ATEX – Principles and Practice
By Pat Swords BE CEng FIChemE PPSE CEnv MIEMA

hazard.

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PM Group – Pat Swords, Principal Process and EH&S Consultant

• Pat Swords is a Fellow of the Institution of Chemical Engineers, a Professional Process Safety Engineer and a Chartered Environmentalist. Since graduation in 1986, Pat has worked for PM Group in developing the chemical, pharmaceutical, food and general manufacturing industries in both Ireland and over a dozen other countries throughout Europe and North America.

• Since 1999 he has worked extensively on EU Technical Aid Projects in Central and Eastern Europe helping to implement EU Industrial Pollution Control and Control of Major Accident Hazards legislation.
Introduction

- This training course by PM Group provides an overview to explosion safety and the requirements as established under ATEX legislation in the EU and its similar implementation internationally.
  - The relevant employer and equipment instructions need to be consulted for all work in hazardous areas.
  - If in doubt ask!!
Contents of Presentation

- Two strands of ATEX: Worker Safety and Equipment Certification
- Flammable hazards – liquids and gases
- Dust explosion hazards – combustible dusts
- Principles of Prevention – in order of priority
  - (1) Avoiding the formation of a potentially explosive atmosphere
  - (2) Avoiding effective ignition sources
    - Hazardous area classification – zoning
    - Electrical protection
    - Non-electrical protection
  - (3) Mitigating the detrimental effects of an explosion
  - (4) Where necessary supplementing with measures against the propagation of explosions.
- Organisational Measures
What we are trying to ensure!
ATEX – What we have to comply with
Legislation, Guidance and Standards
The three most relevant EU legislative measures on the subject of explosion safety are:

1. **The framework safety Directive 89/391/EEC**


3. **ATEX Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.**
Principles of Prevention – It all comes down to this!

- Relevant Principles of Prevention (89/391/EEC)
  - Avoiding risks
  - Evaluating risks which cannot be avoided
  - Combating the risks at source
  - Adapting the work to the individual
  - Adapting to technical progress
  - Replacing the dangerous by the non-dangerous or less dangerous
  - Giving collective protective measures priority over individual protective measures
  - Giving appropriate instructions to the workers
  - Developing a coherent overall prevention policy
• You always had to have a safe plant ➔ Framework Directive and jurisprudence strengthened requirement for risk assessments and implementation of protective measures that are ‘reasonably practical’.

• ATEX ‘worker protection’ Directive 1999/92/EC is one of the 19 ‘Daughter Directives’ and outlines the specific details with regard to Explosive Atmospheres.

• Principles are applicable globally.
ATEX Directive 1999/92/EC

- ‘WORKER PROTECTION DIRECTIVE’
- Safeguard workers
- Applicable since July 2003
- Prepare Explosion Protection Document (EPD)
- In order of priority:
  - Prevent explosive atmospheres
  - Avoid ignition sources
  - Mitigate effects of explosion
  - Where appropriate, measures to prevent explosion propagation
ATEX Directive 1994/9/EC

- ‘EQUIPMENT DIRECTIVE’ – part of ‘New Approach’ legislation and associated CE marking, i.e. free movement of products.

- Applies to all equipment (Electrical and Non-Electrical) for use in potentially explosive atmospheres
- All flammable atmospheres (vapours and dusts)
- Applicable since July 2003
- Hazardous area classification (zoning) determines equipment certification requirements;
  - The more stringent the zone, the more stringent the design and certification of the equipment
New Approach Directives

- ATEX ‘equipment Directive’ is a ‘New Approach’ Directive, where the EU defines ‘Essential Health and Safety Requirements’.
- Harmonised standards for compliance are then developed by European Standards Institutes; CENELEC (electrical) and CEN (non-electrical).
- National Standards Authority of the Member States adopts these EN Standards, e.g. BS EN xxxx, DIN EN xxxx, etc.
• IEC has developed its own IECEx set of standards and Ex conformity / certification scheme based on the electrical aspects of the ATEX ‘equipment’ Directive 94/9/EC and its previous CENELEC standards.

• Internationally electrical standards for Ex equipment are to be found in the IEC 60079 range of standards.

• In time the IEC and the International Organisation for Standardisation (ISO) will adopt standards for non-electrical equipment based on Directive 94/9/EC and the associated non-electrical CEN standards now in place.
  • Russia, etc.: GOST standards and conformity
  • China: Mandatory GB Codes
The Importance of EN / IEC Standards

- Manufacturers can demonstrate compliance with the ‘Essential Health and Safety Requirements’ without following the harmonised standards – but it is easier to follow them and there is a ‘presumption of conformity’
- Similarly operating companies would be wise to be in compliance with the relevant technical standards:
  - How many companies have completed inspections to IEC 60079-17?
If there is an accident, such as leak, formation of an explosive atmosphere, followed by ignition and resulting explosion, the judge will ‘benchmark’ you against the relevant technically standard!

This concept applies globally in all jurisdictions.

Both operating companies and equipment designers have to be aware of the constant pace of development in international standards – they are your operating benchmark.

Keep ‘dipping’ into the Websites of the Standard Organisations:

- [https://www.cen.eu/](https://www.cen.eu/)
- [www.cenelec.eu/](http://www.cenelec.eu/)
ATEX Legislation - Summary

- ATEX = ATmospheres EXplosibles
- ATEX makes what was essentially ‘good engineering practice’ a legal requirement.
- EU: “previous equipment standards set a common high safety standard” and “equipment should not need modification to comply with the new laws”.
- For a high specification plant compliance will be generally related to documentation and work practices.
Flammable and Dust Explosion Hazards
Cause and Effect

consequence.

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Fire versus Explosion

- Oxygen
- Ignition
- Fuel

Confinement
- Fuel
- Mixing

Oxygen
Prerequisites for a Vapour Explosion

ISSA Prevention Series No. 2032E: Gas Explosions
What causes a liquid to be classified as Flammable?

- Flash point test; liquid gradually heated until it is just possible to ignite the vapour above its surface (closed cup). Liquid temperature equals flash point.

- UN Global Harmonised System (GHS) classifies liquids as flammable if the flash point is $< 60^\circ$C.

- Combustible liquids, such as most Diesel blends do not form explosive atmospheres (F.P. $> 60^\circ$C), but can do so if heated up.

- Combustible liquids when sprayed in fine droplets can form explosive atmospheres at temperatures below flashpoint.
Flashpoint Temperature Relationship of Ethanol
Flammable Liquid ➔ explosive under all environmental conditions?

- EU Commission guidance (previously German Ex regulations:
  - Explosive mixtures are not assumed to be present inside equipment if the temperature of the liquid is at all times kept far enough below the flash point; 5°C for a pure substance and 15°C for a mixture.
  - Example: Flashpoint of glacial acetic acid is 40°C, therefore maintain below 35°C.
• A Hazardous Area is defined in EU Guidance as one in which special precautions are necessary.
• 10 litres of explosive atmosphere in an enclosed room is deemed a hazardous potentially explosive atmosphere.
• Flammable liquid in a sealed container is not hazardous if handled properly, e.g. 100g of petrol in a car fuel tank could kill someone, but only when a welding torch is foolishly applied to the outside.
• 10 Litres of explosive atmospheres releases about 10 kJ of energy, which is about equivalent in energy to the impact of a 10 kg weight falling 100 m.

• Lower Explosion Limit of ethanol is:
  • 3.1 vol. %
  • 59 g/m³

• 10 litres of explosive atmosphere ➔ 0.59 grams
Prerequisites for a Dust Explosion

ISSA Prevention Series No. 2044 (E) Dust Explosions
Dust Explosions do happen!

- Insurance industry in Europe estimates that a dust explosion occurs on average every day.
- German safety officials have over 25 years investigated 600 dust explosions, which they estimate is less than 10% of the total that have occurred in Germany.
- For the ‘other’ classification, which includes chemicals:
  - Mechanical ignition and electrostatic ignition were the main causes with each being 23.7% of the total.
  - Milling equipment was main location at 18.6%.
Dust Explosions - General

- The likelihood is that a fire in a dust layer will occur rather than a dust cloud explosion.
- Where there is a presence of dust layers the first explosion event can whirl up the dust layers and ignite them. This process can repeat itself in a chain reaction, so that in this manner it can lead to devastating and expanding consecutive explosions over large operating areas.
Grain Silo Explosion In Blaye (France)

- Accident occurred in 1997 and resulted in 11 fatalities:
  - Aria No. 11657:
Minimum Quantity for a Dust Explosion

- For many organic materials the lower explosive limit is 10-50 g/m³.
- An explosible dust cloud therefore resembles a very dense fog, visibility less than 2 m.
- A layer of flour 0.3 mm thick on the floor can in principle fill a room with an explosible dust cloud up to 3 m above floor level.
A dust cloud is an immediate explosion hazard:
- Every dust layer is a potential dust cloud.
Explosive Properties of a Dust

- Intuition is a good guide to the flammable properties of liquids, but a poor friend with regard to explosive properties of a dust.
- Many common compounds form explosive dusts, e.g. milk powder, coffee, aluminium powder, flour, grain and aspirin.
- It is normally necessary to test the powder in a specialist laboratory.
- The compound must be fine (<0.5 mm) and dry; if moisture content is greater than 25% it is unlikely to be held in suspension ➞ weak or no explosive properties.
- Dust properties depend on the processing conditions, finer dusts are far more explosive:
  - Conditions depend on the performance of the equipment, e.g. mills, abrasion in conveyors, etc.
Explosive Properties of Dusts

• Therefore dust explosion testing required if data not already available; can be €7,000 per sample plus cost of destroying about a kilo of material.
Explosion Protection Measures
Explosive Atmospheres
careful.
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Protective Measures in order of PRIORITY

• **Avoidance of explosive atmospheres**, e.g. sealed equipment, clean plant, inerting.

• **Avoidance of ignition sources**, e.g. ATEX certified equipment for areas zoned as hazardous.

• **Constructional explosion protection**, e.g. explosion resistant construction, explosion venting, explosion suppression, explosion isolation.

• Where necessary be combined and / or supplemented with measures against the propagation of explosions.
Avoidance of Explosive Atmospheres: Replacement

• For example:
  • Replacing a flammable substance by a non-flammable substance, e.g. hydrocarbons with a low flash point by other hydrocarbons, whose flash point exceeds the ambient temperature by a sufficient margin (usually 15°C).
  • Processing a dust with a larger grain size thereby reducing the extent of the flammable atmosphere.
  • Processing a dust with a higher moisture content.
Avoidance of Explosive Atmospheres: Inerting

- Oxygen is displaced by non-flammable gases such as nitrogen or carbon dioxide to such an extent that an explosion can no longer take place.
  - Reliable method used in closed plant items such as vessels, dryers, centrifuges, etc.
  - Oxygen analysers or defined purge cycles used to ensure inert atmosphere.
  - Oxygen limits / procedures must be adhered to.
  - Widely practiced in the chemical industry and coal mills.

- Less widely used is the addition of inert solids to combustible solids, e.g. use of limestone rock dust in coal mining.
Example of Inerting


F.3 Top discharge centrifuge

Key
1 = Low pressure inert gas supply
2 = Vent
3 = Pressure control or oxygen control
4 = Inert gas supply to bearings

PI = Pressure Indicator
PC = Pressure Controller
FI = Flow Indicator
O₂ = Oxygen sensor
Limiting the Explosive Atmosphere: Closed Systems (Sealed Plant)

- A high quality plant with sealed equipment, such as enclosed conveyors or high specification piping, will reduce if not eliminate the formation of explosive atmospheres external to the equipment.
- Leakproof systems are available, e.g. welded pipe, sealed conveyors and transfer systems ➔ no Jubilee hose clips.
- Such a plant must be maintained to this high standard.
Limiting the Explosive Atmosphere: Ventilation

- Ventilation, particularly with flammable vapours, can be used to reduce the local concentration and extent of hazardous area. Unlikely to eliminate the zone entirely.
- Ventilation equipment, such as local extract arms, must be maintained in good condition and used correctly.
- For vapours heavier than air the exhaust gas outlets should be positioned near the floor and for gases lighter than air (usually only hydrogen) near the ceiling.
• A dust cloud is an immediate explosion hazard, dust layers which build up over time are potential dust clouds.

• Sealed equipment and prompt cleaning, if dust layers are not left to the end of a shift and dust clouds are not present the area can be considered non-hazardous!

• Good housekeeping can therefore eliminate a dust hazard, KEEP IT CLEAN!

• If vacuum cleaners are used these must be Ex rated!!
Housekeeping: Avoid Generating Explosive Atmospheres!

ISSA Prevention Series No. 2044 (E) Dust Explosions
Avoidance of Ignition Sources: Use of Zones

• Directive 1999/92/EC requires hazardous places to be classified in terms of zones on the basis of the frequency and duration of occurrence of an explosive atmosphere.
• The extent of the protection measure is proportionate to the frequency of occurrence of the potentially explosive atmosphere.
• The more stringent the Zone, the more advanced / developed the protection measure.

• Zoned areas are designated by warning signs or appropriate markings.
<table>
<thead>
<tr>
<th>Zone 0</th>
<th>A place in which an explosive atmosphere consisting of a mixture with air or flammable substance in the form of gas, vapour or mist is present continuously, for long periods or frequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1</td>
<td>A place in which an explosive atmosphere consisting of a mixture with air or flammable substance in the form of a gas, vapour or mist is likely to occur in normal operation occasionally.</td>
</tr>
<tr>
<td>Zone 2</td>
<td>A place in which an explosive atmosphere consisting of a mixture with air or flammable substance in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.</td>
</tr>
<tr>
<td>Normal Operation</td>
<td>This means the situation where installations are used within their design parameters</td>
</tr>
</tbody>
</table>

Zoning Flammables (IEC 60079-10-1)
## Zoning Dusts (IEC 60079-10-2)

<table>
<thead>
<tr>
<th>Zone</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 20</td>
<td>A place in which an explosive atmosphere in the form of a cloud of combustible dust in the air is present continuously, or for long periods or frequently.</td>
</tr>
<tr>
<td>Zone 21</td>
<td>A place in which an explosive atmosphere in the form of a cloud of combustible dust in the air is present during normal operation occasionally.</td>
</tr>
<tr>
<td>Zone 22</td>
<td>A place in which an explosive atmosphere in the form of a cloud of combustible dust in the air is not likely to occur in normal operation, but if it does occur, will persist for a short time only.</td>
</tr>
<tr>
<td>Any other Source</td>
<td>Layers deposits and heaps of combustibles dusts shall be considered as ‘any other source’ which can form an explosive dust atmosphere.</td>
</tr>
</tbody>
</table>
Example – Tank of Flammable Liquid
Example – Tank of Flammable Liquid

Zone 1
Example – Tank of Flammable Liquid
German ATEX Guide for Bakeries – No Zone

DGUV Guidance ASI 8.52
Hazardous Area Classification

- Methodology prescribed in IEC 60079-10-1 (gases) and IEC 60079-10-2 (dusts), but how big should the zone be?
  - UK Energy Institute Model Code 15 – but petroleum orientated and calculation method dependent on knowing leak size.
  - IGEM/SR/25 Edition 2 - Hazardous area classification of Natural Gas installations – good, but limited to that sector.
  - German Ex examples (Beispielsammlung) developed over decades for gases, liquids and dust; very comprehensive, but in German only.

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Avoidance of Ignition Sources

- Thirteen different ignition sources recognised:
  - Hot surfaces
  - Flames and hot gases
  - Mechanically generated sparks
  - Electrical apparatus
  - Stray electrical currents, cathodic corrosion protection
  - Static electricity
  - Lightning
  - Electromagnetic fields in the frequency range from 9 kHz to 300 GHz
  - Electromagnetic radiation in the frequency range 300 GHz to 3 x 10^6 GHz or wavelength range from 1,000 µm to 0.1 µm (optical spectrum)
  - Ionising radiation
  - Ultrasonics
  - Adiabatic compression, shock waves, gas flows
  - Chemical reactions
Possible ignition sources

ISSA Prevention Series No. 2032E: Gas Explosions
All Potential Ignition Sources must be Controlled

- Dangerous electrical installation
- Broken gland on electrical equipment – dust ingress
- Cigarette butts
- Hot work in hazardous area
• Once an area is zoned only equipment certified for that zone or a more stringent zone can be used.
• Under ATEX this applies to both electrical and non-electrical equipment, where previous older standards related to electrical equipment only.
• Non-certified equipment, such as maintenance equipment, can be used under a hot work permit.
• With a few exceptions, non-certified fork trucks cannot be used in zoned areas.
Hazardous Areas – Equipment (ATEX)

- From July 2003 ATEX equipment for zoned areas should be certified to the following categories.
  
  - Zone 0 - Category 1 G equipment
  - Zone 1 - Category 1 G or 2 G equipment
  - Zone 2 - Category 1 G, 2 G, or 3 G equipment
  
  - Zone 20 - Category 1 D equipment
  - Zone 21 - Category 1 D or 2 D equipment
  - Zone 22* - Category 1 D, 2 D, or 3 D equipment (*For conductive dusts unless equipment specially marked for Zone 22 minimum 2 D equipment required)
IECEx Equipment Protection Levels (EPLs)

- Essentially same system, just different designation
  - Zone 0 ➞ Ga
  - Zone 1 ➞ Ga, Gb
  - Zone 2 ➞ Ga, Gb, Gc

  - Zone 20 ➞ Da
  - Zone 21 ➞ Da, Db
  - Zone 22 ➞ Da, Db, Dc
ATEX Category and Degree of Protection

- **Category 1**: Requisite level of protection even in the event of rare incidents relating to equipment - 2 levels of protection or assure the requisite level of protection in the event of the two faults occurring independently of each other.

- **Category 2**: Requisite level of protection, even in the event of frequently occurring disturbances or equipment faults which normally have to be taken into account - 1 level of protection based on frequent disturbances or faults.

- **Category 3**: Requisite level of protection during normal operation – 1 level of protection based on normal operation.
ATEX Category and Degree of Protection

- Category 3 – Only have to consider faults in normal operation. Nothing special or expensive, vendors can self-certify!

- Category 2 – Faults related to frequent disturbances have to be considered. Starts to get more complex, vendors can self-certify non-electrical equipment, but need Notified Body for electrical equipment.
EX Category and Degree of Protection

- Category 1 – Rare faults need to be considered and two independent levels of protection applied. Approval of Notified Body required.

- Category 1 equipment is horribly expensive, often seven times more expensive than Category 3 (exception is instrumentation).

- Therefore design out Zone 0 / 20 areas as much as possible or restrict equipment in them to instrumentation.
Labelling of Ex Equipment

Typical ATEX/IECex Marking

- European Conformity Mark
- Notified Body Number
- Explosion Protection Mark
- Equipment Group
- Equipment Category
- “G” for GAS
- “D” for DUSTS
- Protection Type Code
- Gas Group
- Temp Code
- Equipment Protection Level

* ATEX Only
* ATEX/IECex
Electrical Equipment for Hazardous Areas

• This is very defined in the IEC 60079 series of standards.
• Standards have to be rigorously followed with respect to design, installation, commissioning and maintenance, e.g. cable types, tightening of bolts on enclosures, etc.

• Some limited examples of protection types to follow.
Increased Safety – E x e

- **Applicable Code:** IEC 60079-7
- **Design Principles:** Increased safety protection is based on the prevention of arcs, sparks or excessive temperatures through the imposition of more stringent design criteria than are the norm in industrial equipment.
Intrinsically Safe – E x i

- **Applicable Code:** IEC 60079-11 and IEC 60079-25
- **Design Principles:** Intrinsically Safe Protection is based on limiting the energy which can flow into the hazardous area to a level which is too low to ignite the hazardous atmosphere.

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**Diagram:**

- Hazardous Atmosphere
- Safe Area
- Associated Apparatus (Usually Barrier)
- Intrinsically Safe Apparatus

**Intrinsically Safe Protection**

**E x i**
**Applicable Code:** IEC 60079-1

**Design Principles:** Flameproof protection relies on the enclosing of parts, which are capable of igniting a hazardous atmosphere within an enclosure, which is capable of withstanding the pressure developed by an internal explosion and which will prevent the transmission of any such explosion or combustion to the explosive atmosphere surrounding the enclosure.
What is Non-electrical Equipment?

- EU’s guidance on ATEX ‘equipment’ Directive 94/9/EC:
  - A final product assembled using both electrical and mechanical elements may not require assessment as electrical equipment provided the combination does not lead to additional ignition hazards for this assembly.
  - An assembly of components comprising moving parts driven by an electrical motor may well be considered as non-electrical equipment.
  - However, non-electrical equipment not defined.
Historical

- National standards for electrical equipment were well developed by the time the EU started implementing its ATEX (explosive atmospheres) legislation in the period 1994 – 2003.
- However, there was no equivalent process or standards in place for non-electrical equipment.
- Certainly confusion occurred and many suppliers tried to take advantage of it; the ‘Y2K’ syndrome was evident.
Reality of situation

- EN 13463-1:2009
- Whereas common electrical equipment working within its design parameters often contains effective ignition sources, this is not true for most mechanical equipment.
- In most cases, the normal operation of mechanical equipment within its design parameters will not lead to ignition of an explosive atmosphere.
- In other words, most mechanical equipment performing its designed duty without malfunctions and with proper maintenance will not produce ignition sources in normal operation.
- Thus, additional protective measures that are commonly used for electrical explosion protected equipment (e.g. enclosures) are not needed.
• EN 13463-1:2009
• Even where malfunctions have to be considered, much mechanical equipment can meet the requirements for Category 2 equipment by a proper choice of well-tried constructional measures that would reduce failures causing ignition sources to an acceptably low level.
Differences to electrical equipment

- Electrical equipment associated with inherent electrical ignition sources ➔ control of ignition sources.

- Non-electrical equipment not associated with inherent ignition sources ➔ typical approach is based on an ignition hazard assessment to prevent occurrence of effective ignition sources.
Methodology for the risk assessment of non-electrical equipment - EN 15198:2007

Figure 1 – Ignition risk assessment for design of equipment or component (extracted from EN 15198:2007)

1 Protective measures/types of protection and equipment conformity are not part of ignition risk assessment.
Non-Electrical Equipment
Preventive measures and protective measures / types of ignition protection

- EN standards available for:
  - Prevent ignition sources arising: Constructional Safety “c”;
  - Ensure ignition sources cannot become active: Control of Ignition Sources “b”;
  - Standards to prevent explosive atmosphere reaching ignition source: Liquid Immersion “k”, Pressurisation “p”, Flow Restricting Enclosures “fr”;
  - Standards to contain the explosion and prevent flame propagation: Flameproof Enclosures “d”, Flame arrestors, Explosion-resistant design;
  - Standards for protective measures are: explosion relief, explosion suppression, explosion isolation systems.
Static Implications

- Annex II section 2.3 of directive 1999/92/EC states that;
  - “prevention of ignition hazards in accordance with Article 3 must also take account of electrostatic discharges, where workers or the working environment act as charge carrier or charge producer.
  - Workers must be provided with appropriate clothes consisting of materials which do not give rise to electrostatic discharges that can ignite explosive atmospheres”.
Electrostatic brush discharges are ubiquitous – such as walking across the room and touching a door handle.

Such electrostatic discharges amount to an energy of 4 mJ.

Flammable solvents are ignited by less than 1 mJ.

Small electrostatic discharges will ignite all common solvents at or above their flashpoint.
In general equipment (vessels, pipes, etc) should have a resistance to earth of \( < 10^6 \, \Omega \).

International standards (IEC) require in Zones 0 and 1 that footwear and flooring should not exceed \( 10^8 \, \Omega \).

- For dusts same applies for Zone 20 and Zone 21 (when Minimum Ignition Energy < 10 mJ)
- This is called dissipative or more commonly ‘anti-static’.
- A bare concrete floor is dissipative, dirty floors or shoes, particularly floors with paint or oil residues are not!
- Be careful with overshoes or working at height!
- Note: No restrictions for Zone 2 or 22 unless charging mechanism is continuous.
Flexible IBCs (Big bags)

• Flexible intermediate bulk containers (FIBCs) are widely used for storage and transport of powders.
• There are four types of FIBCs; A, B, C and D in increasing level of anti-static precautions.
• Make sure the correct type of FIBC is used and the correct earthing procedure for that FIBC!
• Same principle applies to plastic drum liners!
Earthing Straps

- When filling / unloading drums or IBCs it is essential to use the correct earthing straps provided.
- Similarly if a conductive hose, such as a metal braided hose, is specified then non-conductive hoses should not be used.
- Failure to follow correct earthing procedures could lead to ignition!
Mitigate the Detrimental Effects of an Explosion - Constructional Explosion Protection

- It may not be possible to avoid an explosive atmosphere and an ignition source, such as:
  - A hot surface within a dryer ➔ self ignition / glowing nest.
  - The internals of a high speed mill.
  - We cannot guarantee complete elimination of small electrostatic discharges.
    - If the powder is not ignition sensitive, Minimum Ignition Energy (MIE) > 10 mJ, then avoidance of ignition sources on its own can be seen as the single protective method.
    - If the powder is ignition sensitive, MIE < 10 mJ, we need to consider additional measures.
  - The choice is to inert or apply constructional measures.
Examples of Constructional Measures

- Constructional explosion protection: Explosion resistant design, explosion venting, explosion suppression.

ISSA Prevention Series No. 2032E: Gas Explosions
Example of Explosion Venting

- Venting of a 250m³ vessel – explosion venting is violent and can damage adjoining infrastructure and injure personnel present.
ATEX requires that measures of prevention of explosive atmospheres, avoidance of ignition sources and mitigation of explosions shall where necessary be combined and / or supplemented with measures against the propagation of explosions.
Explosion Isolation: Rotary Valve (Certified)
Explosion Isolation: Extinguishing Barrier

ISSA Prevention Series No. 2033 (E) Dust Explosion Prevention and Protection
Explosion Isolation: Rapid Action Gate Valve

ISSA Prevention Series No. 2033 (E) Dust Explosion Prevention and Protection
Explosion Isolation: Rapid Action Barrier Valve (Passive device)
Explosion Isolation: Rapid Action Barrier Valve (Active Device)
Explosion Isolation: Explosion Diverter

ISSA Prevention Series No. 2033 (E) Dust Explosion Prevention and Protection
Constructive and Explosion Propagation Measures

- The technology relating to constructive and explosion propagation measures is only relatively recently established. Older plants in general do not meet best practice, but neither is it realistic to completely rebuild them.
- For a new plant they can be incorporated efficiently in the design stage, it is like a modern car that now comes complete with air bags – but how many air bags?
- Measures should be risk appropriate!
Organisational Protection Measures
Explosive Atmospheres

organise.
Organisational Measures

• Complimentary to preventive and constructional measures, organisational measures must be taken to reduce the risk of fire and explosion and to ensure the effectiveness of the technical measures.

• In particular if plant equipment, processes or materials are changed it is necessary to review that the explosion protection measures are adequate.

• In EU legislative requirement to keep the Explosion Protection Document up to date.
ATEX Compliance - Organisational Measures

• Need to demonstrate in Explosion Protection Document adequate:
  • Work procedures
  • Training of staff
  • Hot work permits
  • Warning signs on entry to hazardous areas
  • Coordination duties

• CULTURE! – Difficult to change a dirty plant to a clean plant, but with a new plant it is handed over clean and should always remain that way.
Organisational Measures

ISSA Prevention Series No. 2032E: Gas Explosions
Provision of Operating Instructions and Training

- The operating instructions must govern the behaviour of the employees during normal operation and in the case of a malfunction. The responsibilities for the implementation of the measures must be clearly specified.
- The employees must be informed of possible hazards at regular intervals and their attention drawn to the proper code of behaviour.
Monitoring and Maintenance

- Particular attention should be paid to regularly checking and maintenance of the plant, particularly safety devices such as sensors and any equipment / plant units which could act as ignition sources, e.g. bearings.
Protective Clothing / Equipment and Plant Cleaning

- The necessary protective clothing and equipment, e.g. conductive shoes, must be provided, used and kept in serviceable condition.
- Cleaning must be carried out not only at regular intervals but also particularly during or after work which produces any dust deposits.
Signposting or Closure of High-Risk Zones

• Areas (Zones) which are endangered by explosion must be signposted.
• Areas where there is a hazard due to explosion venting (effects of pressure and flames) or due to the use of inert gases (danger of suffocation) must be signposted and cordoned off.
Coordination Duties

- Where workers from several undertakings are present, each employer is responsible for all matters under his control.
- The employer responsible for the workplace is also responsible for coordinating the implementation of all measures concerning workers’ health and safety with all other employers sharing the workplace.
- The Explosion Protection Document shall state the aim of coordination and the measures and procedures for implementing it.
Summary

• ATEX is more comprehensive than previous regulations – particularly with regard to dusts and non-electrical equipment.
• In EU:
  • Companies must now be compliant
  • Equipment must comply with hazardous Zones
  • Work procedures must address hazards.
  • Training is required.
• Outside EU
  • Increasingly companies will be benchmarked against IECEx and emerging ISO standards.
• Explosion Protection Document – Legally required in the EU, but also relevant elsewhere as representative of good practice.
Questions or ?