

Dust Explosion Hazard Assessment

Including OSHA Combustible Dust NEP

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Dust Explosion Hazard Assessment

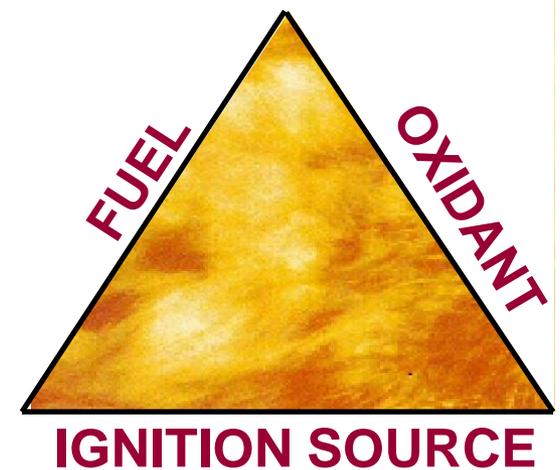
Including OSHA Combustible Dust NEP

Presentation Outline

- ❑ **CONDITIONS FOR A DUST CLOUD EXPLOSION**
- ❑ **OSAH COMBUSTIBLE DUST NATIONAL EMPHASIS PROGRAM (NEP)**
- ❑ **EXPLOSION CHARACTERISTICS OF DUST CLOUDS**
 - Sensitivity to Ignition
 - Explosion Severity
- ❑ **MANAGEMENT OF DUST CLOUD EXPLOSION RISKS**
 - Control of Flammable Atmospheres
 - Elimination of Ignition Sources
 - Explosion Protection

Fire Triangle

- ❑ **FUEL** – Liquid (vapor or mist), gas, or solid capable of being oxidized. Combustion always occurs in the vapor phase; liquids are volatilized and solids are decomposed into vapor prior to combustion
- ❑ **OXIDANT** – A substance which supports combustion – Usually oxygen in air
- ❑ **IGNITION SOURCE** – An energy source capable of initiating a combustion reaction



Conditions Required for Dust Cloud Explosions to Occur

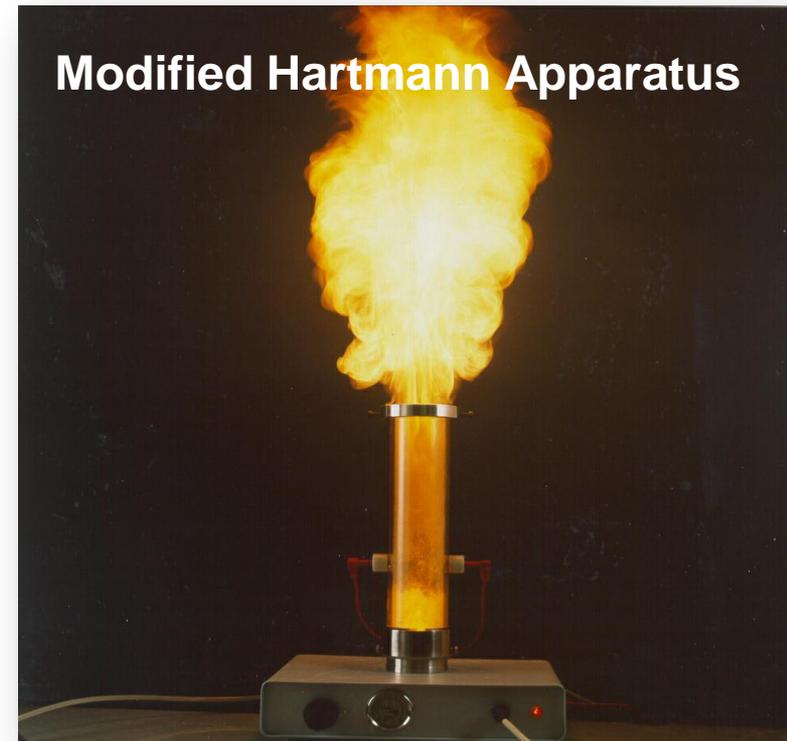
A number of conditions must exist simultaneously for a dust explosion to occur:

- Dust must be explosible (combustible, Flammable)
- Dust must be airborne
- Dust concentrations must be within explosible range
- Dust must have particle size distribution capable of propagating a flame
- The atmosphere in which the dust cloud is present must be capable of supporting combustion
- An ignition source with sufficient energy to initiate flame propagation must be present

Is Dust Cloud Explosible?

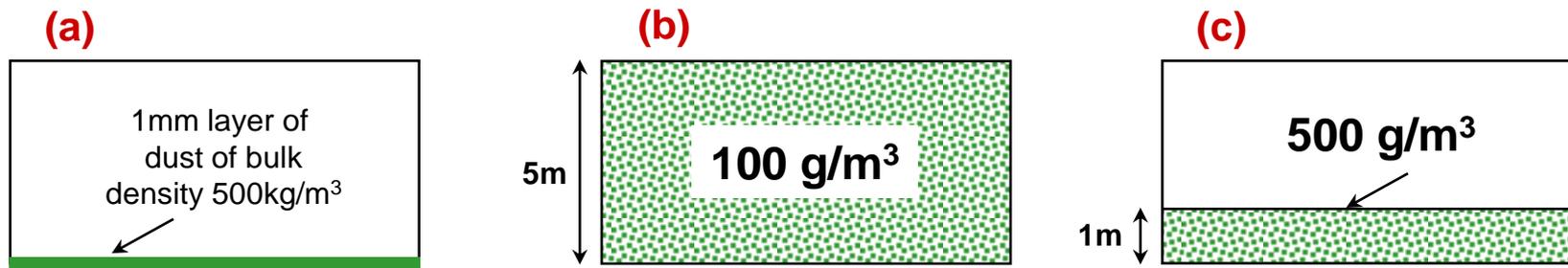
Use a Hartmann Bomb, 20L sphere or 1m³ sphere test vessel to determine whether the dust cloud is explosible at the dust handling/processing conditions.

- ❑ Dusts which ignite and propagate away from the source of ignition are considered “**explosible**” (Group A).
- ❑ Dusts which do not propagate flame away from the ignition source are considered “**non-explosible**” (Group B).
- ❑ Group B powders are known to present a fire hazard and may be explosible at elevated temperatures (e.g. in dryers)



Formation of Explosible Dust Cloud

Illustration of the potential hazard of even thin dust layers. A 1mm layer of a dust of bulk density 500Kg/m^3 will generate a cloud of average concentration 100g/m^3 if dispersed in a room of 5m height. Partial dispersion up to only 1m gives 500g/m^3 (Eckhoff)



$$C = P_{\text{bulk}} * h / H$$

- C is dust cloud concentration
- P_{bulk} is powder bulk density
- h is dust layer thickness
- H is dust cloud height in the room

Hybrid Mixtures

When combustible dust and flammable vapors co-exist

Hybrid mixture is hazardous for the following reasons:

- ❑ When combustible dusts and flammable gas/vapor mixtures are present below their respective flammable limits, they may form an explosible (hybrid) atmosphere when mixed together
- ❑ Dust mixtures in the presence of flammable vapors/gases may be more easily ignitable in air, even if the concentration of the vapor/gas is below its LFL
- ❑ Materials (powders) that are too coarse to be explosible may become explosible when in the presence of a flammable vapor/gas even if the vapor/gas is below its LFL

OSHA Combustible Dust National Emphasis Program (NEP)

CPL 03-00-008, March 11th, 2008

The purpose of this NEP is to inspect facilities that generate or handle combustible dusts which pose a deflagration or other fire hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape

OSHA National Emphasis Program (NEP)

OSHA Combustible Dust NEP Inspection and Citation Procedures Include:

- ❑ Assessment of the combustible dust threat to employees
 - *Does the MSDS indicate a dust explosion hazard?*
 - *Are dust accumulations hazardous?*
 - *What is the site history of fires involving dust?*
 - *Are the dust and management practices hazardous?*

- ❑ Collection of samples of combustible dusts for laboratory analysis
 - *From high places*
 - *From floors and equipment surfaces*
 - *From within ductwork*

OSHA will only characterize a sample sufficiently to prove (or disprove) that the sample meets the definition for Class II dusts based on E.S or the I.S test results

- ❑ Audit of dust management practices and equipment including dust collectors, ductwork, and other dust containers.
- ❑ Audit of room safeguards
- ❑ Audit of ignition source management

OSHA National Emphasis Program (NEP)

Tests which May be Performed to Determine Explosibility and Combustibility Parameters of Dusts

| Test | Particle Size | Moisture Content | Test Apparatus |
|---|------------------|------------------|--|
| % Through 40 Mesh (420µm) | As Received | As Received | 40 Mesh (420µm) Sieve |
| % Moisture Content | Less than 420µm | As Received | Drying Oven at 75°C for 24 hrs |
| % Combustible Material | Less than 420µm | As Received | Muffle Furnace at 600°C for 1 hr |
| % Combustible Dust | Less than 420µm | - | (Calculation) |
| Max. Normalized Rate of Pressure Rise - Kst | As Received | Less than 5% | 20-Liter Sphere (2500J Igniters) |
| Min. Explosible Concentration | Less than 420µm | Less than 5% | 20-Liter Sphere (2500J Igniters) |
| Class II* | Less than 75µm | | 1-Liter Hartmann Bomb for Explosion Severity (E.S) |
| Resistivity | As Received | As Received | |
| Minimum Ignition Energy (MIE) | Less than 75µm ? | ? | Hartmann Lucite Chamber |
| Minimum Ignition Temperature (MIT) | Less than 75µm ? | ? | Godbert-Greenwald Furnace |

- ❖ Classification of combustible dusts in accordance with the National Electric Code
- ❖ OSHA will only characterize a sample sufficiently to prove (or disprove) that the sample meets the definition for Class II dusts based on E.S or the I.S test results

Management of Dust Cloud Explosion Risks

- ❑ Site Audit
 - Understand process operations and existing measures (basis of safety) for eliminating/controlling dust explosion hazards
 - Identification of locations where combustible dust cloud atmospheres are or could be present during normal and abnormal operating conditions
 - Identification of potential ignition sources that could be present under normal and abnormal conditions
 - On-site electrostatic measurements (electrical field, electrical continuity measurements, etc.), where applicable
- ❑ Understanding of the explosion characteristics of the dust(s)
- ❑ Proper process and facility design to prevent and/or minimize the occurrence of dust explosions and protect people and facilities against their consequences
- ❑ Regular inspection and maintenance of equipment to minimize ignition sources and dust releases

Flammability of Dust Cloud Atmospheres

Laboratory Testing to Assess Flammability Characteristics

- ❑ **Under what conditions does the material support combustion?**
 - Minimum Explosible Concentration (Dust Clouds)
 - Limiting Oxygen for Combustion (Dust Clouds)

- ❑ **How easily will it ignite?**
 - Minimum Ignition Energy (Dust Clouds)
 - Minimum Ignition Temperature (Dust Clouds and Layers)
 - Thermal Decomposition
 - Impact and Friction Sensitivity

- ❑ **What will happen if it does ignite? (Consequences of Ignition)**
 - Maximum Explosion Pressure
 - Maximum Rate of Pressure Rise
 - Layer Burning Rate
 - Gas generation

- ❑ **Electrostatic Characteristics**
 - Chargeability
 - Surface Resistivity
 - Volume Resistivity / Conductivity
 - Discharge Incendivity

Management of Flash Fire and Explosion Hazards

- ❑ **Control of the spread of flammable atmospheres:**
 - Proper plant design
 - Use of local exhaust ventilation
 - Management of dust deposits

- ❑ Elimination/control of potential ignition sources including:
 - Electrostatic discharges
 - Mechanical friction and sparks
 - Hot surfaces and equipment
 - Thermal decomposition
 - Electrical arcs (sparks)

- ❑ Application of explosion safeguards:
 - Explosion protection (containment, relief venting, explosion suppression)
 - Explosion isolation
 - Inert Gas Blanketing

Control of the Spread of Flammable Atmospheres

- ❑ Equipment should be maintained and operated in a manner that minimizes the escape of material
- ❑ Regular cleaning frequencies should be established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility
- ❑ Continuous exhaust ventilation should be provided for processes where flammable vapor or combustible dust is liberated in normal operation so as to minimize the spread of the flammable atmosphere

Control of the Spread of Flammable Atmospheres - Ventilation

Main methods of ventilation for controlling flammable atmospheres include:

Dilution Ventilation

- Provides a flow of fresh air into and out of the building
- Background concentration of the flammable atmosphere in the working area is reduced, but there is no control at the source of release
- This method is seldom used to control the concentration of dust cloud atmospheres

Local Exhaust Ventilation

- Intercepts the flammable atmosphere at the source of release and directs it into a system of ducting connected to an extract fan
- Less expensive to run than dilution ventilation because less air is used

Management of Flash Fire and Explosion Hazards

- ❑ Control of the spread of flammable atmospheres:
 - Proper plant design
 - Use of local exhaust ventilation
 - Management of dust deposits

- ❑ **Elimination/control of potential ignition sources including:**
 - **Electrostatic discharges**
 - **Mechanical friction and sparks**
 - **Hot surfaces and equipment**
 - **Thermal decomposition**
 - **Electrical arcs (sparks)**

- ❑ Application of explosion safeguards:
 - Explosion protection (containment, relief venting, explosion suppression)
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Elimination / Control of Potential Ignition Sources

- **Electrostatic Discharges**

Recommended Practice on Static Electricity – NFPA 77

The purpose of NFPA 77 is to provide assistance in controlling the hazards associated with the generation, accumulation, and discharge of static electricity by providing:

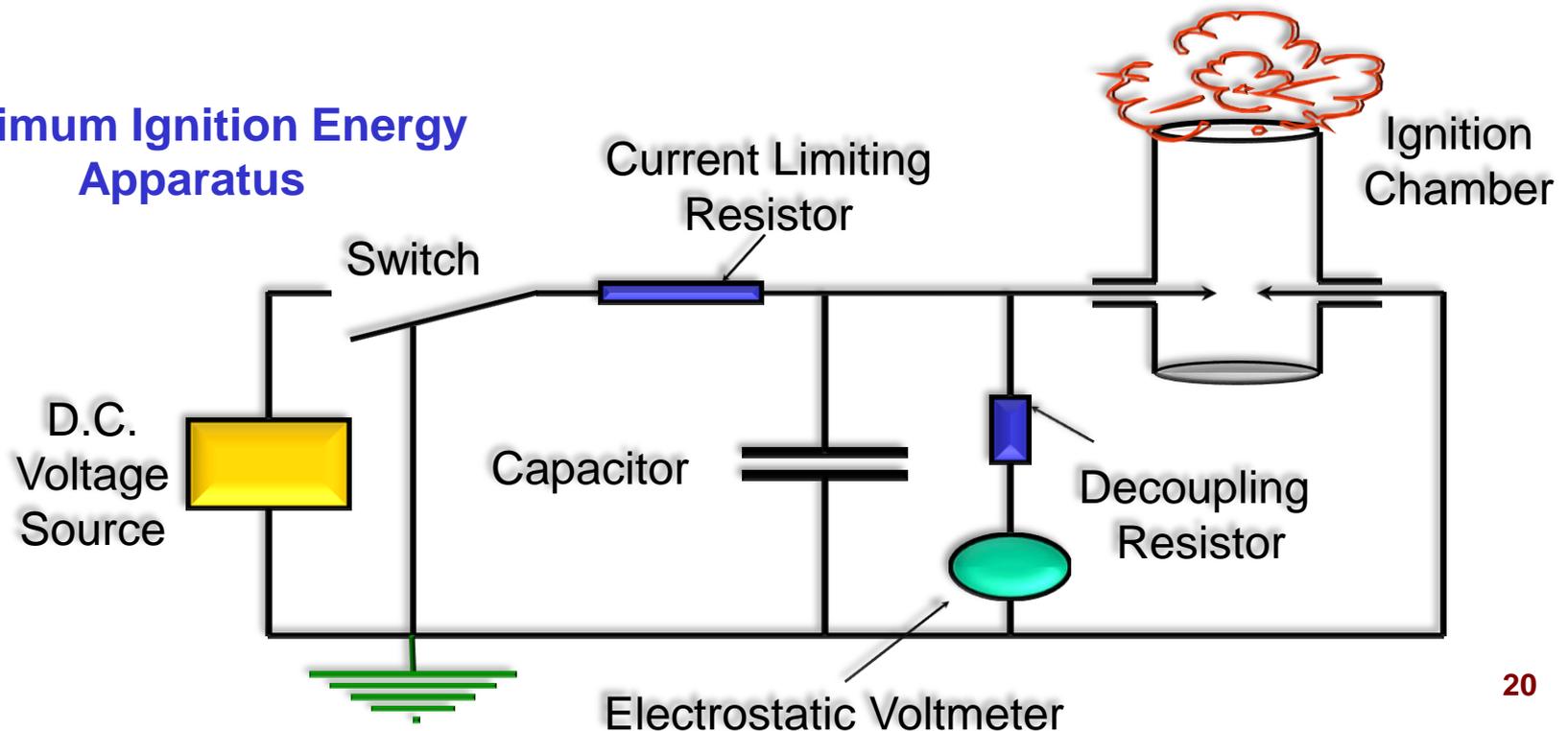
- A basic understanding of the nature of static electricity
- Guidelines for identifying and assessing the hazards of static electricity
- Techniques for controlling the hazards of static electricity
- Guidelines for controlling static electricity in selected industrial applications

Relevant Laboratory Test

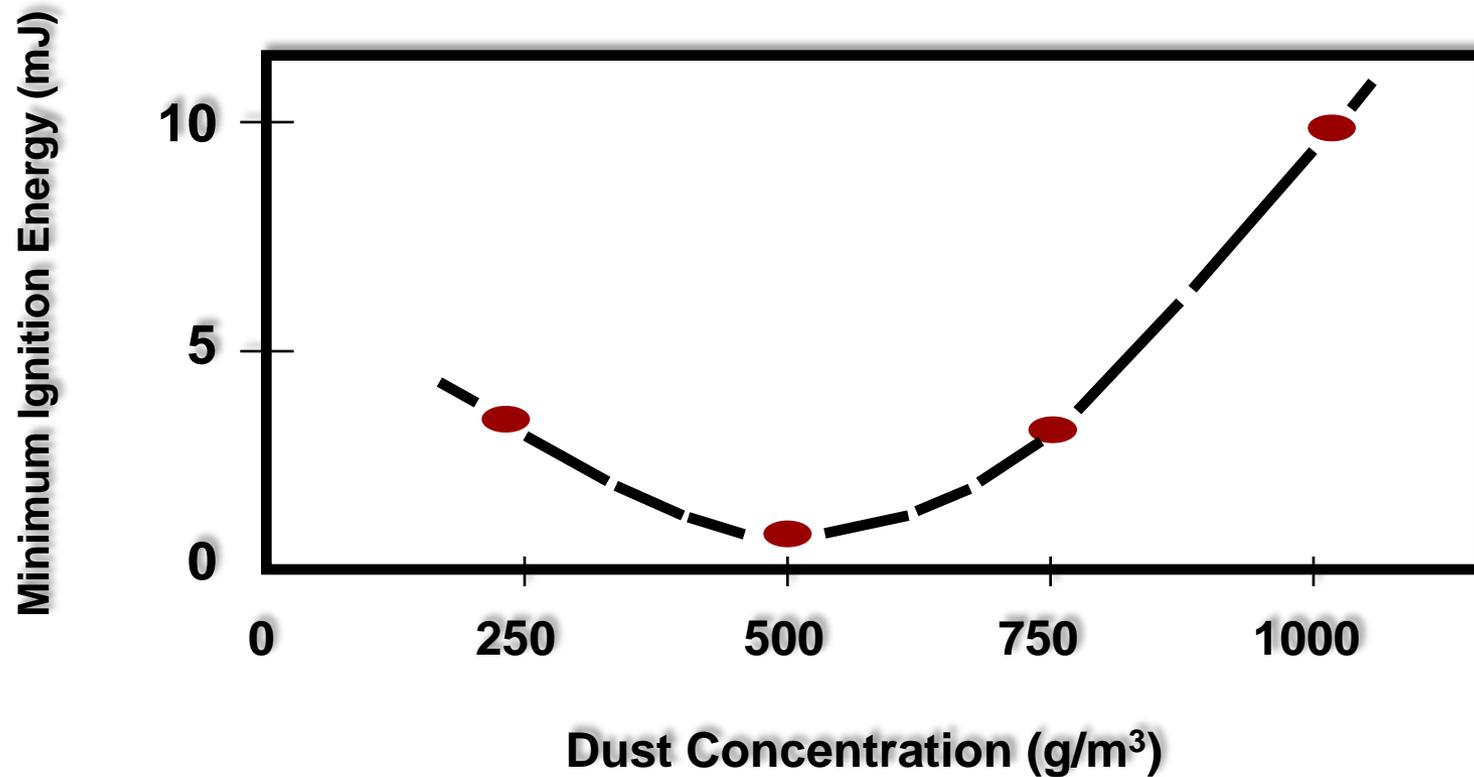
Minimum Ignition Energy (MIE), (ASTM E 2019)

MIE of a flammable material is the smallest electrostatic spark energy needed to ignite an optimum concentration of the material using a capacitive spark

Minimum Ignition Energy Apparatus



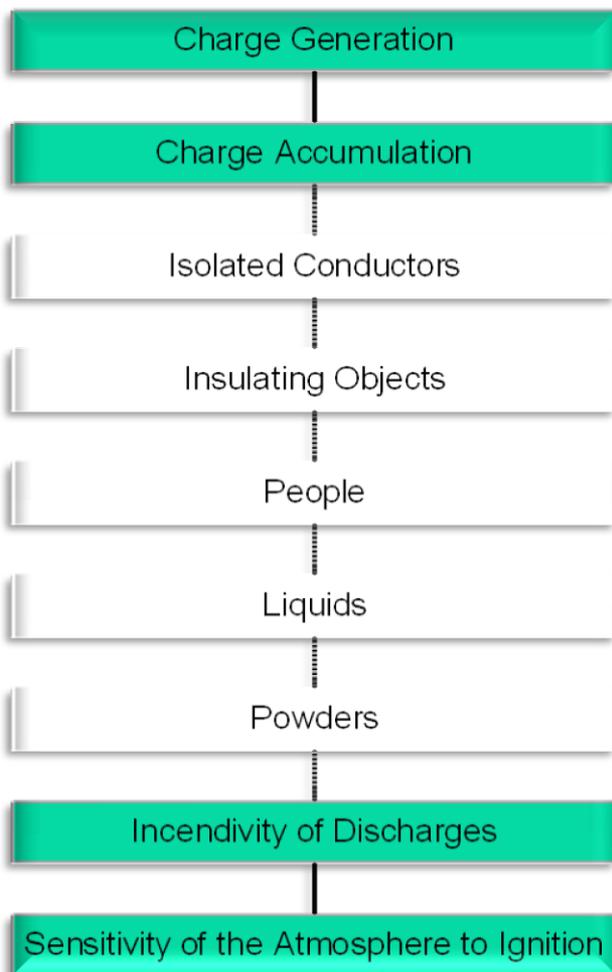
MIE and the Effect of Dust Cloud Concentration



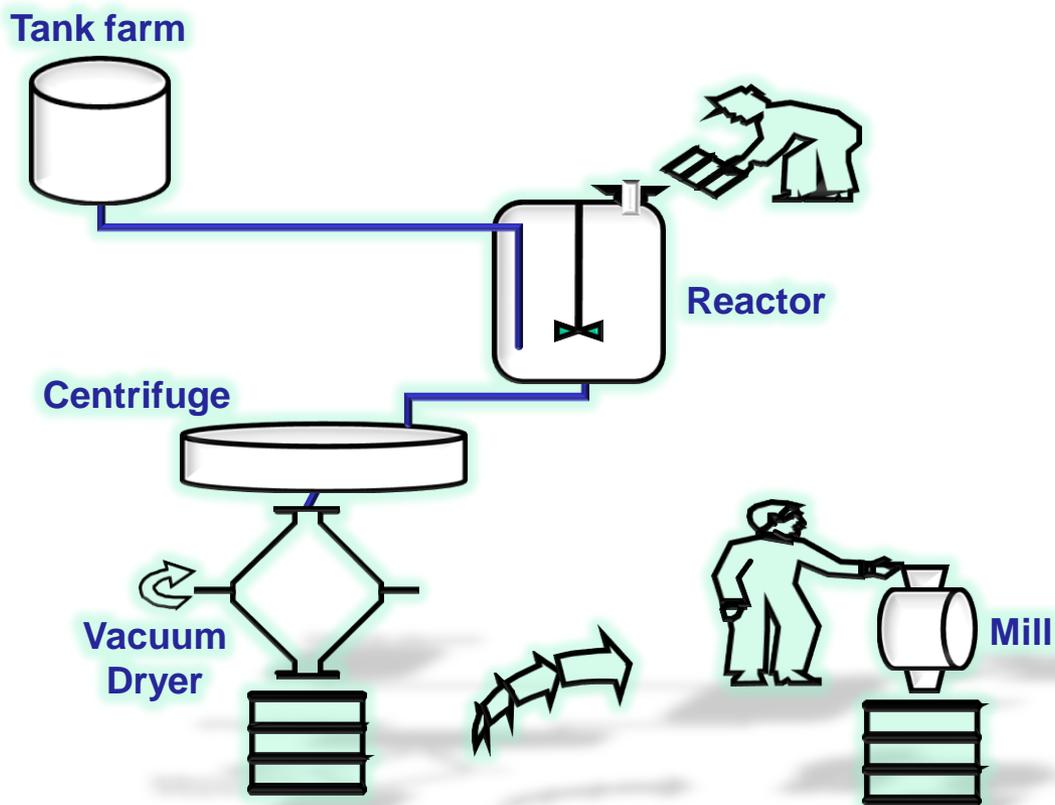
Factors Affecting Minimum Ignition Energy

| Some Influencing Factors | Effect |
|---|---|
| Increasing Particle Size |  |
| Increasing Moisture Content |  |
| Presence of Flammable Vapor (even if below LFL) |  |
| Increase in Ambient Temperature |  |

Systematic Approach to Electrostatic Hazard Assessment



Schematic of a Typical Chemical Processing Plant



Electrostatic Discharges and Their Control

Several types of electrostatic discharges are distinguished depending on resistivity and the geometric arrangement of the charged object and the geometry of the discharge initiating electrode:

❑ **Spark Discharge** - *Spark from ungrounded conductor*

Stored (Spark) Energy = $\frac{1}{2} C V^2$

- Resistance to ground should be checked. If $R > 10$ ohm, direct ground connection is required

❑ **Propagating brush Discharge** - *Discharge from the surface of an insulator backed by a conductor (e.g. plastic or glass-lined metal pipes and vessels) and from the surfaces of plastic pipes and hoses used for transfer of low conductivity liquids and pneumatic conveying of powders*

Maximum discharge energy of 1,000mJ to 2,000mJ

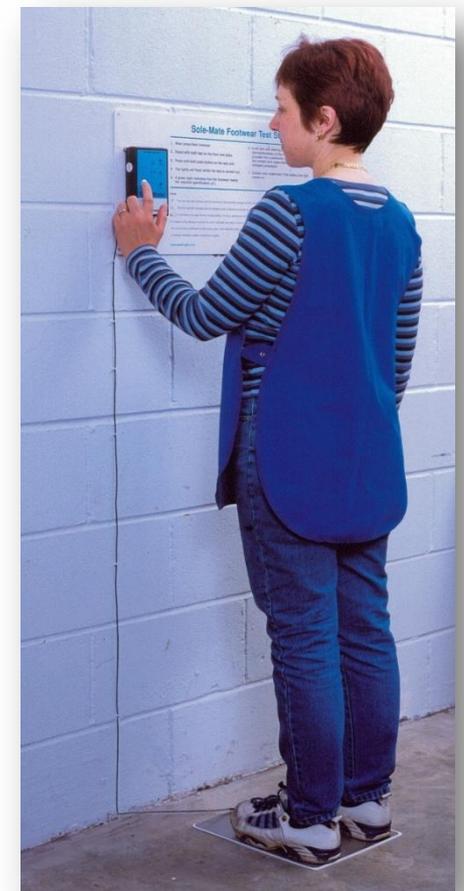
- Avoid the use of plastic pipes and hoses for pneumatic conveying of powders
- Avoid plastic containers/liners for powders with high charge densities

Electrostatic Discharges and Their Control

❑ *Discharges from Human Body*

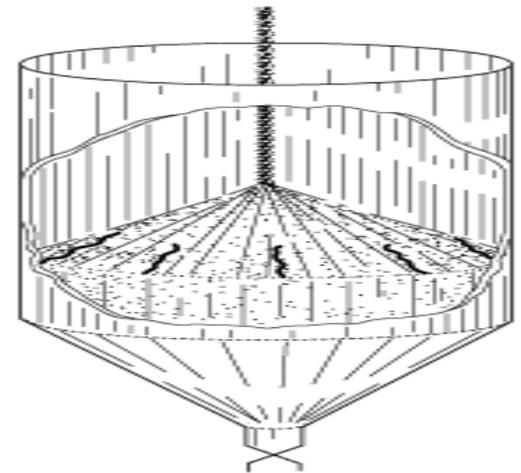
Maximum energy of about 25mJ to 30mJ

- Personnel should be grounded so that their resistance-to-ground $<1 \times 10^8$ ohm
- Static dissipative footwear may be used
- Resistance of the floor/surface on which the operator is standing should also be $<1 \times 10^8$ ohm



Electrostatic Discharges and Their Control

- **“Bulk”/“Cone” Discharge** - Discharges on the surface of the powder during filling of vessels/bins/containers
 - Discharge energy depends on powder Volume Resistivity, Electrostatic Chargeability, particle size, and vessel dimensions
 - Maximum discharge energy about 25mJ



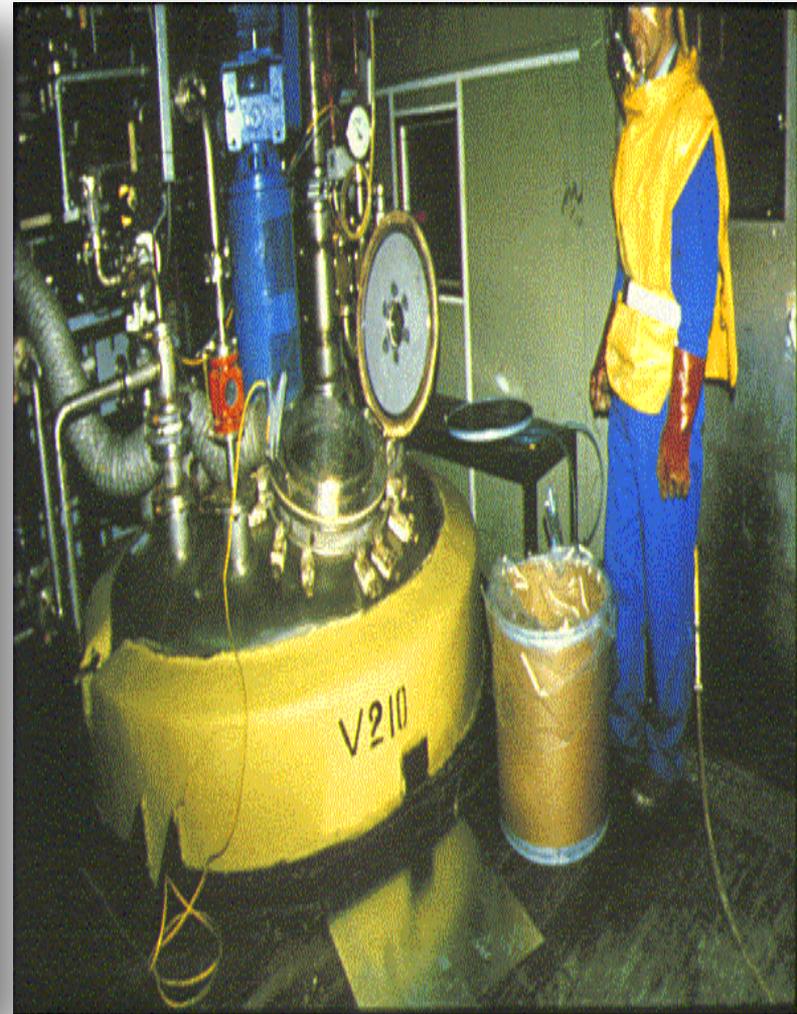
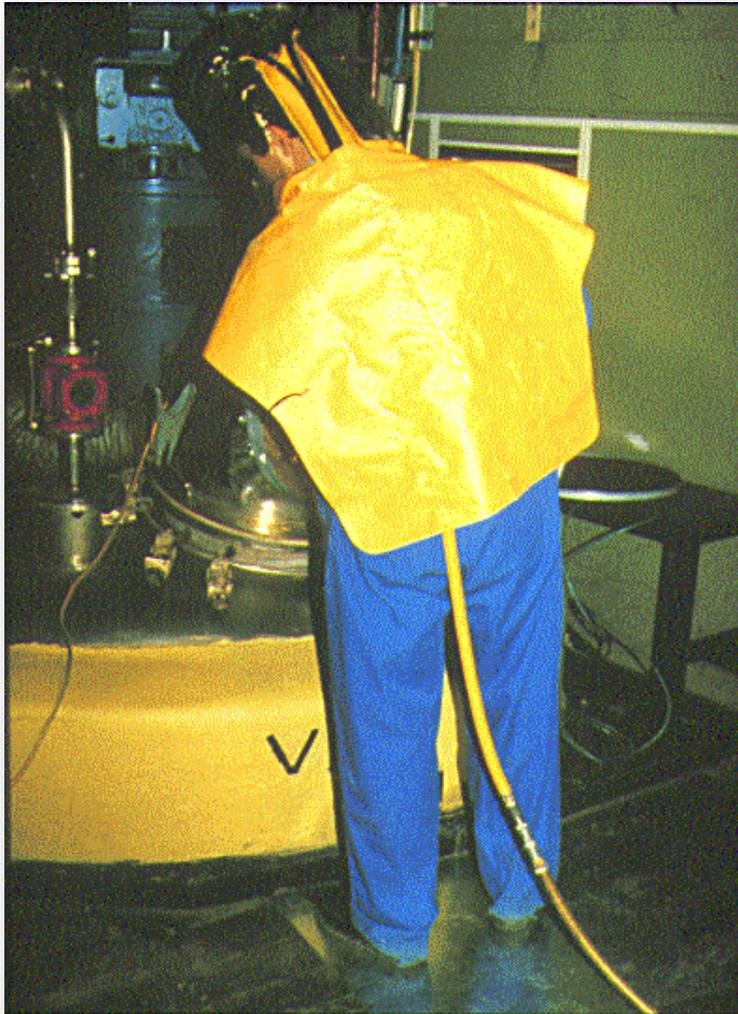
Electrostatic Discharges and Their Control

- **“Bulk”/“Cone” Discharge** - Discharges on the surface of the powder during filling of vessels/bins/containers
 - **Volume Resistivity $< 10^9$ Ohm.m**
No electrostatic charge accumulation and hence on “Bulk” discharge if powder is handled in grounded conductive plant
 - **Volume Resistivity $> 10^9$ Ohm.m and Minimum Ignition Energy > 25 mJ**
No electrostatic ignition hazard in grounded conductive plant
 - **Volume resistivity $> 10^9$ Ohm.m and Minimum Ignition Energy < 25 mJ**
 - If the Electrostatic Chargeability test results show that the quantity of electrostatic charge on the particles is sufficient to cause discharges from the surface of the bulking powder one of the following measures is suggested:
 - Installation of inert gas blanketing, or
 - Installation of explosion protection

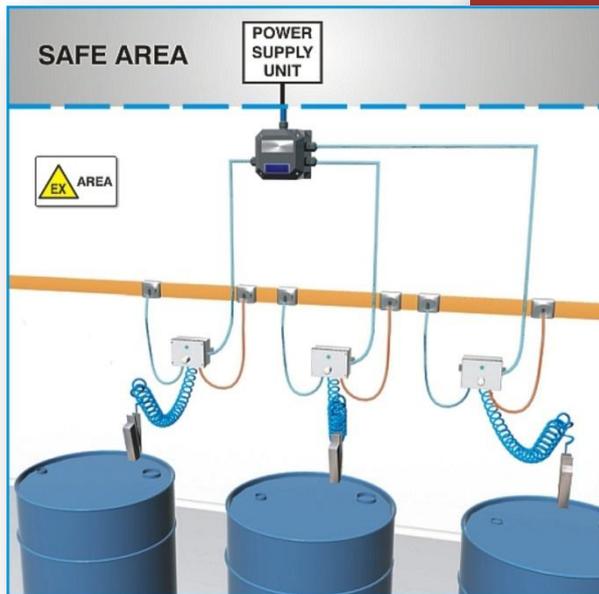
Electrostatic Discharges and Their Control

- **“Brush” Discharge - Discharges Between Conductors and Insulators**
 - Maximum discharge energy of 4mJ
 - Brush discharges are capable of igniting flammable gas and vapor atmospheres
 - Avoid the use of insulating (non-conductive) materials where flammable gas and vapor atmospheres might be present. Examples of insulating materials include plastic hoses, bags, liners, drums
 - **Consider conductive or static dissipative materials (Surface Resistivity < 1×10^{11} ohm/square)**

Manual Transfer of Powder to Reactor



Painted Metal Drums – Ground Clamp Must Penetrate the Paint



Fiberboard Drum – Metal Chime Must be Grounded



Elimination / Control of Potential Ignition Sources

- **Mechanical friction and sparks**
- **Hot surfaces and equipment**
- **Thermal decomposition**

Control of Heat Sources and Frictional Sparks

- ❑ If the material is subjected to heat as part of the normal process (e.g. during drying), the temperature should be maintained below the self heating temperature
- ❑ Isolation or shielding of hot surfaces
- ❑ Use of approved electrical equipment (correct temperature rating)
- ❑ Prevent overheating due to misalignment, loose objects, belt-slip/rubbing etc. by regular inspection and maintenance of plant
- ❑ Prevention/removal of dust accumulations on hot surfaces
- ❑ Preventing overloading of processing plant (grinders, conveyors, etc.)
- ❑ Prevent foreign material from entering the system when such foreign material presents an ignition hazard. Consider use of screens, electromagnets, pneumatic separators, etc.
- ❑ Hot work operations should be controlled by a hot work permit system in accordance with NFPA 51B, Standard for Fire Prevention During Welding, Cutting and Other Hot Work

Thermal Instability (Self-Heating)

- ❑ Ignition of bulk powders can occur by a process of self-heating
- ❑ Ignition occurs when the temperature of the powder is raised to a level at which the heat liberated by the exothermic reaction is sufficient to exceed the heat losses and to produce runaway increase in temperature
- ❑ The minimum ambient temperature for self-ignition of a powder depends mainly on the nature of the powder and on its dimensions

Thermal Instability Testing

EXPOSURE
TIME

SCALE
(THICKNESS + SHAPE)

AIR
AVAILABILITY

CONTAINMENTS

LABORATORY TESTING

BULK POWDER TEST

Simulate bulk powder in IBC,
Bags, bottom of hopper

AERATED POWDER TEST

Simulate fluidized bed drying

AIR OVER LAYER TEST

Simulate powder deposits
on dryer surfaces or walls

BASKET TEST

Simulate large scale storage
or transport conditions

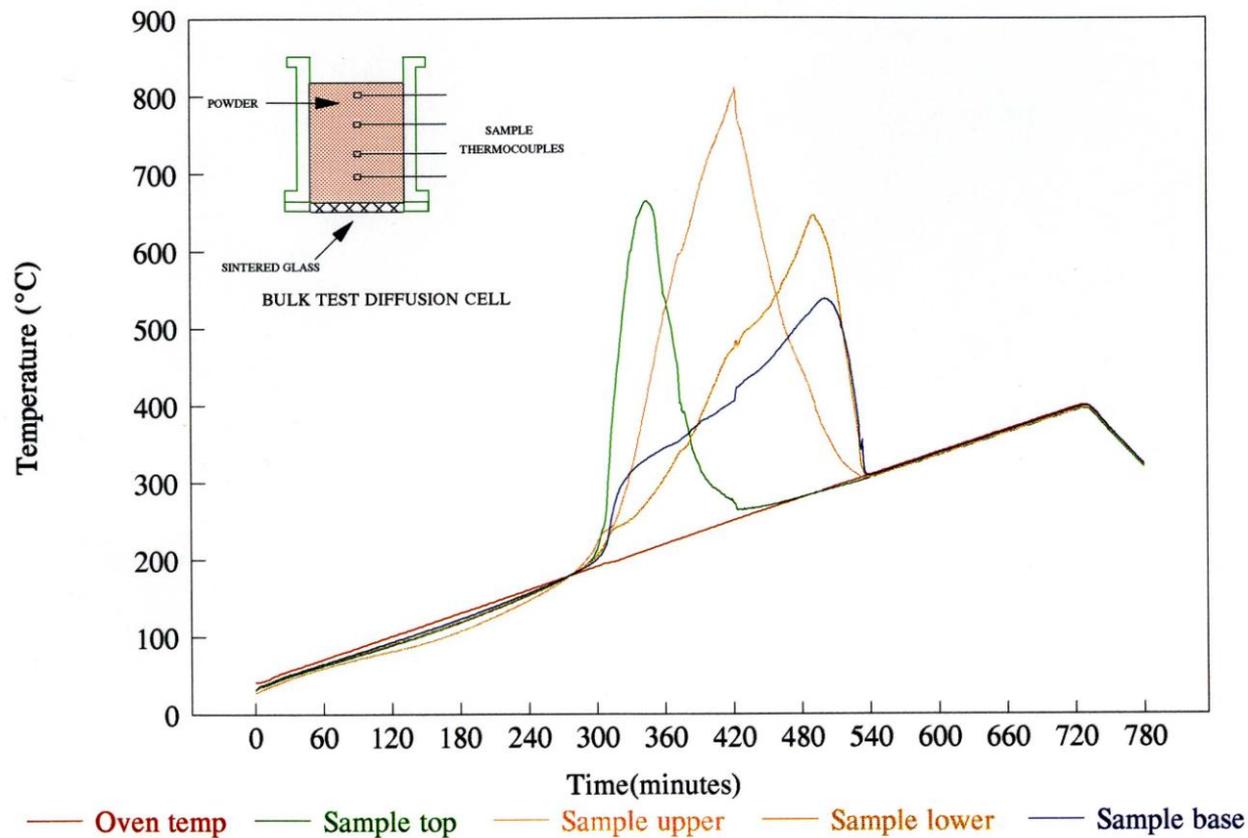
- Is difference between onset and drying temperature $< 50^{\circ}\text{C}$?
- Is drying cycle longer than screening test period?
- Is onset temperature $< 200^{\circ}\text{C}$?

ISOTHERMAL TEST

Temperature: 50°C above drying temp.
Duration: longer than drying or storage time

Thermal Instability (Self-Heating)

Bulk Powder (Diffusion Cell) Screening Test

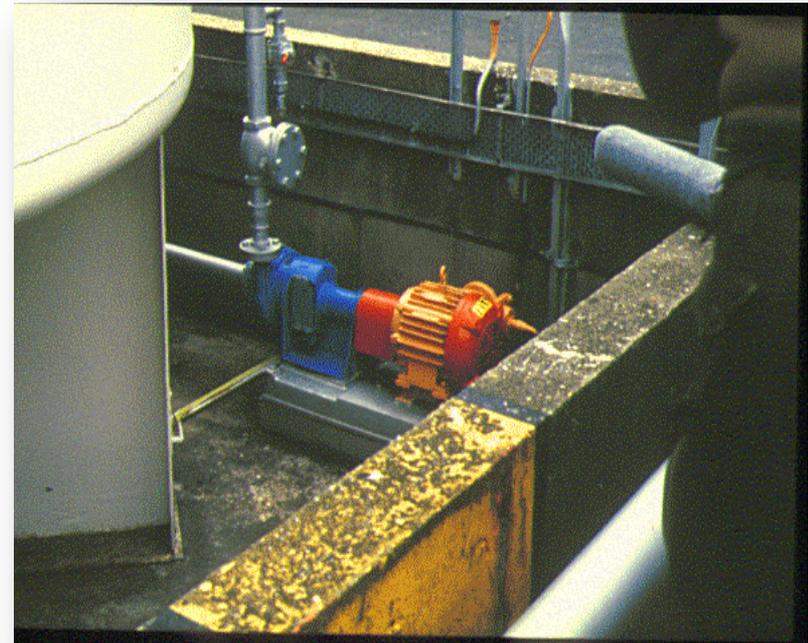


Elimination / Control of Potential Ignition Sources

- **Electrical arcs (sparks)**

Elimination/Control of Potential Ignition Sources – Electrical Equipment

- ❑ Incorrectly specified electrical equipment is a potent ignition source for flammable gases, vapors and dusts
 - Sparks
 - Hot surfaces
- ❑ In facilities handling flammable materials the electrical equipment used must be suitable for the environment in which it is to be used
- ❑ In order to determine the type of equipment it is necessary to define hazardous (classified) locations



Electrical Area Classification

- ❑ Electrical area classifications defined under Article 500 of the National Electrical Code (NFPA 70)
- ❑ The intent of Article 500 is to prevent electrical equipment from providing a means of ignition for an ignitable atmosphere
- ❑ Two classes of hazardous locations:
 - Class I Flammable gases or vapors (NFPA 497)
 - Class II Combustible dusts (NFPA 499)
- ❑ Two divisions of hazardous locations:
 - Division 1 Normally or frequently present
 - Division 2 Not normally present, but possible

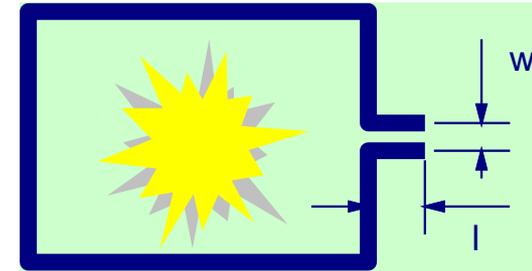
SIZING OF AREAS - AVAILABLE GUIDES

- ❑ **NFPA 70 / NEC (*National Electric Code*)**
- ❑ **NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas***
- ❑ **NFPA 499, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas***
- ❑ **ISA 12, The Instrumentation, Systems, and Automation Society**
- ❑ **API 500, *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Division 1 and 2***
- ❑ **BS EN 60079-10, *Electrical apparatus for explosive gas atmospheres, Part 10: Classification of hazardous areas* (British and European Standard)**
- ❑ **IEC Standards**
- ❑ **NEMA Standards**
- ❑ **UL Standards**

TYPES OF PROTECTION

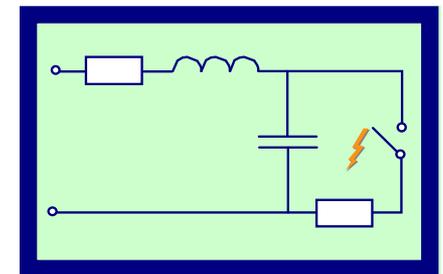
Explosion proof

- ❑ Housing able to contain explosion
- ❑ Narrow gap quenches the flame
- ❑ External surface temperature restricted



Intrinsically safe

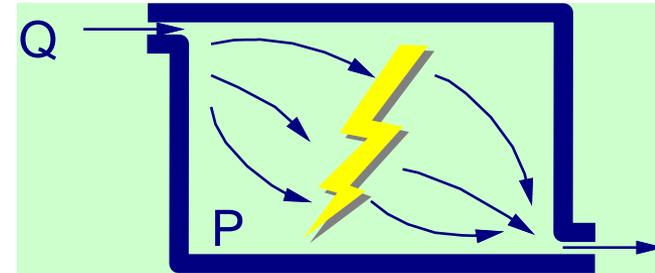
- ❑ Limit the energy and temperature available to a level too low to ignite the atmosphere
- ❑ Connected circuit is important



TYPES OF PROTECTION

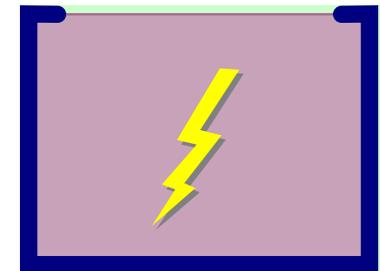
Purged or Pressurized

- Pressurized to exclude external atmosphere, and/or
- Continuous dilution to maintain non-flammable atmosphere
- T_{external} restricted



Hermetically sealed

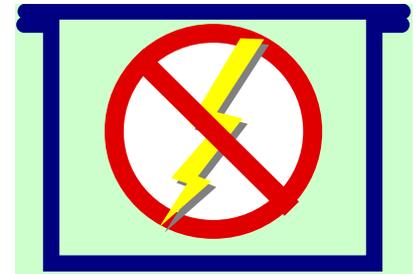
- A hermetically sealed device should be sealed against an external atmosphere and the seal should be made by fusion, e.g., soldering, brazing, welding, or the fusion of glass to metal
- T_{external} restricted



TYPES OF PROTECTION

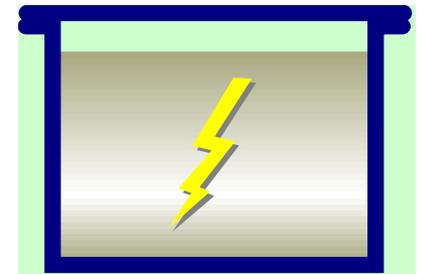
Non-incendive and Non-sparking

- ❑ Apparatus does not spark in normal operation or the spark is not capable of igniting the flammable atmosphere
- ❑ Restrict internal and external temperatures



Oil immersion

- ❑ All components immersed in oil so that flammable atmosphere cannot reach the potential ignition sources
- ❑ T_{external} restricted



Management of Dust Cloud Explosion Hazards

- ❑ Control of the spread of combustible dust atmospheres:
 - Proper plant design
 - Use of local exhaust ventilation
 - Management of dust deposits

- ❑ Elimination/control of potential ignition sources including:
 - Electrostatic discharges
 - Mechanical friction and sparks
 - Hot surfaces and equipment
 - Thermal decomposition
 - Electrical arcs (sparks)

- ❑ **Application of explosion safeguards:**
 - **Explosion protection (containment, relief venting, explosion suppression)**
 - **Explosion isolation**
 - **Inert Gas Blanketing**

Relevant Laboratory Test

Explosion Severity of Dust Cloud, K_{st} (ASTM E 1226)

□ An indication of the severity of dust cloud explosion

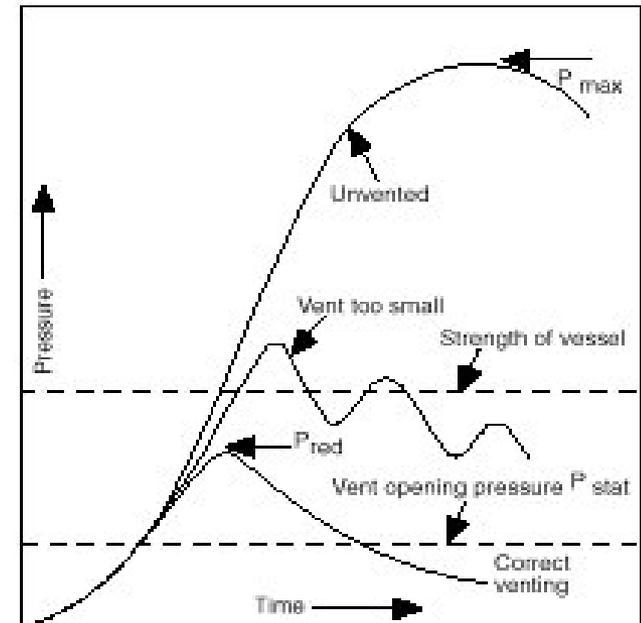
□ Data produced:

- Maximum developed pressure, P_{max}
- Maximum rate of pressure rise, $(dP/dt)_{max}$

□ Deflagration index (explosion severity) K_{st}

$$K_{st} = (dP/dt_{max}) \cdot V^{1/3} \quad [\text{bar.m/s}]$$

Where V is the volume of the test vessel (m^3)



□ Used for the design of deflagration protection (venting, suppression, Containment)

Explosion Severity - Dust Explosion Hazard Classification

Based on test data using 1m³ and 20L Vessels and 10KJ Ignition Source

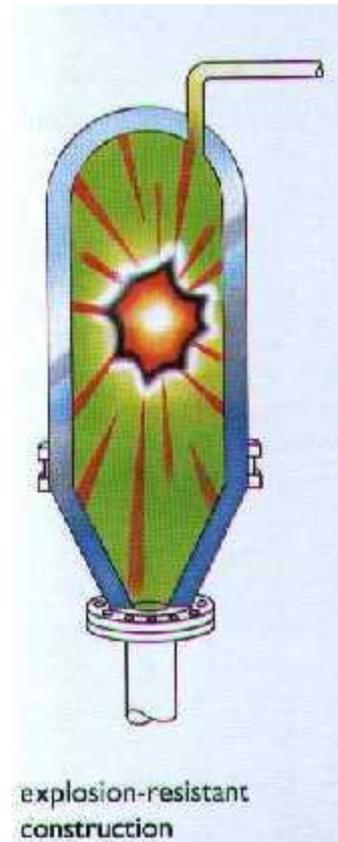
| Dust Explosion Class | K_{st} (bar.m/s) | Characterization |
|----------------------|----------------------|-------------------------------|
| St 0 | 0 | Non-explosible |
| St 1 | $0 < K_{st} < 200$ | Weak to moderately explosible |
| St 2 | $200 < K_{st} < 300$ | Strongly explosible |
| St 3 | $K_{st} > 300$ | Very strongly explosible |

Note:

- Any explosion can cause burn injuries
- Any explosion can cause structural damage if the structure is not strong enough

Explosion Protection Techniques – Containment

- ❑ Must withstand the maximum pressure that is expected
- ❑ All parts of the plant made strong
 - includes pipes, ducts, flanges, covers, etc.
- ❑ Maintain strength over lifetime
- ❑ Strong plant is expensive to build and can be difficult to operate

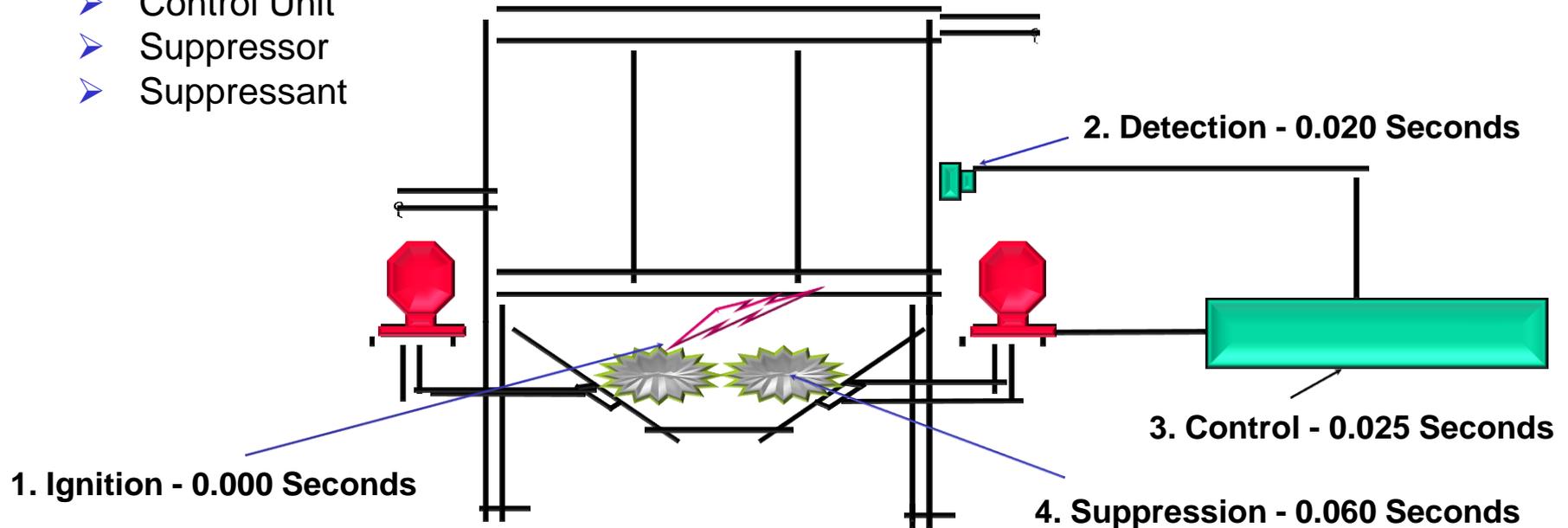


Explosion Protection Techniques – Explosion Suppression

Relies on early detection of an explosion and rapid injection of suppressant. Typically at moment of detection, explosion pressure is 35 to 100 m bar g. Suppressant extinguishes the flame within approximately 50msec.

To achieve explosion suppression, the following are required;

- Explosion Detector
- Control Unit
- Suppressor
- Suppressant

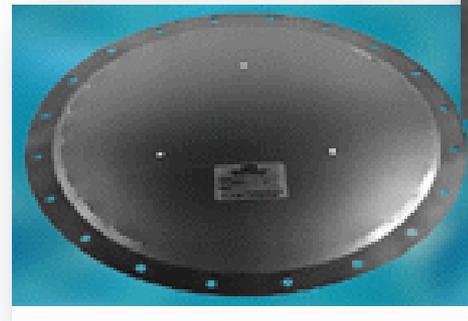


Explosion Protection Techniques – Venting

Relies on rapid opening of panel(s) or door(s) hence allowing the release of hot gases and unburnt product from within a process component or room

Advantages and disadvantages

- Relatively low cost
- Simple to install in most cases
- Not suitable for toxic materials
- Venting to inside of buildings is usually unacceptable



Explosion Protection Techniques - Isolation

An explosion, initiated in one plant item should be prevented from propagating along pipes, chutes, conveyors etc. and starting a subsequent explosion in other plant items.

The simplest isolation method is avoidance of unnecessary connections. If this is not possible, special measures should be taken to create barriers to avoid propagation of an explosion.

- **Mechanical Isolation (Barriers)**
- **Chemical Isolation (Barriers)**

Inert Gas Blanketing Techniques - NFPA 69

An explosion (or fire) can be prevented by reducing the oxidant concentration below a level that will no longer support combustion through the addition of an inert gas to the vessel where the flammable/combustible atmosphere exists.

There are 3 commonly used inerting techniques:

Pressure Purging

Vessel is pressurized with an inert gas, then relieved to the outside. This procedure is repeated until the desired oxygen concentration is reached.

Vacuum Purging

Vessel is evacuated and then pressure is increased to atmospheric using an inert gas.

Flow-Through Purging

Vessel is purged with a continuous flow of inert gas.

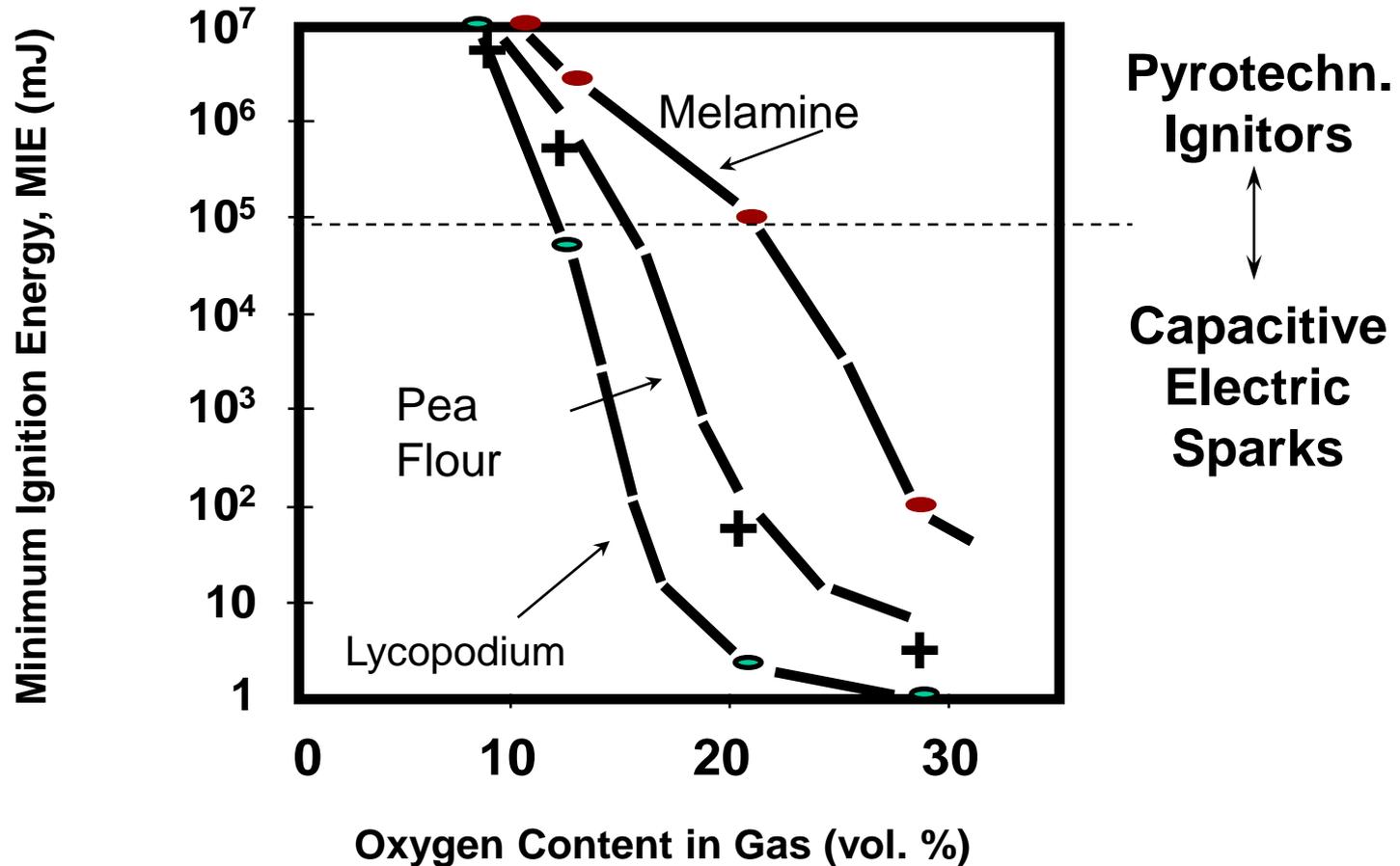
Relevant Laboratory Test

Limiting Oxidant Concentration (ISO 6184/1)

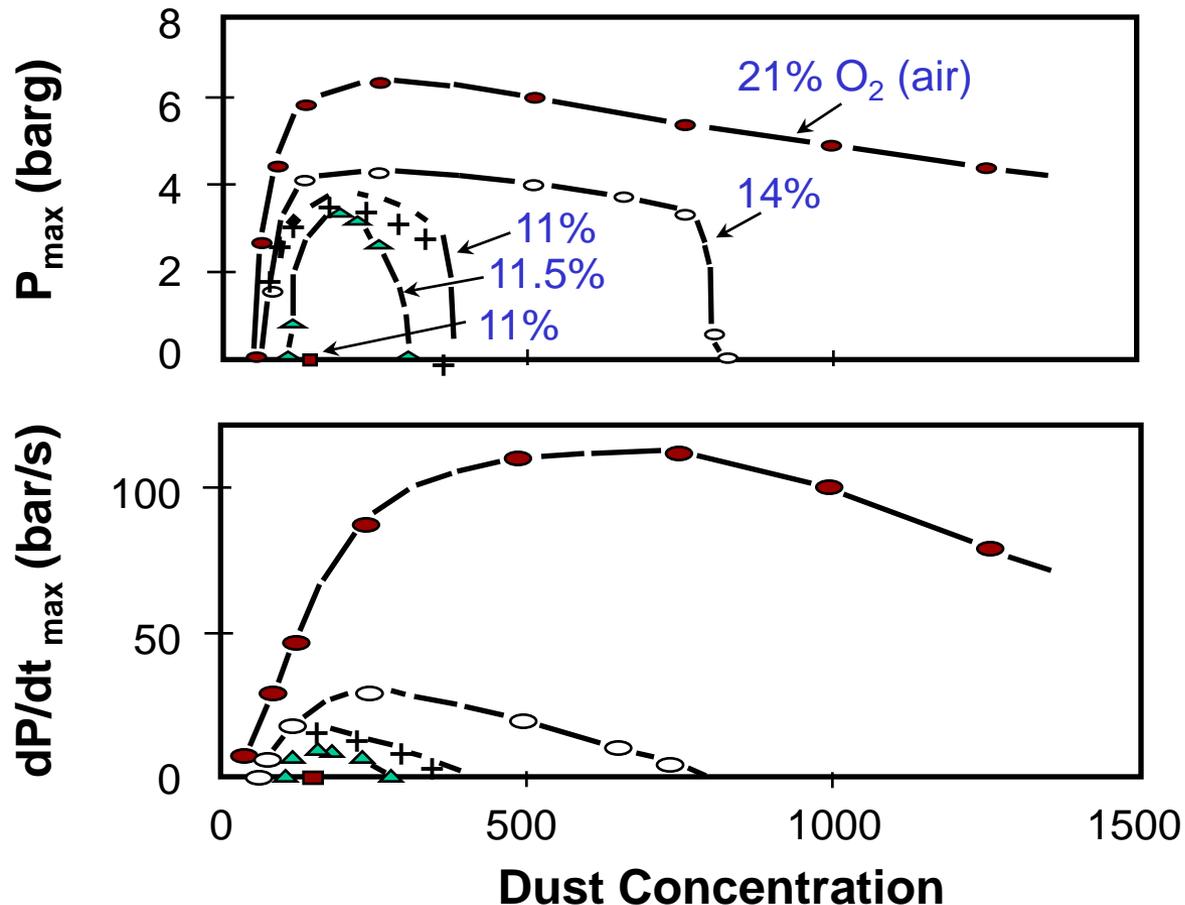
- ❑ The concentration of oxidant below which a deflagration cannot occur is referred to as the **Limiting Oxidant Concentration (LOC)**
- ❑ Limiting Oxidant Concentration (LOC) for combustion is dependent on the type of fuel and the inert gas used
- ❑ Nitrogen gas is the most commonly used inert gas. Carbon dioxide and argon are also used



Influence of Oxygen Content in Gas on MIE (Eckhoff)



Influence of oxygen content in the gas on the maximum explosion pressure and maximum rate of pressure rise of brown coal dust for various dust concentrations. Nitrogen as inert gas. (R. K.Eckhoff, 1997)



Best Industry Practices

Industries handling and processing explosible dusts must be fully aware of Best Industry Practices as described in pertinent dust Codes and Standards, and follow these recommendations. Relevant codes and standards include:

- ❑ NFPA 61, “Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities”
- ❑ NFPA 68, “Guide for Venting of Deflagrations”
- ❑ NFPA 69, “Standard on Explosion Prevention Systems”
- ❑ NFPA 77, “Recommended Practice on Static Electricity”
- ❑ NFPA 484, “Standard for Combustible Metals, Metal Powders, and Metal Dusts”
- ❑ NFPA 499, “Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas”
- ❑ NFPA 654, “Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids”
- ❑ NFPA 655, “Standard for Prevention of Sulfur Fires and Explosions”
- ❑ NFPA 664, “Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities”

Dust Explosion Hazard Assessment

Including OSHA Combustible Dust NEP

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Presentation at

Metropolitan New York AIHA Local Section

*October 16th, 2009
New York, NY*

Chilworth Technology

Process Safety Consulting, Testing, Training, Engineering, and Management

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- Process safety
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- Litigation support
- Process design
- Static electricity applications / problems



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- OSHA Combustible Dust NEP – GAP Analysis
- Gas & Vapor Flammability Hazards
- Electrostatic Hazards, Problems, Applications
- Chemical Reaction Hazards
- Process Hazard Analysis (PHA)
- PSM, RMP, and NJTCPA Auditing
- Expert Witness & Litigation Support
- Process Safety Culture



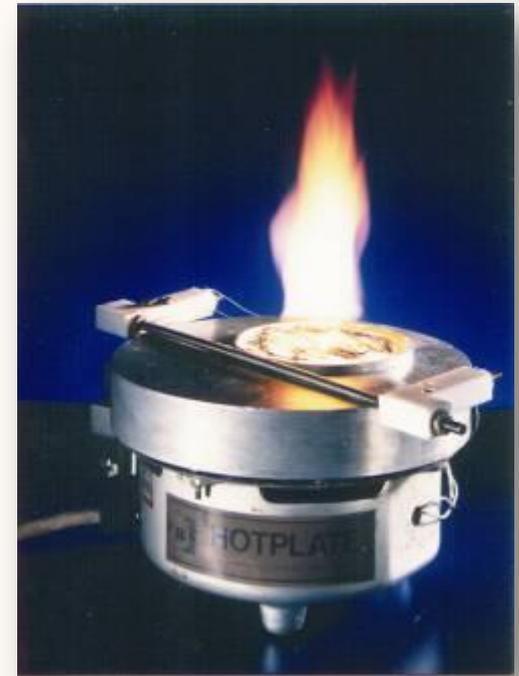
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- OSHA Combustible Dust NEP Tests
- Thermal Stability
- Electrostatic Conductivity, Resistivity, Chargeability, Discharge Incendivity
- DOT & UN Transportation
- Explosivity / Energetic Materials
- Gas & Vapor Flammability



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- Chemical Process Development & Optimization
- Handling Toxic and Highly Active Materials
- Customized & Large-Scale Testing

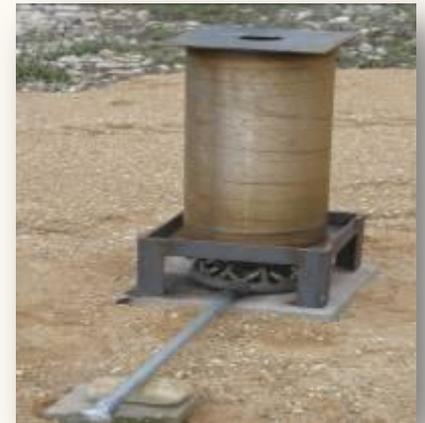


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- Explosion & Propulsion Analysis & Testing
- Propellants & Explosives Formulation, Analysis, Initiation Sensitivity & Performance Output Testing & Analysis
- Waste Explosive Propellant Pyrotechnics Disposal Remediations & Recovery
- Engineering & System Hazard Analysis



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Regulatory Support

- UN Transportation
- Classification, packaging, labelling (CHIP)
- NONS (notification of new substances)
- REACH
- ATEX (DSEAR)
- SEVESO (COMAH)
- IEC 61508 (IEC 61511)
- Material Safety Data Sheet



Fire Service

- Fire Litigation Support
- Fire Research & Engineering
- Fire Modeling
- Standard & Custom Fire Testing
- Mattress & Furniture Fire Testing
- ICAL Construction
- Performance Based Design Consulting
- Product Development Support
- Fire Test Apparatus / Instrumentation Development
- Fundamental Fire Research



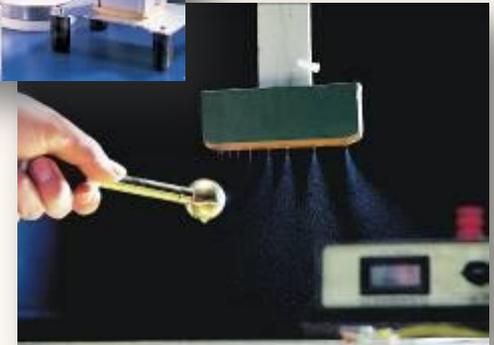
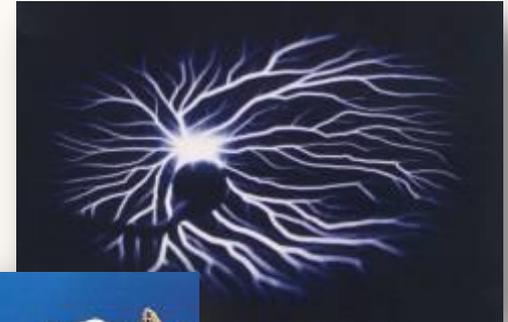
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Electrostatic Problems & Applications

Our services

- **Electrostatic Applications**
 - Coatings (powder, liquid)
 - Atomisation
 - Separation
 - R&D
- **Electrostatic Problems**
 - Powder adhesion/ flow
 - Cling
 - Nuisance shocks
 - Product quality loss
- **Laboratory Testing/Measurements**



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Process Design

- **Process Evaluation**
- **Laboratory Studies**
 - process development & optimisation
- **Process Design**
 - Lab simulations
 - Basic process design (layouts, P&ID, equipment, SOP...)
 - Detailed process design



Chilworth Training

- Dust Explosion Prevention & Protection Techniques
- OSHA Dust Explosion Inspection Preparatory Training
- Understanding & Controlling Static Electricity
- Managing Gas & Vapor Explosion Hazards
- Chemical Reaction & Thermal Instability Hazards
- Process Hazard Analysis
- Electrical Area Classification



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Litigation support

Our clients

- Law firms
- Manufacturing companies
- Insurance carriers
- Origin & cause investigators
- Government agencies

Our services

- Expert advice for litigation support
- Laboratory investigations
- Origin & cause investigation



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Global Provision

- ❑ **Chilworth Technology was first established in the UK in 1986**
- ❑ **Providing process safety services through our facilities in:**
 - **United States of America:**
 - Chilworth Technology, Inc - New Jersey
 - Safety Consulting Engineers - Chicago
 - Chilworth Pacific Fire Laboratories - Kelso, Washington
 - **United Kingdom - Chilworth Technology Ltd**
 - **Italy - Chilworth Vassallo Srl**
 - **France - Chilworth SARL**
 - **Spain - Chilworth Amalthea SL**
 - **India - Chilworth Safety and Risk Management Ltd with offices in:**
 - New Delhi
 - Mumbai
 - Chennai



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Client Industries

- 
- A world map is centered in the background, with different regions highlighted in various colors: North America (light blue), South America (yellow), Europe (light blue), Africa (yellow), Asia (yellow), and Australia (pink).
- Agrochemicals
 - Chemicals
 - Engineering/ consultants
 - Fine Chemicals
 - Food & Drink
 - Government
 - Wood / Paper
 - Legal / Insurance
 - Metals
 - Personal & Household Products
 - Oil & Petrochemical
 - Pharmaceuticals
 - Plastics & Rubber
 - Coal Fired Power Generating plants

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