_{oc} \leq 28.1$ VDC

Isc of the barrier must meet all of the following conditional requirements.

1) $I_{sc} \leq I_{max(DVC6200)} + I_{sc(475)} \rightarrow 226$ mA + 0.032 mA $\rightarrow 226.032$ mA

2) $I_{sc} \leq I_{max(DVC6200)} \rightarrow 226$ mA

3) $I_{sc} \leq I_{max(475)} \rightarrow 200$ mA

$I_{sc} \leq 200$ mA

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