Combustible Dust Hazard Recognition and Control –

NFPA Standards for Combustible Dusts

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Objectives

Questions to answer:

1. Is my dust combustible?
2. Why is it important to know?
3. What do I need to know to answer that?
4. What can I do to safeguard my facility and operations?
5. What resources are there to help me?

Case Study – CTA Acoustics

- Corbin, KY
  - February 20, 2003
  - 7 fatalities
- Dust involved – phenolic resin
- Ignition source – open curing oven
- Dust cloud created – during housekeeping
- Jahn Foundry explosion in 1999 involved same resin
- Dust explosion potential unrecognized

CSB Combustible Dust Study

- 281 combustible dust fires and explosions between 1980 and 2005
- 119 fatalities and 718 injuries in the United States;
- Seven catastrophic dust explosions in the past decade
- Wide range of industries and many types of combustible dusts

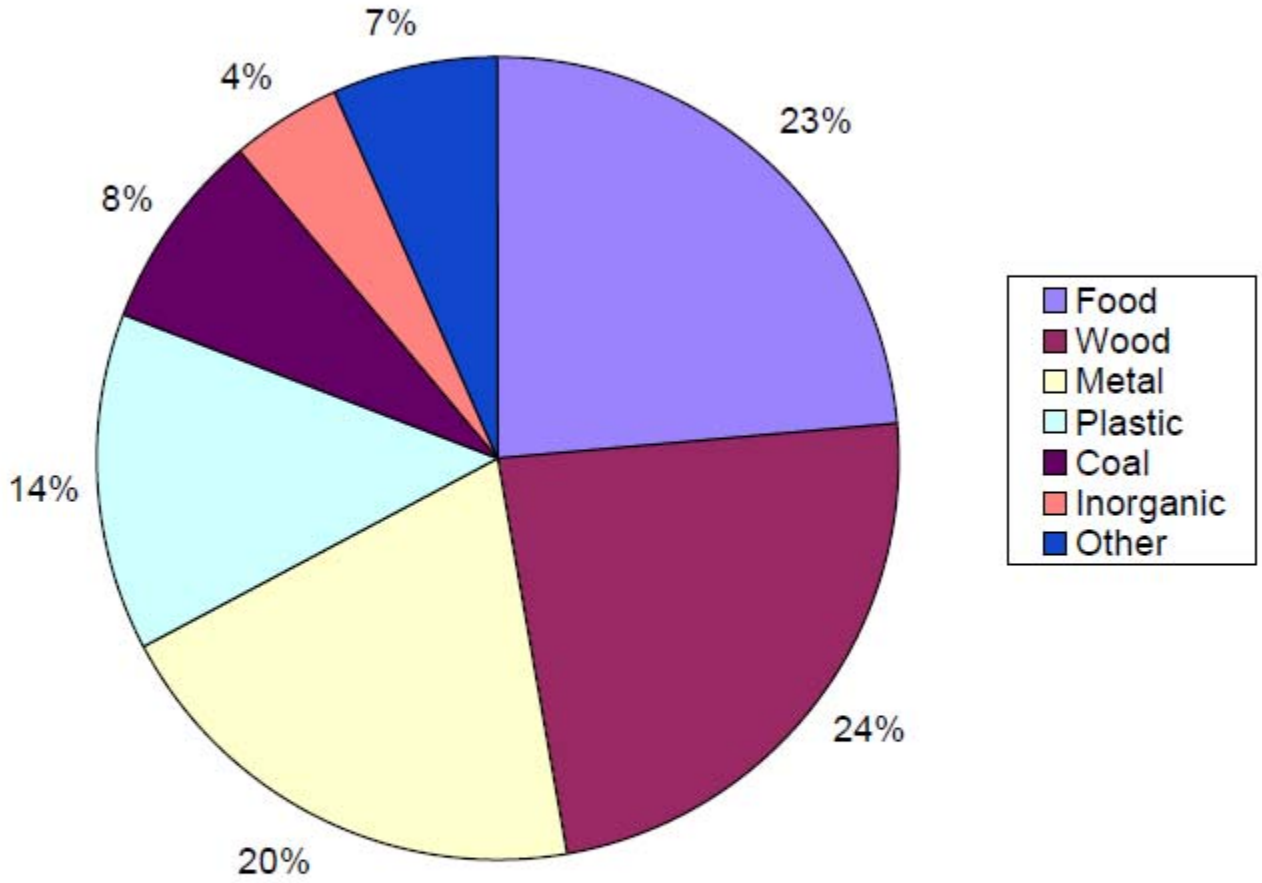


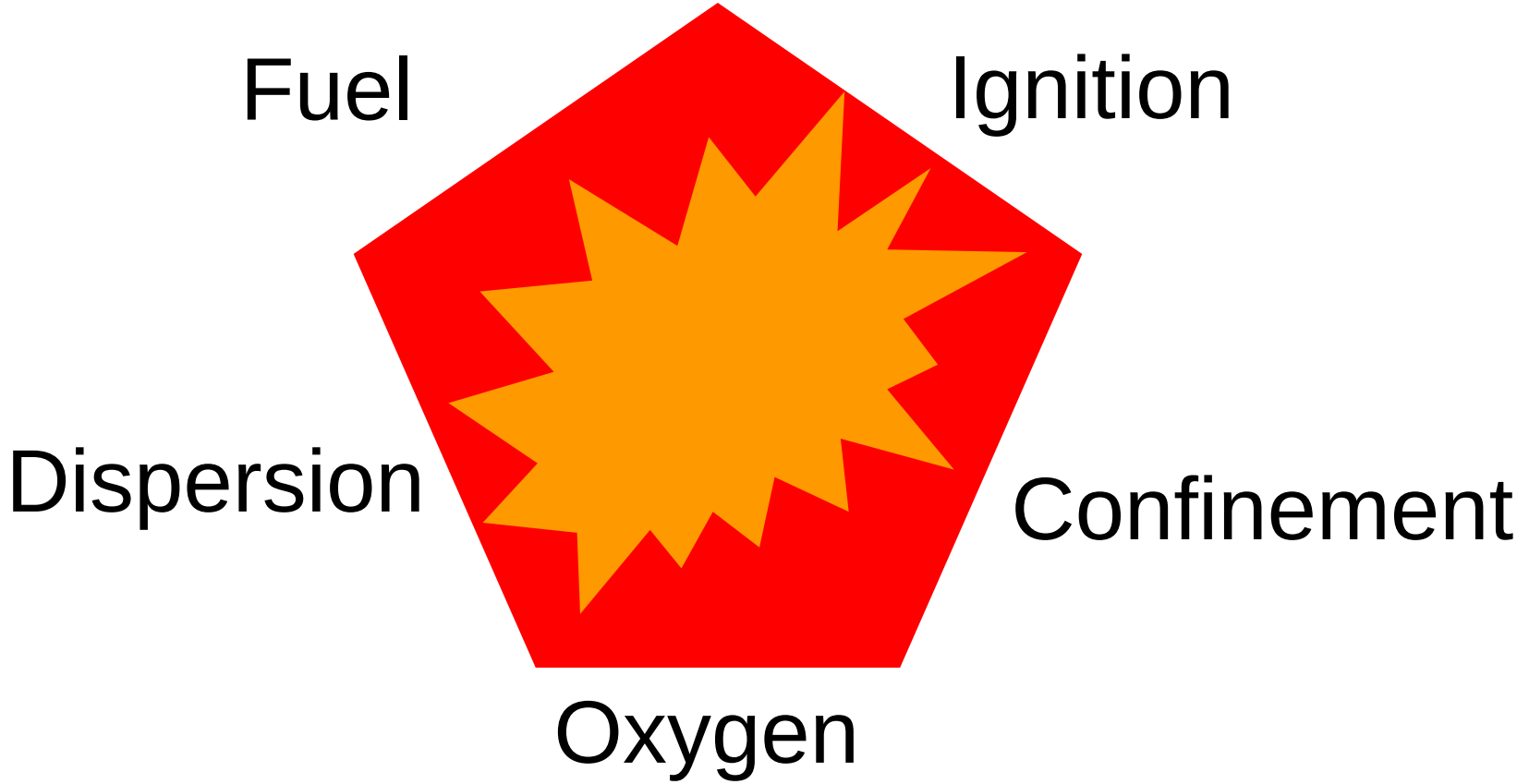
Figure 13. Distribution of combustible dust incidents by material

Protect Against Two Hazards

- Fires
  - Flash fire hazard
  - Threat to property
  - Thermal exposure extremely dangerous for workers
- Explosions
  - Overpressure impacts structure
  - Primary and secondary explosions

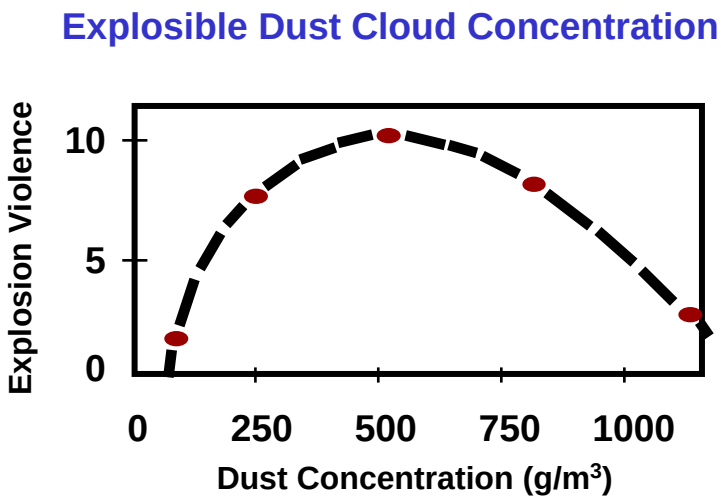
Conditions for a Dust Explosion

Dust Explosion Pentagon



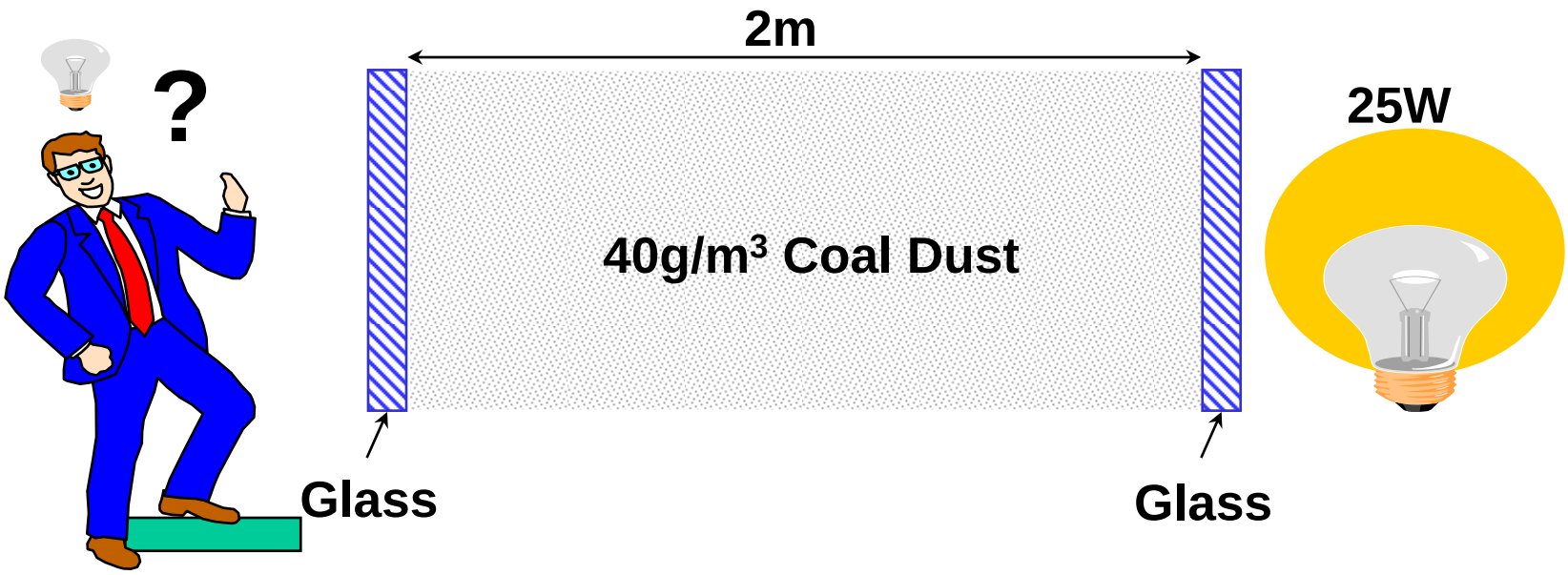
Airborne Dust and Explosible Concentration

- Minimum Explosible Concentration (MEC)
  - Determined by testing
  - Average value 400 to 500 grams per cubic meter



Appearance of an Explosible Dust Cloud

A cloud of 40g/m^3 of coal dust in air is so dense that a glowing 25W light bulb can hardly be seen through a dust cloud of 2m thickness *(Eckhoff)*



Combustible Particulate Solid

- Any combustible solid material, composed of distinct particles or pieces, regardless of size, shape or chemical composition.

  (NFPA 654-2006)

Combustible Dust

- Combustible Dust* “A combustible particulate solid that presents a fire or deflagration hazard when suspended in air or other oxidizing medium over a range of concentrations, regardless of particle size or shape.” [NFPA 654]

Particle Size Influence on Explosibility

- 420 microns threshold
- Smaller particles – more easily lofted
  - Flakes or fibers behave differently
  - Consider aspect ratio for different solid forms
- Dusts of critical size created from any size particulate solid

Deflagrable Wood Dust

- Wood particulate with median diameter of 420 microns or smaller (i.e., material that will pass through a U.S. No. 40 Standard Sieve), having a moisture content of less than 25 percent (wet basis).[NFPA 664]

Property	Definition	ASTM Test Method	Application
K_{St}	Dust deflagration index	ASTM E1226	Measures relative explosion severity
P_{max}	Maximum explosion overpressure	ASTM E1226	Used for enclosure design and predict explosion severity
$(dp/dt)_{max}$	Maximum rate of pressure rise	ASTM E1226	Predict explosion violence; used to calculate K_{St}
MIE	Minimum Ignition Energy	ASTM E2019	Predict ease and likelihood of dust cloud ignition
MEC	Minimum Explosible Concentration	ASTM E1515	Minimum amount of dust dispersed in air; like LFL for gases and vapors

NFPA 654

- *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids* (2006 edition)
  - Represents fundamental dust provisions

NFPA 654 Scope

- Apply to manufacturing, processing, handling
- Combustible particulate solids or hybrid mixtures
- Particle size independent
- Fire or explosion hazard

NFPA 654 Application

- Does not apply to:
  - NFPA 30B – Aerosols
  - NFPA 61 – Agricultural and Food Products*
  - NFPA 120 – Coal Preparation Plants
  - NFPA 484 – Combustible Metals Code*
  - NFPA 664 – Wood Processing and Woodworking*

NFPA 654

- Chapter 4 – General Requirements
- Chapter 5 – Performance-based Design Option
- Chapter 6 – Facility and Systems Design
- Chapter 7 – Process Equipment
- Chapter 8 – Fugitive Dust Control and Housekeeping
- Chapter 9 – Ignition Sources
- Chapter 10 – Fire Protection
- Chapter 11 – Training and Procedures
- Chapter 12 – Inspection and Maintenance

NFPA 664

- *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities* (2007 edition)
  - Applicable to pellet fuels processing

Scope

- Applies to facilities that process wood or manufacture wood products, using wood or other cellulosic fiber
- Applies to woodworking operations that either:
  - Occupy areas of more than 465 m^2 (5000 ft^2), or
  - Require an aggregate dust collection flow rate of more than 2549 m^3/hr (1500 ft^3/min)

Chapter 4 General Requirements

- Process Analysis
- Management of Change
- Objectives
  - Life safety
  - Structural integrity
  - Mission continuity
  - Mitigation of fire spread and explosions
- Options – performance-based or prescriptive

Chapter 6 Building Construction

- Compartmentation – fire walls, fire partitions, fire barrier walls
- Protection of openings and penetrations
- Life safety and means of egress
- Surfaces and ledges
- Damage-limiting construction
  - Dust accumulation threshold established
- Draft curtains

Chapter 7 – Ignition Control

- Hot work
- Electrical systems
- Hot surfaces
- Industrial trucks
- Lighting
- Fuel-fired equipment
- Lightning protection
- Static electricity
- Smoking
- Machines and processing equipment
- Foreign material
- Friction
- Fans
- Spontaneous ignition and chemical action
- Propellant-actuated tools
- Portable electric tools

Chapter 8 – Processes, Operations, and Special Systems

- Particulate conveying and dust collection
  - Pneumatic conveying – see NFPA 654
  - Duct system
  - Hoods and enclosures
  - Fans or blowers (air-moving devices)
  - Dust collectors (air-material separators)
  - Recycling exhaust air

Chapter 10 Human Element

- Inspection and maintenance
- Record retention
- Employee training
- Contractors and subcontractors
- Portable appliances
- Incident investigation
- Impairments of fire protection systems
- Hot work
- Emergency planning and response

Chapter 11 Housekeeping

- Vacuuming is preferred
- Sweeping or water wash down is acceptable
  - Vigorous sweeping can generate dust cloud
- Blowing down with steam or compressed air – least preferable
  - After other methods used and only to access hard-to-reach areas
  - Limits on air pressure
  - Shut down other operations if ignition source

Additional References

- NFPA 68, *Standard for Explosion Protection by Deflagration Venting,* 2007
- NFPA 69, *Standard on Explosion Prevention Systems*, 2008
- NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*, 2004

NFPA 664 Revision

- June 2011 revision in process
- Report on Proposals published
- Public Comment deadline September 3, 2010
- Committee meets prior to November 5, 2010
- Issued by Standards Council summer 2011 as 2012 edition

PHA Primer

- How much do you know about your solids processing?
  - Which materials are combustible?
  - If not known, but suspected, then data are needed
  - Don’t overlook any combustible particulate solids
    - “Dust” formation often comes with material handling

PHA Primer (continued)

- Where are solids produced and/or handled?
  - Closed or open processes?
  - Rate of generation or release of solids to an environment?
  - Any collection methods in place?
- Conclusion: process generates or handles solids and dusts are formed in process, potential exists

Questions to Consider

- Hazard analysis includes material property input
- Basis for safety
  - Collect dusts and minimize accumulation
  - Control ignition sources
  - Protect equipment and structures from explosion
  - Limit impact on facility through design or isolation measures

Dust Symposium

- NFPA and Fire Protection Research Foundation presenting 2-day dust symposium, October 20 – 21, 2010
  - Kansas City, MO
  - Registration information – www.nfpa.org
- NFPA 1-day Combustible Dust Seminar
  - October 19, 2010 preceding the dust symposium

Thank you!

- Questions