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
Airborne Dust and Explosible Concentration

- **Minimum Explosible Concentration (MEC)**
  - Determined by testing
  - Average value 400 to 500 grams per cubic meter
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]
<table>
<thead>
<tr>
<th>Property</th>
<th>Definition</th>
<th>ASTM Test Method</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{St}$</td>
<td>Dust deflagration index</td>
<td>ASTM E1226</td>
<td>Measures relative explosion severity</td>
</tr>
<tr>
<td>$P_{max}$</td>
<td>Maximum explosion overpressure</td>
<td>ASTM E1226</td>
<td>Used for enclosure design and predict explosion severity</td>
</tr>
<tr>
<td>$(dp/dt)_{max}$</td>
<td>Maximum rate of pressure rise</td>
<td>ASTM E1226</td>
<td>Predict explosion violence; used to calculate $K_{St}$</td>
</tr>
<tr>
<td>MIE</td>
<td>Minimum Ignition Energy</td>
<td>ASTM E2019</td>
<td>Predict ease and likelihood of dust cloud ignition</td>
</tr>
<tr>
<td>MEC</td>
<td>Minimum Explosible Concentration</td>
<td>ASTM E1515</td>
<td>Minimum amount of dust dispersed in air; like LFL for gases and vapors</td>
</tr>
</tbody>
</table>
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

  – 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 m² (5000 ft²), or
  – Require an aggregate dust collection flow rate of more than 2549 m³/hr (1500 ft³/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 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