Frequently Asked Questions about Intrinsic Safety

QUESTION: What is intrinsic safety and why is it important?

ANSWER: Intrinsic safety is generally referred to as an energy limitation protection technique. In plants and environmental areas where gasses, volatile chemicals and fine dusts are processed and used, the smallest spark of electrical energy can set off a dangerous explosion. Instruments used in these environments must be incapable of generating energy sufficient to cause ignition. Historically, instruments installed to gather and control physical quantities in these hazardous areas were limited to those of pneumatic design. With the advent of the semiconductor, including integrated circuits, the low power required to operate circuitry and process data is now considered insufficient to ignite most of these dangerous substances. In addition, the use of intrinsically safe devices precludes the necessity of completely enclosing the hazardous area in question, or of segregating the instruments in purged, explosion-proof containers. These latter methods, although used in the past, are extremely costly in terms of design, installation and serviceability.

QUESTION: What is ignition temperature?

ANSWER: Minimum ignition temperature is the point at which an air/gas mixture will self-ignite. Therefore, processes, including any instrumentation operating within these processes, must operate without generating temperatures at or near the minimum ignition temperature. Instruments are typically classified by a T Class rating (→ **fig. 2**, “Temperature Classification”).

QUESTION: What is flash point?

ANSWER: Flash point is the temperature at which volatile liquids give off ignitable fumes, or gasses. Instruments operating at temperatures above the flash point of substances present in the process must be intrinsically safe.

QUESTION: How are hazardous areas classified In Europe?

ANSWER: Zones are generally used in Europe:

- **Zone 0:** Flammable gasses are present continuously or for long periods (typically more than 1 000 hours per year).
- **Zone 1:** Gasses are likely to occur in normal operation (typically between 10 and 1 000 hours per year).
- **Zone 2:** Gasses unlikely to occur and will occur only for short periods (typically between 0,1 and 10 hours per year).

European standard EN 50.014 requires that all instrumentation be subdivided into two groups:

- **Group I:** To be used in mines; presence of methane and coal dust.
- **Group II:** To be used in surface industries; presence of gasses or vapors (Class 1). In Group II, a letter designation is appended indicating the level of ignition energy, with A being the lowest (propane), B higher (ethylene) and C the highest (hydrogen, acetylene).

QUESTION: How are hazardous areas classified In North America?

ANSWER: Divisions are generally used in North America:

- **Division 1:** Dangers can be present during normal functioning (typically more than 10 hours per year).
- **Division 2:** Dangers can only be present during abnormal functioning (typically between 0,1 and 10 hours per year).

Further, these divisions can be subdivided into:

- **Class I:** Gasses or vapors are grouped by the level of ignition energy, with D being the lowest (propane), C higher (ethylene), and A and B being the highest (acetylene, hydrogen).
- **Class II:** Dusts are grouped by the level of ignition energy, with G being the lowest (grain dust), F higher (coal dust) and E being the highest (metal dust).
- **Class III:** Fibers are not sub-grouped.

Area Classification

Commonly Used Figures	Continuous Hazard More Than 1000 Hours/Annum	Intermittent Hazard Between 10 and 1000 Hours/Annum	Hazard Under Abnormal Conditions Between 0.1 and 10 Hours/Annum
IEC/CENELEC/EUROPE	Zone 0 (Gases), Zone Z (10) (Dusts)	Zone 1 (Gases), Zone Z (10) (Dusts)	Zone 2 (Gases), Zone Y (11) (Dusts)
NORTH AMERICA	Division 1 (Gases and Dusts)		Division 2 (Gases and Dusts)

Zones and Divisions: A measure of the likelihood of the hazard – whatever it may be – actually being present. This defines the method of protection that may be used. (Dusts: Europe standards issued only by UK (Zone Y and Z) and Germany (Zone 10 and 11).

Gas Groups

Typical Gas Hazard	EUROPE CENELEC EN 50 014 IEC	North America NEC Article 500 (Class I)	Minimum Ignition Energy (Microjoules)
PROPANE	IIA	D	180
ETHYLENE	IIB	C	60
HYDROGEN	IIC	B	20
ACETYLENE	IIC	A	20

Group I electrical apparatus is intended for use in mines susceptible to fire damp. Gas classification and ignition temperatures relate to mixture of gas and air at ambient temperature and pressure.

North American Hazard Categories

CLASS I (Gases and Vapors)	Group A (Acetylene), Group B (Hydrogen), Group C (Ethylene) and Group D (Propane)
CLASS II (Dusts)	Group E (Metal Dust), Group F (Coal Dust) and Group G (Grain Dust)
CLASS III (Fibers)	No Sub-Groups

Fig. 1. Area classification, gas groups and North American hazard categories.

QUESTION: What are the basic differences between European and North American practices?

ANSWER: Zone 2 and Division 2 are almost equivalent, while Division 1 includes the corresponding Zones 0 and 1. An instrument designed for Zone 1, however, cannot be directly used in Division 1. In Europe, instruments are certified on the basis of design and construction; in North America, they are classified on the basis of the zone of possible installation.

QUESTION: What are the various methods of protecting instrumentation in a hazardous area?

ANSWER: Explosion containment (Ex "d") allows the explosion to occur, but confines it in a well-defined place, avoiding propagation to the surrounding atmosphere. Explosion-proof enclosures are part of this method.

Segregation attempts to physically separate or isolate electrical parts or hot surfaces from the explosive mixture. Pressurization (Ex "p") and encapsulation (Ex "m") techniques are used in this method. Other related methods worth noting are oil immersion (Ex "o"), powder filling (Ex "q") and extra heavy-duty design electrical apparatus (Ex "e").

Prevention limits thermic and electric energy to within safe levels. Non-incendive approval (Ex "n") assures that under normal operating conditions no explosion will occur. Intrinsic safety approval (Ex "ia" and "ib") assures that no explosion will occur even if faults in the electronic circuitry occur. This paper deals with the design and approval of electronic circuitry and instrumentation that is intrinsically safe.

Temperature Classification (T Class)

Maximum Surface Temperature °F (°C)	IEC 79-8 T Class	Maximum Surface Temperature °F (°C)	IEC 79-8 T Class
+842°F (+450°C)	T1	+275°F (+135°C)	T4
+572°F (+300°C)	T2	+212°F (+100°C)	T5
+392°F (+200°C)	T3	+185°F (+85°C)	T6

This relates the maximum temperature of a piece of apparatus (normally assuming a +104 °F (+40 °C) ambient) to the ignition temperature of a gas. There is no relationship between ignition energy and ignition temperature, e.g., hydrogen ignition energy = 20 μJ and ignition temperature = +1 040 °F (+560 °C)

Testing Authorities

Testing Authority	Country/Main EC Testing Authorities	Marks Used
BASEEFA	United Kingdom	Ex FLP
SCS	United Kingdom	
PTB	Federal German Republic	Ex
BVS	Federal German Republic	Sch
INERIS	France	MS AE
LCIE	France	MS AE
LOM	Spain	–––
CESI	Italy	AD-PE
INIEX	Belgium	Ex
DEMKO	Denmark	Ex
KEMA	The Netherlands	KEMA KEUR
ALL	–––	Ex
Main North American Testing Authorities		
Underwriters Laboratory	USA	UL
Factory Mutual	USA	Factory Mutual System Approved
U.S Department of Labor Mine Safety and Health Administration	USA	United States Department of Labor MSHA Mine Safety and Health Administration
CSA	Canada	SP
Other Testing Authorities		
NEMKO	Norway	N Ex
Standards Australia	Australia	AUS

Fig. 2. Temperature classification (T class) and testing authorities.

QUESTION: What is the philosophy of electronic intrinsically safe circuitry?

ANSWER: An intrinsically safe electric circuit is defined as such, according to CENELEC EN 50.020 when no spark or thermal effect, generated during normal functioning and/or specific fault condition, is able to ignite a given explosive atmosphere. All parts of a circuit that are able to store energy (inductance and capacitance to operate switches) must release energy that is only lower than the minimum ignition energy of the explosive mixture present in the hazardous location.

QUESTION: What is the difference between "ia" and "ib" intrinsically safe instrumentation?

ANSWER: Under European standards, an instrument of category "ia" should not be able to ignite a dangerous air/gas mixture during normal functioning, in the presence of a single fault or in the presence of any combination of two faults. An instrument of category "ib" should not be able to ignite such a mixture during normal functioning, or in the presence of a single fault. Category "ia" guarantees the safety with two faults where the one of category "ib" guarantees the safety only with one fault. North American standards are based on the occurrence of a maximum of two faults.

QUESTION: What are the agencies or standards that control the specifications for intrinsically safe apparatus?

ANSWER:
- **Europe:** European Standard CENELEC EN 50.20
- **Australia:** Standards, Australia, Australian Standards, Section 2380, Part 7
- **USA:** National Fire Protection Association, National Electrical Code, Article 500
- **Canada:** Canadian Standards Association, CAN/CSA-C22.2 Number 157-92

QUESTION: How does a supplier gain equipment approval as acceptable for use under a certain standard?

ANSWER: Various testing agencies undertake to test, qualify and certify instruments under application. They are different around the world (→ **fig. 2**, "Testing Authorities"). The current trend is towards international acceptance of these approvals.

QUESTION: What is the difference between non-incendive and intrinsically safe instrumentation?

ANSWER: Non-incendive and intrinsically safe instrumentation are constructed in accordance with the likelihood of failure during exposure to the hazardous atmosphere.

Non-incendive instrumentation is designed for safe use in areas that may be hazardous under abnormal conditions (Zone 2, Division 2). The low incidence of a hazardous atmosphere in a Zone 2 or Division 2 area makes it unlikely that an instrument failure will occur while explosive gasses are present.

Intrinsically safe equipment is designed for safe use in areas that intermittently have a hazardous atmosphere ("ib" for Zone 1) or where the hazardous atmosphere continuously exists ("ia" for Zone 0, Division 1). The intermittent hazardous atmosphere of Zone 1 requires that an instrument experiencing a worst-case failure will not cause an explosion. The continuous hazardous atmosphere of Zone 0 and Division 1 requires that an instrument experiencing two worst-case failures will not cause an explosion.

QUESTION: What approvals apply to SKF Condition Monitoring products, and for what applications and regions do they apply?

ANSWER: See the SKF Product Approvals Chart, listing the SKF Condition Monitoring products that currently have approvals and the specific approval received. The included charts show the specific nature of the environmental conditions under which the instrument has been approved.

SKF Condition Monitoring Product Approvals Chart

For Usage in Zone 0, 1, 2 and Division 1, 2

Model Number	***Description***	***Agency Approval***	***Characteristic Gas***	***Agency***
CMSS 793-CA CMSS 793L-CA CMSS 793V-CA	Accelerometer	Class I, Division 1, Group A, B, C, D	acetylene, hydrogen, ethylene, propane	CSA
CMSS 665-16-xx System CMSS 668-16-xx System	Eddy Current Displacement Probe	Class I, Division 1, Group A, B, C, D and EEx ia IIC T2	acetylene, hydrogen, ethylene, propane	CSA, FM and BASEEFA
CMSS 786A-FM CMSS 786F-FM CMSS 793-FM CMSS 793L-FM CMSS 797-FM CMSS 797L-FM	Accelerometer	Class I, II, III, Division 1, Group A, B, C, D, E, F, G	acetylene, hydrogen, ethylene, propane	FM
CMSS 793-EE CMSS 797-EE	Accelerometer	EEx ia IIC T4 (Tamb = –50 to +120 °C)	acetylene, hydrogen, ethylene, propane	BASEEFA
CMSS 793V-FM CMSS 797V-FM	Accelerometer	Class I, II, III, Division 1, Group C, D, E, F, G	ethylene, propane	FM
CMSS 793V-5EE CMSS 793V-EE	Accelerometer	EEx ia IIA T4 (Tamb = –50 to +120 °C)	propane	BASEEFA

For Usage in Zone 1, 2 and Division 2

Model Number	***Description***	***Agency Approval***	***Characteristic Gas***	***Agency***
CMVA 30	SKF Microlog	EEx ib IIC T5	acetylene, hydrogen, ethylene, propane	NEMKO (Norway only) AUS
CMVA 30-CE	SKF Microlog	EEx ib IIC T5	acetylene, hydrogen, ethylene, propane	NEMKO

For Usage in Zone 2 and Division 2

Model Number	***Description***	***Agency Approval***	***Characteristic Gas***	***Agency***
CMSS 665-20-xx System CMSS 668-20-xx System	Eddy Current Displacement Probe	Class I, Division 2, Group A, B, C, D (without barriers)	acetylene, hydrogen, ethylene, propane	FM
CMSS 786A-FM CMSS 786F-FM CMSS 793-FM CMSS 793L-FM CMSS 793V-FM CMSS 797-FM CMSS 797L-FM CMSS 797V-FM	Accelerometer	Class I, II, III, Division 2, Group A, B, C, D, E, F, G (without barriers)	acetylene, hydrogen, ethylene, propane	FM

For Mining Usage

Model Number	***Description***	***Agency Approval***	***Characteristic Gas***	***Agency***
CMVA 30/M	SKF Microlog	Methane/Air and Coal Dust	methane	MSHA

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