Combustible Dust - Things that go Boom

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Presentation Objectives

After attending this presentation you will:

- Learn the hazards of combustible dust;
- Understand how dust explosions occur;
- Be familiar with dust control measures;
- Increase your awareness of combustible dust;
- Identify training topics
Why are we here – Combustible Dust Hazards

- Combustible dust is typically finely ground:
  - Organic Dust
  - Metal Dust

- Deflagration hazard – especially confined areas
- Secondary explosions
- Proper safe work practices are critical
Combustible dust explosion
Recent Dust Explosions

- 1999: Natural gas explosion resulted in coal dust explosion: 6 fatalities and 14 injuries;

- 2002: Rubber fabricating plant: 5 Fatalities and 6 Injuries – caused by dust accumulation;

- 2003: West Pharmaceuticals: 6 Deaths, numerous injuries, hundreds of job losses - Plastic powder accumulated above suspended ceiling
Recent Dust Explosions (Cont’d)

- Imperial Sugar: 2/7/2008 Explosion
- 14 Fatalities; 36 hospitalized
- OSHA Settlement: $6,050,000
- Accumulations of Sugar Dust:
  - Workrooms;
  - Electrical Motors;
  - Other Equipment
Dust Explosion Fundamentals

Elements needed for dust explosion:
1. Combustible Dust (Fuel);
2. Ignition Source (Heat);
3. Oxygen in Air (Oxidizer)

Additional elements Required:
4. Dispersion in sufficient quantity/concentration
5. Confinement of Dust Cloud
Thin Dust Layers Can Be Hazardous: 1/32” on 5% or more of floor area
Secondary Dust Explosion Mechanism

Dust settles on flat surfaces

Some event disturbs the settled dust into a cloud

Dust cloud is ignited and explodes
What is a Combustible Dust?

NFPA 654® (2013 Edition) defines combustible dust as:

“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.”
Combustible Dust

Typical dusts of concern:

- Metal Dust – Such as Aluminum and Magnesium;
- Wood dust;
- Coal and other Carbon dusts;
- Plastic dust and additives;
- Biosolids;
- Organic Dust – Sugar, Flour, Paper, Soap, Dried Blood;
- Certain Textile materials
**Dust Explosion Tests**

**Kst**: Measure of explosion severity. Larger value – more severe explosion.

**Note**: Actual class is sample specific and will depend on sample characteristics such as particle size and moisture.

<table>
<thead>
<tr>
<th>Dust Explosion Class*</th>
<th>$K_{ST}$ (bar.m/s)</th>
<th>Characteristic</th>
<th>Typical material</th>
</tr>
</thead>
<tbody>
<tr>
<td>St 0</td>
<td>0</td>
<td>No explosion</td>
<td>Silica</td>
</tr>
<tr>
<td>St 1</td>
<td>&gt;0 and ≤ 200</td>
<td>Weak explosion</td>
<td>Powdered milk, charcoal, sulfur, sugar, and zinc</td>
</tr>
<tr>
<td>St 2</td>
<td>&gt;200 and ≤ 300</td>
<td>Strong explosion</td>
<td>Cellulose, wood flour, polymethyl acrylate</td>
</tr>
<tr>
<td>St 3</td>
<td>&gt;300</td>
<td>Very strong explosion</td>
<td>Anthraquinone, aluminum, and magnesium</td>
</tr>
</tbody>
</table>
Dust Explosion Testing (Continued)

- **Minimum Ignition Energy (MIE):** Predicts the ease and likelihood of ignition of a dispersed dust cloud.
- **Minimum Explosive Concentration (MEC):** Minimum amount of dust dispersed in air required to spread an explosion.
- **Minimum Ignition Temperature (MIT):** Measure of sensitivity to ignition by hot surfaces, friction sparks, and electrical equipment.
Material Involved in Explosions

Source: Combustible Dust Policy Institute
Affected Industries

Typical Industries handling Combustible Dust:

- Agriculture;
- Food Products;
- Chemicals;
- Textiles;
- Forest and Furniture Products;
- Metal Processing;
- Tire and Rubber Manufacturing;
- Paper Products;
- Pharmaceuticals;
- Wastewater Treatment;
- Recycling Operations (metal, paper, and plastic);
- Coal Dust – Coal Handling and Processing Operations
Facility Assessment - Electrical Classification

Electrical Classification must be appropriate:

- Class II – Combustible Dust
- Division (1 or 2)
- Group:
  - E (Combustible Metal Dust);
  - F (Combustible Carbonaceous Dust);
  - G (Other Dusts – Flour; Grain; Wood; Plastic)
Hazard Mitigation

- Dust Control
- Housekeeping
- Ignition Source Control
- Damage Control
Dust Control

NFPA 654 Recommendations:

- Minimize dust escape from process equipment and ventilation systems;
- Use dust collection systems and filters;
- Utilize surfaces that minimize dust accumulation and facilitate cleaning;
- Perform regular dust inspections;
- Clean dust residue at regular intervals;
- Only use approved vacuum cleaners
Ignition Source Control

NFPA 654® Recommendations:

- Appropriate electrical equipment/wiring methods;
- Control static electricity;
- Control open flames, sparks, smoking;
- Control mechanical sparks and friction;
- Use separator devices – to remove combustible dust;
- Separate heated surfaces from dusts;
- Separate heating systems from dusts;
- Proper use/type of industrial trucks;
- Proper use of cartridge activated tools
Damage Control

NFPA 654®: Minimize Danger/Damage from Explosion –

- Detachment (outside or other building)
- Separation (distance within same room);
- Segregation (barrier);
- Pressure resistant construction;
- Pressure relieving construction;
- Spark/ember detection and extinguishing systems;
- Explosion protection systems (Refer to NFPA® 69);
- Sprinkler systems;
- Other specialized suppression systems
Training

● Employees
  ♦ Awareness training for **EVERYONE!**
  ♦ Safe work practices

● Management
  ♦ Ensure facility analysis prior to introducing new hazards to workplace;
  ♦ Be familiar with and support combustible dust safety program
OSHA National Emphasis Program

As of October 2009:

**Inspections:**
Federal: 669 (3786 violations)
State Program: 226 (1140 violations)
Types of Industries inspected

<table>
<thead>
<tr>
<th>Industry Type</th>
<th># of Inspections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Products</td>
<td>235</td>
</tr>
<tr>
<td>Food Products</td>
<td>141</td>
</tr>
<tr>
<td>Metal Products</td>
<td>102</td>
</tr>
<tr>
<td>Chemical Ind</td>
<td>90</td>
</tr>
<tr>
<td>Rubber/Plastic</td>
<td>90</td>
</tr>
<tr>
<td>Primary Metal</td>
<td>65</td>
</tr>
<tr>
<td>Furniture</td>
<td>51</td>
</tr>
<tr>
<td>Elec/Sanitary Svs</td>
<td>35</td>
</tr>
<tr>
<td>Transp Equip</td>
<td>35</td>
</tr>
<tr>
<td>Dur. Goods</td>
<td>30</td>
</tr>
<tr>
<td>Paper Products</td>
<td>26</td>
</tr>
<tr>
<td>Textile Mills</td>
<td>14</td>
</tr>
</tbody>
</table>
Combustible Dust Related Violations

# of violations

5(a)(1) 211
HazCom 548
Fire Exting 210
Electrical 223
Housekeeping 388
Compressed Air 99
PPE 226
First Aid 73

# of violations
OSHA References:

- Combustible Dust National Emphasis Program: CPL 03-00-008;
- 29 CFR 1910.22 (Housekeeping);
- 29 CFR 1910.176 (c) [Housekeeping in Storage Areas];
- 29 CFR 1910.272 (Grain Handling Facilities)
- 29 CFR 1910.307 [Hazardous (classified) locations.]

Also, refer to OSHA Combustible dust explosion website:

[www.osha.gov](http://www.osha.gov)
Combustible dust upgrades
NFPA References

- NFPA 61®: “Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities”;
- NFPA 68®: “Standard on Explosion Protection by Deflagration Venting”;
- NFPA 69®: “Standard on Explosion Prevention Systems”;
- NFPA 70®: “National Electrical Code”;
- NFPA 499®: “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”;
Where do we go from here?

- Evaluate facility for presence of combustible dust.
- Sample dust if needed.
- Review OSHA combustible dust NEP.
- Obtain copy of NFPA 654 and other standards.
- Develop a corrective action plan.
- Train your employees.
- Follow good housekeeping!
Conclusion

Questions or Comments?