Guide to Intrinsically Safe Portable Radios

An overview of common IS standards

SUMMARY

The development of equipment for explosive atmospheres has evolved over decades to meet an increasing need to keep workers safe and productive while operating around hazardous materials. As technologies and industry advance, exposure to hazardous materials may become more frequent, placing greater demands on the protection mechanisms we employ to keep workers safe.

Intrinsically Safe (IS) equipment is designed to operate in potentially explosive atmospheres without the risk of becoming an ignition source or creating a spark that might cause a fire or explosion.

IS equipment is required in a wide range of industries, from Public Safety and Utilities, to Mining, Petrochemical and Transportation. IS radios allow critical communications to be conducted in hazardous environments where use of non-IS radios would be potentially dangerous.

A number of different standards worldwide help guide manufacturers, purchasers and users in the design, manufacture, selection and operation of IS radios.

This document will help you to interpret these standards, based on their location in the world, and the environment under which the IS radios will be used.

Information in this document should be used in conjunction with the relevant regulatory authority in your region of operation to ensure compliance with any and all relevant local safety requirements.

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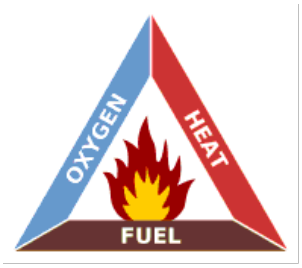
INTRINSIC SAFETY: WHAT IS IT AND WHY IS IT IMPORTANT

For users or purchasers of equipment for use in potentially explosive atmospheres, Intrinsic Safety (IS) is likely to be a key requirement. Intrinsically Safe radios are designed to prevent ignition of specific potentially explosive atmospheres. Intrinsic Safety is a protection technique that focuses on preventing sparks or hotspots that might ignite a potentially explosive atmosphere, even under improbable fault conditions.

For an explosion to take place, there must be **fuel** (gas or dust) mixed with **oxygen** (air) in the right ratio, and a source of **heat** – either a hot surface or a spark of sufficient energy. Generally, IS addresses the **heat** aspect of the "fire triangle" to prevent ignition.



GLOBAL EXPLOSIVE ATMOSPHERE REGULATIONS

IECEx – International Standard for Explosive Atmosphere Equipment

The International Electrotechnical Commission (IEC) system for explosive atmospheres (Ex) equipment, is now the international benchmark. It is used in 30+ or more IECEx member countries, including Australia, Brazil, China, Great Britain, New Zealand, Canada and the USA.

Local standards

- While IECEx has been widely adopted, there are a number of local regulations also in use. For example:NEC/CEC – US and Canada.
- ATEX – Europe
- InMetro – Brazil
- ANZEx – Australasia

NEC/CEC - North America

In the United States, equipment must meet the National Electrical Code (NEC) ANSI/NFPA-70. Equipment can be approved for divisions or zones. Equipment for use in explosive atmospheres in Canada must meet the Canadian Electrical Code (CEC) CSA C22.1.

The United States Occupational Safety and Health Administration (OSHA) accredits Nationally Recognized Testing Laboratories (NRTL) who test and certify to US and Canadian standards. Examples include FM Global, MET, UL, and CSA.

Division certified equipment will bear the mark of the certifying body (for example MET, FM or UL), plus the Division rating (Div 1 or Div 2). Zone certified equipment will also bear the mark of the certifying body, as well as AEx marking or Ex marking for the USA or Canada respectively.

ATEX – The European Directives

Equipment for use in explosive atmospheres in Europe is covered by Directive 94/9/EC (ATEX Equipment) until April 19th, 2016 and Directive 2014/34/EU from April 20th, 2016. The term ATEX is taken from the directive title "Atmosphères Explosibles".

At the equipment technical level, IECEx and ATEX are very similar. The standards used to meet ATEX are generally European versions of the IEC 60079 series standards. The ATEX directive also defines equipment groups and categories, which gives ATEX equipment additional label markings (compared with IECEx).

In addition to the ATEX equipment directive, there is Use or Workplace Directive 1999/92/EC. This specifies Health and Safety requirements for employers and utilizes fairly standard processes of hazard identification, risk assessment, hazard mitigation, and surveillance.

It is the application of the Use directive that results in a Hazard Plan with appropriate zoning of areas subject to risk.

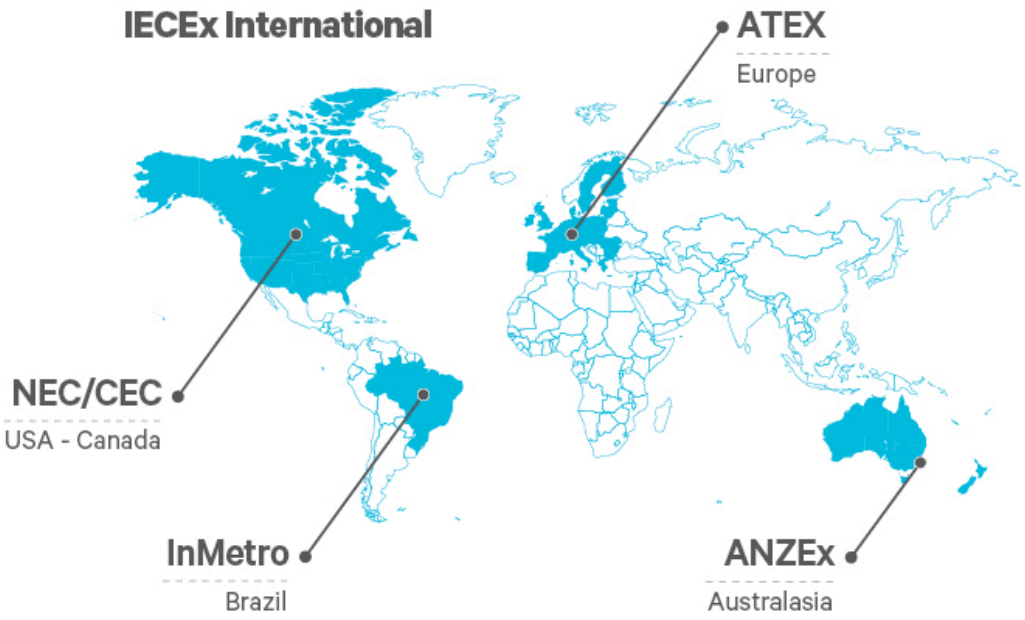
It is ultimately the responsibility of the employer to ensure they have a Hazard Plan and are using appropriate equipment.

INMETRO – Brazil

Brazilian government regulations are administered by INMETRO. Equipment for use in explosive atmospheres requires INMETRO certification. Now that Brazil has adopted the IECEx scheme, INMETRO certification is relatively straightforward, via submission and review of the IECEx documentation.

ANZEx – Australia and New Zealand

The ANZEx Scheme is the official program for certification of equipment for explosive atmospheres for Australia and New Zealand. IECEx certification will be directly accepted.



HAZARDOUS LOCATION CLASSIFICATIONS

Area classification is required by government regulatory bodies, for example the US Occupational Safety and Health Administration.

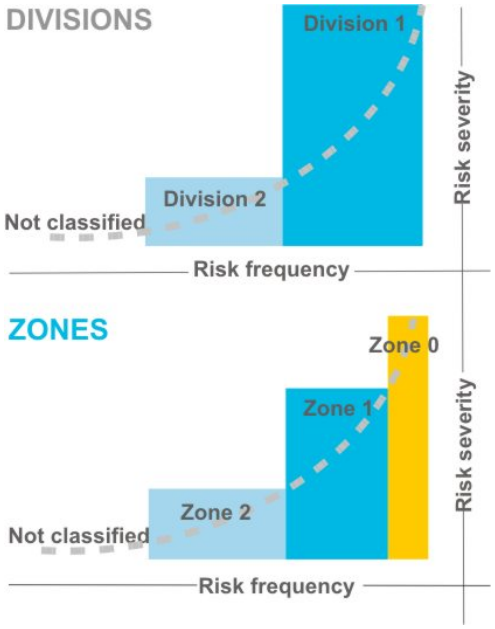
Divisions vs Zones

Globally, the main area classifications are divisions and zones. Division classification is traditionally used in North America. Zone classification originated in Europe but is now adopted worldwide. While they have much in common, there is a significant difference in how they rate perceived risk, which can cause confusion for sales people and customers alike.

The Division/Zone classification determines the risk profile for an area. The rating that a product is awarded by compliance testing has a direct correlation with the division or zone classification.

While each radio model has additional specifications (see labeling on page 8), this overall rating is the first step in assessing the suitability of a radio for a specific situation. This diagram shows how division and zone classifications differ.

While zone classification has been adopted globally, the legacy division classification continues to be used. This can cause problems as equipment transitions to zone based ratings, while the locations remain classified under divisions. For example, a product that is rated for use in Zone 1 may be considered suitable for use where there is an occasional risk present. However under division area classification, the product could only be used in a Division 2 area. In this case the division classification is too coarse.



The chart shows the differences between divisions and zones. Note also the class ratings.

DIVISIONS			What types of hazardous substances may be present?	ZONES
Gas/vapours? Class 1	Dust? Class II	Fibers/flyings? Class III	Gas/vapours? Zones 0, 1, 2	Dust? Zones 20, 21, 22

How often are hazardous substances present?				
Likely to exist under normal operating conditions?	Unlikely to exist under normal operating conditions?	Continuously, or long periods under normal operating conditions?	Likely to exist under normal operating conditions?	Unlikely to exist under normal operating conditions?
Division 1	Division 2	Gas/vapour: Zone 0 Dust: Zone 20	Gas/vapour: Zone 1 Dust Zone: 21	Gas/vapour: Zone 2 Dust Zone: 22

NOTE: *Zone 0 rating denotes highly-specialized equipment.*

NOTE: *Area classification must be performed only by authorized personnel.*

LABELING – THE NUMBERS AND LETTERS ON THE BACK OF THE RADIO

Certification is carried out by approved bodies, who may be registered under multiple systems.

- In North America these are Nationally Recognized Testing Laboratories (NRTLs).
- In Europe the laboratories are Notified Bodies under the ATEX scheme. Under the IECEx system they are Certification Bodies (ExCB).
- In Brazil the laboratories are accredited by INMETRO.

All IS certified electrical equipment will carry a label specifying the exact IS rating, along with a reference to the particular body that certified it.

In addition to the marking examples below, there will be additional markings, including certificate details, model and serial number. The Equipment Protection Level (EPL, Gb for gas or Db for dust) may also be appended.

A further point to check is whether there is an 'X' after the Ex certificate number. This indicates special conditions that must be observed, which will be explained in the user manual.

IECEx Markings

Below are two examples of IECEx IS markings, or 'Ex' marking.

Gas atmosphere

Ex ib IIC T4

Ex	ib	IIC	T4
Explosion-protected	Protection Concept Intrinsic Safety (ib = Zones 1 and 2)	II = Gas C = Sub-group	Temperature Class

Dust atmosphere

Ex ib IIIC T135°C T_L200°C

Ex	ib	IIIC	T135°C	T_L200°C
Explosion-protected	Protection Concept Intrinsic Safety (ib = Zones 21 and 22)	III = Dust C = Sub-group	Maximum surface temperature	Maximum surface temperature under a dust layer

For countries that accept IECEx directly, such as Australia and New Zealand, there is no additional compliance marking, as there is for ATEX.

ATEX Marking

Example of equipment marking for non-mining, high protection (Zone 1), Gas and Dust explosive atmospheres:

CE 1234 Ⓔx II 2GD

CE	1234	Ⓔx	II	2	GD
European conformity marking	Notified body number	Explosion Protection Marking	Group II Non-mining	Category 2	Material group G = Gas D = Dust

Note: *The ATEX marking is supplemented by the Ex marking.*

North American Marking

With the addition of zones to CEC and NEC, Canada and the US now have both division and zone markings.[1]

Divisions

Example of equipment marking for Intrinsic Safety for gas and dust:

IS, CL I II III, DIV 1, GP C D E F G, T4

IS	CL	I II III	DIV I	GP	C D E F G	T4
Type of Protection: Intrinsically Safe	Class	I = Gas II = Dust III = Fibre	Division 1	Material group	C = Ethylene D = Propane E = Metal dust F = Carbon dust G = Grain dust	Temperature class

Note: *CEC/NEC material groups for gas and dust differ from the ATEX and IECEx equipment groups (mining/non-mining). NEC also defines a finer-grained temperature class.*

Zones

The CEC/NEC zone-based marking is very similar to the IECEx marking, but prefixed with A ("AEx"). The class is still marked and Zone replaces Division. For example:

IS, CL I, Zone 1, AEx ib IIB T4

IS	CL1	Zone 1	AEx	ib	IIB	T4
Type of Protection: Intrinsically Safe	Class 1 Gas	Zone 1	A + Ex	Protection Concept Intrinsic Safety (ib = Zones 1 and 2)	Material group Ethylene	Temperature class

[1] Canada does not yet have Zones for Dust Atmospheres. Not all US jurisdictions have adopted the newer versions of the NEC.

MATCHING THE LOCATION AND THE LABEL MARKING

Once we understand Hazardous Location classification and what the equipment markings are, we can compare them to make sure the equipment is suitable for use.

In the North American marking scheme, the division or zone is specifically mentioned, so matching equipment to location is relatively easy. With ATEX and IECEx marking, the zone is indirectly specified, either by the IS Rating or the Equipment Protection Level (EPL). The table below offers some guidance:

Zone	Explosion Atmosphere	IS Rating	EPL	ATEX Category
0	Continuous	ia	Ga	1 G
1	Likely	ib	Gb	2 G
2	Unlikely	ic	Gc	3 G

Note: *Dust ratings are similar; just prefix 2 for the zone and substitute D for G. However ic protection is not available for dust. Tc level (protection by Enclosures standard) could be used instead for Zone 22.*

Equipment of a higher rating (say "ib") can always be used in a safer zone (Zone 2). The same applies for divisions. Division 1 equipment can be used in Division 2.[2]

Material Groups

Matching the IS rating and the zone is only the first part of the process. A location is classified as hazardous because of a particular substance that has the potential to create an explosive atmosphere. The equipment must also be rated for that particular substance.

In Ex marking, substance is denoted by the Gas/Dust group and the subgroup: IIC is Gas subgroup C, which includes hydrogen; IIIC is dust subgroup C, which includes conductive dusts.

Group IIA contains less dangerous gasses, Group IIC contains the most dangerous gasses. Equipment rated IIC can be used in a location with less dangerous gasses. The same logic applies for dusts.

In class and divisions, class denotes the base material. Class I = Gas; Class II = Dust; Class III = Fibers. The material group identifies the specific materials.

Material Group		Typical Material
Ex Zone	Division	
IIC	A	Acetylene
	B	Hydrogen
IIB	C	Ethylene
IIA	D	Propane

The tables that follow compare divisions and zones for dusts

Division Material Group	Typical Material
E	Metal dusts (aluminium)
F	Carbon dusts (coal)
G	Non-conductive dusts (flour)

Zone Material Group	Typical Material
IIIC	Conductive dusts
IIIB	Non-conductive dusts
IIIA	Combustible Flyings

[2] Depending on local regulations, zone equipment may be used in division-classified locations. Equipment rated Zone 0, 1 or 2 may be used in Division 2. Only Zone 0 equipment may be used in Division 1. Division-rated equipment may be used in zone-classified locations. Division 1 equipment may be used in all zones; Division 2 equipment may only be used in Zone 2. It is important to check with your local Regulatory Authority.

INTRINSIC SAFETY APPLICATIONS

In any scenario, risk can be heightened by individual events and requirements. This will be part of the individual organization's operational procedures and Health and Safety program.

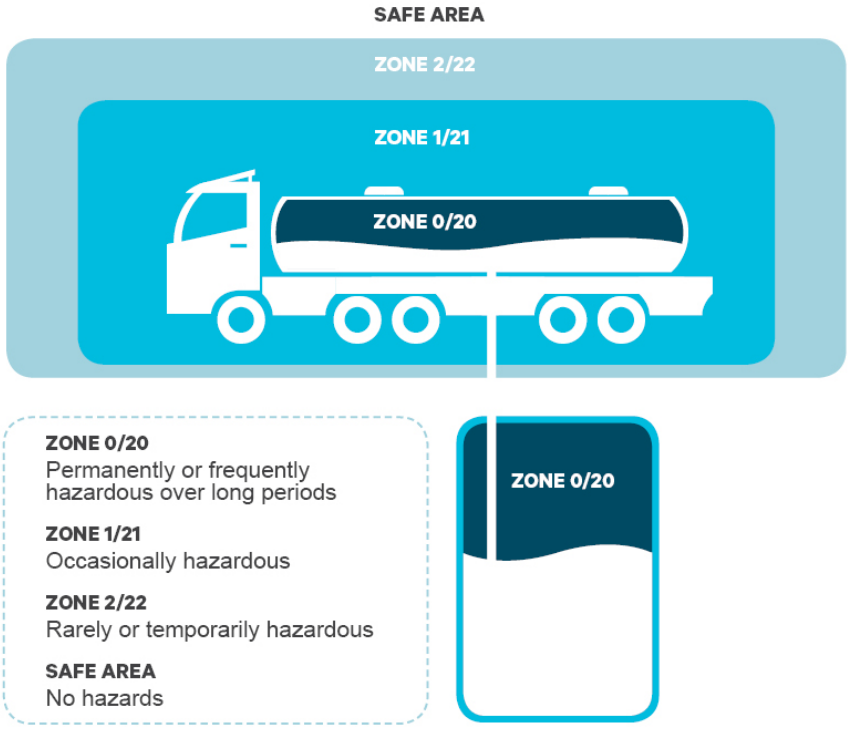
Note: *These scenarios are examples only. They are not intended as an assessment of hazardous locations. Area classification must be performed only by authorized personnel.*

Scenario 1: Maintenance workers on a gas pipeline

Normal operating conditions are well ventilated or outdoors with minimal risk of gas combustion. However, on occasions they can expect gas release, for example when checking or testing pipeline valves, or encountering unexpected leaks.

An appropriate rating would be Zone 1: occasionally hazardous. However, should they be called upon to perform maintenance within a tanker, a ship's hold, or underground tank, the risk is increased considerably, to Zone 0.

In addition to a matching zone rating, the equipment must also be approved for the specific hazardous substance (gas or dust).



Scenario 2: Petrochemical workers on oil drilling platform

An oil drilling platform presents a constant, but well-ventilated hazardous environment. Workers will experience low levels of vapor often.

This might be classified as Zone 1: occasionally hazardous. However, below decks and in tanks and storage areas where ventilation is reduced, a much greater risk could exist.

Scenario 3: Stores/Warehouse workers in food processing

Airborne dust from flour, sugar and other products within a food processing warehouse and plant create a potentially volatile situation. Combustion risk may vary, depending on stock movement and processing, for example while hoppers are filled or emptied.

Maintenance inside tanks and hoppers create additional risk, and processes for radio use within these sites would need to be carefully assessed, communicated and enforced.

BATTERIES AND ACCESSORIES

As well as the radio itself having an IS rating, all batteries and accessories must also be compliant. If any one part of the radio + battery + accessory system is non-compliant, the whole system is non-compliant and presents a safety risk.

Batteries

Use only specified batteries from the original equipment manufacturer. Any other battery is unlikely to be IS-compliant and thus presents a real safety risk.

Battery chargers specified by the original equipment manufacturer will be compliant. Any other battery charger is unlikely to be IS-compliant and thus presents a real safety risk.

Accessories

Audio accessories such as speaker microphones also need to match the radio. The radio equipment manufacturer will specify appropriate accessories, including earphones. Entity Parameters' which define the accessory interface for IS purposes also allow use of other suitable accessories, so assessment should be made by a competent person.

Carry accessories specified by the original equipment manufacturer will be compliant. Carry accessories from other vendors may not be compliant and could present a safety risk.

Programming accessories specified by the original equipment manufacturer will be compliant. Other programming accessories may not be compliant and could present a safety risk.

TIPS FOR PURCHASERS OF IS EQUIPMENT

- Commission a professional risk analysis and evaluation of the environment in which you operate.
- Identify hazardous materials.
- Determine the probability or frequency of a potentially explosive atmosphere.
- Consider the consequence of ignition – what Equipment Protection Level (EPL) do you require? It may be appropriate to specify equipment with an EPL that is higher (or lower) than the Zone category would normally equate to.
- Investigate which manufacturers offer IS equipment, and what experience similar organizations have had.
- Ensure company operational procedures are up to date and clearly explain the hazards and how the equipment can (or cannot) be used.
- Ensure your workforce are trained and understand the operational procedures.

TIPS FOR USERS OF IS EQUIPMENT

- Understand your radio and your company procedures – know where you can or cannot use your radio and under what conditions.
- IS radios should be readily identifiable, by conspicuous labels on both the radio and battery and possibly by a distinguishing color (light blue is standard for ATEX equipment).
- Ensure that any accessories also have a suitable IS rating.
- Never remove your portable radio battery in a hazardous environment, or carry a spare battery into that environment, if the label warns against doing so.
- Battery charging must be performed outside of hazardous areas.
- All repairs must be carried out by an approved service facility with appropriate certification.
- The battery is not repairable. If it fails, it must be replaced.

WHO DO YOU NEED TO TALK TO FOR MORE INFORMATION

- Industry regulatory bodies, such as:
  Workplace Safety (OSHA), Department of Labor, Electrical Safety Regulator.
- Consultants
- Your operations staff

Obviously, both Workplace Safety assessments and Hazardous Location assessments provide critical information in decision making.