5 Steps to Safely Handle Combustible Dust

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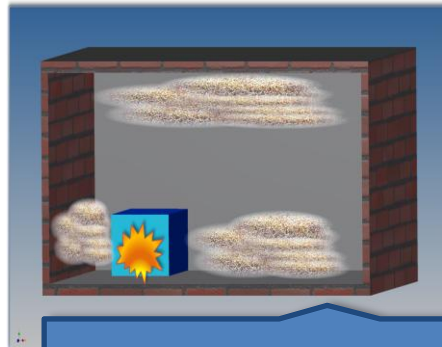
Rev 0415

Overview: 5 Steps for Combustible Dust
10,000 ft View

Identify



Evaluate

Protect

Manage

Audit

Introduction to Combustible Dust

- What is Combustible Dust (CD) ?
- What is a Combustible Dust Explosion?
- Key Terms
- Key Players
- Why does Combustible Dust explode?

Characteristics of CD

Combustible Dust—What is It?

- Fine material that can catch fire when mixed with air.
- Typically a process material (flour, plastic, API powder/dust) or
- Generated as a by-product of manufacturing (waste/fugitive dust)

NFPA 654 Combustible Dust:
A finely divided combustible particulate solid that presents a flash-fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations.

What is a Dust Explosion

- A dust explosion occurs when a fine, combustible dust is suspended in air and ignited.
- This causes a **very rapid burning** of the fuel (dust).
- This rapid burning releases gaseous products and heat that cause additional nearby particles to ignite rise and pressure to rise.
- **The resulting force** of the pressure wave and **extreme**

Explosion. The bursting or rupture of an enclosure or container due to the development of internal pressure from a deflagration. **[69, 2014]**

Dust explosions can be categorized as either

Primary or Secondary

Definitions Explosion Types

- Primary
  - occurs when a dust suspension within a container, room or piece of equipment is ignited and explodes
- Secondary
  - occurs when dust accumulated on floors or other surfaces is lifted into the air and ignited by the primary explosion

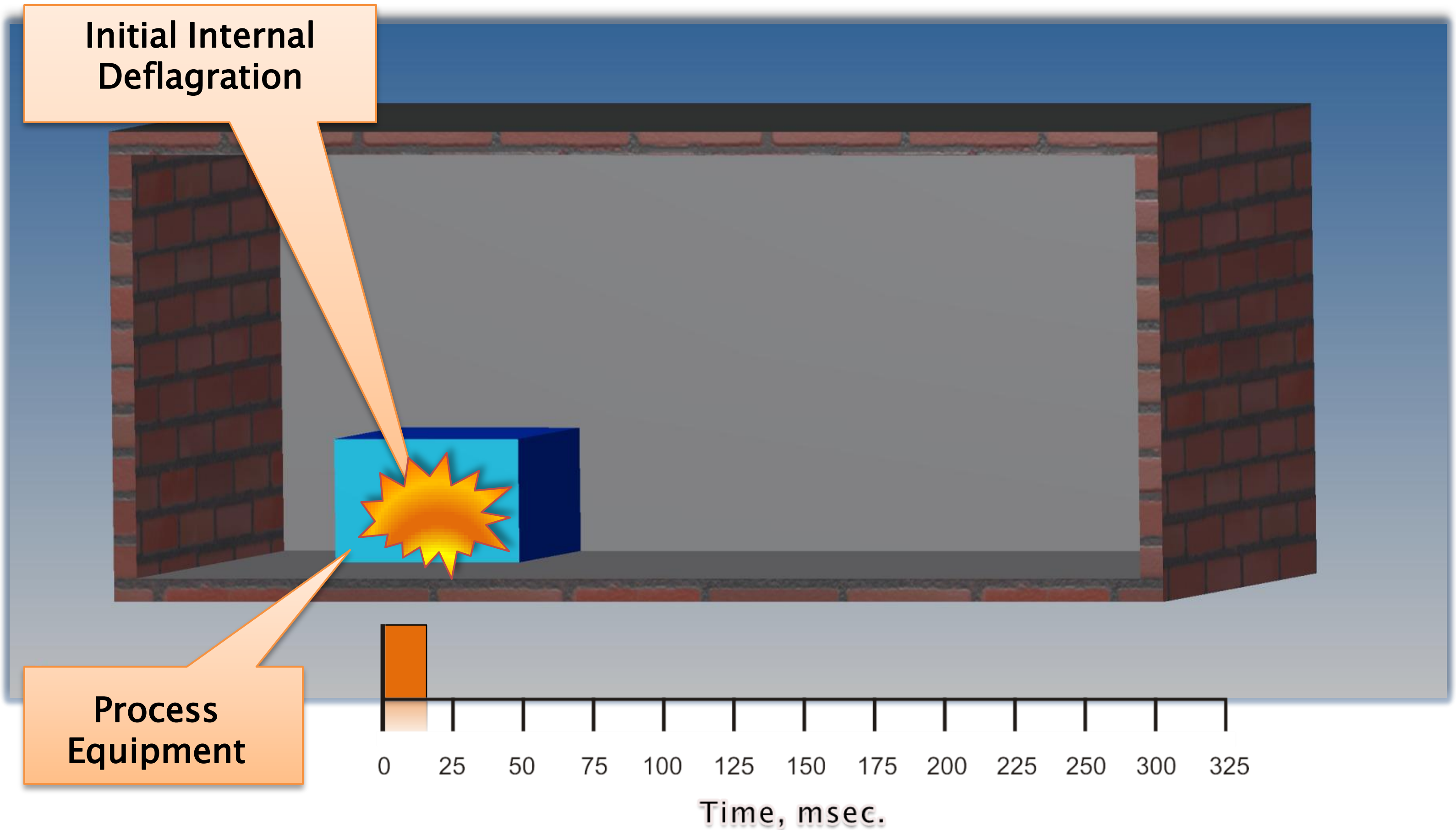
Where Do Primary Dust Explosions Occur?

- Dust collectors
- Transfer points in enclosed conveyors or bucket elevators
- Elevator legs
- Holding bins (Enclosures)
- Electrical equipment

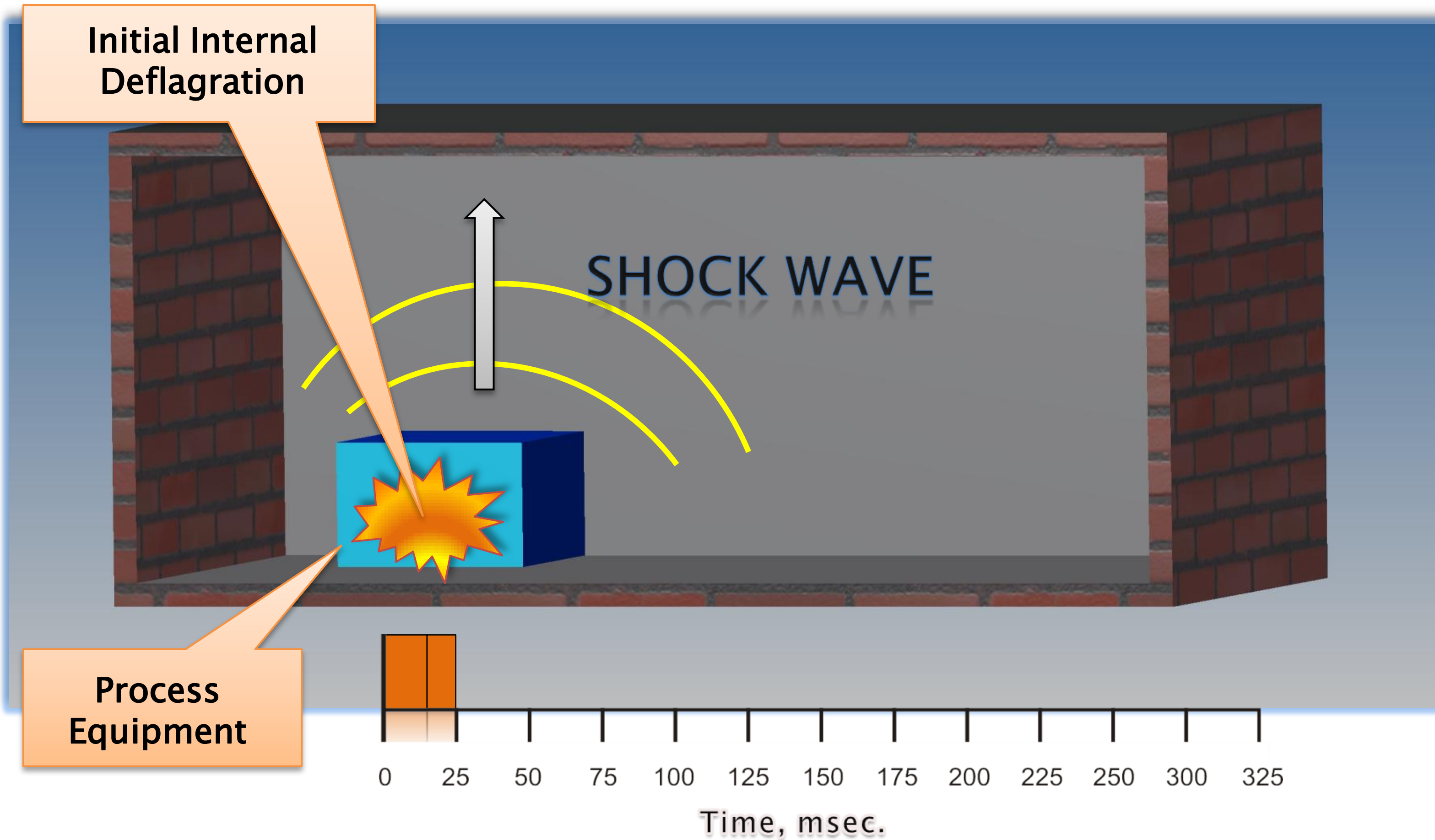
Where Do Secondary Dust Explosions Occur?

- Anywhere dust can accumulate in the workplace
  - On top of equipment
  - On top of pipes
  - In hidden spaces
  - In the rafters
  - On floors, walls, ceilings

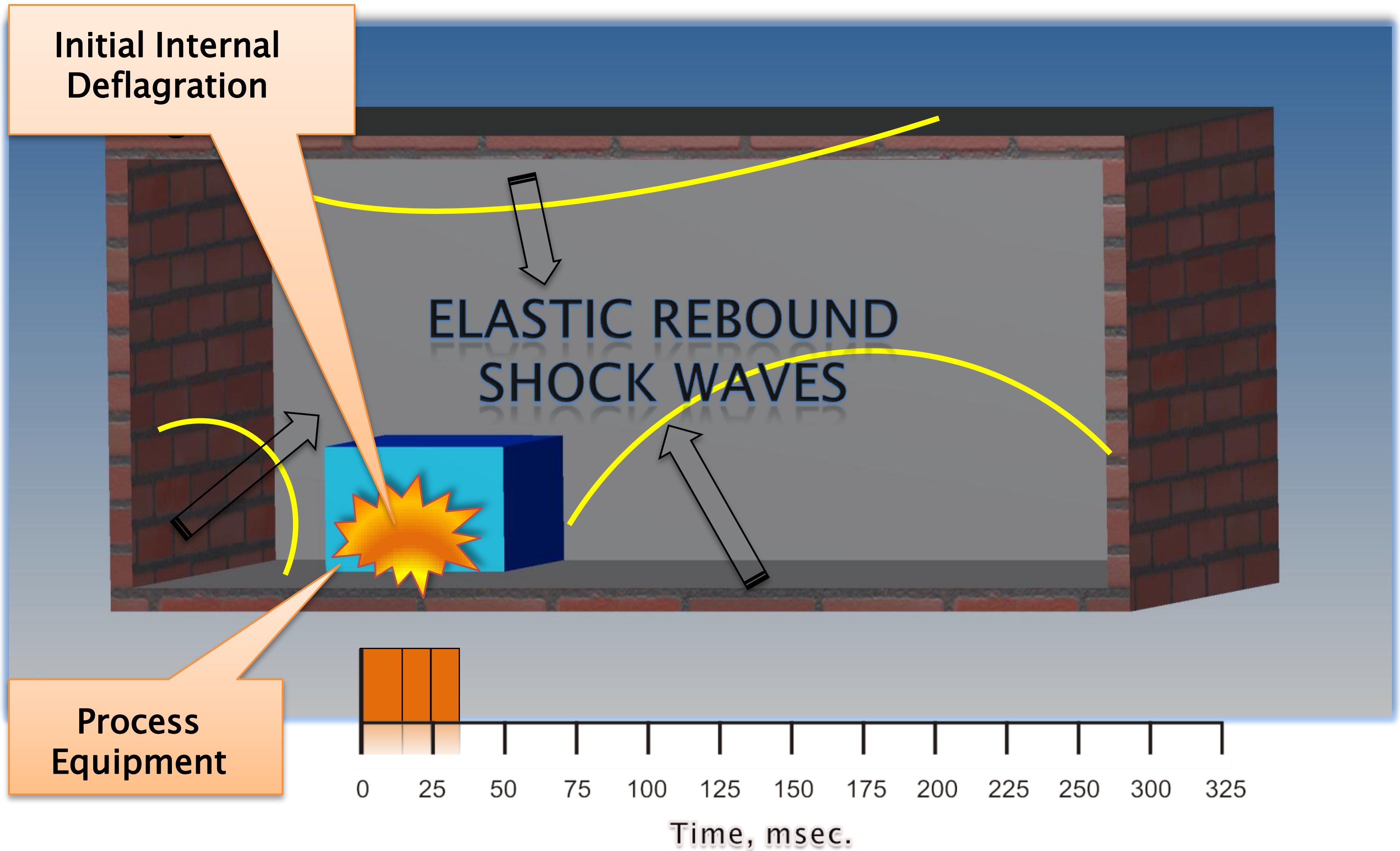
The " Typical" Primary Explosion Event



The "Typical" Primary Explosion Event



If Inadequate Housekeeping
Secondary Explosion will Ignite



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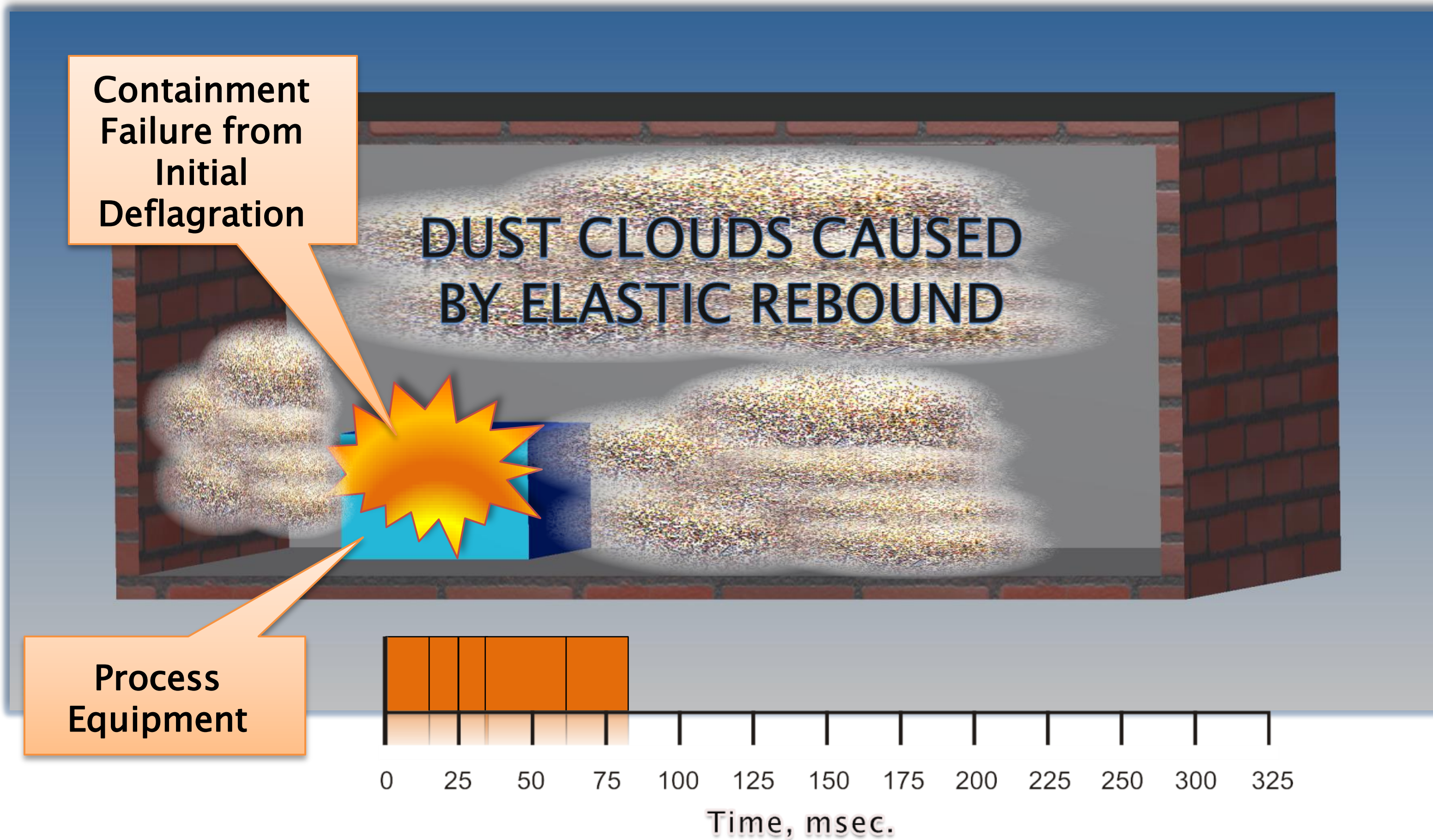
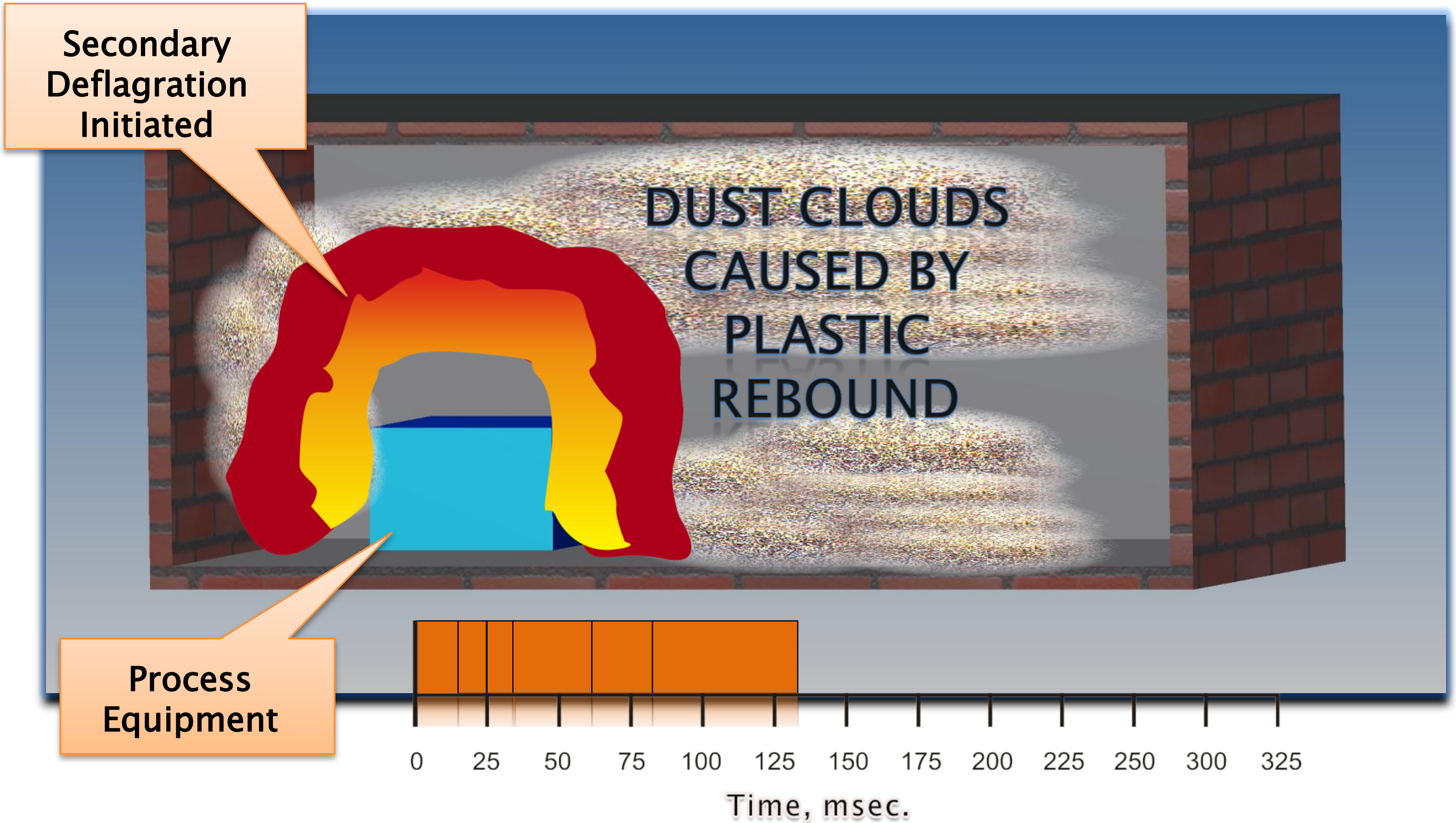
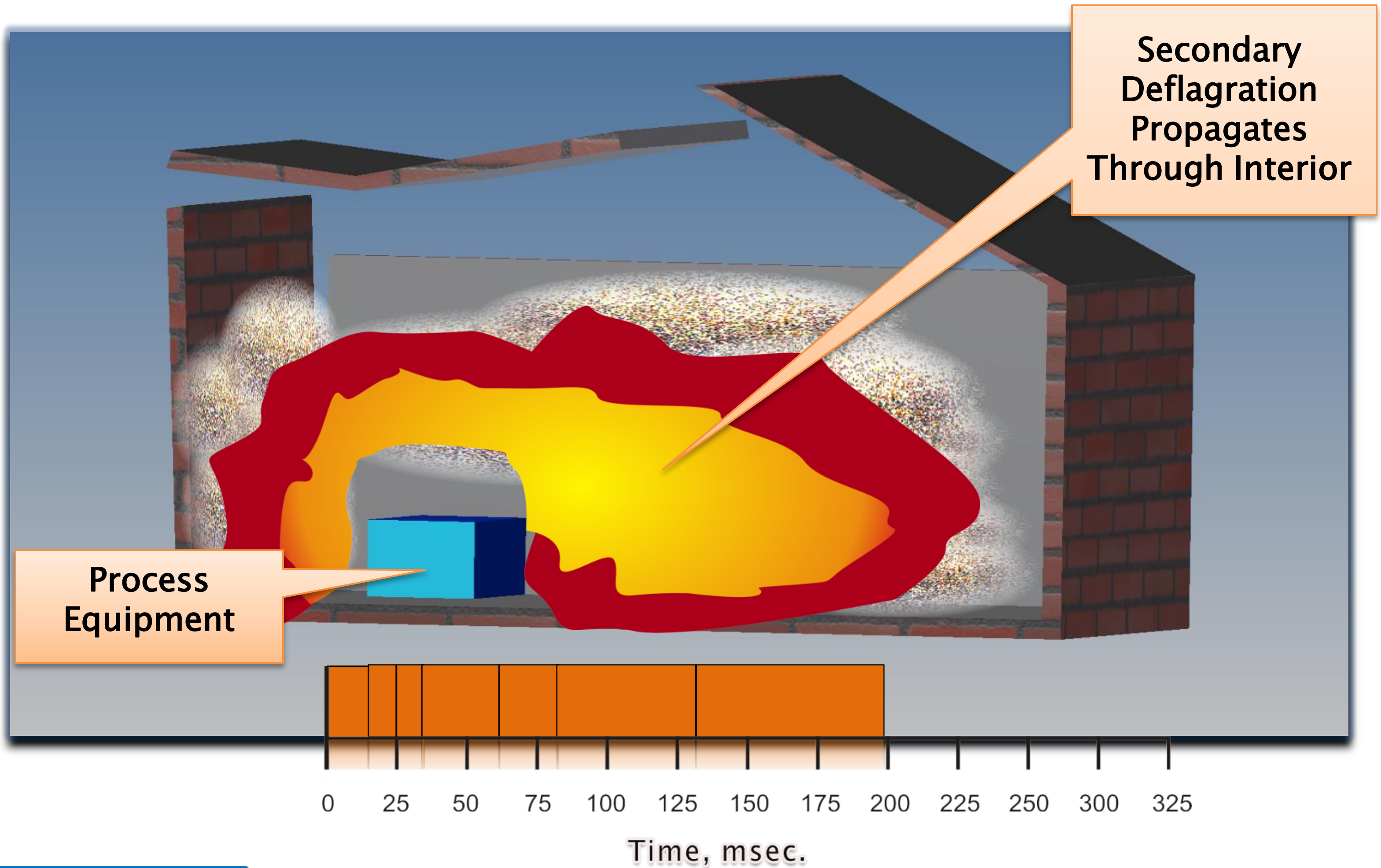


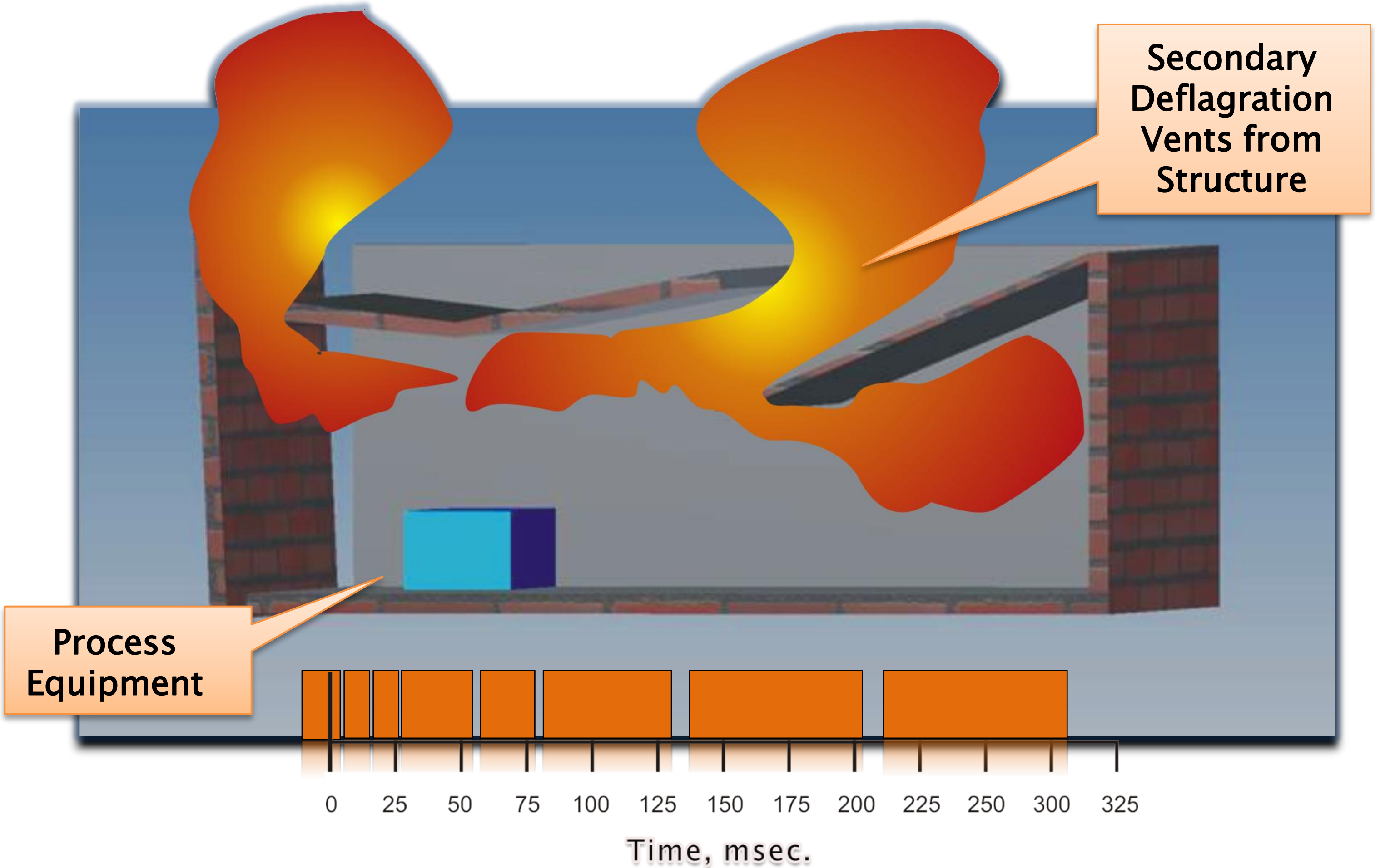
Secondary Explosion



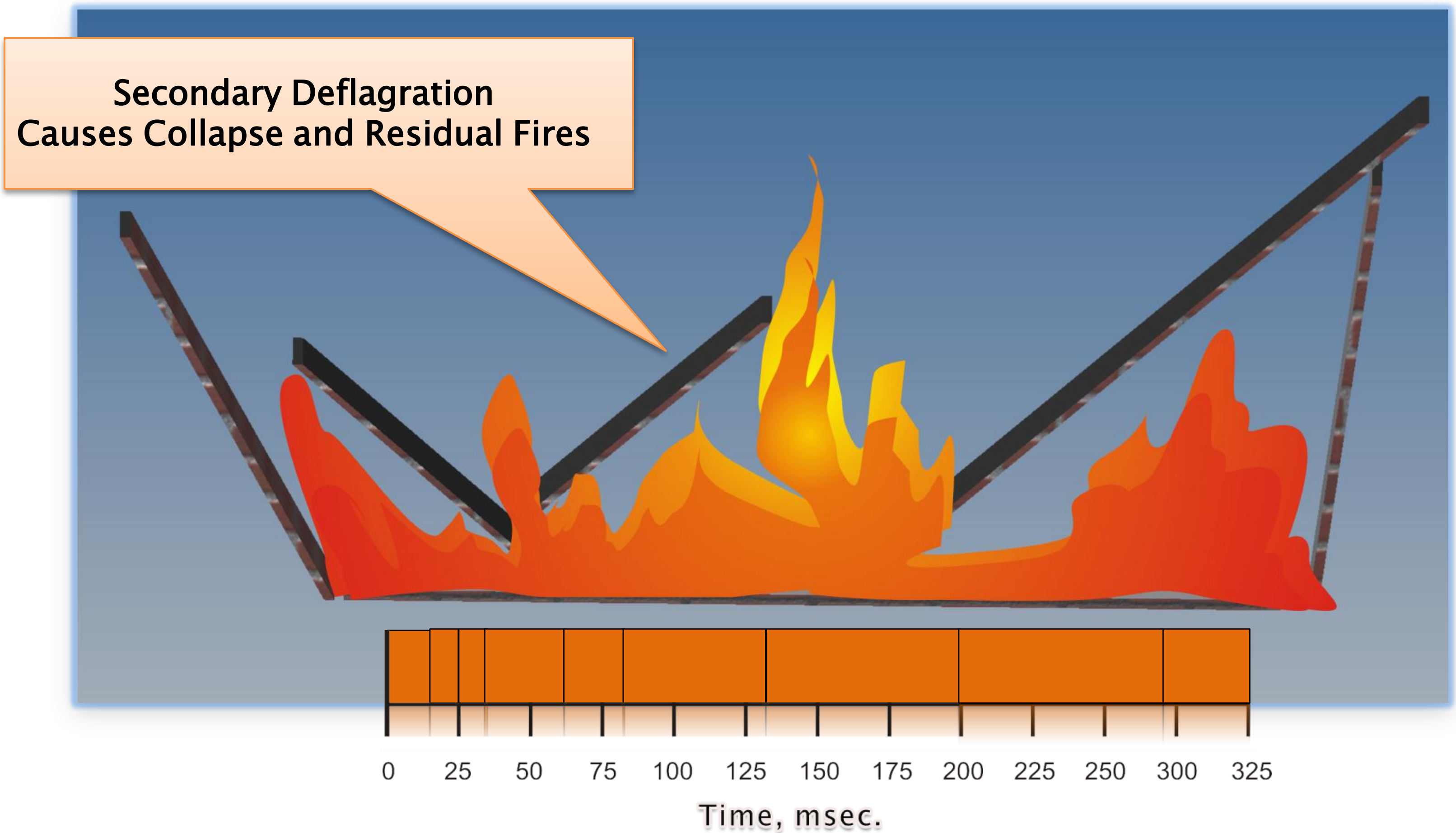
Secondary Explosion



Secondary Explosion



The “Typical” Explosion Event
(continued)



Clarification

- Deflagration
  - Subsonic combustion that spreads by heating the next layer of cold material and igniting it. Most "fire" found in daily life, from flames to explosions, is technically a deflagration
- Detonation
  - Propagation of a flame or combustion zone through a fuel/air mixture at a velocity greater than the speed of sound in the un-reacted medium (NFPA 69)
  - Only under very unique circumstances will a dust deflagration accelerate to a detonation
    - **Produce very devastating damage**
    - **Hard to quench/stop once started**
    - **Prevention is usually the key**

Defla 2.mp4

Some Dusts are Not Combustible

Certain materials will not form combustible dust, including:

Cement,
Gypsum,
Limestone,
Sand And
Table Salt.

Forget The Perfect Storm and Remember This:

Workers and supervisors are the first line of defense:

Recognizing unsafe conditions

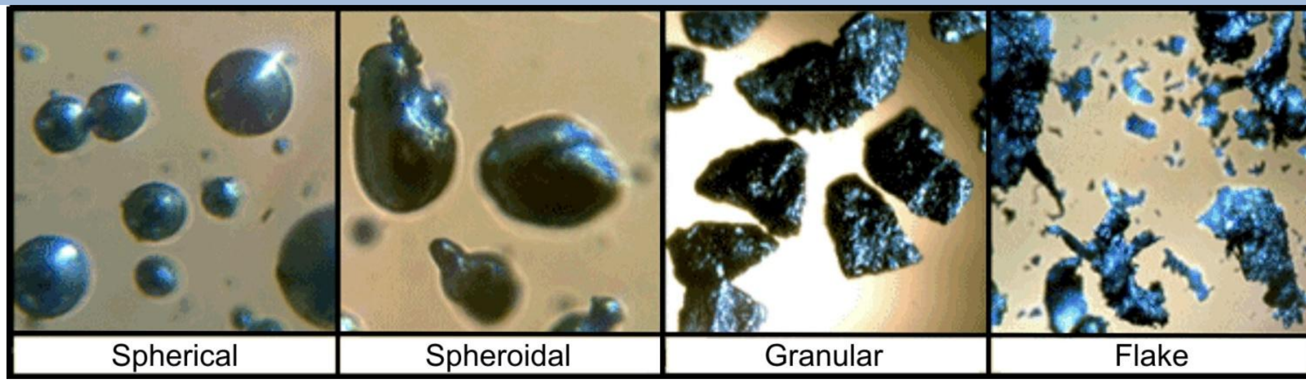
Taking preventative action, and/or

Alerting management

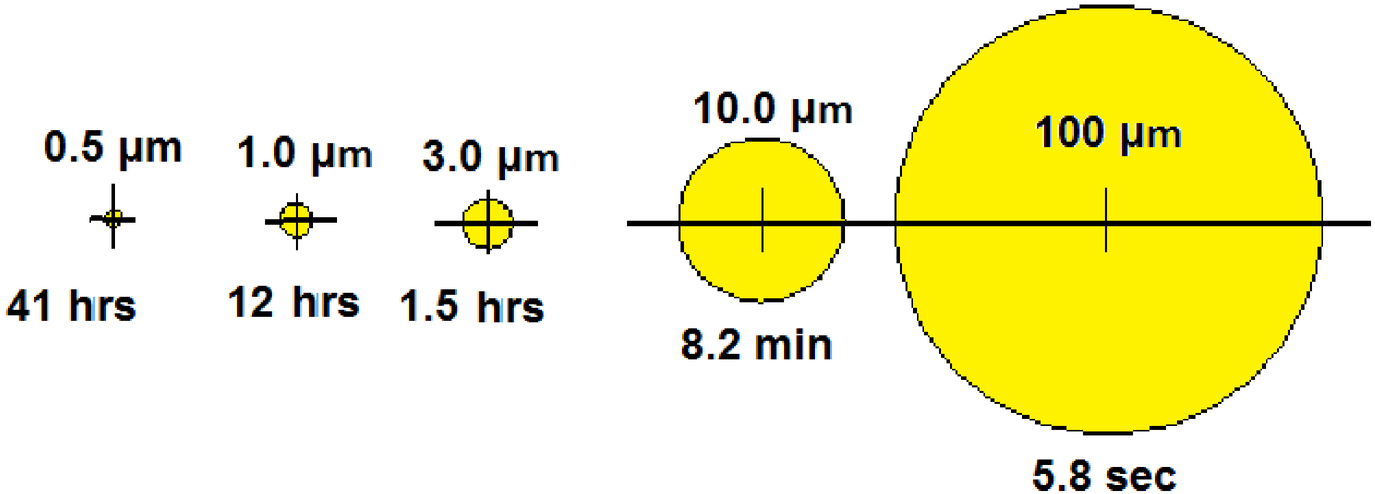
Why does Combustible Dust explode?

- Characteristics of Combustible Dust
  - Particle size and shape
  - Particle size Distribution
  - Chemical properties of dust
  - Moisture content
  - Cloud dispersion

Particle Size & Shape

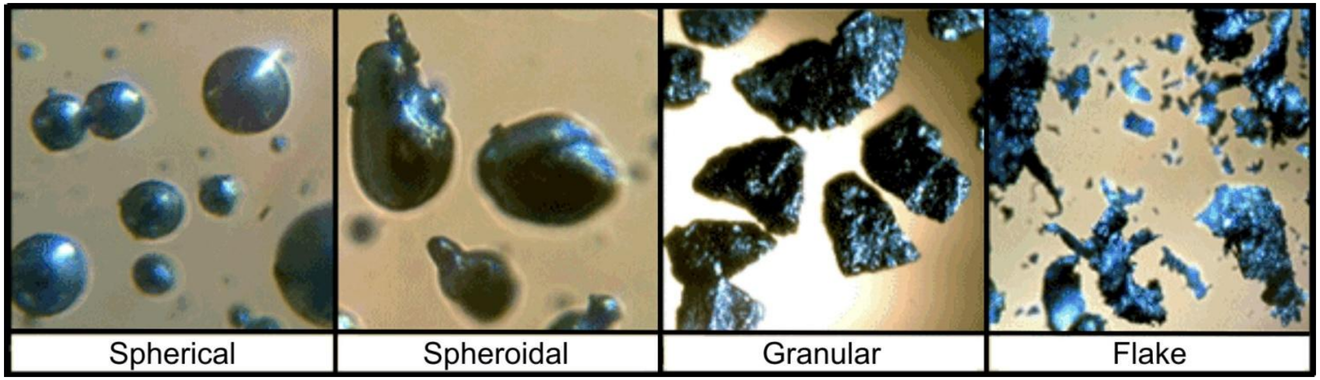


TIME TO SETTLE 5 FEET BY UNIT DENSITY SPHERES



Source: NIOSH

So why does particle size or shape matter?



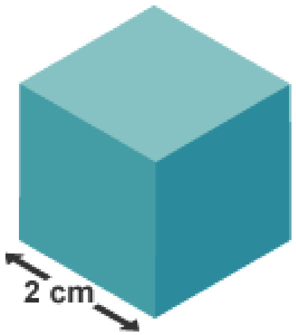
- Flake particles have a large surface area that can be in contact with an oxidizer when compared with a spherical particle.

- Granular particles often have sharp edges that can ignite more easily than the smooth, round edges of an atomized powder.

Today's Math…Let's go figure..

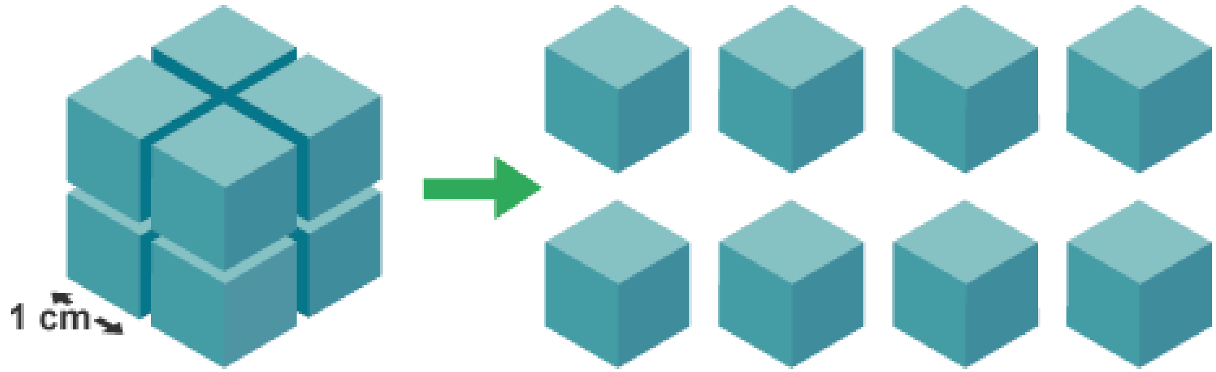
A cube with the length of every side is 2cm

Area of face: 2 x 2 = 4 cm^2



Cube has six faces,

Surface area of cube is 4 cm^2 x 6 = 24 cm^2



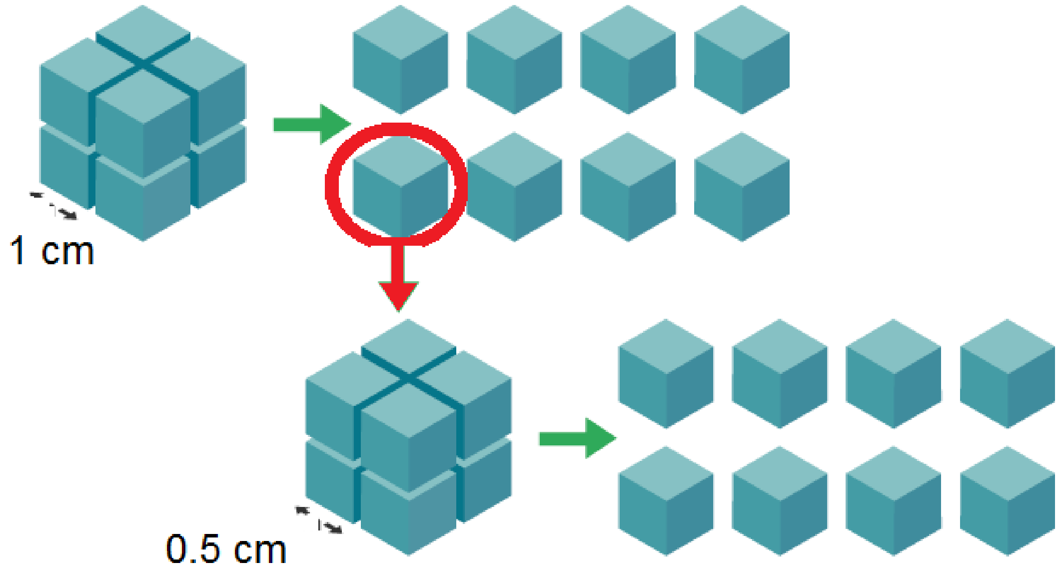
Area of 1 face 1cm x 1cm = 1cm^2

Area of 1 cube 1cm^2 x 6 faces = 6 cm^2

Total surface Area 6 cm^2 x 8 cubes = 48 cm^2

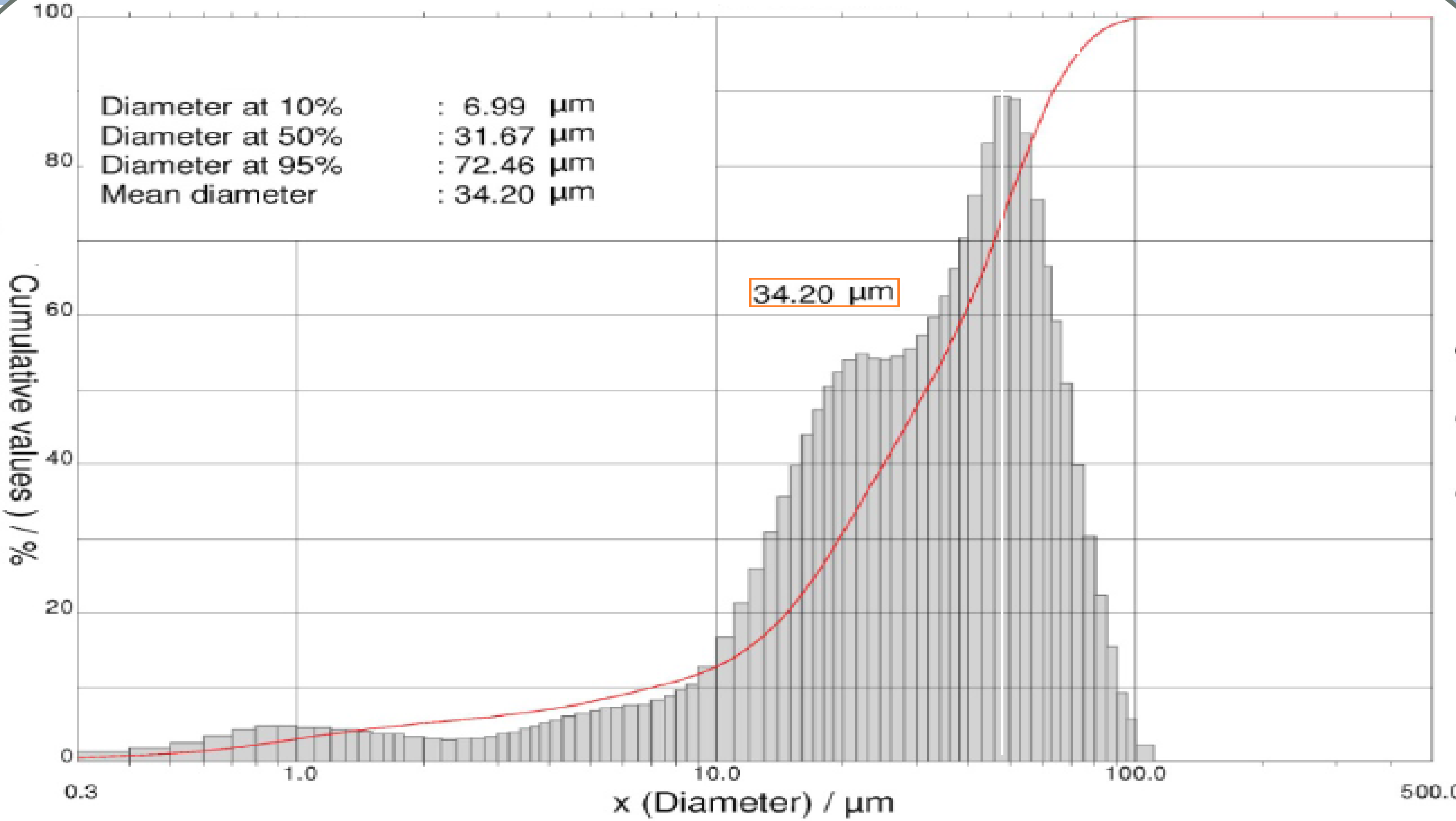
Increase of Surface Area

Repeat Hundreds of Times



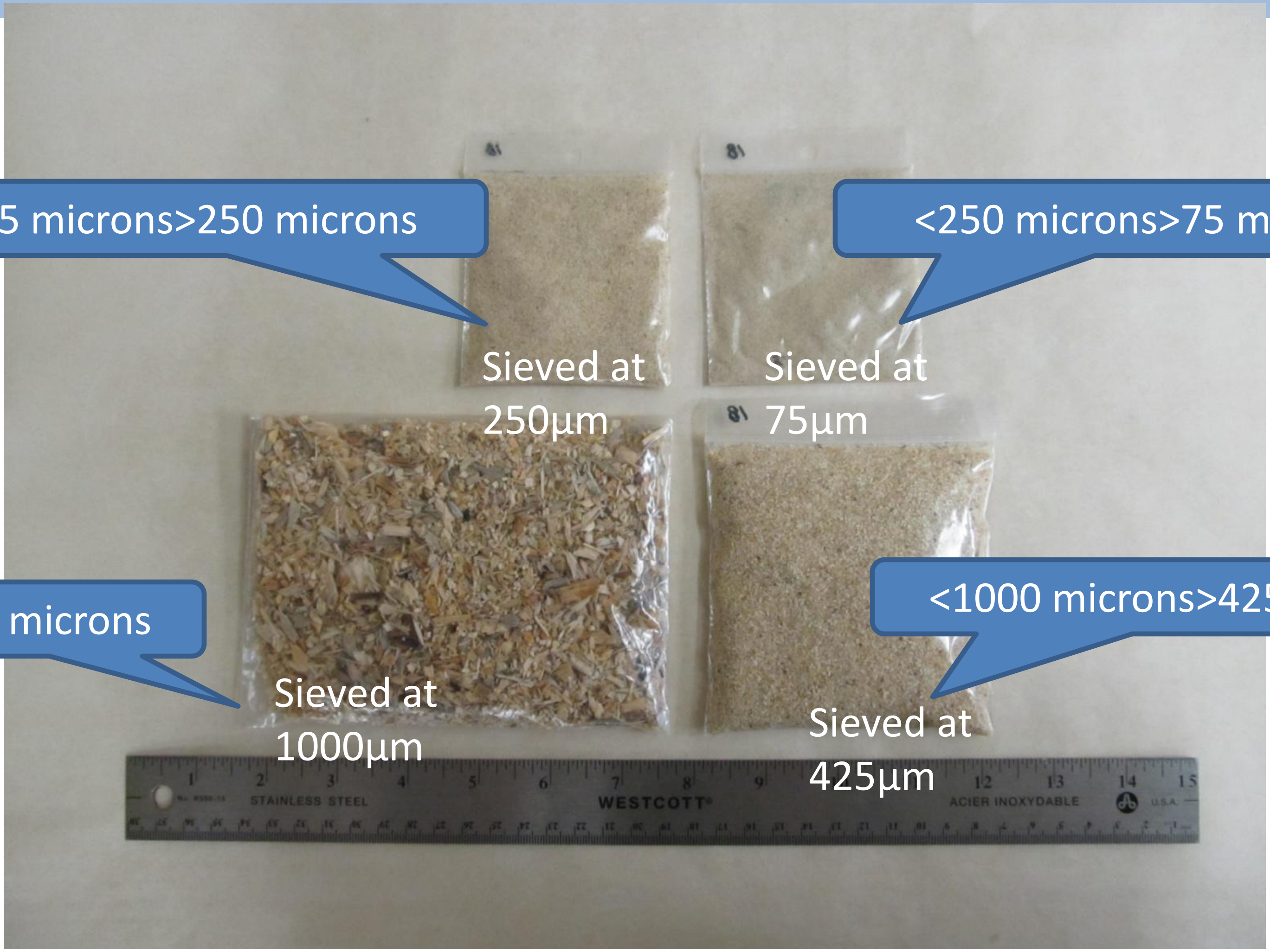
Particle Size Distribution

~~Particle Size~~



Material	Moisture Content (wt.%)	Mean Particle Size (µm)	K_{St} (bar m/s)
Saw Dust	3.5	34 96% < 75µm	185 ± 12%

Average Size of Un-sieved Sample: 700.7µm



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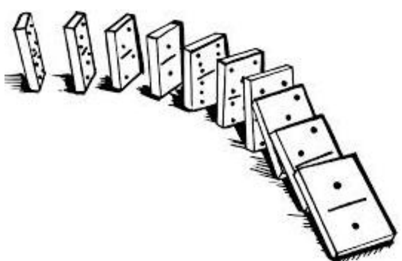
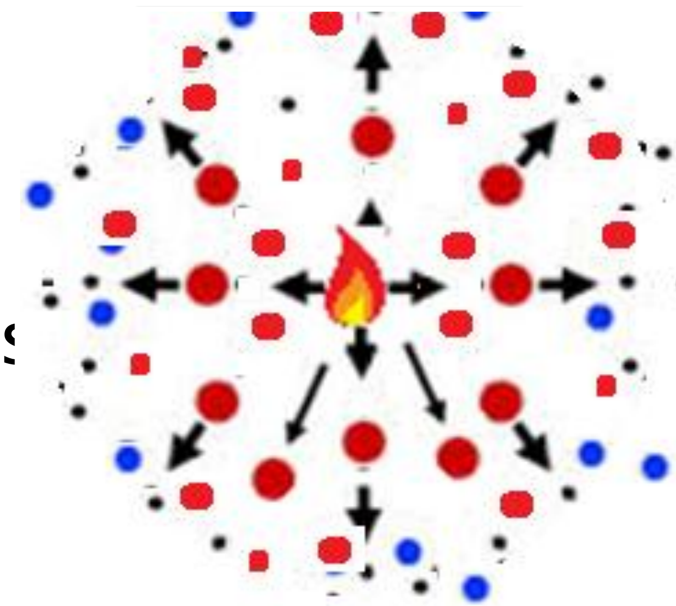
Chemical Properties
Cloud Density and Spark . .

- Optimum cloud density   Minimum Explosible Concentration
  - Sufficient distance between particles
  - Access to oxygen around particles



- Fire
  - Rapid oxidation proces
  - $2C + O_2 \rightarrow 2CO$
  - Minimum Ignition Energy



Chemical Properties

- Materials may be a mixture of two or more substances
- Coal contains volatile components and variable quantities of incombustible ash
- Incombustible matter in the form of inert solid material, and non-flammable volatile components tends to reduce the flammability of the dust by chemical inhibition
- Particulate may contain solvents from previous processes
- Metal dusts may be contaminated with oxide

Chemical Properties – Reaction Rates

- The speed of a chemical reaction is affected by:
  - Temperature
  - Concentration
  - Particle size and shape

- It can be calculated by measuring changes in reactants/products

Combustion Rate Increase

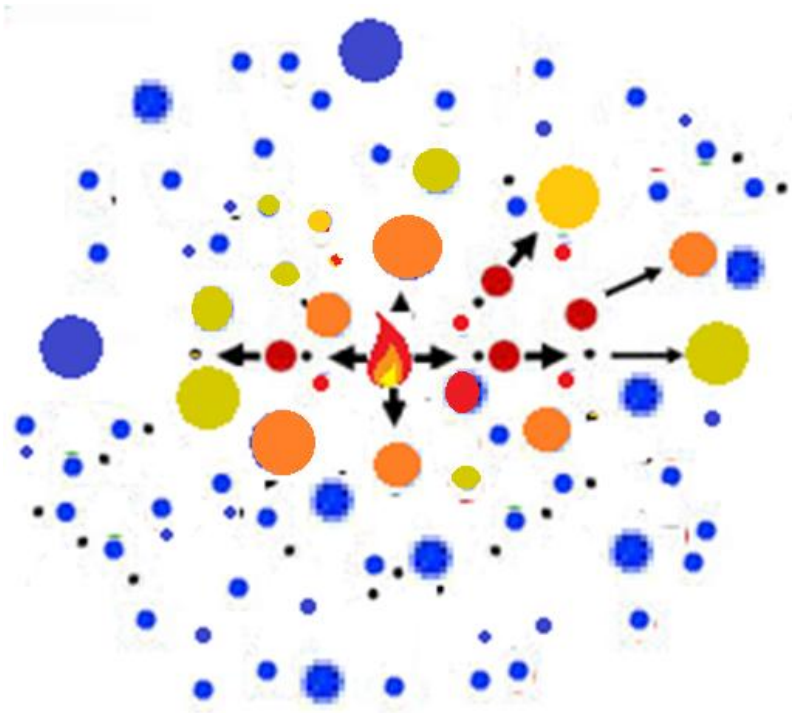
Combustion Rate Increases with Increasing Subdivision

Slow Combustion

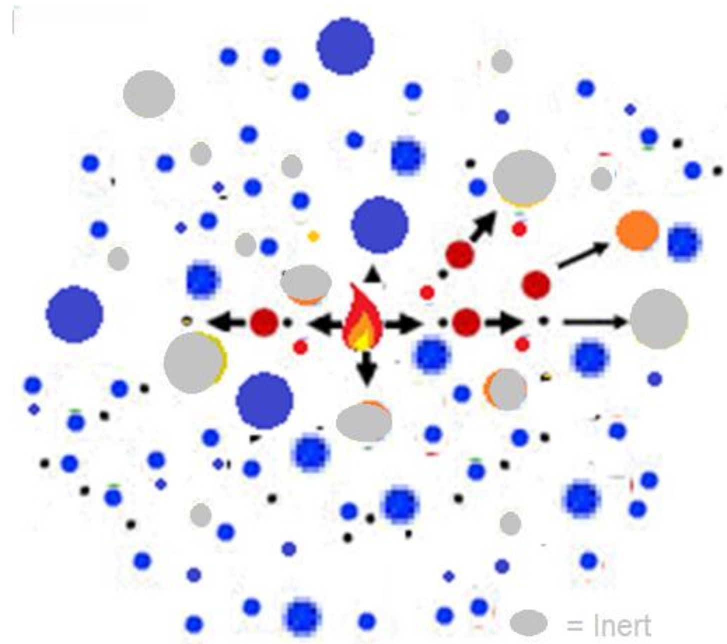
Fast Combustion

Deflagration/ Explosion

Combustion Rate



Size Distribution Affects Rate



Content Affects Rate

Explosion Dynamics

- Thermodynamics
  - Amount of heat liberated during combustion
  - Different types of dust generate various levels of heat
  - This also can be calculated

Thermodynamics

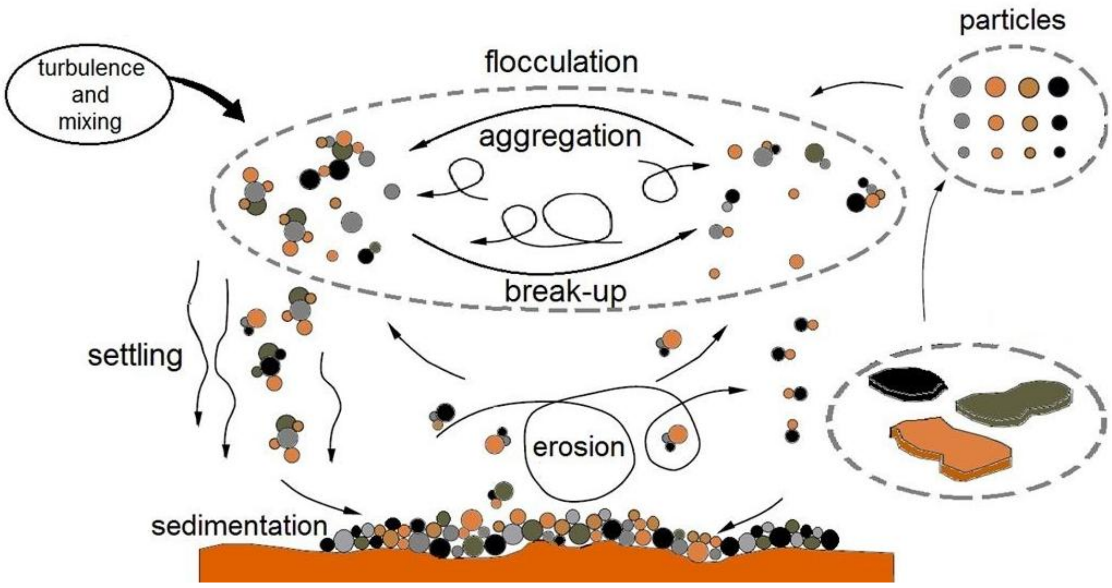
Substance	Oxidation product (s)	KJ/mole O_2
Ca	CaO	1270
Mg	MgO	1240
Al	Al_2O_3	1100
Si	SiO_2	830
Cr	Cr_2O_3	750
Zn	ZnO	700
Fe	Fe_2O_3	530
Cu	CuO	300
Sucrose	CO_2 and H_2O	470
Starch	CO_2 and H_2O	470
Polyethylene	CO_2 and H_2O	390
Carbon	CO_2	400
Coal	CO_2 and H_2O	400
Sulphur	SO_2	300

Moisture Content

- Moisture tends to reduce the flammability of the dust both by chemical inhibition and by the cooling effect of the particles.
- High concentrations of moisture in the dust may also impede the formation of a dust cloud.
- Moisture may increase “clumping” of particulate

Ease of Dispersion

- Individual density of dust particles
- Diameters
- Shapes
- Cohesive properties with respect to each other
- Adhesive properties with respect to supporting surfaces



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External Factors of Dispersion

- Structure/intensity of aerodynamic disturbances
- Location of dust loading
- Geometry of surfaces

Dust Build-up on Pipes

Dust on verticle surface and conduit

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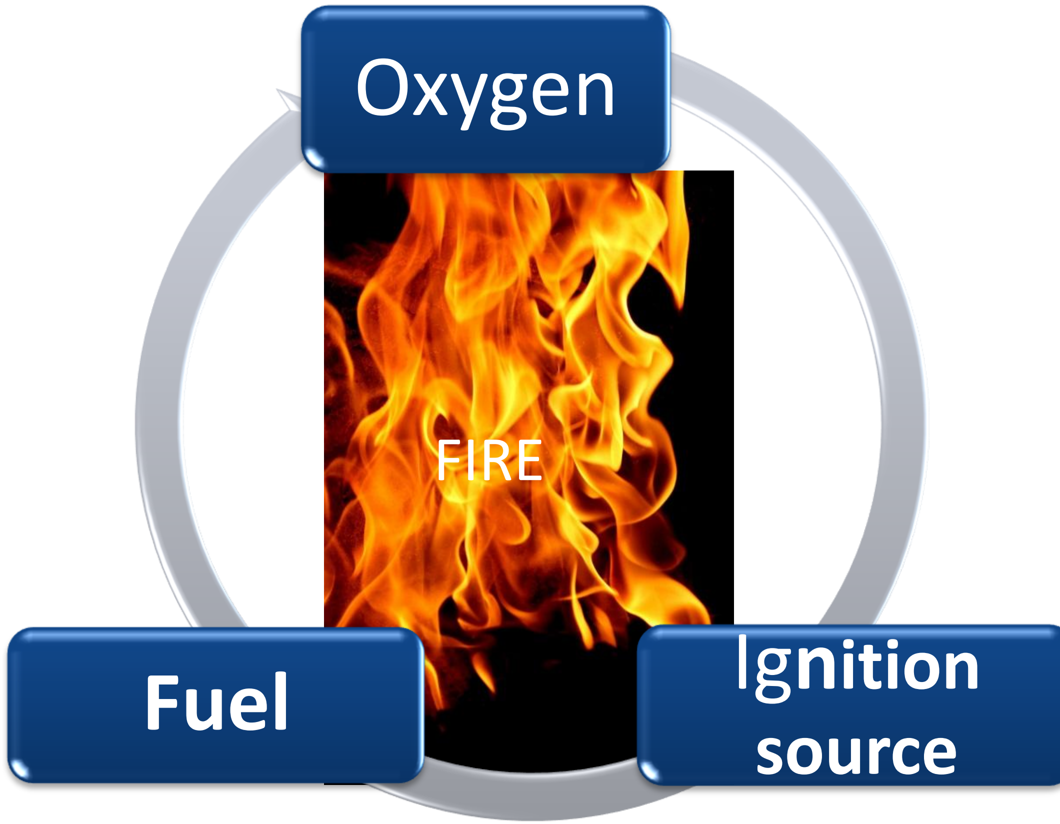
Dust Build Up on Overhead Surfaces

Conditions Needed for a Fire

Three elements needed for a fire.

The Fire Triangle



Add Dispersion

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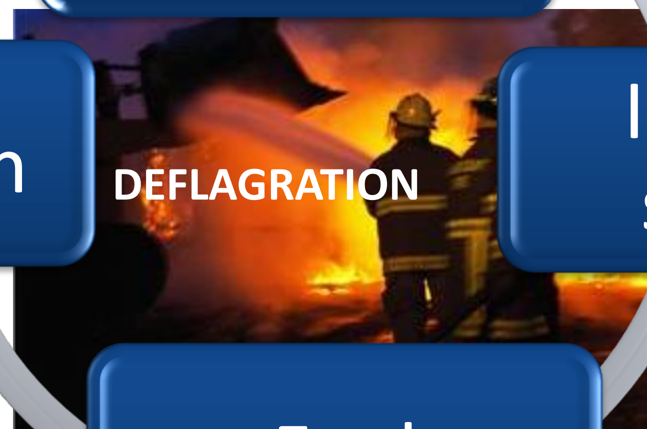
From Fire to Deflagration… (continued)

Conditions Needed for a CD Deflagration

One more is needed for a deflagration.

Oxygen

Dispersion



Ignition source

Fuel

Add Confinement

The Deflagration Diamond

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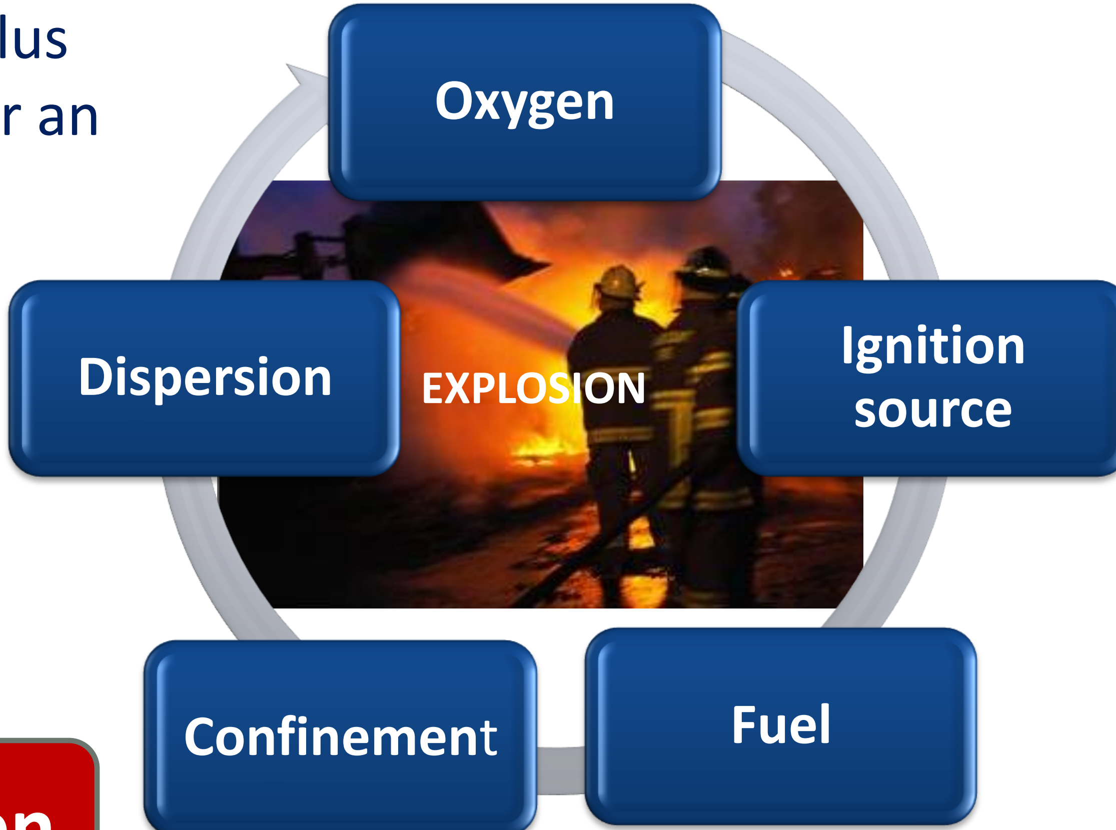
Conditions Needed for Dust Explosion

Deflagration elements plus one more are needed for an explosion.



Explosion Pentagon

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Prevent One Element – No Explosion!

1. Minimize fuel
2. Control for potential ignition sources
3. Control for potential mechanisms of dispersion
4. Remove the confinement
5. Remove the oxygen

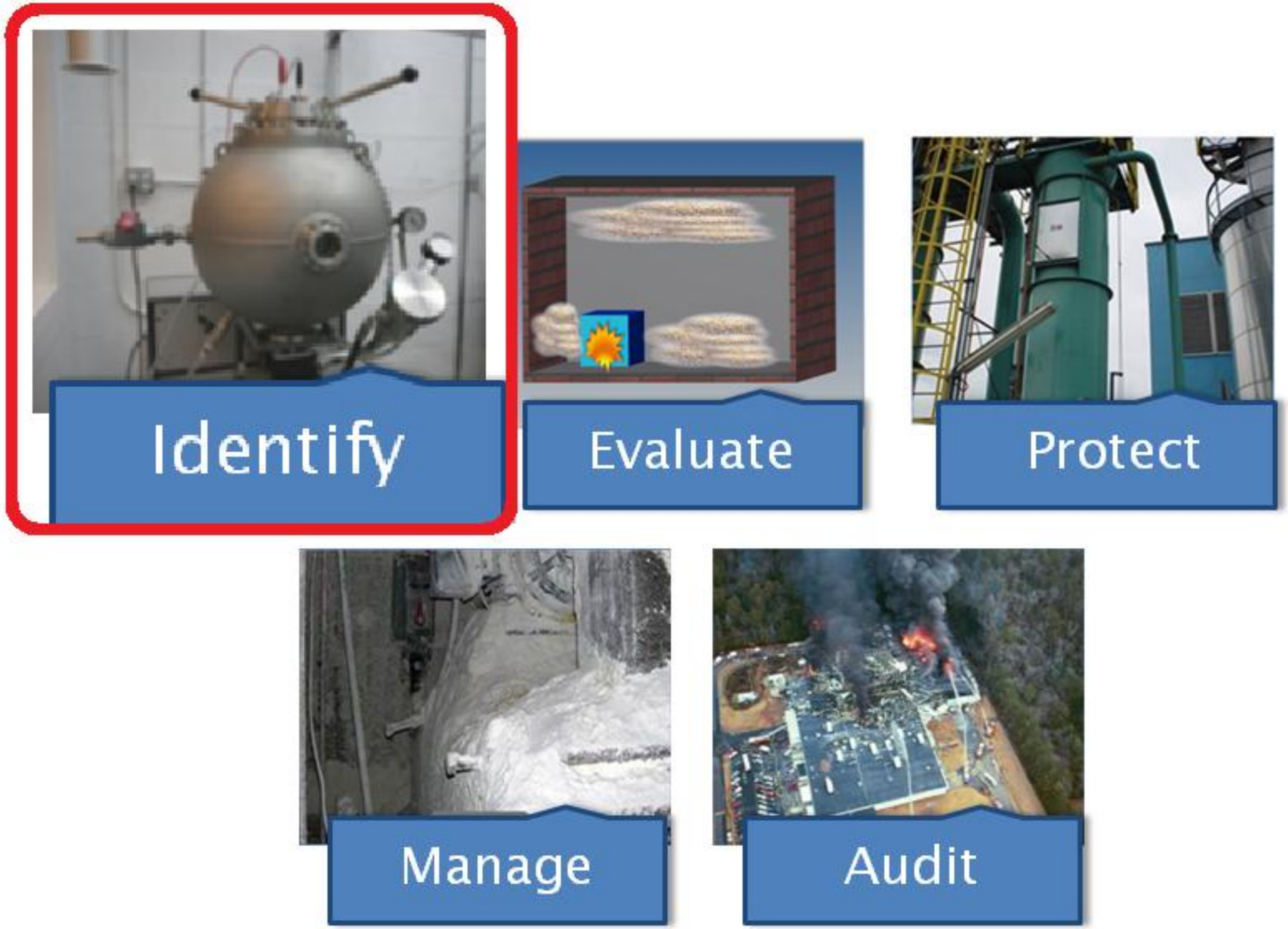
Dust Accumulation Prevention

- **3 Keys to Preventing Dust Accumulation:**
- **Preventive Maintenance, Repair, & Housekeeping**

1. Implement Preventive Maintenance Program
2. Implement housekeeping plan
3. Implement hazardous dust inspection, and audit

Most fatalities, injuries and property damage caused by secondary explosions.

5 Steps for Combustible Dust



Checklist 1: Identify

- Got Dust ? or Got Powder ?
- Where is it ?
  - On floor
  - On equipment
  - On rafters
  - On ducting/water lines
  - Be Comprehensive
- How did it get there ?
  - Spills
  - Equipment Leak
  - Duct leaks
- Why did it stay there ?

What kind ?

Wood

Food or Grain

Metal

Sulfur

Plastic

Chemical / Pharma

What NFPA Standard

What needs to change

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Sampling Strategy
from where

- Consider from receipt of raw materials to end product packaging
  - Where are Dust deposits ?
  - Where is Dust in a cloud ?
- Enclosed equipment
  - Hoppers, bins, dryers
- Locations where properties of the material could change
  - Size reduction
  - Change in moisture content
  - Chemical exposure
- Test material with finest particle size
  - Baghouse or dust collector
  - Elevated horizontal surfaces

Source: Hughes Environmental

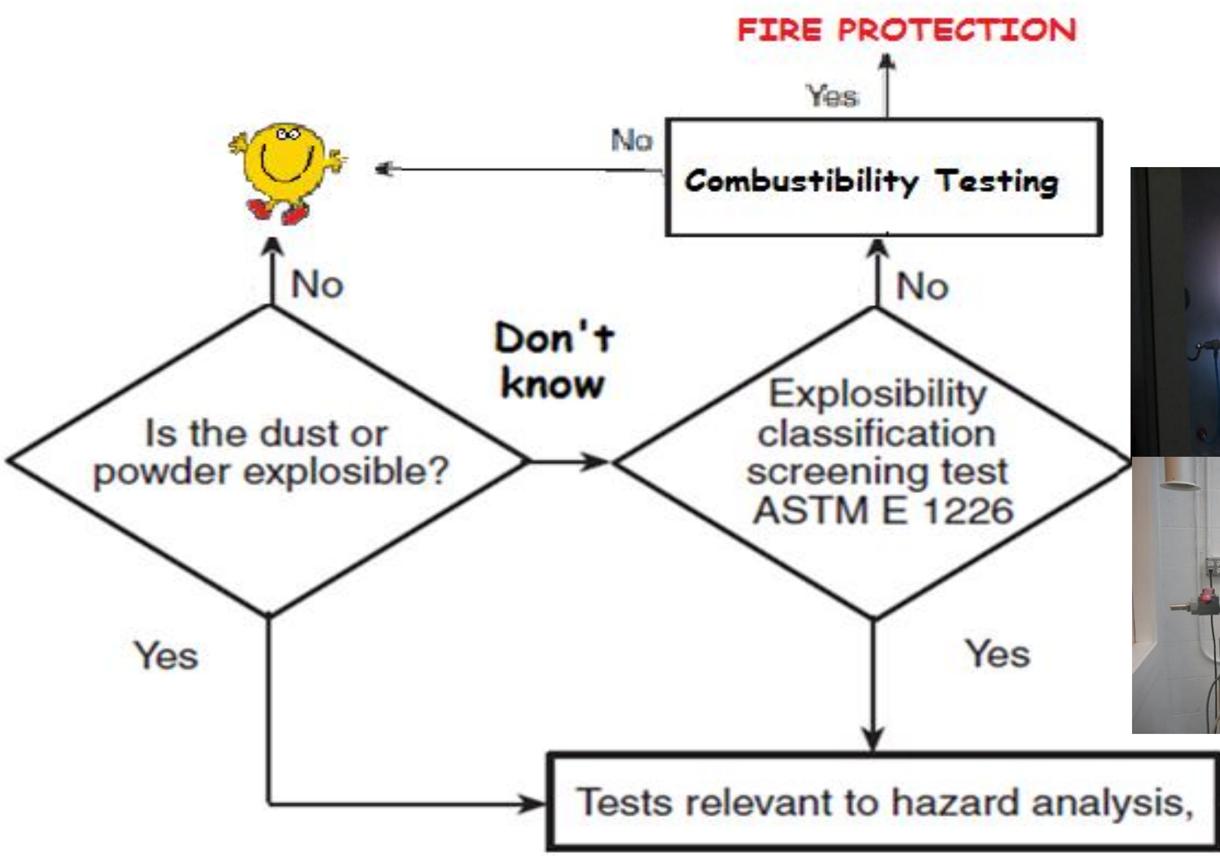
Is the dust/powder a waste or a product ?

- If waste, your focus may be only on the dust collectors

If product, you may have to focus on

size reduction
compaction
conveying
mixing
drying and
dust collectors, just to name a few

GO / NO GO IDENTIFICATION



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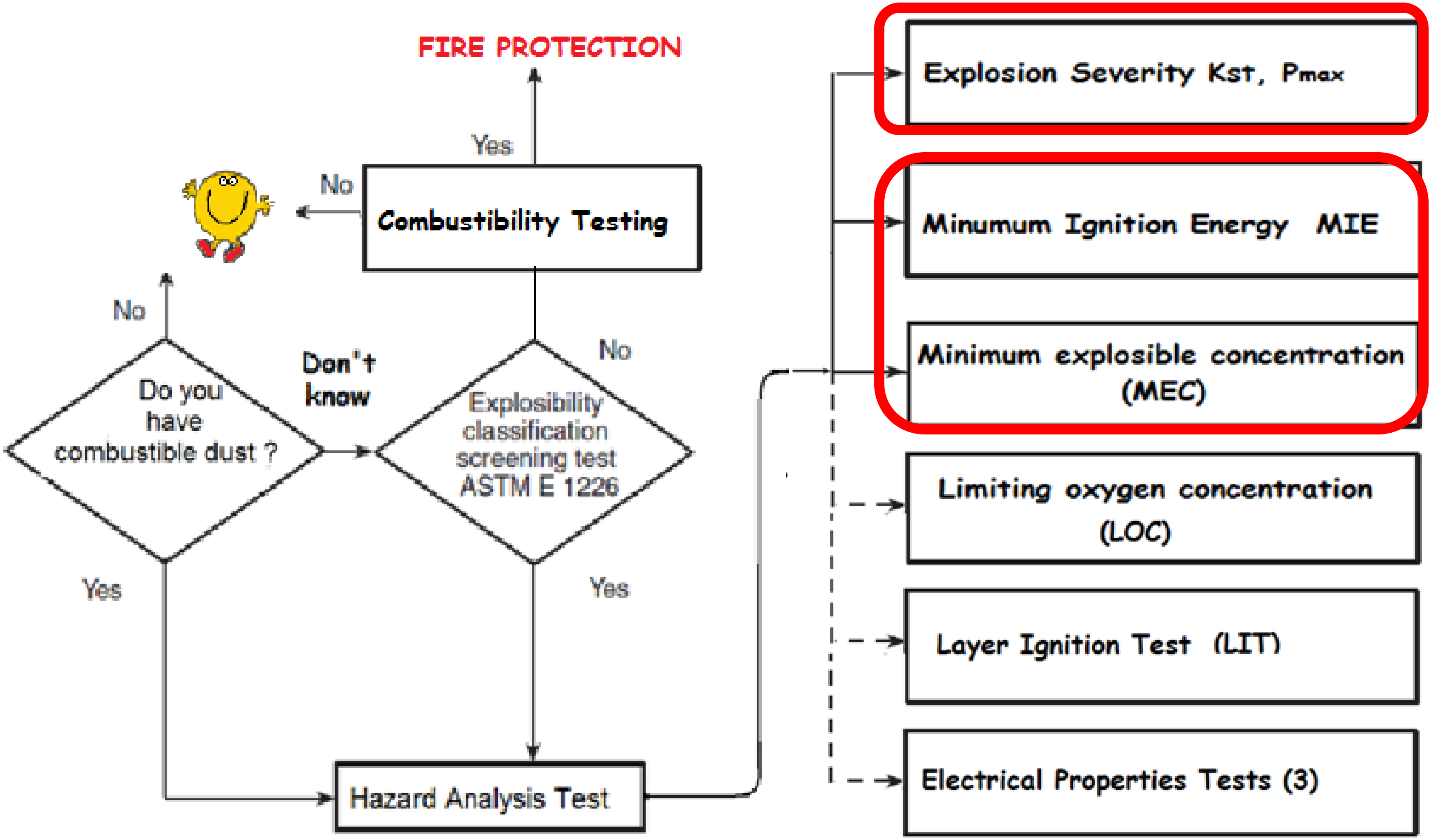
Sampling Strategy

Test for what ?



Characterize the Fire Potential of a "Material"

Combustibility for powders and dusts:

Preliminary screening test set forth in the **UN Recommendations on the Transport of Dangerous Goods: *Model Regulations***—*Manual of Tests and Criteria,* Part III, Subsection 33.2.1.

or

Other equivalent fire exposure test methods

a.k.a. the Orange Book

Characterize the Explosion Potential of a "Material"

- Explosion severity – violence of the explosion
  - K_{St} – Dust deflagration index
  - P_{max} – Maximum overpressure
  - $(dP/dt)_{max}$ – Maximum rate of pressure rise
- Ignition sensitivity – ease of ignition
  - MIE – Minimum ignition energy
  - MEC – Minimum explosible concentration

Definitions

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

Predicts the violence of an explosion. Used to calculate K_S

- P_{max} Maximum Explosion Pressure

Predicts the violence of an explosion. Used to calculate K_S

- **MEC,** Minimum Explosion Concentration

The minimum concentration of a combustible dust suspended in air, measured in mass per unit volume, that will support a deflagration

- **MIE,** Minimum Ignition Energy

The minimum amount of energy released at a point in a combustible mixture that causes flame propagation away from the point, under specified test conditions.

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Definitions

- K_{St} , Deflagration index

Value indicated by the use of variable, K as a measure of explosion severity.

- LIT, Layer Ignition Temperature

Minimum temperature a dust should attain to ignite on a heated surface

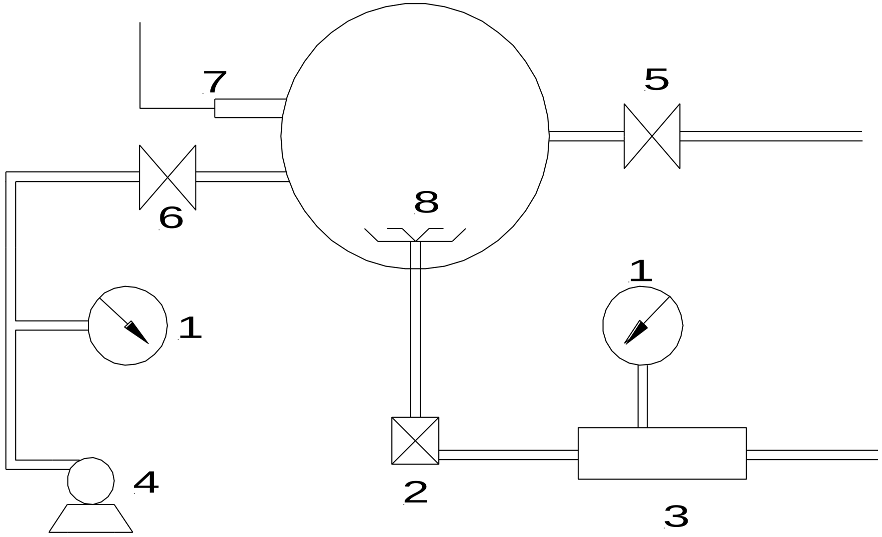
- LOC, Limiting Oxygen Concentration

Determines the least amount of oxygen required for explosion propagation through the dust cloud

- ECT Electrostatic Charging Tendency

Predicts the likelihood of the material to develop and discharge sufficient static electricity to ignite a dispersed dust cloud

20-L Siwek Test Chamber



1. Pressure gauge
2. Solenoid valve
3. Dust storage chamber
4. Vacuum pump
5. Exhaust valve
6. Vacuum valve
7. Pressure transducers
8. Rebound nozzle

Source: Fauske & Associates, LLC

10 kJ ignition source

20 Liter Testing

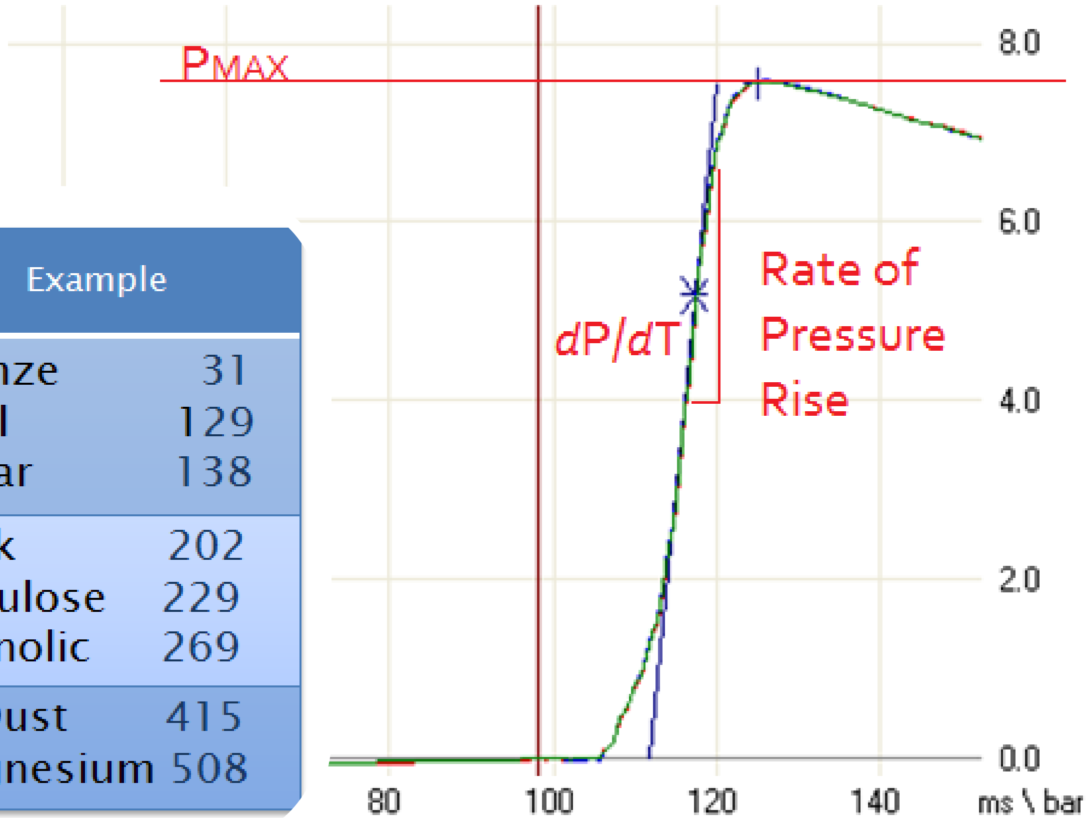
$(dP/dt)_{max}$ and P_{max} needed for K_{st} and Explosion Vent Sizing Calculations

- Same test done around the world:
  - ASTM E1226, EN 14034/1 & 2
- Performed in 20 liter (or larger) spherical test bomb, unvented
- 10 kJ pyrotechnic ignition source
- Test measures “gas generation rate” of a dust explosion
- Tests repeated to give statistical average

20 Liter Testing

Typical Data Plot – Kst Test

Hazard Class	K_{St} (bar-m/sec)	Example
St-1	< 200	Bronze 31 Coal 129 Sugar 138
St-2	200-300	Cork 202 Cellulose 229 Phenolic 269
St-3	>300	Al Dust 415 Magnesium 508



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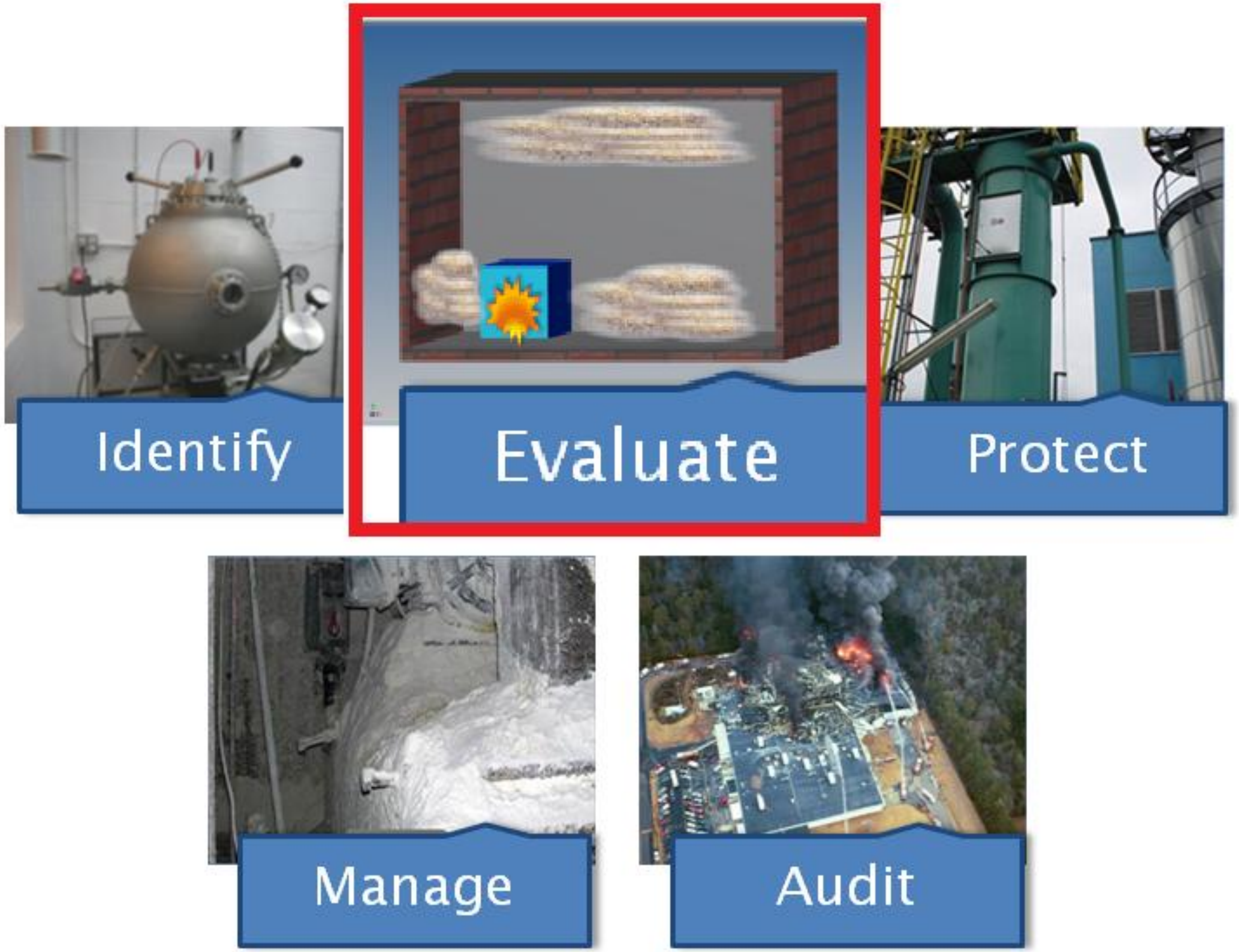
Commonly Measured Properties of Combustible Dusts

Property	Definition	ASTM Test Method	Application
K_{St}	Dust deflagration index	ASTM E 1226	Measures the relative explosion severity compared to other dusts
P_{max}	Maximum explosion overpressure generated in the test chamber	ASTM E 1226	Used to design enclosures and predict the severity of the consequence
$(dP/dt)_{max}$	Maximum rate of pressure rise	ASTM E 1226	Predicts the violence of an explosion. Used to calculate K_{st}
MIE	Minimum Ignition Energy	ASTM E 2019	Predicts the ease and likelihood of ignition of a dispersed dust cloud
MEC	Minimum Explosible Concentration	ASTM E 1515	Measures the minimum amount of dust dispersed in air, required to spread an explosion Analogous to the lower flammability limit (LFL) for gas/air mixtures
LOC	Limiting Oxygen Concentration	ASTM standard under development	Determines the least amount of oxygen required for explosion propagation through the dust cloud
ECT	Electrostatic Charging Tendency	No ASTM standard	Predicts the likelihood of the material to develop and discharge sufficient static electricity to ignite a dispersed dust cloud

Evaluate: Combustible Dust Hazard Analysis (DHA)



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NFPA 652
Chapter 7: Dust Hazards Analysis (DHA)

- Dust Hazards Analysis required
- Requirement is retroactive
  - During Modifications/Construction or
  - Complete within 3 years (from when??)
- Must be validated every 5 years
- Must be led by a qualified person

NFPA 654, 2017

Complete within 5 years

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NFPA 652
Dust Hazards Analysis

- A systematic review to identify and evaluate the potential fire, flash fire, and explosion hazards associated with the presence of one or more combustible particulate solids in a process or facility.

DOES DHA = OSHA PHA ?

DOES DHA = OSHA PHA ?

- **Dust Hazards Analysis –** *In the context of this definition,*

NO. *It is not intended that the DHA must comply with the Process Hazards Analysis (PHA) requirements contained in OSHA regulation 29 CFR 1910.119.*

- *While the DHA can comply with OSHA PHA requirements, other methods can also be used.*

YES. *Some processes may fall within the scope of the OSHA regulation, 29 CFR 1910.119 and there may be a legal requirement to comply with that regulation*

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Where are Combustible Dust Requirements and Enforcement Today?

- Major Players
  - OSHA
  - NFPA
  - ASTM
  - U. S. Chemical Safety Board
  - U. S. Congress
  - Individual States
    - California
    - Georgia

5 Occupancy Standards that Address Combustible Dust

- NFPA 652, **Standard on the Fundamentals of Combustible Dust**
- NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*
- NFPA 484, *Standard for Combustible Metals*
- NFPA 654, *Standard for 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*

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NFPA

Many NFPA Standards Affect CD

Fundamentals Standard

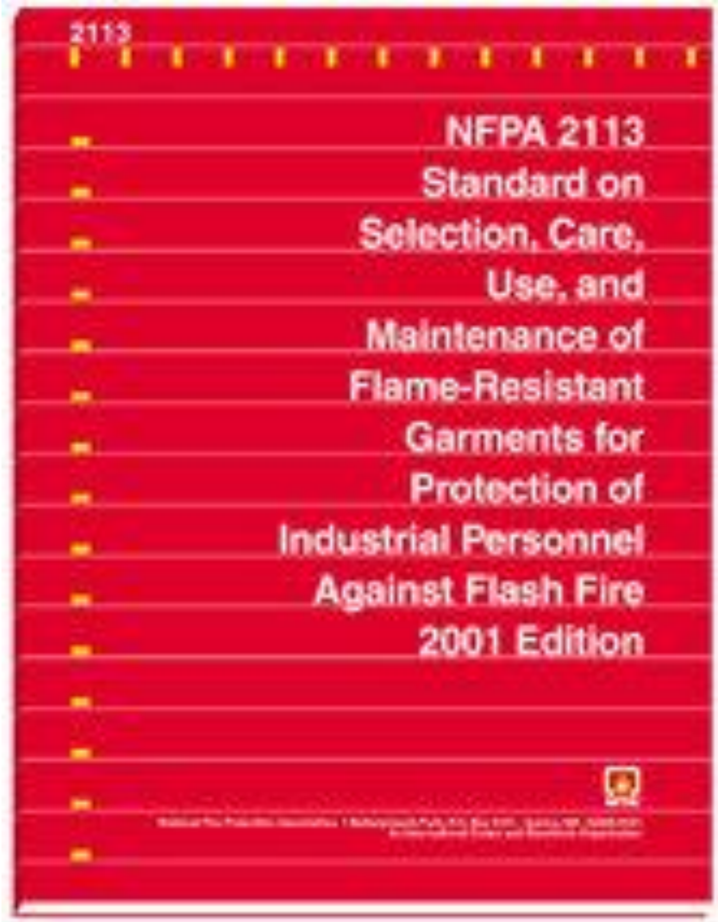
Occupancy Standards
- Agricultural
- Metal
- Sulfur
- Wood
- General

Design Standards
- Explosion Protection
- Deflagration Venting
- Ventilation
- Electrical Classification
- National Electric Code
- Static Electricity

Life Safety Standards
- FR Garments
- Life Safety
- Hot Work
- LOTO
- Others

NFPA 2113 FR Garments

OSHA has deemed that 2113 is the standard to follow when determining the personal protective equipment workers should wear.



NFPA®

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Personal Protective Equipment (PPE)

PPE based on documented analysis of the potential for personnel to be exposed to hazards

- 29 CFR 1910.132 (General requirements);
- 29 CFR 1910.133 (Eye and face protection);
- 29 CFR 1910.135 (Head protection);
- 29 CFR 1910.136 (Foot protection);
- 29 CFR 1910. 137 (Electrical protective equipment);
- 29 CFR 1910.138 (Hand protection)

- NFPA 2113 (selection and care of FR clothing)

Where are Combustible Dust Requirements and Enforcement Today?

The NFPA has no power,
nor does it undertake
to police or enforce compliance.

The NFPA does not
list, certify, test, or inspect
products,
designs, or
installations for compliance.

Understand the Risk Factors

Dust Hazard Analysis (DHA)

- Dust properties:
  - type
  - particle size
  - moisture content
- Ignition sensitivity
- Ignition sources
- Explosion Severity
- Quantity of material (fuel)
- Dispersion mechanisms
- Confinement

Source: U.S. Chemical Safety Board (U.S. CSB) Report #2003-09-I-KY

Identify Hazards:
Dust Hazard Analysis (DHA)

- Review Material Handling Equipment
  - Receiving, storage, use, processing and disposal of all fine particulate materials
  - Fire/explosion suppression and venting system(s), warning devices and onsite extinguishing capabilities

Source: U.S. Chemical Safety Board (U.S. CSB) Report 2003-07-I-NC

- Fugitive Dust
  - Identify accumulation and possible sources, consider spills

- Identify sampling points and collect sample(s), as necessary

Identify Equipment Where Hazard Exists

Dust Hazard Analysis (DHA)

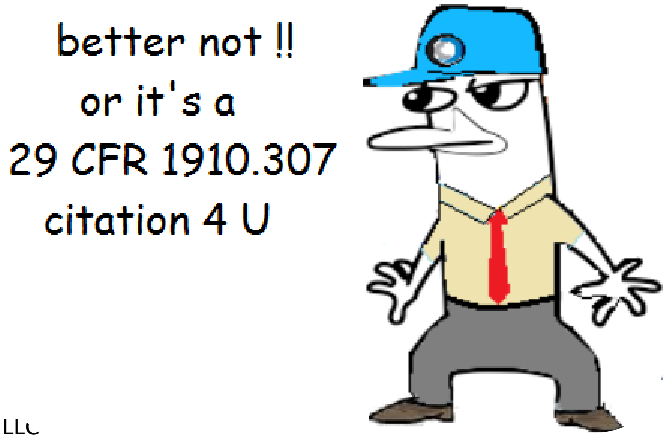
- Air material separators:
  dust collectors, cyclones
- Bulk storage: hoppers, bins
- Blending/mixing
- Material transfer:
  pneumatic conveying, vacuum system
- Material feeding systems
- Bucket elevators
- Enclosed conveyors
- Size Reduction Equipment
- Dryers

Source: Donaldson Torit

Gap Analysis
Dust Hazard Analysis (DHA)

- Evaluate Compliance with Relevant National, Local and Industry Standards (e.g. National Fire Protection Association [NFPA] and International Fire Code [IFC])
- Perform Gap Analysis Per Prescriptive-based Requirements
- Recommendations for Risk Reduction
- Electrical Area Classification Evaluation

Source: U.S. Chemical Safety Board (U.S. CSB) Report #2008-05-1-GA



Determine Consequences
Dust Hazard Analysis (DHA)

- Flash fire

Deflagration Diamond ?

- Vessel failure due to explosion

Blast Effects ?

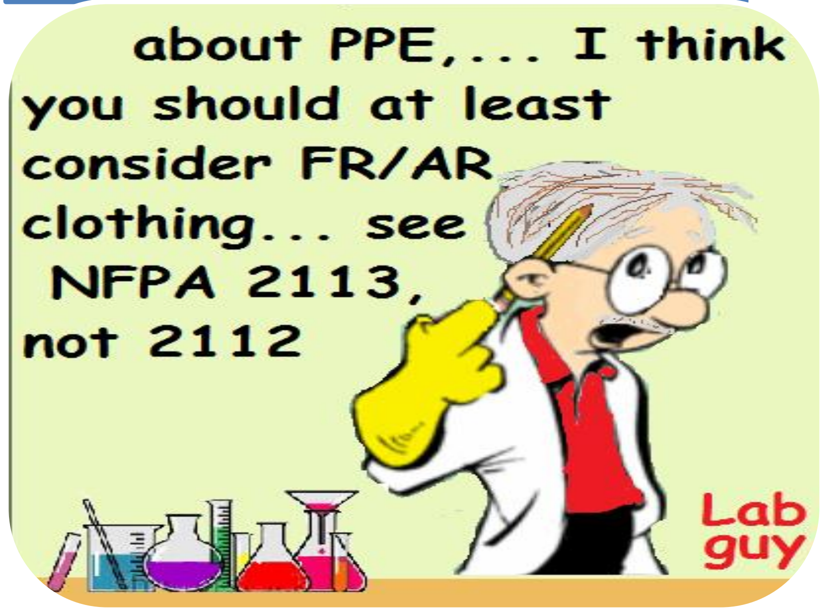
- Possibility for secondary explosion

How's Your House keeping ?

- Potential personnel exposure

PPE Considerations ?


Source: U.S. CSB



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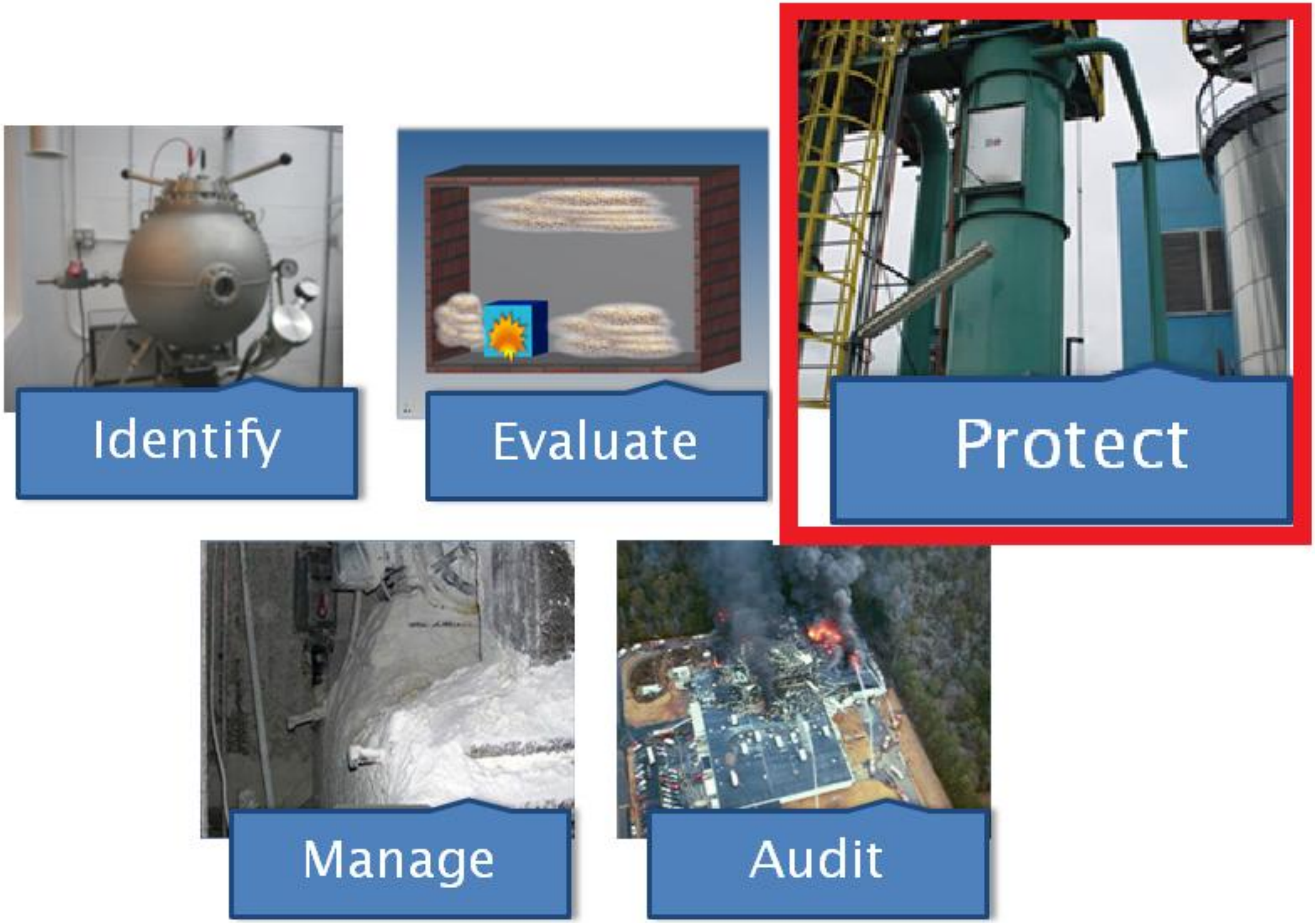
Evaluate Risk
Dust Hazard Analysis (DHA)

- Identify where fire, flash fire and explosion hazards exist
- Identify current safeguards in place
- Identify safe operating ranges
- Recommend additional safeguards
- Prioritize recommendations


Identify
Evaluate
Protect
Manage
Audit

NFPA 652; Equipment Protection

- **8.9.3.1* General.** Where an explosion hazard exists within any operating equipment greater than 8 ft3 (0.23 m) of containing volume, the equipment shall be protected from the effects of a deflagration.

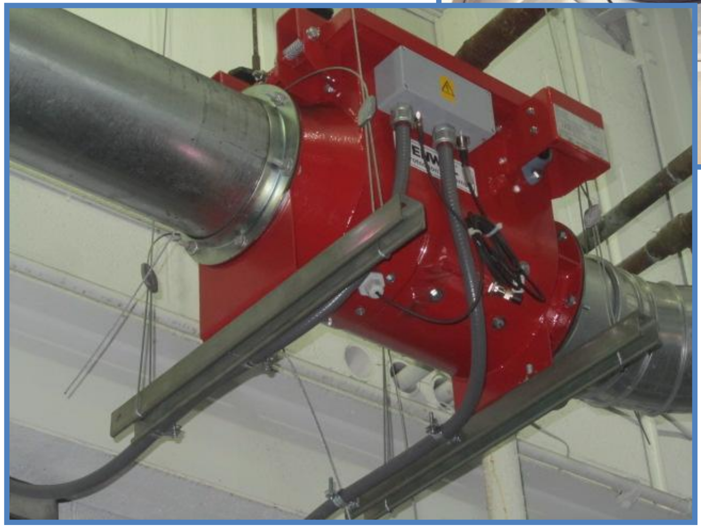
Mitigative & Preventive Safeguards

- Equipment and building design
- Explosion prevention/protection
- Fire protection
- Dust control
- Ignition source control
- Electrical area classification
- Personal protective equipment (PPE)

Source: Fenwal – IEP Technologies

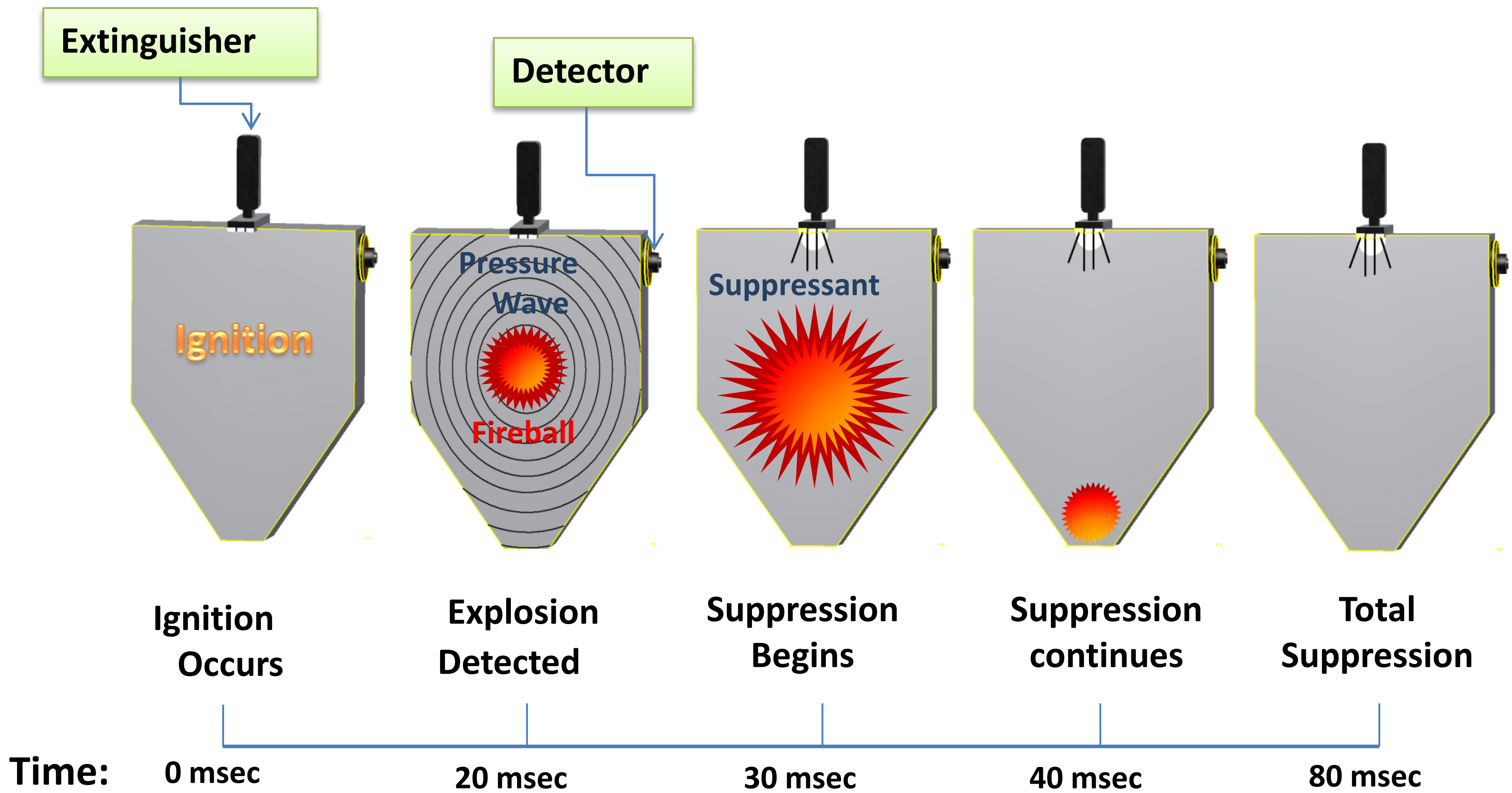
Equipment Protection

- Oxidant concentration reduction
- Fuel concentration reduction
- Deflagration venting
- Deflagration pressure containment
- Deflagration suppression
- Deflagration venting through a flame-arresting device
- Isolation of equipment

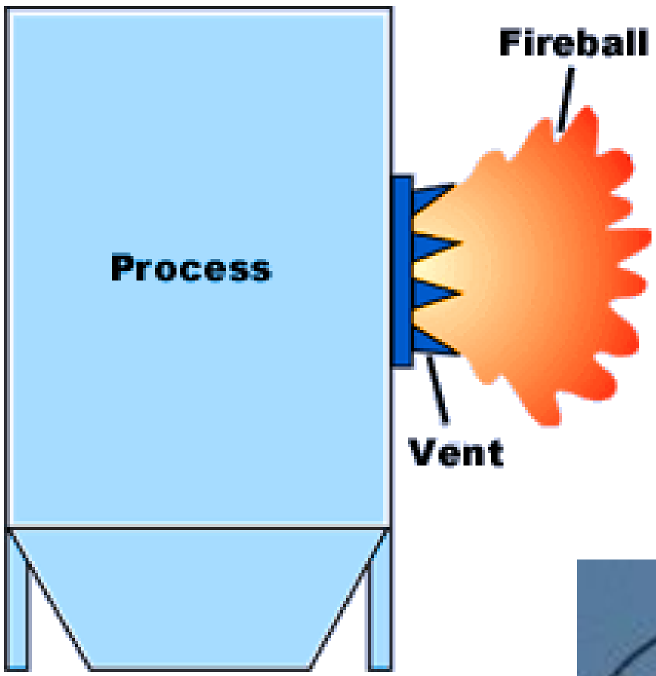


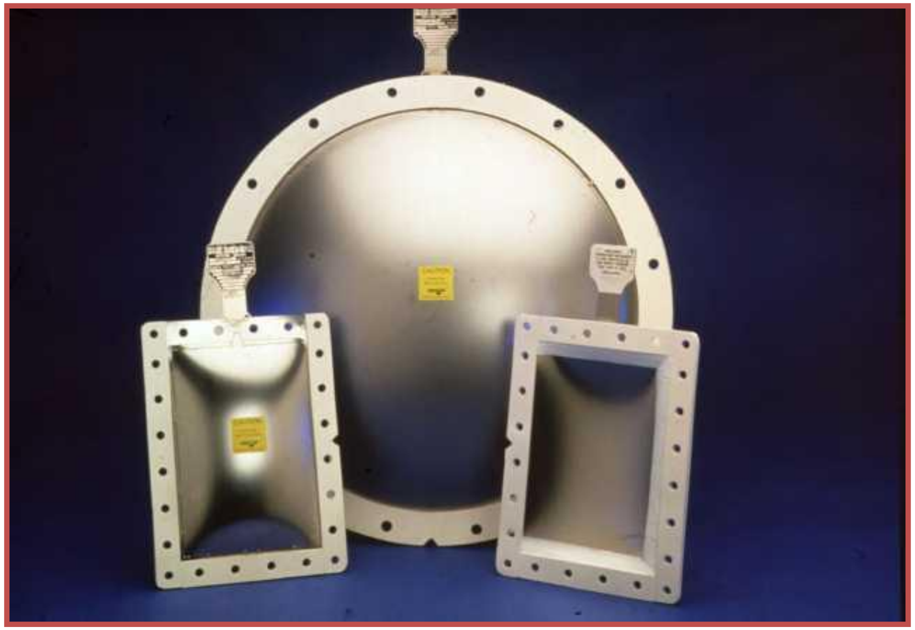
Source: Fenwal – IEP Technologies

Deflagration Chemical Suppression

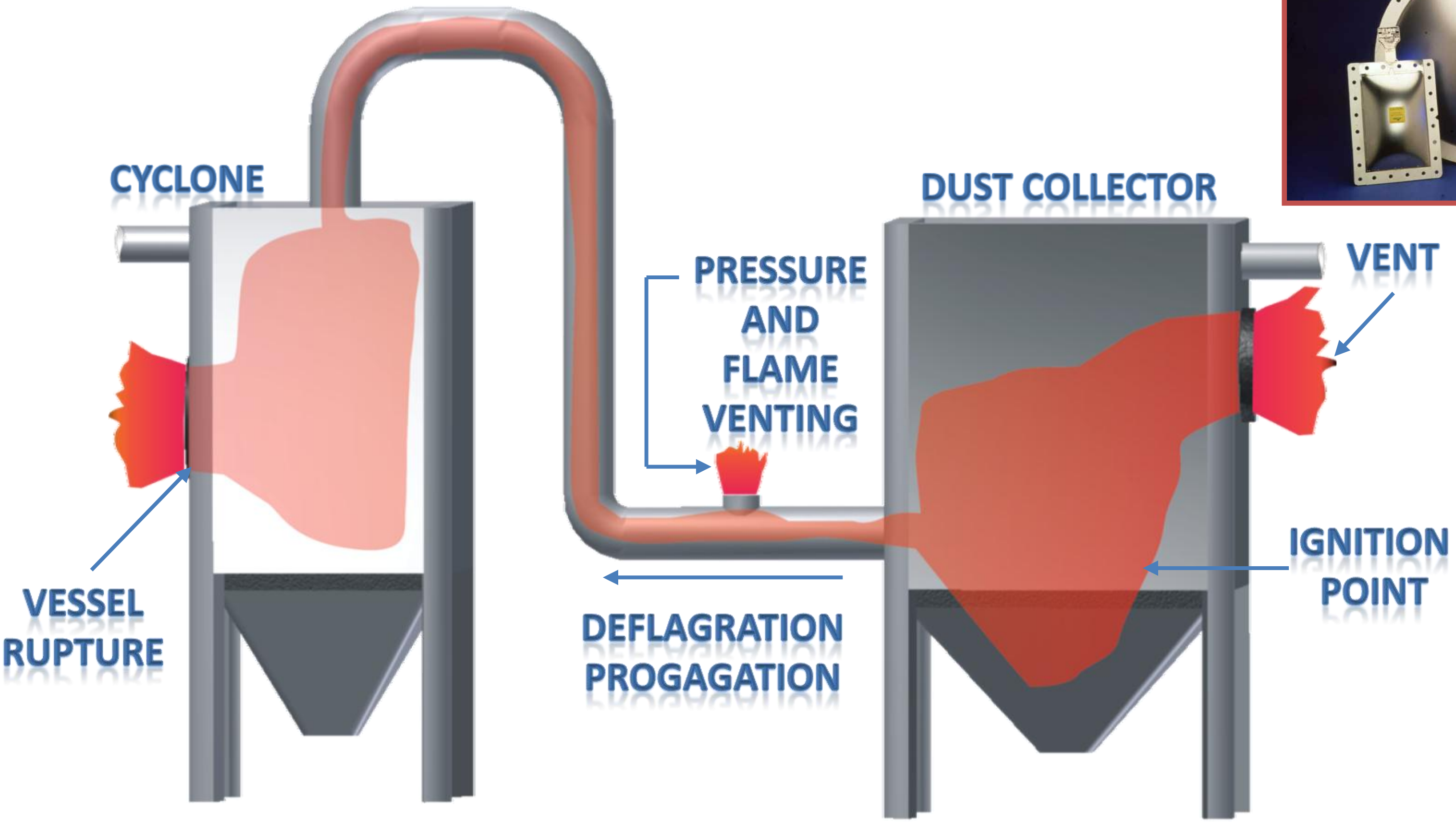


Explosion Prevention Systems: Passive Vents

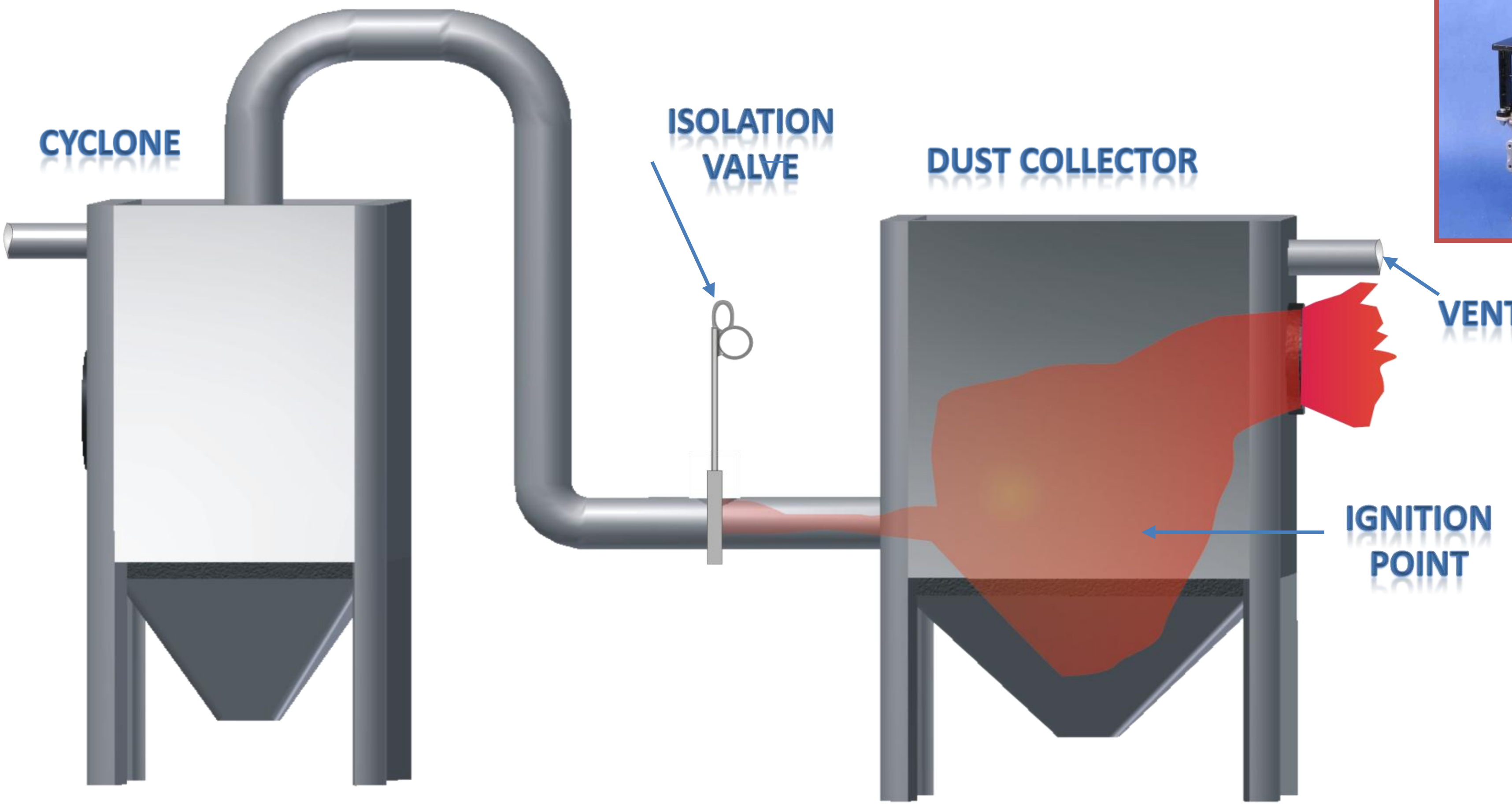




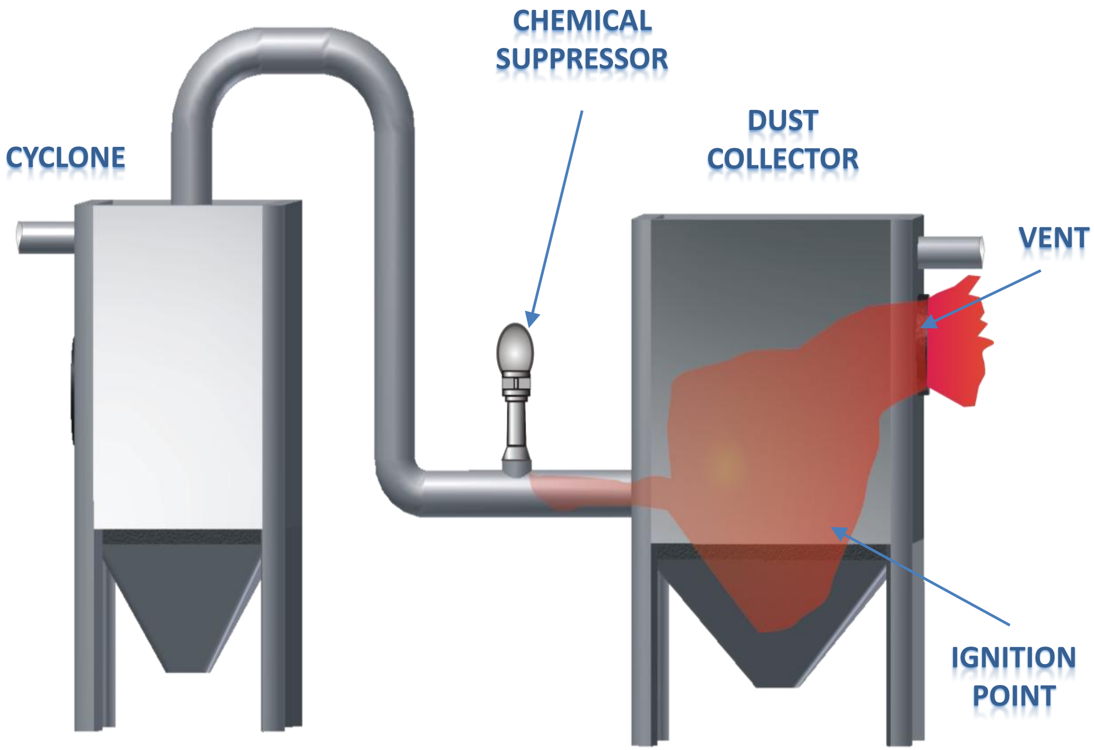
Deflagration Propagation with Vent but Without Isolation

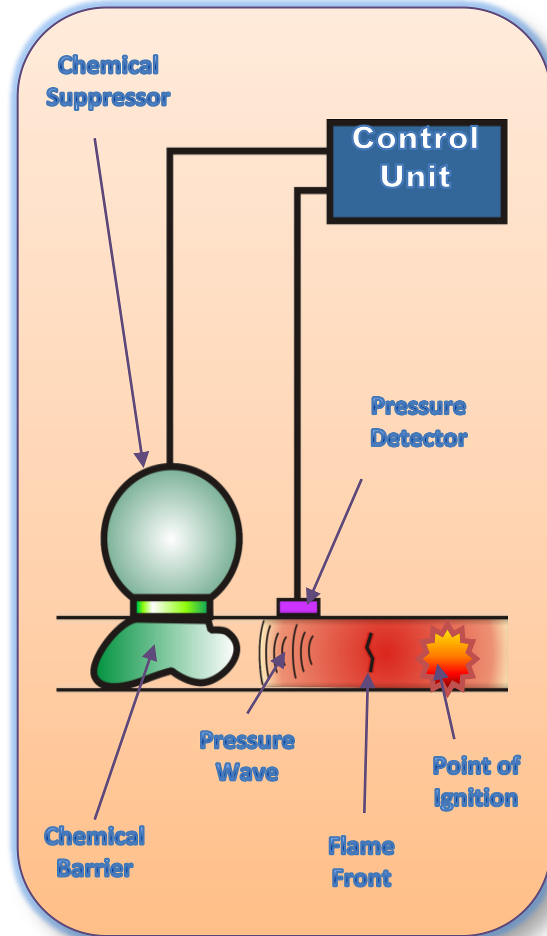


Deflagration Propagation Using Mechanical Isolation

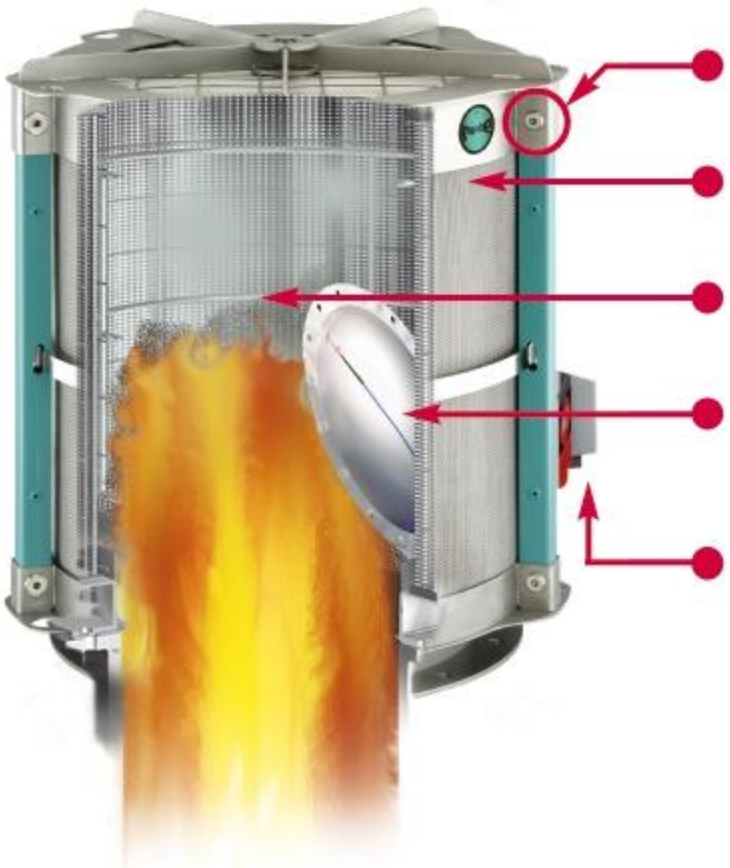


Deflagration Propagation Using Chemical Suppression for Isolation





Explosion Protection Systems: Flameless Vent



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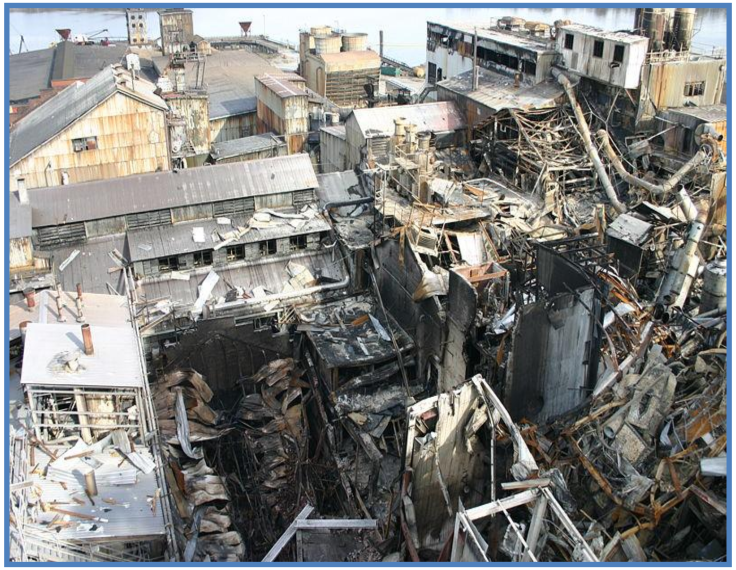
Mitigative & Preventive Safeguards
Management Systems

- Housekeeping
- Operating procedures and practices
- Inspection, testing and maintenance
- Training and hazard awareness for employees and contractors
- Emergency planning and response
- Incident investigation
- Management of change (MOC)
- Document retention
- Management systems review
- Employee participation



Source: U.S. Chemical Safety Board (U.S. CSB)

Housekeeping

Source: U.S. Chemical Safety Board (U.S. CSB)

- Comprehensive cleaning
- Visual baseline
- Cleaning methods and frequency
- Inspections

Housekeeping –Fugitive Dust Control

- Contain and remove combustible dust
- Design of facility and process equipment
- Continuous suction…where combustible dust is liberated in normal operation
- Dust-tight system components
  - Pneumatic conveying systems
  - Dust collection systems
  - Centralized vacuum systems
- Bin vents properly sized

Source: U.S. Chemical Safety Board (U.S. CSB)

Source: FAI

Ignition Source Control:
Hot Work and Open Flames

- Smoking
- Open flames
- Welding
- Abrasive cutting
- Grinding
- Tools
- Vehicles

Ignition Source Control:
Hot Surfaces or Sparks

- Electric sparks from equipment
- Electric sparks from electrostatic discharge
- Hot surfaces on process or electrical equipment
  - Light fixtures
  - Electric Motors
- Smoldering/burning conveyed process materials
- Mechanical impact → heat or sparks
- Exothermic reactions

Fire Prevention and Control

- Hot work permits
- Lockout/tagout policies
- Design specifications for storage of flammable materials
- Severity reduction policies, practices and procedures designed to minimize the spread of fire
- Emergency plans
- Alarm systems

Fire Prevention and Control

- Portable fire extinguishers
- Cleanup policies, practices and procedures designed to return the affected area to an operational level
- Recharging portable extinguishers
- Removal of debris to an appropriate waste site
- Equipment and facility repair

Inspection, Testing & Maintenance

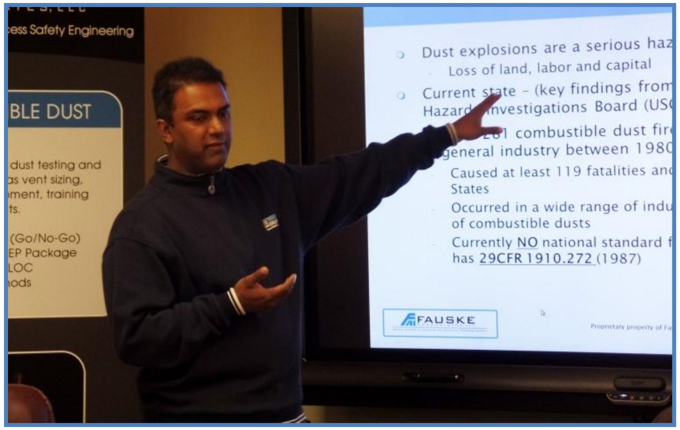
Establish procedures and schedules for maintaining safe operating conditions for facility and equipment

- Fire and explosion protection and prevention equipment
- Dust control equipment
- Potential ignition sources
- Electrical, process, and mechanical equipment, including process interlocks
- Lubrication of bearings

Initial & Refresher Training

Combustible Dust Awareness and Affected Procedures

- Hazards of their workplace
- General orientation, including plant safety rules
- Process description
- Equipment operation, safe startup and shutdown, and response to upset conditions
- Proper functioning of related fire and explosion protection systems
- Equipment maintenance requirements and practices
- Housekeeping requirements

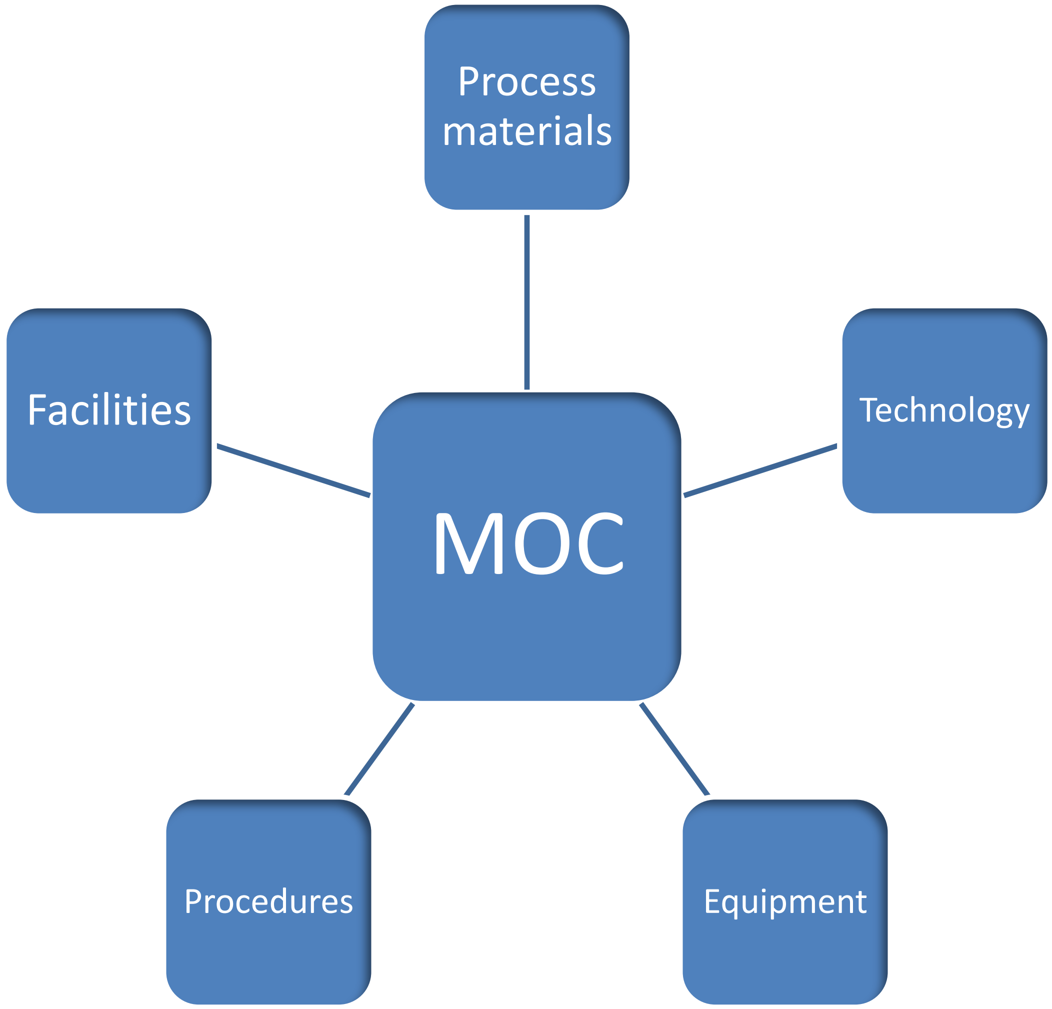


Recognizing Dust Hazards

Combustible Dust Awareness

- All employees should be trained to recognize the hazards
  - Conduct general facility wide appraisals of dust explosion possibilities on a periodic basis.
  - Conduct internal and external audits in order to identify potential explosion hazards.
  - Encourage a preventative attitude among employees for dust explosions.
  - Have employees and supervisors identify explosion hazards through JHAs.
  - Pay particular attention to dust collection systems and other areas not in plain view during the assessment.

Management of Change (MOC)



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Management of Change

- This is a **Retroactive Requirement**
- Must have **Written procedures** to manage proposed changes to process materials, technology, equipment, procedures, and facilities.
- Not required for **replacements-in-kind**.
- Must Update Design documentation

Management of Change

Must addressed the following:

(1) The technical basis for the proposed change

(2) Safety and health implications, including hazard analysis

(3) Whether the change is permanent or temporary

(4) Modifications to operating and maintenance procedures

(5) Employee training requirements

(6) Authorization requirements for the proposed change

(7) Results of characterization tests used to assess the hazard, if conducted

Self-Audit

Management Systems Review

- Evaluate the effectiveness of the management systems by conducting a periodic review of each management system.
- This is an ongoing effort.
- Verify that procedures and schedules are being followed.

Example: Housekeeping

- Verify housekeeping effectiveness based on routine, scheduled cleaning and inspections.
- Document the cleaning.
- Document the Audit and Corrective Actions

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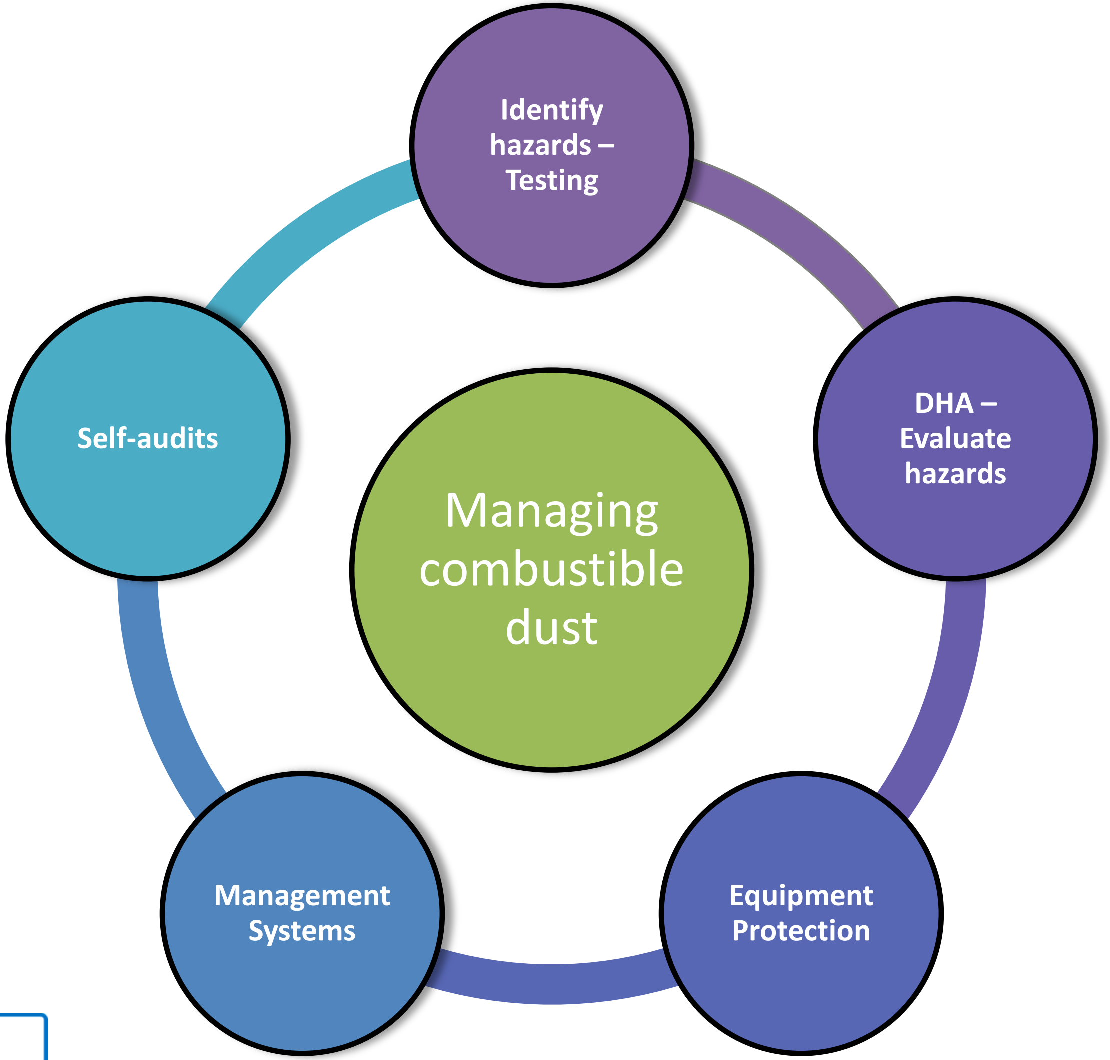
Summary: 5 Steps to Managing Combustible Dust Hazards



Timothy L. Cullina, P.E.
www.Fauske.com
Cullina@Fauske.com

Intro video - CBC story.mp4

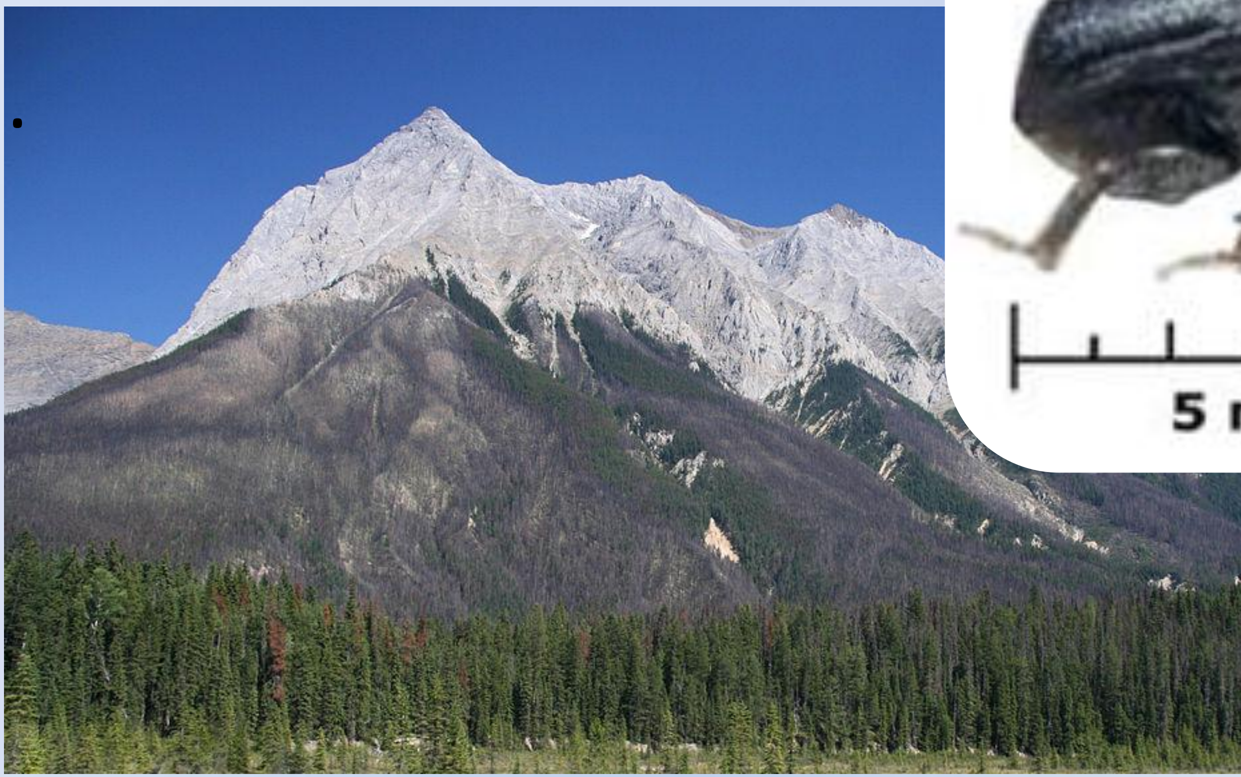
Saw Mill Explosion and Fire

FALSE

What happened in BC?

- Many woodworking facilities process feedstock with high moisture content (i.e., fresh cut trees) and the resulting dust is large, wet, and coarse in nature.

- These dynamics can change if the sawdust is allowed to accumulate on elevated surfaces which typically allow the dust to dry out and become smaller in size.



Huge swaths of central BC forests have been killed, with over 40 million acres. Harvesting affected stands aids fire management by removing the forest fire hazard and breaking the continuity of the fuels.

Circumstances Change

Your safety programs must be dynamic and forward looking

Management of Change

Typical Explosion Properties of Some Agricultural Materials

Material	Mean Particle Size (μm)	MEC (g/m^3)	P_{max} (bar)	K_{St} (bar m/s)	MIE (mJ)	MIT Cloud (°C)	MIT Layer (°C)
Cotton (flocks)	44	30	7.2	24		560	350
Wood Dust	14	15	8.5	99		420	335
Dextrose	80	60	4.3	18		500	570
Oats	295	750	6.0	14		410	350
Coffee	10	60	9.0	90		470	450
Maize Starch	15	60	10.1	169		460	435
Wheat flour	30	125	8.8	70		480	450

Data from BGIA

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Typical Explosion Properties of Some Plastic Materials

Material	Mean Particle Size (µm)	MEC (g/m³)	P_{max} (bar)	K_{St} (bar m/s)	MIE (mJ)	MIT Cloud (°C)	MIT Layer (°C)
ABS	200	60	9.2	147		480	450
Acrylic Resin	37		7.8	174			
Epoxy Resin	13	<15	8.7	169			
Melamine Resin	56	125	9.7	88		470	500
Polypropylene	162		7.7	38		440	
Polypropylene	35	15	8.4	123		440	
PVC emulsion	73	125	9.3	101		700	450

Data from BGIA

Typical Explosion Properties of Some Metallic Materials

Material	Mean Particle Size (µm)	MEC (g/m^3)	P_{max} (bar)	K_{St} (bar m/s)	MIE (mJ)	MIT Cloud (°C)	MIT Layer (°C)
Aluminum	<10	60	11.2	515		560	430
Aluminum	70	60	11.5	292		560	450
Iron	32	500	5.1	41		520	450
Magnesium	28	30	17.5	508			
Silicon	21	125	10.8	135	>100	850	450
Steel/Al	63	60	8.8	149			
Zinc	26		1.3	23		530	750

Data from BGIA

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OSHA Fines Manufacturer $197k for Explosion, Fire Hazards

- July 13, 2016
- RWS Manufacturer facing $197,820 in fines from OSHA
- Company exposed its employees to uncorrected explosion and recurring fire hazards.
- OSHA said RWS Manufacturing did not address combustible dust hazards involving the dust collection system that the company had agreed to correct.

OSHA Fines Manufacturer $197k for Explosion, Fire Hazards

- Inspectors also found new and recurring hazards because RWS Manufacturing failed to:
  - Address combustible dust related fire and explosion hazards for conveyor equipment,
  - Repair an inoperable spark detection/fire suppression system
  - Inspect fire extinguishers annually, and maintain them in fully charged and operable condition
  - Remove accumulations of combustible wood dust and shavings on rafters and other surfaces
  - Remove piles of wood dust and shavings on floors that create fire, slip, trip, and fall hazards.

Where are Combustible Dust Requirements and Enforcement Today?

- Introductions to the other Major Players
  - U. S. Chemical Safety Board
  - OSHA
  - NFPA
  - ASTM
  - U. S. Congress
  - Individual States
    - California
    - Georgia

General Industry Standards

Applicable to Combustible Dust

1910 Subpart D, Walking-working surfaces

- 1910.22, Housekeeping

1910 Subpart E, Emergency Action Plans, and Fire Prevention Plans

- 1910.38, Emergency action plans
- 1910.39, Fire prevention plans

1910 Subpart G, Occupational health and environmental control

- 1910.94, Ventilation

1910 Subpart J, General environmental controls

- 1910.138, Personal Protective Equipment
- 1910.146, Permit-required confined spaces

General Industry Standards

Applicable to Combustible Dust

1910 Subpart L, Fire protection
- 1910.157, Portable fire extinguishers
- 1910.165, Employee alarm systems

1910 Subpart N, Materials handling and storage
- 1910.176, Handling materials – general
- 1910.178, Powered industrial trucks

1910 Subpart S, Electrical
- 1910.307, Hazardous (classified) locations

1910 Subpart Z, Toxic and hazardous substances
- 1910.1200, Hazard communication

Specific Industry Standards

Applicable to Combustible Dust

- 1910 Subpart R, Special industries
  - 1910.261, Pulp, paper, and paperboard mills
  - 1910.263, Bakery equipment
  - 1910.265, Sawmills
  - 1910.269, Electric power generation, transmission, and distribution]
  - 1910.272, Grain handling facilities

General Duty Clause

Applicable to Combustible Dust

- If a hazard is not addressed by an OSHA standard, then
- Section 5(a)(1) of the OSH Act

But, we will come back to these later

Where are Combustible Dust Requirements and Enforcement Today?

- Major Players, of a 2nd kind

Many Insurance Companies Provide some guidance documents, About Combustible Dust Safety…

But few, if any, provide the level of details as these FM Global Documents

  - Insurance Companies
  - Trade Associations

Most Notably - FM Global

  - California
  - Georgia

FM Global Data Sheet

FM Global
Property Loss Prevention Data Sheets **7-76**

March 2009
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PREVENTION AND MITIGATION OF COMBUSTIBLE DUST EXPLOSION AND FIRE

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