Intrinsically Safe Concepts and Standards Summary

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Extreme mobility solutions

Introduction

"Intrinsically Safe" (IS) is a protection certification for safe operation with electronic equipment in explosive atmospheres. The concept was developed for safety in ex- plosive hazardous areas like petrochemical plants, where explosive hydrocarbon compounds, hydrogen and ammonia are common industrial gases. The concept extends to other areas with explosive hazards, including utilities, marine transfer operations, granaries, pharmaceuticals, consumer packaged goods, alcohol processing, paint manufacturing and many others.

A device termed "intrinsically safe" is engineered, designed and, most importantly, certified to be incapable of producing heat or spark sufficient to ignite an explosive atmosphere, regardless of the source: flammable gasses, vapors, or combustible dusts or fibers. Tablets, cell phones, smart phones, PDAs and other hand-held devices can be ignition sources for explosives. An intrinsically safe device will not ignite explosives.

Understanding IS approval ratings can be a difficult proposition. For instance, the certification process for North America is different from that in Europe, but the two certifications have nearly identical results. Individual countries sometimes have additional certifications. The United States and Canada organize hazardous areas by classes, divisions, and groups and certify mobile phones for use in those areas under the UL 913 Standard. Simpler devices like Land Mobile Radios (LMRs) fall under FM 3610 or 3640. The European Union applies a classification system based on zones generally referred to as ATEX certification (an acronym for the French term "Atmosphères Explosibles"), an EU law that regulates intrinsically safe certification.

The U.S. and the EU are trending toward a uniform standard through a project called the "US-EU Cooperation on Workplace Safety & Health." The U.S. Department of Labor, OSHA, and the EU European Agency for Health and Safety at Work are sharing information on current safety and health topics of common interest, including Intrinsic Safety, which is covered under Regulations (Standards - 29 CFR), Hazardous (classified) locations 1910.307 and 1926.407. This collaboration may result in a global standard, but, currently, standards are splintered by location.

Regardless of the certifying body, the presence of an IS rating on a device does not necessarily mean that a device is safe for use in any IS area. Each intrinsically safe device is certified for a different level of volatility and should only be used in the appropriate hazardous environments if explosions are to be avoided. Close attention must be given to the specific IS approval certification for each individual piece of equipment to prevent loss of life and facilities. Each type of hazardous environment has specific certification requirements that equipment must meet to be considered IS. Intrinsically safe equipment must be labeled as such, with the exact IS rating for the equipment, the name of the Nationally Recognized Testing Laboratory that tested it, and a certification string detailing the types of threats for which the device is safe.

While electronics manufacturers prefer that emphasis be taken off "intrinsically safe" and put on education, intelligent planners consider the human behavior realities, as well as Total Cost of Ownership, when deciding on systems. Understanding the differences in IS approval

certifications and certification levels can be a difficult task, and can make a purchasing decision for an IS device a painful and lengthy process, but this verification process is extremely important to ensure safety for both people and facilities. Utilizing devices with maximum certifications prevents accidents.

EU Labeling

In Europe, all equipment certified for use in hazardous areas must be labeled to show the type and level of protection applied. In addition to the European CE mark showing that the product has met EU consumer safety, health or environmental requirements, and the code number of the certifying body for the 'quality certificate', the label must show:

1. The Explosion Protection String, which provides general level and type of protection by indicating, in order, the following:

Ex mark (CENELEC Hexagon enclosing an "Ex"); Gas Group Roman numeral; Temperature Category number; and if Group II equipment, the indication relating to gasses (G) or dust (D).

For example:
Ⓔx II 1 G (Explosion protected, Any Group II Gas, Temperature Category 1, Gas)

2. In addition, the normative marking "EEx" will be able to establish the specific type or types of protection being used. As examples:

Ⓔx II 2 G EEx ia IIC T4. (Type ia, Group 2C gasses, Temperature category 4).
Ⓔx II 2 G EEx na II T3 X. (Type n- non-sparking, Group 2 gasses, Temperature category 3, special conditions apply).

3. The IP (Ingress Protection) code should also be indicated where appropriate.

4. Also included in the marking are at least:

a) The manufacturers name or trademark and address.
b) The apparatus type, name and serial number.
c) Year of manufacture.
d) Any special conditions of use.

EU Labeling Considerations

Gas Groups

Group	Representative Gasses
I	All Underground Coal Mining, Firedamp (methane)
IIA	Industrial methane, propane, petrol and most industrial gasses
IIB	Ethylene, coke oven gas and other industrial gasses
IIC	Hydrogen, acetylene, carbon disulphide

An indication of II without an A, B, or C after it is suitable for any gas group.

The list above is in order of least volatile (I) to most volatile (IIC). The groups also indicate how much energy is required to ignite the gas by spark ignition, Group I requiring the most energy and IIC the least.

Some listings add Dust as a Group III.

Temperature Classifications

It is possible that the surface temperature of electrical equipment may rise beyond the auto-ignition temperature of ambient flammable gas or vapor, causing explosion. Temperature Class should match expected environmental chemicals.

The temperature classification on the electrical equipment label will be one of the following (in degree Celsius):

America °C		**UK °C**	**Germany ° Continuous - Short Time**
T1 - 450	T3A - 180	T1 - 450	G1: 360 - 400
T2 - 300	T3B - 165	T2 - 300	G2: 240 - 270
T2A - 280	T3C - 160	T3 - 200	G3: 160 - 180
T2B - 260	T4 - 135	T4 - 135	G4: 110 – 125
T2C - 230	T4A - 120	T5 - 100	G5: 80 – 90
T2D - 215	T5 - 100	T6 - 85	
T3 - 200	T6 - 85		

The above table tells us that the surface temperature of a piece of equipment with a temperature classification of T6 will not rise above 85 °C, or 185 °F. The T6 Temperature Classification is safest, while T1 will still ignite many explosives as listed below.

Auto-Ignition Temperatures

The auto-ignition temperature is the temperature at which a substance will ignite automatically by itself without a spark. Examples for common substances are:

Gas	Ignition Temp	Dust	Ignition Temp
Methane	= 580 °C	Sugar	= 460 °C
Hydrogen	= 560 °C	Wood	= 340 °C
Ethylene	= 425 °C	Flour	= 340 °C
Acetylene	= 305 °C	Grain dust	= 300 °C
Naphtha	= 290 °C	Tea	= 300 °C
Carbon disulfide	= 102 °C		

Equipment Code

Each electrical apparatus for use in hazardous areas needs to be designed and constructed in such a way that it will not provide a source of ignition. There are 10 recognized types of protection for hazardous area electrical apparatus. Each type achieves its protection against ignition in different ways, and not all are equally safe. In addition to the equipment being suitable for the Gas Group and the Temperature Class required, the type of protection must be suitable for the zone in which it is to be installed. The different types of protection and the zones for which they are suitable are as follows:

Equipment Code	Description	Suitable for zones…
Eex ia	Intrinsic safety ‘ia’	0, 1, 2
Eex ib	Intrinsic safety ‘ib’	1,2
Eex ic	Intrinsic Safety ‘ic’	2
Eex d	Flameproof protection	1,2
Eex p	Purge/pressurized protection	1,2
Eex px	Purge/pressurized protection ‘px’	1,2
Eex py	Purge/pressurized protection ‘py’	1,2
Eex pz	Purge/pressurized protection ‘pz’	2
Eex e	Increased safety	1,2
Eex m	Encapsulation	1,2
Eex ma	Encapsulation	0,1,2
Eex mb	Encapsulation	1.2
Eex o	Oil immersion	1,2
Eex q	Sand / powder (quartz) filling	1,2

Eex n	Type – n protection	2
Eex s	Special protection	Normally 1 and 2

There are three zones for gasses and vapors:

Zone 0	Flammable atmosphere highly likely to be present - may be present for long periods or even continuously
Zone 1	Flammable atmosphere possible but unlikely to be present for long periods
Zone 2	Flammable atmosphere unlikely to be present except for Flammable atmospher unlikely to be present except for short periods of time - typically as a result of process fault condition.

North American Labeling

CLASS I - FLAMMABLE GASES, VAPORS OR LIQUIDS

Class I Area Classifications
(In accordance with UL 913 5th Edition)

Division 1:
Where ignitable concentrations of flammable gases, vapors or liquids can exist all of the time or some of the time under normal operating conditions.

Division 2:
Where ignitable concentrations of flammable gases, vapors or liquids are not likely to exist under normal operating conditions.

(In Accordance to IECEx 60079-11 or UL 913 7th Edition and pending 8th Edition)
Zone 0:
Where ignitable concentrations of flammable gases, vapors or liquids can exist all of the time or for long periods of time under normal operating conditions.
Zone 1:
Where ignitable concentrations of flammable gases, vapors or liquids can exist some of the time under normal operating conditions.
Zone 2:

Where ignitable concentrations of flammable gases, vapors or liquids can exist some of the time under normal operating conditions.

Class I Groups

Division 1 & 2
A (acetylene)
B (hydrogen)
C (ethylene)
D (propane)

Zone 0, 1 and 2
IIC (acetylene & hydrogen)
IIB (ethylene)
IIA (propane)

Class I Temperature Codes

Division 1 & 2	**Zone 0, 1 and 2**
T1 (≤450ºC)	T1 (≤450ºC)
T2 (≤300ºC)	T2 (≤300ºC)
T2A, T2B, T2C, T2D (≤280ºC, ≤260ºC, ≤230ºC, ≤215ºC)	
T3 (≤200ºC)	T3 (≤200ºC)
T3A, T3B, T3C (≤180ºC, ≤165ºC, ≤160ºC)	
T4 (≤135ºC)	T4 (≤135ºC)
T4A (≤120ºC)	
T5 (≤100ºC)	T5 (≤100ºC)
T6 (≤85ºC)	T6 (≤85ºC)

Class I, Division 1 and 2 Protection Methods

Area	Protection Methods	United Sates	Canada
Div. 1	Explosion proof	ANSI/UL 1203	CSA-30
	Intrinsically safe (2 fault)	ANSI/UL 913	CSA-157
	Purged/pressurized (Type X or Y)	ANSI/NFPA 496	ANSI/NFPA 496

Div. 2	Non-Incendive	UL 1604	CSA-213
	Non-sparking device	UL 1604	CSA-213
	Purged/pressurized (Type Z)	ANSI/NFPA 496	ANSI/NFPA 496
	Hermetically sealed	UL 1604	CSA-213
	Any Class I, Div. 1 method	----	----

Class I, Zone 0, 1 and 2 Protection Methods

Area Protection Methods		Applicable Certification Standards			
		U.S.	Canada	IEC	Europe
Zone 0 - Intrinsically safe, 'ia' (2 fault);		UL 2279, Pt. 11	CSA-E79-11	IEC 79-11	EN 50020
• Class I, Div. 1 intrinsically safe (2 fault)		ANSI/UL 913	CSA-157	----	----
Zone 1 • Encapsulation,	'm'	UL 2279, Pt. 18	CSA-E79-18	IEC 79-18	EN 50028
• Flameproof	'd'	UL 2279, Pt. 1	CSA-E79-1	IEC 79-1	EN 50018
• Increased safety	'e'	UL 2279, Pt. 7	CSA-E79-7	IEC 79-7	EN 50019
• Intrinsically safe	'1b' (1 flt)	UL 2279, Pt. 11	CSA-E79-11	IEC 79-11	EN 50020
• Oil immersion	'o'	UL 2279	CSA-E79-6	IEC 79-6	EN 50015
• Powder filling	'q'	UL 2279	CSA-E79-5	IEC 79-5	EN 50017
• Purged/pressurized	'p'	UL 2279, Pt. 2	CSA-E79-2	IEC 79-2	EN 50016
• Any Class I, Zone 0 method		----	----	----	----
• Any Class I, Div. 1 method		----	----	----	----
Zone 2 • Non-Incendive	'nC'	UL 2279, Pt. 15	CSA-E79-15	IEC 79-15	prEN 50021
• Non-sparking device	'nA'	UL 2279, Pt. 15	CSA-E79-15	IEC 79-15	prEN 50021
• Restricted breathing,	'nR'	UL 2279, Pt. 15	CSA-E79-15	IEC 79-15	prEN 50021
• Hermetically sealed	'nC'	UL 2279, Pt. 15	CSA-E79-15	IEC 79-15	prEN 50021
• Any Class I, Zone 0 or 1 method		----	----	----	----
• Any Class I, Div. 1 or 2 method		----	----	----	----

The 'IP' Code

The IP (Ingress Protection) Code gives an indication of the equipment's ability to keep out unwanted liquids and solids. The code is given in the form of two numbers, for example: IP54. The first numerical digit, in the previous example '5', is the degree of protection against solids and is given a value between 0 and 6. The second number is the degree of protection against liquids, and has a value between 0 and 8.

A third number to indicate resistance to impacts is being considered, and will be based on a standard impact, measured in joules.

Table of Reference

1st Digit	Degree of Protection (Dusts/Particulates)	2nd Digi	Degree of Protection (Liquids)
0	No protection	0	No protection

1	Protection against ingress of large solid foreign bodies	1	Protection against drops of water
2	Protection against ingress of medium sized solid foreign bodies	2	Protection against drops of liquid falling at any angle up to 15° from vertical
3	Protection against ingress of small solid foreign bodies greater in diameter than 2.5 mm	3	Protection against drops of liquid falling at any angle up to 60° from the vertical
4	Protection against ingress of small solid foreign bodies greater in diameter than 1 mm	4	Protection against splashing. Liquid splashed from any direction shall have no harmful effect
5	Protection against the ingress of dust in an amount sufficient to interfere with satisfactory operation of the enclosed equipment	5	Protection against water projected by nozzle from any direction
6	Complete protection against ingress of dust	6	Protection against powerful water jets
		7	Protection against temporary immersion in water
		8	Protection against immersion in water for a defined pressure and time

Conclusion

Understanding intrinsic safety regulations for specific work zones and geographic regions is essential for maintaining safe operations in any industry where explosive atmospheres are present. Selecting the correct devices with the correct IS certifications ensures enterprises operating hazardous locations are doing so with the utmost security and safety to prevent explosions that could cause loss of life and property.

Contact Aegex Technologies at contact@aegex.com to consult an expert on IS certifications and the appropriate IS devices for your operations.