Safe Choice Education:
Combustible Dust

Understanding and Resolving Risks to Create Safer Facilities

An estimated 30,000 U.S. facilities are at risk for a combustible dust fire or explosion according to the Occupational Safety and Health Administration (OSHA). Many of you are likely thinking, "Well, not my company." Are you sure? Since 1980, there have been at least 350 documented dust explosions in the U.S., killing more than 100 people and injuring hundreds more.

Every manufacturing facility, regardless of industry, is vulnerable.

- September 10, 2012 – Authorities say two workers cleaning up years of old sawdust in the attic of Rockhard Design and Surfaces, a door manufacturer in Phoenix, suffered second- and third-degree burns after a dust explosion. The ignition source is unknown. Reports say the workers fell through the ceiling into an old office as a result of the explosion. A third worker was also injured but refused medical treatment.[1]
- January 10, 2012 – Workers at an electronics recycling company in Austin, Texas, were sorting materials on an output conveyor when combustible dust generated by a nearby ring mill pulverizing machine caused an explosion that sent two workers to the hospital with severe burns. Safety violations identified during the inspection included failing to provide approved and adequate dust collection for the ring mill and inadequate housekeeping to control combustible dust. OSHA has fined the company $60,060 for the violations.[2]

Introduction 1
OSHA Dust Control Recommendations 2
History and Scope 2
How Dust Explodes 3
Industries at Risk Chart 3
Dust Explosion Pentagon 3
Minimizing Risk 4
Housekeeping Practices and Tools 4
OSHA Requirements 4
Certified Explosion Proof Vacuums 5
Explosion Proof vs. Air Operated Vacuums 6
Resources
OSHA Dust Control Recommendations 2
OSHA Requirements 4
Rules to Live By 5
NFPA Resources 5
OSHA Resources 6
Other Resources 6

- October 29, 2011 – A massive explosion at a grain elevator in northeastern Kansas killed six people and seriously injured two others. The force of the blast at Bartlett Grain Company in Atchison, Kansas, was felt up to three miles away, city officials said.[3] The company faces safety violations from OSHA including allowing grain dust – which is nine times as explosive as coal dust – to accumulate. The citations carry $406,000 in penalties.[4]

- December 9, 2010 – An explosion ripped through AL Solutions, Inc., a titanium and zirconium processing facility in New Cumberland, West Virginia. Three workers who were processing titanium powder at the time were killed. The explosion occurred in the main production building, igniting barrels of stored titanium and zirconium. The explosion blew desks and lockers into the parking lot and knocked off doors. The fire burned for nine hours.[5] OSHA cited 18 safety violations and fined the company $154,000.

While an initial blast can be devastating, it often stirs up additional dust, leading to a secondary blast that can take down an entire facility.

Explosions grab headlines, but very little attention is typically devoted to the most common combustible dust-related incidents: fires. Although small dust-related fires might be regular events for some manufacturers, dust fires are precursors to explosions. Fires that don't lead to deadly explosions should be considered near-miss events.

John Astad, founder of the Combustible Dust Policy Institute, discovered through media accounts that 80 percent of combustible dust incidents in 2008 were fires. Some 30 percent of dust explosions were at facilities that had prior related fires.[6] But dust fires are rarely reported to state and federal agencies. Since OSHA only investigates significant incidents involving fatalities or extensive injuries, many of these events go unrecorded.[7]

Regardless of industry or material, combustible dust can be formed from milling, sanding, grinding, crushing, cutting – or simply handling product in powder form. With proper safety, maintenance, housekeeping procedures and housekeeping equipment, manufacturers can prevent a tragedy from happening at their facilities. The information in this white paper will help professionals in EH&S, maintenance and plant operations understand combustible dust and work toward safer facilities.

OSHA Dust Control Recommendations

- 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

Source: OSHA Fact Sheet DSG 3/2008

History and Scope

The first recorded dust explosion occurred at an Italian flour mill in 1785. In the late 1800s, the first studies on mill explosions began in the U.S., and in 1922 the National Fire Protection Association (NFPA) formed the first explosive dust committee. In 2006, the Chemical Safety Board (CSB) urged OSHA to develop a comprehensive standard to control the risk of dust explosions in general industry.

Unfortunately, it took a tragedy to bring the combustible dust problem into focus for industry and lawmakers. On February 7, 2008, in Port Wentworth, Georgia, the Imperial Sugar factory exploded, killing 14 and injuring hundreds of others. It was the worst combustible dust explosion in U.S. manufacturing history.

In March 2008, OSHA reissued CPL 03-00-008 as part of its Combustible Dust National Emphasis Program (NEP), which outlines recommendations and guidelines for decreasing the combustion risk in a multitude of industries. The program specifically lists close to 70 industries by SIC code that are considered "at risk" for a combustible dust incident and includes those that handle wood, metal, coal, plastic, paper, textiles, biosolids, and organic materials like sugar, flour, soap, and blood (see Chart 1). Broken down by industry, the risk data points to food, wood and chemicals as the three sectors most at risk. OSHA's watch list, however, includes more than 120 industries.

How Dust Explodes

Combustible dust, as defined by the NFPA, is any finely divided solid material that is 420 microns or smaller in diameter and presents a fire or explosion hazard when dispersed and ignited in air. OSHA's definition in its NEP says, "particulate solid that presents a fire or deflagration hazard when suspended in air or some other oxidizing medium over a range of concentrations, regardless of particle size or shape."

Chart 1 – Industries at Risk

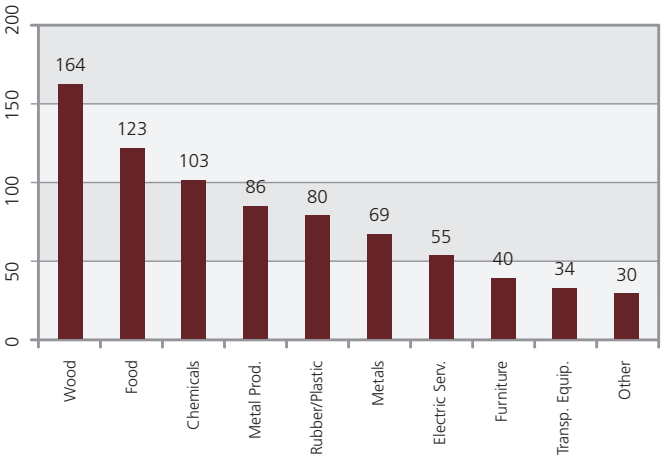
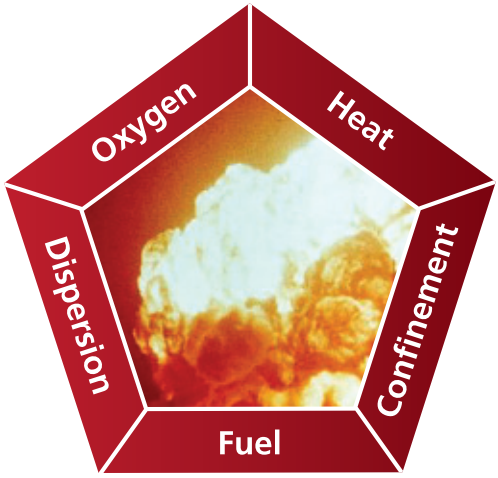


Figure 1 – Dust Explosion Pentagon



Combustible dust explosions happen when there are five elements/conditions in place (see Figure 1):

1. Fuel to burn (combustible dust)
2. Oxygen to sustain the fire (air)
3. Heat from an ignition source (spark)
4. Dispersion of a high concentration of dust into the air (deflagration)
5. Confinement of the dust within an enclosure or structure (explosion)

Most industrial facilities have all five elements, and if fire ignites in a contained area where combustible dust particles have accumulated, such as inside a duct system or on the overhead beams in a closed room, the formula for an explosion is complete. A facility is at risk according to OHSA if it has dust accumulation of more than 1/32", the thickness of a paperclip, covering more than 5 percent of a plant.[8]

However, there are a multitude of factors that comprise risk, such as the dust's material of composition, its combustibility, other materials in the environment (such as vapor from other fuels), ignition sources – even the weather!

Minimizing Risk

Dust and debris are inevitable in manufacturing and the only way to completely eliminate combustible dust incidents is to cease operations. Obviously, that is not an option. Plant owner/operators dealing with combustible dust are obligated by rule of law to take proper steps to minimize risk for all employees. These steps should include:

- Educating employees at all levels to recognize risk factors and how to prevent or remedy them
- Enacting comprehensive maintenance and housekeeping plans
- Properly equipping facilities with sprinklers, explosion protection systems, and deflagration venting
- Identifying and using the correct tools for combatting dust in housekeeping programs
- Creating damage control plans in the event of a fire or explosion

To identify factors that may contribute to an explosion, OSHA recommends a thorough hazard assessment of:

- All materials handled
- All operations conducted, including by-products
- All spaces, including hidden ones
- All potential ignition sources

As part of this assessment, employers can have their dust tested for combustibility. Many states offer consultation through their Department of Labor's Division of Occupational Safety. Private testing labs and OSHA also provide dust testing. Testing is the only way to be completely sure about dust composition and thus flammability. It is a step that cannot be skipped.

OSHA Requirements

The following are OSHA requirements that apply to combustible dust.

- §1910.22 Housekeeping
- §1910.120 Hazardous Waste Operations and Emergency Response
- §1910.269 Electric Power Generation, Transmission and Distribution
- §1910.272 Grain Handling Facilities
- §1910.307 Hazardous Locations
- General Duty Clause, Section 5(a)(1) of the Occupational Safety and Health Act

Housekeeping Practices and Tools

Unfortunately, when it comes to combustible dust, no one cleaning method will work for all facilities. Operators should be aware of the ignition sensitivity and explosion severity of the materials in their plant. This information can be found on each product's MSDS. This, along with combustibility testing, will determine the best way to tackle combustible dust and ensure that the proper safety procedures are used.

Mops, brooms and compressed air have their place in industrial facilities, but using these tools is time-consuming and often creates dust clouds, which are more readily combustible than dust that is not airborne. Mops and brooms are also very limited in what and where they can clean. Dust is often hidden on racks, piping, ductwork and drop ceilings and can't be effectively cleaned with manual tools.

Some manufacturers look to shop-style vacuums sold at big-box retailers. Although these vacuums might be okay for general cleaning, using them to collect combustible dust can not only increase the risk of explosion, it may also violate the requirements set forth in OSHA's Combustible Dust NEP, which calls for electrical vacuums used in dusty areas to be approved for the hazard-classified location, as required under standard 1910.307(b).[9]

A properly equipped, HEPA-filtered industrial vacuum suitable for collecting combustible dust can get the job done in half the time and be used to remove dust from machinery, floors, walls, and overhead pipes and vents. Paper mills and converters will find extreme value in vacuum-assisted overhead cleaning kits, comprised of long extension wands and curved nozzles that quickly and easily remove paper dust from overhead pipes and other areas where dust settles but often goes unseen from the mill floor. Explosion proof industrial vacuums are the best choice for certain conditions and environments, such as grain mills. Facilities with classed materials, too, may require an explosion proof and dust ignition proof vacuum, as determined by Authorities Having Jurisdiction (AHJ).

Certified Explosion Proof Vacuums

A certified explosion proof vacuum is constructed entirely of non-sparking materials like stainless steel, from the outer shell to the internal mechanics including the motor, switches, filters and inner chambers. And the entire vacuum is grounded. Some industrial vacuum companies offer basic models dressed up with a few anti-static accessories and describe them as suitable for explosive material. These imposters can still create arcs, sparks or heat that can cause ignition of the exterior atmosphere and overheating that can ignite dust blanketing the vacuum.

For peak safety and operating efficiency, a vacuum should have a multi-stage, graduated filtration system, which uses a series of progressively finer anti-static filters to trap and retain particles as they move through the vacuum. To eliminate combustible dust from being exhausted back into the ambient air, a HEPA or ULPA filter can be positioned after the motor to filter the exhaust stream. Quality HEPA filters offer an efficient, effective way to trap and retain 99.97 percent of particles, down to and including 0.3 microns. An ULPA filter captures 99.999 percent of particles, down to and including 0.12 microns.

Rules to Live By

The NFPA is working to finalize Standard 652, which would establish general fundamental rules on combustible dust that would supersede five other industry-specific standards currently in place. It was expected that the standard would go into place no later than Summer 2012.

Congress, unfortunately, has not made any significant progress on dust lawmaking since the start of 2011. Legislation that was introduced on February 4, 2009 died. It was reintroduced in February 8, 2011 as H.R. 522: Worker Protection Against Combustible Dust Explosions and Fires Act of 2011. It was immediately referred to committee, which has not acted on it since.

NFPA Resources

See *www.nfpa.org* to view NFPA standards:

- 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 the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids
- NFPA 655, Standard for the Prevention of Sulfur Fires and Explosions
- NFPA 664, Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

Purchasing an explosion proof and dust ignition proof vacuum approved by a nationally recognized testing laboratory such as the Canadian Standards Association (CSA) or Underwriters Laboratories (UL) will protect buyers by providing legal certification that the vacuum can be used in a particular NFPA-classified environment. It ensures every component in the vacuum from the ground up meets strict standards for preventing shock and fire hazards.

Explosion Proof vs. Air Operated Vacuums

In environments where electricity is unavailable or undesirable, air operated vacuums for hazardous locations are excellent alternatives, especially in facilities where compressed air is the main power source. But just because a vacuum is air operated, doesn't make it explosion proof. Pneumatic vacuums for hazardous locations should still be constructed of non-sparking materials and outfitted with ignition proof parts and accessories that meet the highest level of operational safety.

But even so equipped, pneumatic vacuums are not "intrinsically safe equipment" as defined by the NFPA:

> *"…equipment and wiring that are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignited concentration."*

This definition makes no mention of pneumatically driven equipment. Air powered vacuums do not generate any electrical energy and are therefore not intrinsically safe.

Nor are all electric explosion proof and dust ignition proof vacuums. They are not equipped with motors and switches that comply with the intrinsic safety protection method. As described in section 504 of the National Electric Code, "intrinsically safe" is an accepted protection technique for hazardous location areas. However, unlike certified explosion proof and dust ignition proof vacuums, intrinsically safe systems are not bound by the provisions of Articles 501 through 503.

OSHA Resources

On *www.osha.gov* you will find:

- Combustible Dust National Emphasis Program
- Safety and Health Information Bulletin (SHIB) (07-31-2005) Combustible Dust in Industry: Preventing and Mitigating the Effects of Fires and Explosions

Other Resources

Authorities Having Jurisdiction
www.reedconstructiondata.com/building-codes

Combustible Dust Policy Institute
www.dustexplosions.blogspot.com

Safe Choice Interactive Guide
www.explosionproof-vacuum.com/interactive-tool

Combustible Dust FAQs
www.explosionproof-vacuum.com/explosion-proof-vacuum-faq.html

Important Government Regulations
www.explosionproof-vacuum.com/vacuum-government-regulations.html

References

[1] Associated Press, published on therepublic.com on 9/10/12.

[2] Shelton Green, KVUE TV News, January 10, 2012.

[3] Joe Sutton, CNN, October 31, 2011.

[4] OSHA news release, April 12, 2012.

[5] Mark A. Griffon, Board Member, United States Chemical Safety & Hazard Investigation Board, NFPA Dust Symposium, September 20, 2011 www.nfpa.org/assets/files//PDF/Proceedings/CSBCombustibleDustIncident.pdf.

[6] "Combustible Dust Policy Incident Blog", www.dustexplosions.blogspot.com/2009/06/osha-regioniv-combustible-dust.html.

[7] "OSHA Response to Significant Events of Potentially Catastrophic Consequences", http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=1666&p_table=DIRECTIVES.

[8] "Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions", www.osha.gov/dts/shib/shib073105.html.

[9] "Hazardous Classified Locations". 14 Feb 2007. Occupational Health and Safety Association, www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=9884&p_table=STANDARDS.

About Nilfisk Industrial Vacuums

Nilfisk Industrial Vacuums, a division of Nilfisk-Advance, Inc., is one of the largest providers of cleaning equipment in North America. From its Morgantown, Pennsylvania, headquarters, Nilfisk Industrial Vacuums supports three brands of industrial vacuum cleaners: Nilfisk, Nilfisk ALTO and Nilfisk CFM. Equipped with exceptionally efficient filtration systems and user-friendly features, the company's vacuums play a critical role in thousands of manufacturing facilities and industrial processes across North America. Supported by a direct sales force and an extensive dealer network, Nilfisk Industrial Vacuums helps customers solve a variety of cleaning challenges, including combustible dust, general maintenance, overhead cleaning, abatement, process integration, laboratory/cleanroom control, and more.

Nilfisk Industrial Vacuums

740 Hemlock Road, Suite 100
Morgantown, PA 19543
Phone: 1-800-645-3475
Web: www.NilfiskIndustrialVacuums.com
E-mail: questions@nilfisk.com

In a World Full of Risk
Choose Nilfisk
Make the Safe Choice