Understanding Ignition Risks from Electrostatic Sources: Practical Measures to Ensure Safety

Michigan Safety Conference
Chemical Division
April 17, 2024

Mike Snyder, PE, CSP, CFPS, CFEI
VP, Operational Risk Management Practice
DEKRA Process Safety
(609) 799-4449 | Cell (609) 578-8441

Mike.Snyder@dekra.com
https://www.linkedin.com/in/SafetySnyder
Follow DEKRA North America
Contact Us

DEKRA

Process Safety Capabilities

We help our clients to adapt PSM to their needs & to build internal competence

Consulting

Engineering

- Dust Flash Fire & Explosion Hazards
- Gas & Vapor Flammability Hazards
- Electrostatic Hazards
- Chemical Reaction Hazards

Process Safety Management

- Program Implementation & Improvement
- Dust & Process Hazard Analysis
- Incident Investigations
- Consequence Modeling

Laboratory Testing

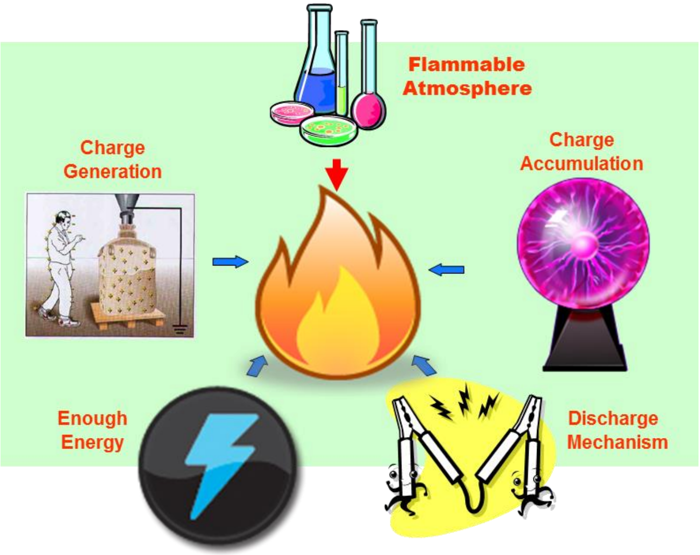
- Combustible Dust Fire & Explosion
- Gas & Vapor Flammability
- Thermal Instability
- Chemical Reactivity
- Static Electricity
- DOT & UN Transportation of Hazardous Materials
- Explosivity/Energetic Materials
- Customized & Large-Scale Testing

Training & Competency

- Courses Cover Practical Applications & Case Studies
- Standard Topics and Customized Options Available
- On-site and Publicly Held options

DEKRA

Outline for Today’s Discussion



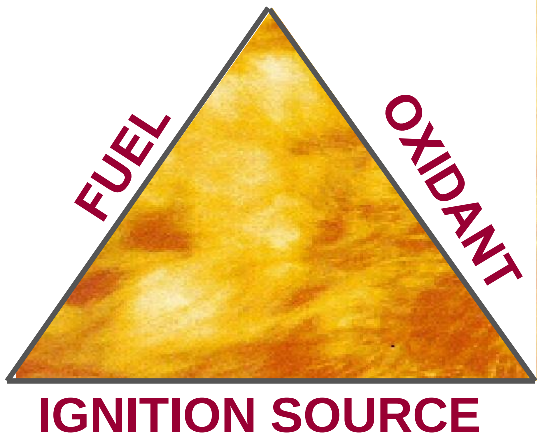
- Fundamentals
  - Fire and Explosion Basics
  - How Static Electricity is Generated
- Overview Static Electricity Ignition Scenarios
- Global Information for Conducting Electrostatics Evaluation
- Electrostatic Hazards Evaluation and Control
- Discussion & Conclusion
- Introduce Table of References

Ignition Risks: The Fire Triangle

- **FUEL**
  - Liquid (vapor or mist), gas, or solid capable of being oxidized. Combustion always occurs in the vapor phase; liquids are volatized and solids are decomposed into vapor prior to combustion

- **OXIDANT**
  - A substance which supports combustion. Usually oxygen in air

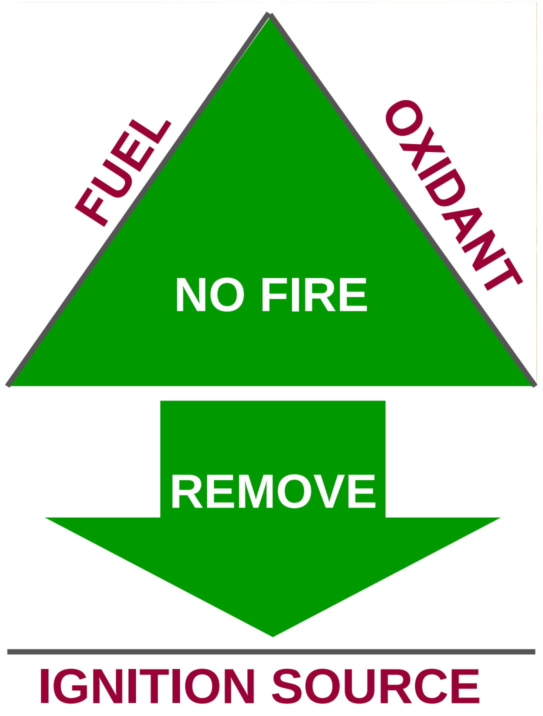
- **IGNITION SOURCE**
  - An energy source capable of initiating a combustion reaction



Explosion Prevention & Protection

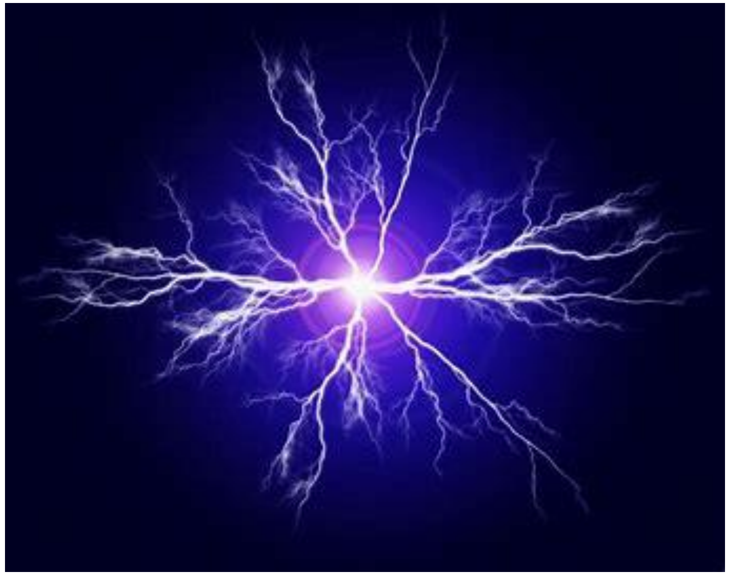
Our Goal is to Establish a Basis of Safety

- Avoidance of flammable atmospheres
- Elimination of (competent) ignition sources
- Control oxygen concentration
- Provision against consequences of ignition



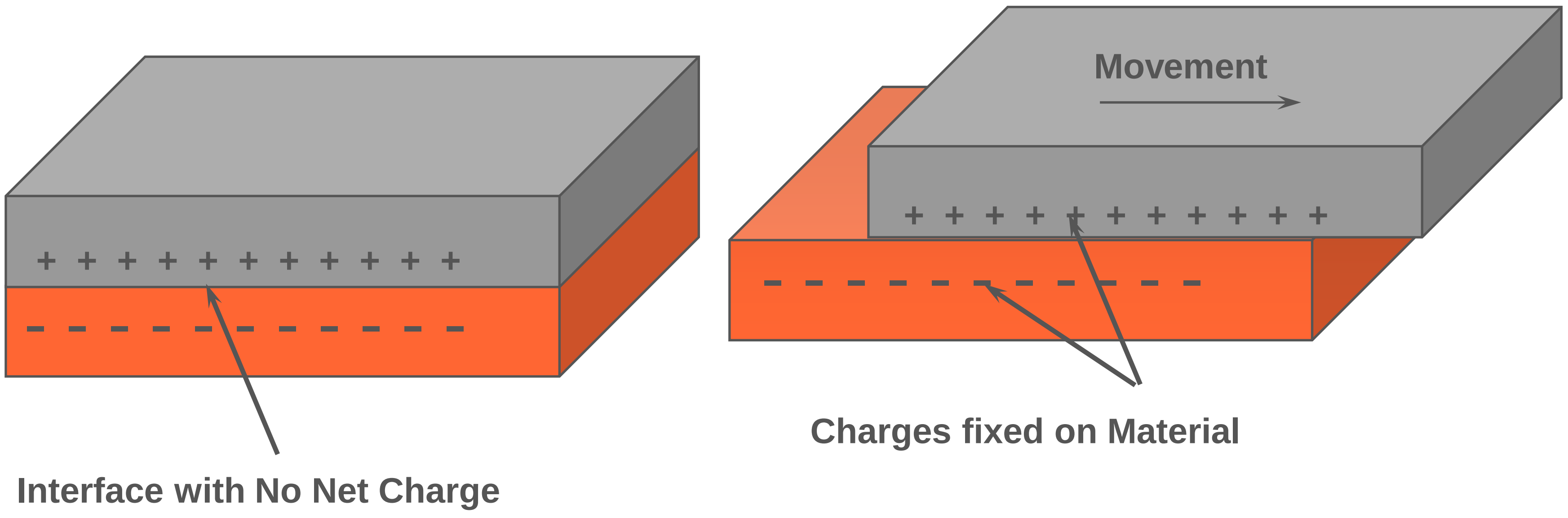
Typical Ignition Sources (BS EN 1127-1)

- Personal smoking materials
- Hot work & Open flames
- Mechanical friction and sparks
- Impact sparks
- Hot surfaces and equipment
- Thermal decomposition
- Electrical equipment
- **Electrostatic discharges**

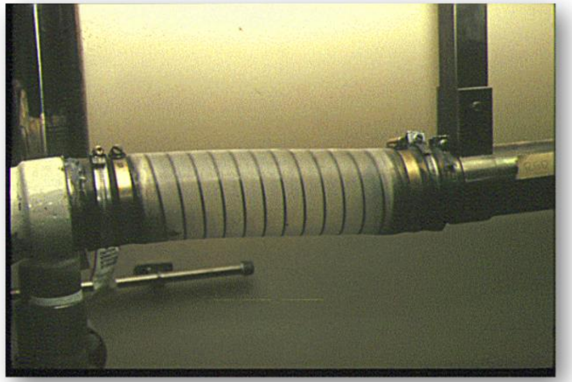


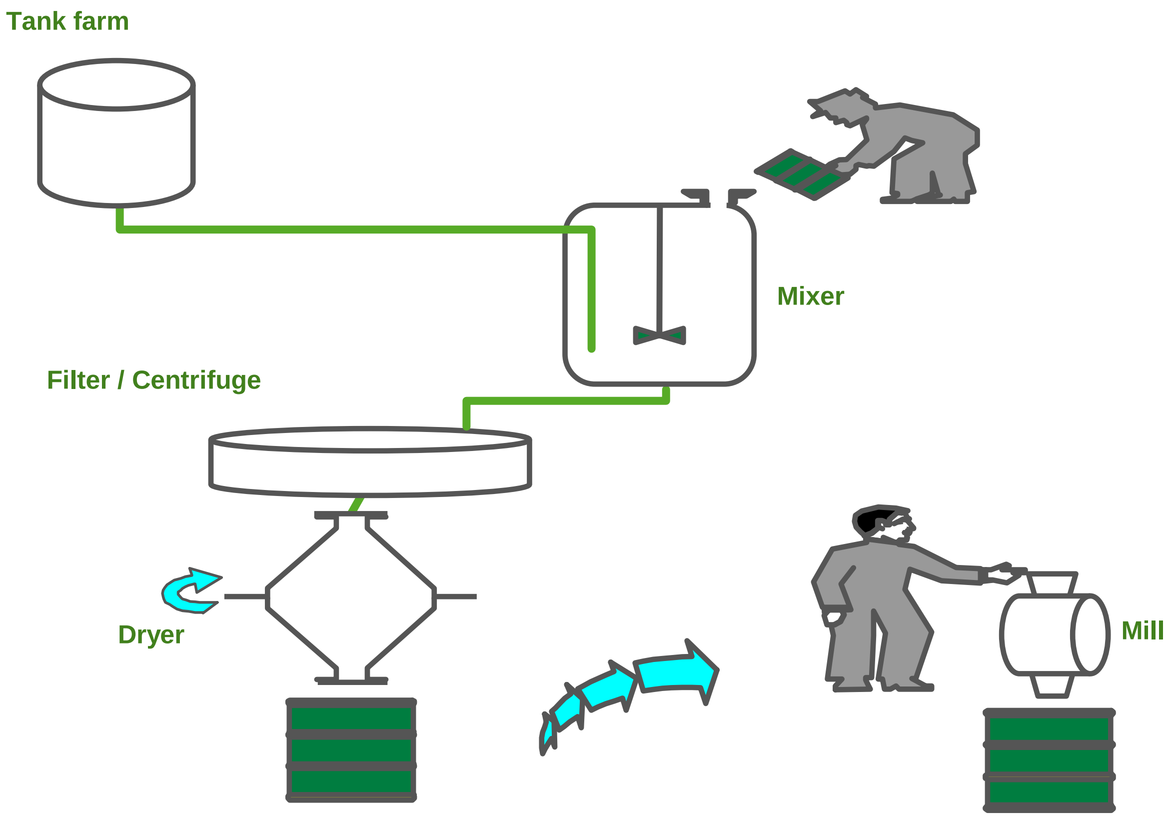
Electrostatic Charge Generation

- Electrostatic charge can be generated when two materials make and then break contact, with one becoming negative and the other positive.
- The accumulation of the charge on electrically isolated conductors and/or on insulating materials, can give rise to electrostatic discharges.

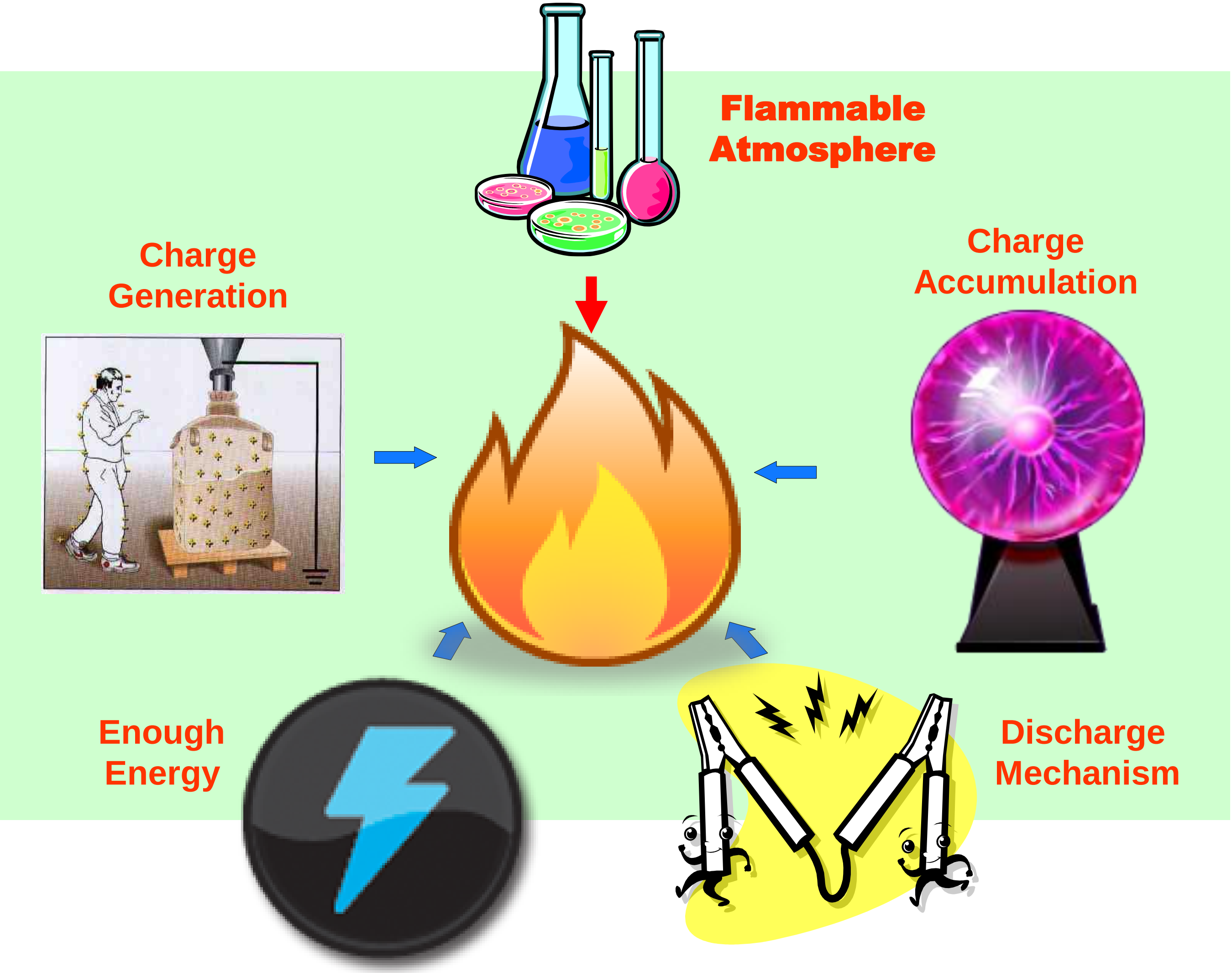


Static Charge Generation: Examples





Evaluating a Static Ignition Scenario



Important Electrostatics Definitions

- ***Conductive***
  - Materials that possess the ability allow electrons to flow freely
- ***Nonconductive (Insulating)***
  - Materials that possess the ability to resist the flow of electrons
- ***Antistatic/static dissipative***
  - Capable of reducing or preventing the build-up of a static electric charge

Types of Electrostatic Discharges

Discharge Type	Origin	Energy	Incendivity
Spark	Isolated Conductor	$E=0.5\ CV^2$	Vapors, Gases, & Dusts
Brush	Solid Insulator	< 4mJ	Vapors, Gases, & Hybrids
Cone (Bulk)	Bulking Powder	< 25mJ	Vapors, Gases, & some Dusts
Propagating Brush	Insulator with metal backing	Up to 2 Joules	Vapors, Gases, & Dusts
Corona	Conductor or Insulator	Not established	Can ignite only extremely low MIE gases i.e. Hydrogen/Acetylene

DEKRA

Typical Minimum Ignition Energy Values

Atmosphere	Material	Minimum Ignition Energy (mJ)
Vapor / Gas	ETHYLE ACETATE	0.460
	METHANE	0.280
	PROPANE	0.250
	ETHANE	0.240
	METHANOL	0.140
	ACETYLENE	0.017
	HYDROGEN	0.016
	CARBON DISULPHIDE	0.009
Dust Cloud **Note:** Values will depend on moisture content and particle size	PVC	1,500
	ZINC	200
	WHEAT FLOUR	50
	POLYETHYLENE	30
	SUGAR	30
	MAGNESIUM	20
	SULPHUR	15
	ALUMINIUM	10
	EPOXY RESIN	9
	ZIRCONIUM	5

DEKRA

Minimum Ignition Energy - Dusts

Some Influencing Factors	
Increasing Particle Size	↑
Increasing Moisture Content	↑
Presence of Flammable Vapor (even if below LFL)	↓
Increase in Ambient Temperature	↓
Inductance of Discharge Circuit	↓

WHAT IS ATEX?

Workplace H&S: Directive 1999/92/EC (ATEX 137->153)

Minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.

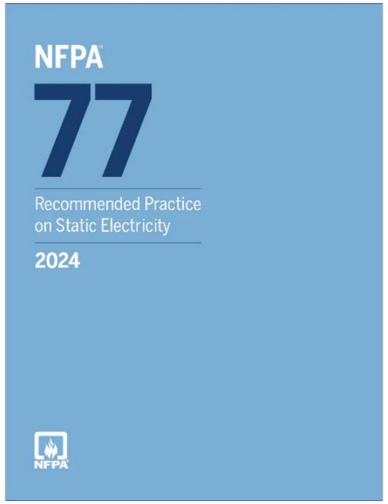
1999/92/EC (ATEX 137->153)
Employer's Obligations - ATEX 153

- The employer shall take ORGANIZATIONAL and/or TECHNICAL measures in order of priority.
- Where necessary these measures shall be combined and / or supplemented with measures to prevent the propagation of explosions.
- ATEX allows for the development of alternative/innovative solutions, rather than applying standard solutions.

ATEX Recordkeeping:
Record Significant Findings

- It is necessary under ATEX Directive 1999/92/EC to Document the significant findings of the risk assessment after assessment is made:
  - In a separate "**Explosion Protection Document** (**EPD**)"
  - Elimination of risk, in order of preference:
    1. Substitution of the dangerous substance,
    2. Reduction of the risks,
    3. Avoidance of ignition/initiation,
    4. Mitigate the consequences.

The US View: Static Electricity



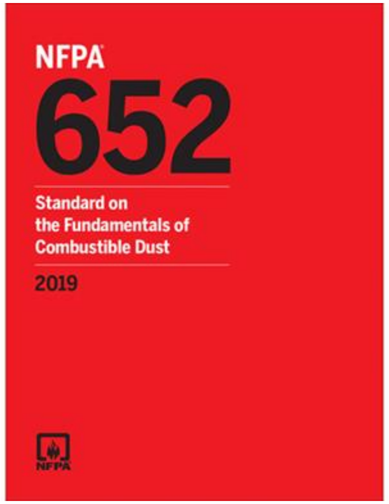
- **NFPA 77 (2024),** Recommended Practice on Static Electricity

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

- Generally considered a Recognized and Generally Accepted Good Engineering Practice (RAGAGEP) for Static Electricity

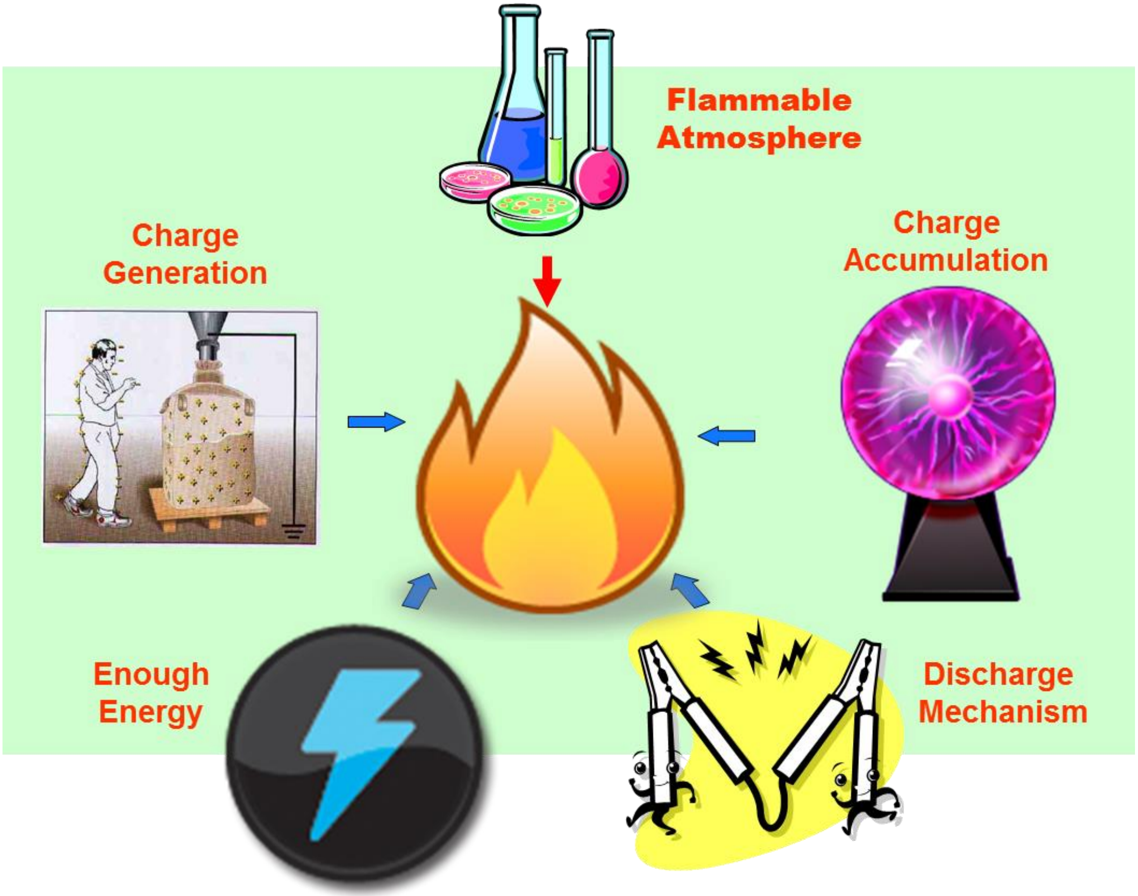
DEKRA

The US View: Static Electricity



- Historically, Static not formally documented in Hazardous Area Classification studies.
- Practices are beginning to evolve.
- Some gaps exist, for example related to use of insulating plastic materials in electrically classified areas.

Tips for Electrostatics Hazards Evaluation and Control



Characteristics of Materials and Plant

- Determine the electrostatic properties of the materials processed, handled, and/or used in the plant
  - Minimum Ignition Energy of flammable atmospheres
  - Resistance-to-Ground of conductive (metal) objects and items of plant
  - Electrical Resistance of operators' footwear and floors

Characteristics of Materials and Plant

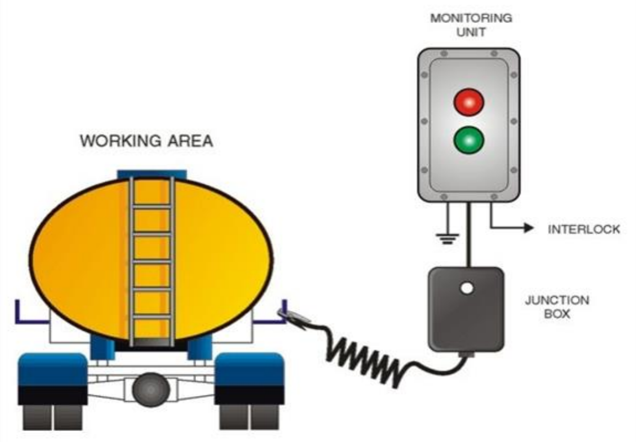
- Determine the electrostatic properties of the materials processed, handled, and/or used in the plant
  - Electrostatic Chargeability of powders and liquids
    - Alternatively, measure surface voltage or electric field during processing
  - Volume Resistivity of powders
  - Conductivity of liquids
  - Surface Resistivity of solid objects such as plastic containers and liners

Controlling Electrostatic Ignition Sources: Conductive (Metal) Objects

- Electrostatic charge can accumulate on electrically isolated conductive (metal) plant and give rise to spark discharges
- Resistance to ground should be checked. If R>10 ohm, direct ground connection is required
- Ground connections should be checked regularly
- Consider on-line monitoring and interlocks for critical applications

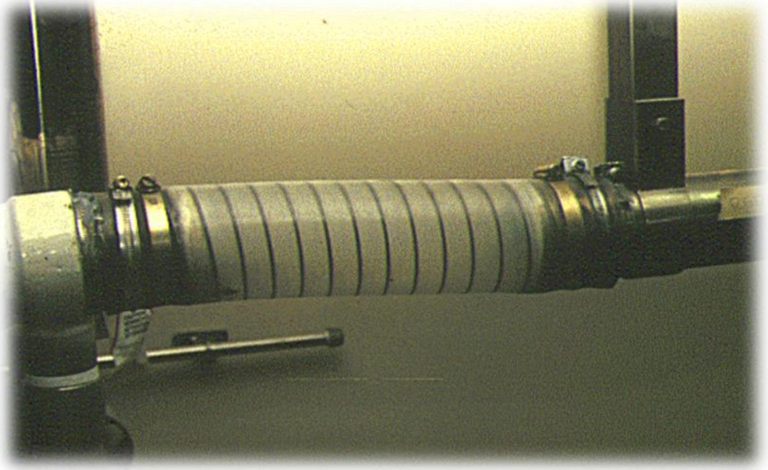
Controlling Electrostatic Ignition Sources: Verified Static Ground Monitoring

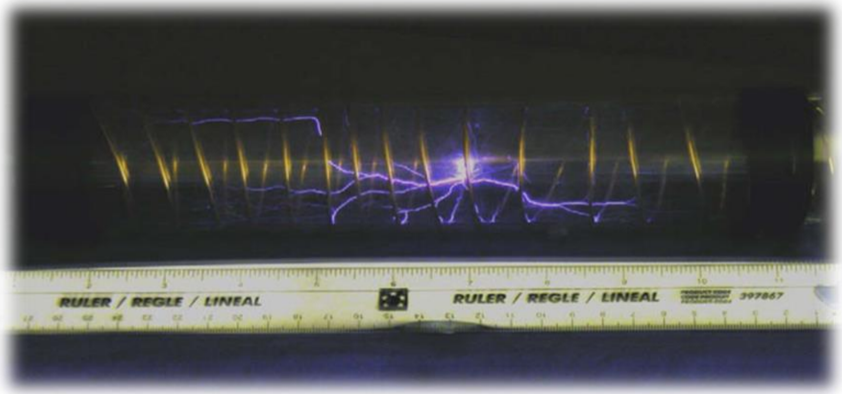
- A number of systems are available that provide visual indication of connection to a verified ground with resistance of <10 ohms.
- Critical applications can be provided with interlocks.
- Multi-point systems can be used to check for isolated conductive components.



Controlling Electrostatic Ignition Sources: Hoses

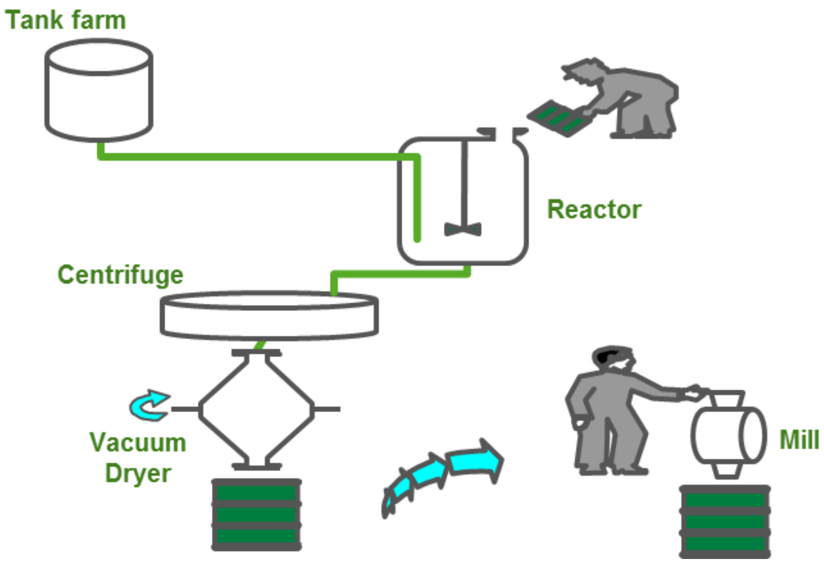
- Significant static charge can be generated where nonconductive hoses are used for solids transport.
- Hoses used immediately downstream of filters in nonconductive liquid service, should use metal or other conductive material.
- Internal metal spirals for electrical continuity.
- Insulating hose has potential to cause high energy Propagating Brush Discharges.





Controlling Electrostatic Ignition Sources: Personnel

- Electrostatic charge can accumulate on personnel
- Personnel can typically attain potentials of 10 to 15kV
  - Maximum discharge energy 20mJ to 30mJ
- Where MIE is ≤ 30 mJ
  - Sparks from personnel can be a competent ignition source



Nonconductive Materials of Construction

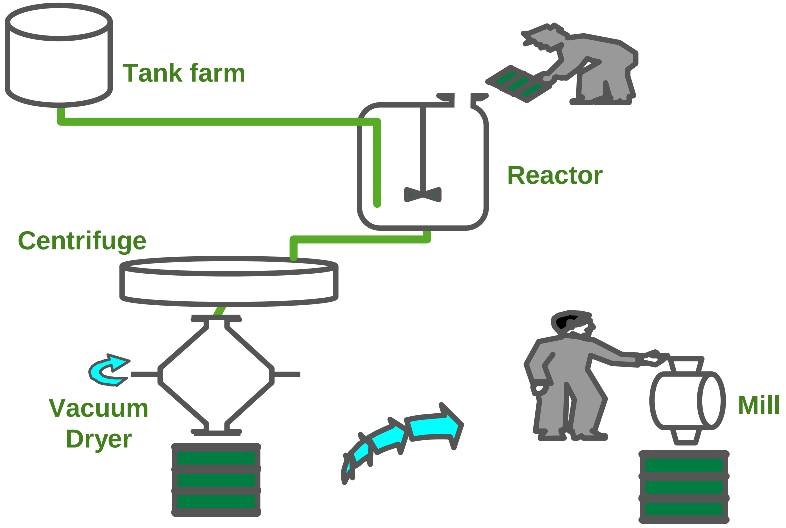
- **Insulating materials can cause:**
  - Build up of static charge
  - Insulation of conductive items
  - Charge retention (accumulation) on powders and liquids in non-conductive containers

- Consider conductive or static dissipative materials with a Surface Resistivity less than 10^{10} Ohm/Square

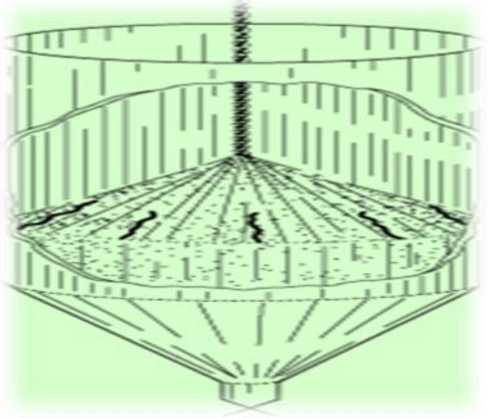
Controlling Electrostatic Ignition Sources: Liquid Considerations

- Charge can generate & accumulate on Liquids:

- Control Actions to consider:
  – Use Electrically Grounded Conductive Plant
  – Increase Liquid Conductivity
  – Filters and Valves – Provide Distance and Diameter
  – Consider Inerting



Controlling Electrostatic Ignition Sources: Powder Considerations



- Highly charged insulating powder entering a vessel can give rise to Bulk/Cone Discharge
- Discharge energy depends on powder's Properties:
- Maximum discharge energy about 25mJ

Resistivity (Ohm.m)	Type	Examples
$<10^6$	Low Resistivity	Metals
10^6 to 10^9	Medium Resistivity	Some organic powders, Concrete, wood
$>10^9$	High Resistivity	Synthetic polymers

DEKRA

Flexible Intermediate Bulk Containers (FIBC) IEC 61340-4-4, Edition 3.0, 2018

- Selection and Use of Flexible Intermediate Bulk Containers (FIBCs) require sensitivity to both the materials being filled/discharged and the surrounding area.
- Each Type of FIBC has different characteristics.
- NFPA 77 (2024), provides background and technical support information.

DEKRA

Use Criteria for Different Types of FIBCs

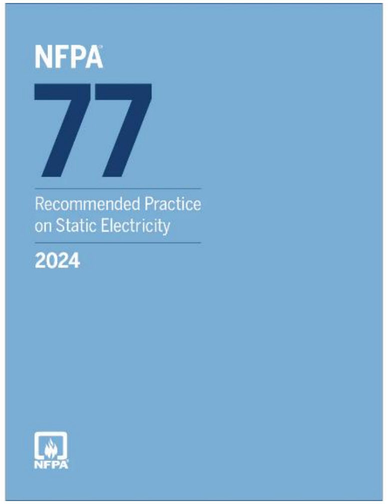
Bulk Product in FIBC	Surroundings		
MIE of Dust	Non Flammable Atmosphere	Dust Zones 21 – 22 1000mJ > MIE > 3mJ	Gas Zones 1 – 2 or Dust Zones 21 – 22 MIE ≤ 3mJ
MIE > 1,000mJ	A, B, C, D	B, C, D	C, D
1000mJ > MIE > 3mJ	B, C, D	B, C, D	C, D
MIE ≤ 3mJ	C, D	C, D	C, D

Note 1. Additional precautions are usually necessary when a flammable gas or vapor atmosphere is present inside the FIBC, e.g., in case of solvent wet powders

Note 2. Non-flammable atmosphere includes dusts having a MIE >1000mJ

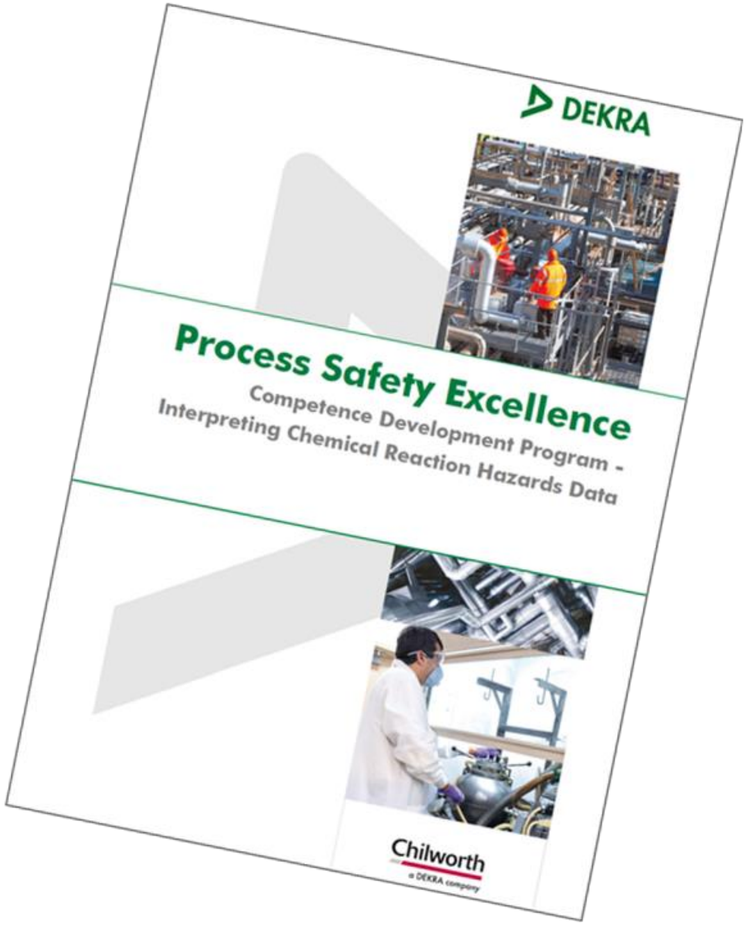
Use of Type D FIBCs shall be limited to atmospheres with MIE ≥0.14mJ

References



- DEKRA Practical Guide to Industrial Electrostatics: Hazards, Problems, and Applications
  - https://www.dekra.us/en/process-safety-training/practical-guide-industrial-electrostatics/
- NFPA 77, Recommended Practice on Static Electricity
  - www.nfpa.org/77
- IEC 60079-32-1: Explosive Atmospheres – Part 32-1: Electrostatic Hazard – Guidance"
  - https://webstore.iec.ch/publication/60166#additionalinfo
  - API RP 2003, Protection Against Ignitions Arising Out of Static, Lightening, and Stray Currents
  - https://www.api.org/~/media/files/publications/whats%20new/2003_e8%20pa.pdf
- BS EN 1127-1:2019, Explosive Atmospheres. Explosion Prevention and Protection. Basic Concepts and Methodology
  - https://www.techstreet.com/standards/bs-en-1127-1-2019?product_id=2082158

DEKRA Process Safety:
A Trusted Safety Advisor



Mike Snyder, PE CSP CFPS CFEI

(609) 578-8441

Mike.Snyder@DEKRA.com

https://www.linkedin.com/in/safetysnyder/

For more information:

https://www.dekra.us/en/home-page/