PDHonline Course C382 (3 PDH)

Combustible Dust Hazards- Awareness

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Combustible Dust Hazards

Presented by:

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Overview

- Background – Why do We Care?
- Dust Hazards
- How to Prevent Dust Related Incidents
- OSHA's Policy
- OSHA's National Emphasis Program

Why Do We Care?

- A 2006 Chemical Safety and Hazard Abatement Board (CBS) Study indicated that:
  - 281 dust fires and explosions occurred between 1980 and 2005 from combustible dust incidents.
  - These incidents reportedly claimed 119 lives and injured 718 people
  - These incidents occurred in 44 states in many different industries and involved a variety of different materials.

Why Do We Care?

- Domino Sugar refinery in Baltimore Maryland on November 2, 2007.
  - There were no fatalities
  - 3 employees suffered minor injuries
  - Employees were performing maintenance on a dust collector at the time of the explosion
  - Maryland Occupational Safety and Health Administration fined Domino $4,000 for allowing dust to accumulate in its refinery

Why Do We Care?

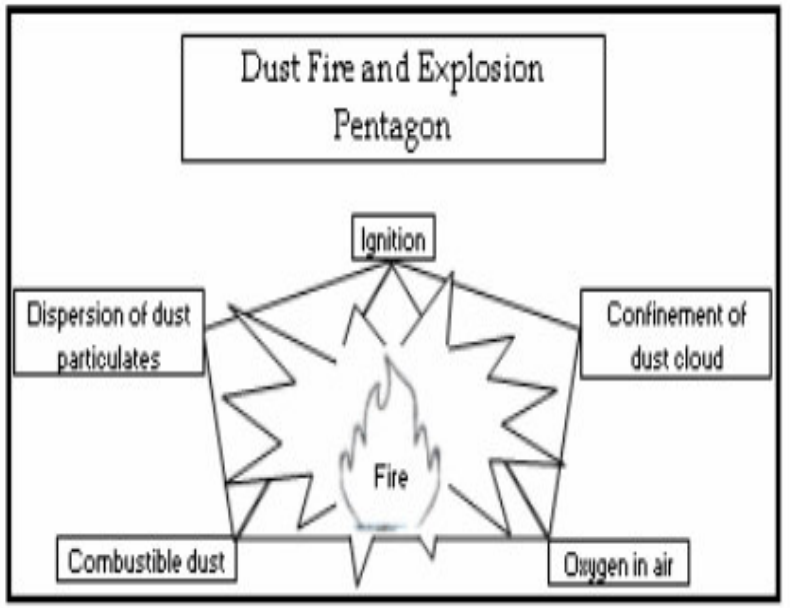
- North Carolina pharmaceutical plant that manufactured rubber drug-delivery components in 2003
  - Six employees were killed and 38 people, including two firefighters, were injured.
  - Cause determined to be an accumulation of a combustible polyethylene dust above the suspended ceilings fueled the explosion.

Why Do We Care?

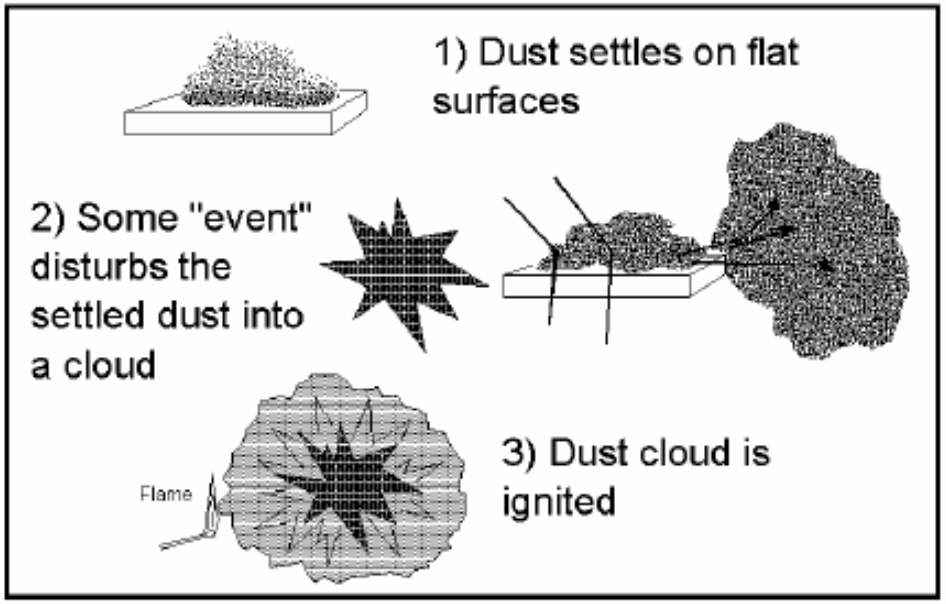
- Imperial Sugar refinery in Port Wentworth, GA on February 8, 2008
  - There were 13 fatalities
  - 40 employees suffered injuries including severe burns
  - OSHA issued penalties of $5.06 MM for the company's Port Wentworth refinery and $3.7 MM based upon an inspection of the company's refinery in Gramercy, LA following the Port Wentworth explosion.
  - The company was issued 69 Willful violations and 51 serious violations at the Port Wentworth refinery and 49 Willful violations and 48 serious violations at its Gramercy, LA refinery

Dust Hazards

- The 3 elements needed for a fire (the “fire triangle”) are:
  1. Combustible dust (fuel)
  2. Ignition source (heat)
  3. Oxygen in air (oxidizer)



Dust Hazards



- Additional elements needed for a combustible dust explosion:
  1. Dispersion of dust particles in sufficient and concentration
  2. Confinement of the dust cloud

Dust Hazards

Industries at Risk

- Plastics production
- Rubber reclamation
- Wood, paper, or pulp processing
- Flour and feed mills
- Manufacture or storage of metal powders
- Chemical production
- Explosives Manufacturing
- Starch and candy production
- Spice, sugar, and cocoa operations
- Coal handling and processing
- Pharmaceutical plants
- Grain elevators, bins, and silos
- Tobacco handling operations

Dust Hazards

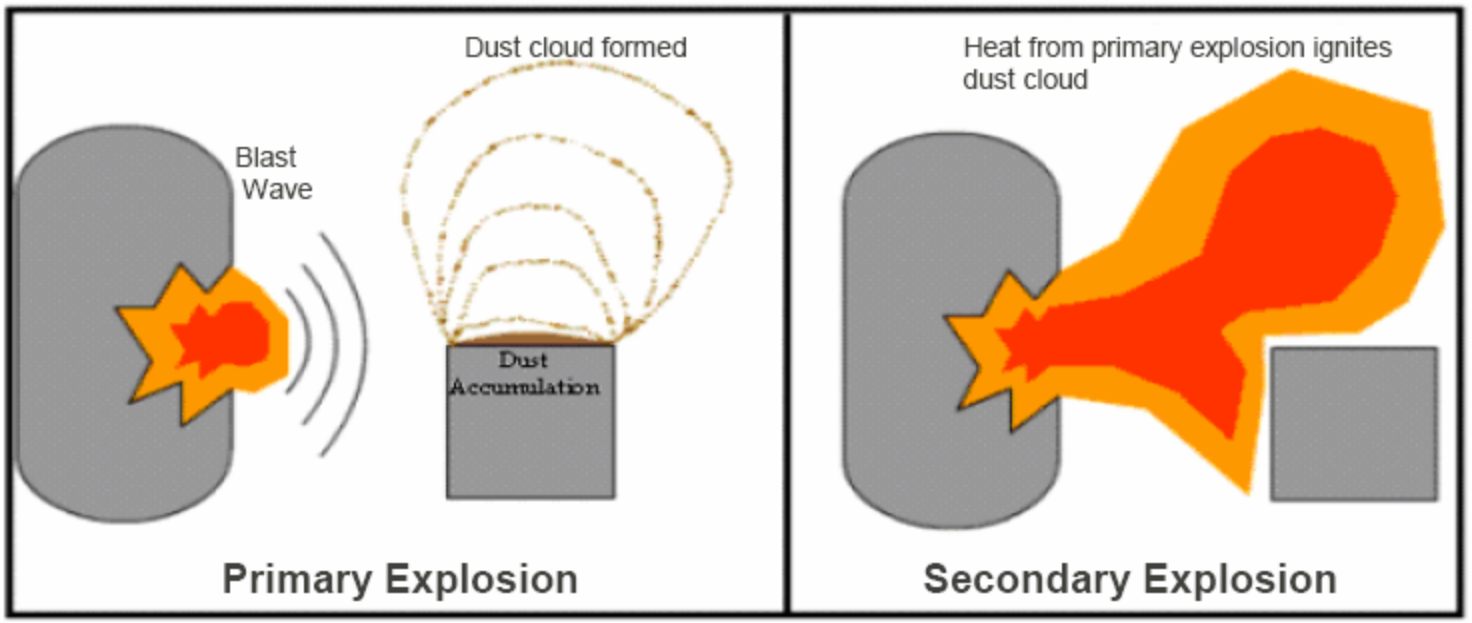


Figure 2

How to Prevent Dust Related Incidents

- Perform a hazard assessment of your facility
  to assess potential for dust explosions
- Review and evaluate:
  - Materials that can be combustible when finely divided
    - You need to determine whether your dust is explosive and collect and analyze dust from:
      - High places
      - Floors and equipment surfaces
      - Within ductwork

Dust Hazards

- **Several Dust Explosion Tests**
  - **Explosibility Screening Test - A/B Classification**
  - **Minimum Ignition Energy Test - Dust Cloud**
  - **Minimum Ignition Energy Test - Dust Layer**
  - **Minimum Ignition Temperature Test - Dust Cloud**
  - **Minimum Ignition Temperature Test - Dust Layer**
- **Kst and Pmax Values**
  - Measure of explosion severity. Used in relief vent sizing and design of explosion suppression and containment systems
- **Limiting Oxygen Concentration (LOC)**
  - Measure of the oxygen concentration below which an explosion will not occur. Used in designing inerting systems.
- **Minimum Ignition Energy**
  - Measure of sensitivity to ignition by electrostatic discharge
- **Minimum Ignition Temperature**
  - Measure of sensitivity to ignition by hot surfaces, friction sparks, and electrical equipment
- **Resistivity, Conductivity, and Chargeability**
  - Measure of ignition risks

Dust Hazards

- NFPA classifies dusts according to their explosibility —
  - Class 0 dusts are rated at 0 KSt (no explosion)
  - Class 1 dusts are rated below 200 KSt (weak explosion)
  - Class 2 dusts range from 200 to 300 KSt (strong explosion)
  - Class 3 dusts are rated above 300 KSt (very strong explosion)
  - As a rule of thumb, when dusts approach 600 KSt, they're so explosive that wet collection methods are recommended.

K_{St} values for common dusts

Dust	Size (in microns)	K_{St} value
Activated carbon	18	44
Aluminum grit	41	100
Aluminum powder	22	400
Asphalt	29	117
Barley grain dust	51	240
Brown coal	41	123
Charcoal	29	117
Cotton	44	24
Magnesium	28	508
Methyl cellulose	37	209
Milk powder	165	90
Paper tissue dust	54	52
Pectin	59	162
Polyurethane	3	156
Rice starch	18	190
Silicon	10	126
Soap	65	111
Soy bean flour	20	110
Sulfur	20	151
Tobacco	49	12
Toner	23	145
Wood dust	43	102

Dust Hazards

The following table specifies the type of data that might be required for some common unit operations involving powders

Unit Operation	Explosion Screening (A/B)[1]	MIE (mJ)	MIT – Cloud (°C)	MIT – Layer (°C)	Explosion Severity – Kst (bar.m/s)	LOC[2] (%)	MEC (g/m³)	Volume Resistivity[3] (Ω.m)	Chargeability[4] (C/Kg)	Self-Heating (°C)
Manual Handling / Pouring	X	X						X	X	
Sieving / Screening	X	X						X	X	
Tumble / Double Cone Blending	X	X			X	X		X	X	
Ribbon Blending	X	X	X	X				X	X	
Milling	X	X	X	X	X	X		X	X	X
Jet Milling	X	X			X	X		X	X	
Spray, Fluidized Bed, Tumble, Flash Drying	X	X			X			X	X	X
Tray Drying	X	X			X					X
Pneumatic Conveying	X	X					X	X	X	
Screw Conveying	X	X	X					X	X	
Transfer to Hopper / Bin / Tote / Container	X	X			X			X	X	
Dust Collector and Exhaust Ventilation	X	X			X		X	X	X	

1. Explosibility Screening test is only conducted if the combustibility of the powder/dust (as being present in the process/facility) is not yet established. If the powder is found to be non-combustible, other tests in the table may not be required.
2. LOC is determined if the basis of safety is inert gas blanketing.
3. Volume Resistivity should be considered if the Minimum Ignition Energy is less than 25mJ.
4. Chargeability should be considered if the Minimum Ignition Energy is less than 25mJ.

Testing to Assess Explosion Characteristics of Dust Clouds, Vahid Ebadat, Chilworth Technology
NFPA Symposium on Dust Explosion Hazard Recognition and Control, Baltimore, May 13 – 14, 2009

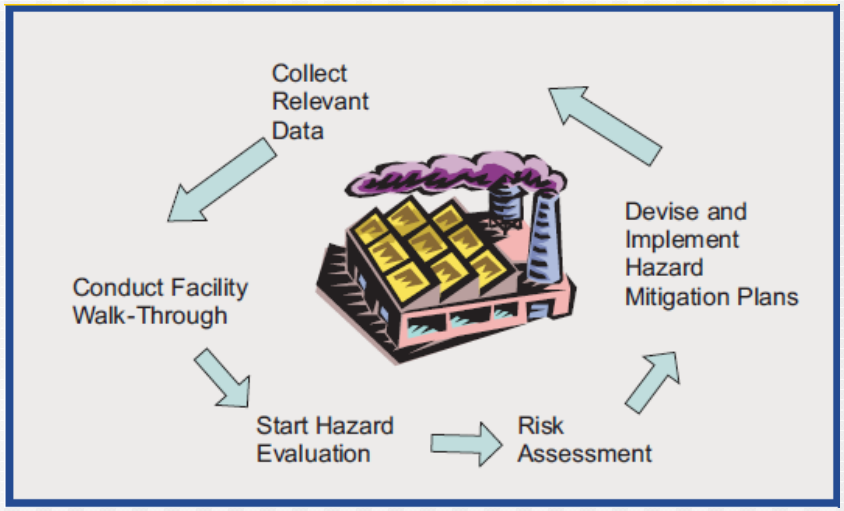
How to Prevent Dust Related Incidents

- Review and evaluate:
  - Processes which use, consume, or produce combustible dusts
    - Conduct internal and external audits in order to identify potential explosion hazard
    - Have employees and supervisors identify explosion hazards through job hazard analyses
    - Pay particular attention to dust collection systems and other areas not in plain view during the assessment.
  - Open areas where combustible dusts may build up
  - Hidden areas where combustible dusts may accumulate (i.e. ceilings, duct work, etc.)
  - Means by which dust may be dispersed in the air
  - Potential ignition sources

How to Prevent Dust Related Incidents

- Additional Questions that Need to Be Answered:
  - What is the site history of fires involving dust?
  - Does the MSDS indicate a dust explosion hazard?
  - Are dust accumulations hazardous?
  - Collection of samples of combustible dusts for laboratory analysis
- Audit of dust management practices and equipment including dust collectors, ductwork, and other dust containers
- Audit of room safeguards
- Audit of ignition source management
  - Location of Hazard Classification Locations

How to Prevent Dust Related Incidents



- Adopt a comprehensive approach to preventing and controlling combustible dust hazards
- 4 major components

Graphic Courtesy of:

Dust Explosion Characterization and Hazard Assessment (Part 2)
By Ashok Ghose Dastidar, Ph.D., MBA

How to Prevent Dust Related Incidents

1. Dust Control
   - Implement a hazardous dust inspection, testing, housekeeping, and control program
   - Use proper dust collection systems and filters
   - Minimize the escape of dust from process equipment or ventilation systems
   - Use surfaces that minimize dust accumulation and facilitate cleaning
   - Provide access to all hidden areas to permit inspection
   - Inspect for dust residues in open and hidden areas at regular intervals
   - If ignition sources are present, use cleaning methods that do not generate dust clouds
   - Use only vacuum cleaners approved for dust collection
   - Locate relief valves away from dust deposits

How to Prevent Dust Related Incidents

2. Ignition Control
   - Use appropriate electrical equipment and wiring methods
   - Control static electricity, including bonding of equipment to ground
   - Control smoking, open flames, and sparks
   - Control mechanical sparks and friction
   - Use separator devices to remove foreign materials capable of igniting combustibles from process materials
   - Separate heated surfaces from dusts
   - Separate heating systems from dusts
   - Select and use industrial trucks properly
   - Use cartridge activated tools properly
   - Use an equipment preventive maintenance program.

How to Prevent Dust Related Incidents

3. Injury and Damage Control Methods
   - Separation of the hazard (isolate with distance)
   - Segregation of the hazard (isolate with a barrier)
   - Deflagration isolation/venting
   - Pressure relief venting for equipmen
   - Direct vents away from work areas

Cartridge dust collector with explosion venting to vent explosion away from building

How to Prevent Dust Related Incidents

3. Injury and Damage Control Methods (Cont)
   - Specialized fire suppression systems
   - Explosion protection systems
   - Spark/ember detection for suppression activation
   - Develop an emergency action plan
   - Maintain emergency exit routes

How to Prevent Dust Related Incidents

4. Training and Educating Employees on Combustible Dust Hazards
   - Safe work practices applicable to their job tasks
   - Overview of dust hazard assessments of the site
   - Overview of dust and ignition control procedures at the worksite
   - Proper use of fire extinguishers on combustible dust fires
   - Emergency evacuation procedures

OSHA's Policy

- Safety and Health information Bulletin - SHIB 07-31-2005
  - Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions
    - Facility Dust Hazard Assessment
    - Dust Control
    - Ignition Control
    - Damage Control
    - Training
    - References

OSHA's NEP

- **Combustible Dust National Emphasis Program (Reissued)**
  - **DIRECTIVE NUMBER: CPL 03-00-008**
  - **EFFECTIVE DATE: 3/11/08**
- Contains policies and procedures for inspecting workplaces that create or handle combustible dusts.

OSHA's NEP

- The dust addressed in the NEP for Combustible Dust include but are not limited to the following:
  - Metal dust such as aluminum and magnesium
  - Wood dust
  - Coal and other carbon dusts
  - Plastic dust and additives
  - Biosolids
  - Other organic dust such as sugar, flour, paper, soap and dried blood
  - Certain textile materials

OSHA's NEP

- There are two main list in the NEP for Combustible Dust that OSHA Area Offices will utilize in scheduling inspections
  - Appendix D-1 (Industries with More Frequent and/or High Consequence Combustible Dust Explosions/Fires)
  - Appendix D-2 (Industries that may have a Potential for Combustible Dust Explosions/Fires)
  - They must schedule 3 inspections from Appendix D-1 and 1 inspection from Appendix D-2

OSHA's NEP

Appendix D-1

Industries with More Frequent and/or High Consequence Combustible Dust Explosions/Fires

SIC	Industry	NAICS
2046	Wet Corn Milling	311221
4911	Electric Services -- Establishments engaged in the generation, transmission, and/or distribution of electric energy for sale	221112
2041	Flour and Other Grain Mill Products	311211
2493	Reconstituted Wood Products	321219
2899	Chemicals and Chemical Preparations, Not Elsewhere Classified	325510, 325998
2099	Prepared foods and miscellaneous food specialties, not elsewhere classified	311212
3471	Electroplating, Plating, Polishing, Anodizing, and Coloring	332813
3341	Secondary Smelting and Refining of Nonferrous Metals	331314
2834	Pharmaceutical Preparations	325412

OSHA's NEP

Appendix D-2

Industries that may have Potential for Combustible Dust Explosions/Fires

SICS	Industry	NAICS
3087	Custom Compounding of Purchased Plastics Resins	325991
3089	Plastics Products, Not Elsewhere Classified	326199
3291	Abrasive Products	327910
3313	Alumina and Aluminum Production and Processing	331312
3334	Primary Production of Aluminum	331312
3354	Aluminum Extruded Products	331316
3363	Aluminum Die-Castings	331521
3369	Nonferrous Foundries, Except Aluminum and Copper	331528
3398	Metal Heat Treating	332811
3441	Metal Cans	332431
3469	Metal Stampings, Not Elsewhere Classified	332116
3479	Coating, Engraving, and Allied Services, Not Elsewhere Classified	332812
3496	Miscellaneous Fabricated Wire Products	332618
3499	Fabricated Metal Products, Not Elsewhere Classified	332999
3548	Electric and Gas Welding and Soldering Equipment	335129
3644	Noncurrent-Carrying Wiring Devices	335932
3761	Guided Missiles and Space Vehicles	336414

OSHA's NEP

- Sample questions CSHOs may use during the course of an inspection
  - What types of combustible dust does the facility have?
  - Does the facility have a housekeeping program with regular cleaning frequencies established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility? Under the housekeeping program, is the dust on floors, structural members, and other surfaces removed concurrently with operations?
  - Is there dust accumulation of 1/32 inch thick, or greater?
  - For housekeeping violations, what are the dimensions of the room and the dimensions of the area covered with the dust?
  - Are the dust-containing systems (ducts and dust collectors) designed in a manner that fugitive dusts are not allowed to accumulate in the work area?
  - Are dust collectors greater than 8 cubic feet in volume located inside of buildings?

OSHA's NEP

- Recent NEP Inspection (Date of article - 3/11/09)
- OSHA cited Thomson, Ga., automotive parts supplier, H P Pelzer, with $135,000 in proposed penalties
- OSHA was issuing citations for 24 occupational health and safety violations against H P Pelzer Automotive Systems Inc. in Thomson, Ga. The agency was proposing $135,000 in penalties against the company.
- A health inspection of the plant revealed seven serious violations resulting in penalties of $32,500. The health violations include the company allowing combustible dust to accumulate, not protecting employees from noise hazards and exposing employees to an airborne concentration of formaldehyde.

Additional References

- NFPA 61, Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities
- NFPA 68, Guide for Venting of Deflagrations
- NFPA 69, Standard on Explosion Prevention Systems
- NFPA 70, National Electrical Code®
- NFPA 91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids
- NFPA 120, Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities
- NFPA 480, Standard for the Storage, Handling, and Processing of Magnesium Solids and Powders
- NFPA 481, Standard for the Production, Processing, Handling, and Storage of Titanium
- NFPA 482, Standard for the Production, Processing, Handling, and Storage of Zirconium

Additional References

- NFPA 484, Standard for Combustible Metals, Metal Powders, and Metal Dusts
- NFPA 495, Explosive Materials Code
- NFPA 499, Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
- NFPA 505, Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation
- NFPA 560, Standard for the Storage, Handling, and Use of Ethylene Oxide for Sterilization and Fumigat
- NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids
- NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities
- NFPA 1124, Code for the Manufacture, Transportation, Storage, and Retail Sales of Fireworks and Pyrotechnic Articles

Questions????


http://guerrillaconsulting.typepad.com/photos/uncategorized/question_mark.jpg

Thank You

Jeffrey R. Sotek, PE, CSP, CIH