

# **Aluminum Dust Management in a Metallizing Facility**

## **Safety and Regulatory Concerns**

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# Overview

- Introduction
- Background
- A Combustible Dust Incident
- Classifications and Standards
- Monitoring, Measurement, and Managing
- Good House Keeping

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# Introduction

- Accumulation of Combustible Dust
  - Fine particulates, dust, derived from any combustible material and from some materials generally not considered combustible, can rapidly ignite and burn
- Disrupted dust = explosible material
  - These dusts include: aluminum, magnesium, wood, coal (carbon dusts), plastics and additives, bio-solids, certain textiles, and even organics such as sugar, flour, paper, soap, and dried blood



[http://www.sparkdetection.com/problem\\_dust\\_explosions.htm](http://www.sparkdetection.com/problem_dust_explosions.htm)

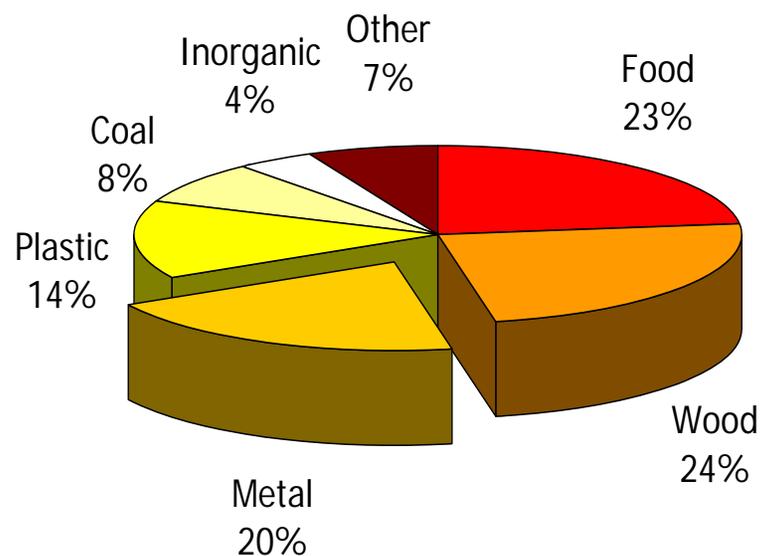
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# Background

- U.S. Chemical Safety and Hazard Investigation Board (CSB)
  - 281 combustible dust incidents between 1980 and 2005
  - Killed 119 and injured 718 workers
  - Occurred in forty-four states, covering a variety of industries, involving many different materials.



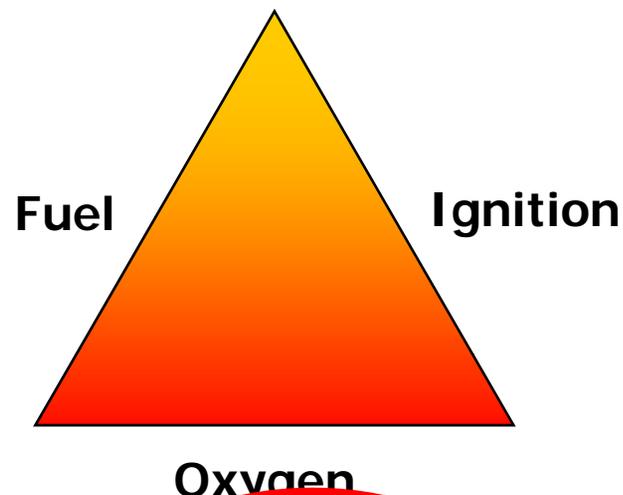
U.S. Chemical Safety and Hazard Investigation Board (CSB) Data

# Background

- Two types of explosions
  - ***Deflagration*** - combustion or reaction waves propagate at velocities less than the speed of sound
    - All combustion can be defined as a deflagration, where the ignition of a fuel-oxidizer mixture a suspended cloud of combustible dust in a confined environment causes rapid increases in pressure, causing explosions with extensive damage
  - ***Detonation*** - combustion or reaction waves propagate at velocities faster than the speed of sound
    - Due to the extremely fast reactions associated with detonation, these explosions create high-pressure shock waves that can cause damage at distances far from the origin of the blast.

# Background

- “Fire Triangle”
  - Fuel, ignition and oxygen must be present simultaneously
    - The fuel can be a gas, a vapor or a combustible dust (e.g. aluminum from metallizing process)
    - The oxidant is typically oxygen in the surrounding air
    - Ignition sources encompass heat sources such as sparks, naked flames, or elevated temperatures
  - Removing any one of these elements of the classic fire triangle eliminates the possibility of a fire

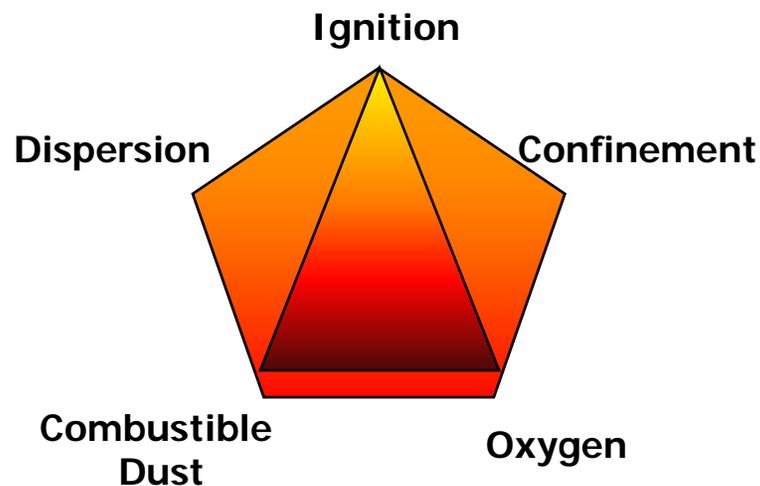


<http://primeca.com/wordpress.com/2008/flames.jpg>

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# Background

- “Explosion Pentagon”
- Dust explosion
  - requires the simultaneous presence of two additional elements—dust suspension and confinement
  - Suspended dust burns more rapidly, and confinement allows for pressure buildup
  - Removal of either element prevents an explosion, although a fire may still occur



<http://www.oldsusa.com/elevator/dust-explosion.jpg>

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# Background

- Combustible dusts are typically explosible
  - Dust has a particle size less than 420 microns (passing thru a U.S. No. 40 standard sieve), or a particle with a surface area to volume ratio greater than a 420 micron diameter sphere
  - Flaky and fibrous materials may also be a hazard even though they will not pass thru a #40 sieve
  - ***A dust explosion still requires the simultaneous presence of two elements—dust suspension and confinement***



# A Combustible Dust Incident

- Chemical Safety and Hazard Investigation Board (CSB)
  - October 29, 2003, aluminum dust exploded at the Hayes Lemmerz International facility in Huntington, Indiana
  - Killing one worker and injuring several others
  - Hayes Lemmerz plant manufactures cast aluminum automotive wheels
  - Explosions were fueled by the accumulation of aluminum dust, a byproduct of the wheel production process



Hayes Lemmerz International facility in Huntington, Indiana

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# A Combustible Dust Incident

- Scrap aluminum from the wheel manufacturing process was chopped into small chips, it was pneumatically conveyed to a scrap processing area where it was dried and then fed into a melt furnace.
- Transporting and drying the aluminum scraps subsequently generated aluminum dust in the ambient atmosphere, which was then pulled into a dust collector
- ***Dust collection system installed was not specifically designed to handle or maintain the dust***, preventing an explosion, or preventing a subsequent explosion from spreading through ducting.

# Classifications and Standards:

- Occupational Safety and Health Administration (OSHA) states
  - Presence of combustible materials in sufficient amounts or concentrations in any location, or in a location where sufficient concentrations could exist to produce an ignitable mixture, it is considered a hazardous location
  - Location becomes classified as a **Class II hazardous location** when the combustible material is a combustible dust
    - The aluminum metallizing process could technically produce aluminum dust as a byproduct - aluminum dust is considered a combustible dust
    - **Whether or not the location is considered hazardous has to do with the concentration within an area**

# Classifications and Standards:

- National Fire Protection Association (NFPA) guidelines
  - Class II, Division 1 hazardous location is any location where
    1. Combustible dust is in the air under normal operating condition is present in sufficient quantities to produce explosive or ignitable mixtures
    2. Combustible dust accumulates on horizontal surfaces greater than 1/8", making the surface color undeterminable,
    3. Mechanical failure or abnormal operation of equipment might cause such explosive or ignitable mixtures to be produced, providing a source of ignition through simultaneous failure of electric equipment
    4. Combustible dusts of an electrically conductive nature may be present in hazardous or sufficient quantities.

# Classifications and Standards:

- NFPA guidelines
  - Class II, Division 2 area as a location where
    1. dust has accumulated on horizontal surfaces less than 1/8" and the surface color is undeterminable
  - Combustible dusts are further divided into groups E, F, and G based on the type of combustible material
    - Most plastics, chemicals, wood, flours, and starches fall into category G
    - Dust from aluminum and aluminum alloys and variations thereof, fall into category E with most metals

# Monitoring, Measuring and Management:

- References from the NFPA and others for the management of combustible dust, in particular metal dusts in NFPA 484
  - NFPA 61, “Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities”
  - NFPA 68, “Guide for Venting of Deflagrations”
  - NFPA 69, “Standard on Explosion Prevention Systems”
  - NFPA 77, “Recommended Practice on Static Electricity.”
  - NFPA 484 , “Standard for Combustible Metals, Metal Powders, and Metal Dusts
  - NFPA 499, “Recommended Practice for the 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”
  - OSHA Directive Number: CPL 03-00-008 - Combustible Dust National Emphasis Program
  - FM Global 7-76 – Combustible Dust Explosion and Fire

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## Monitoring, Measuring and Management:

- Occupational Safety and Health Administration (OSHA)
  - Established a National Emphasis Program (NEP) to increase enforcement activities focusing on specific industry groups that have experienced frequent combustible dust incidents
  - Initiated NEP on October 18, 2007 and because of some recent accidents involving dust explosions -intensify its focus on this hazard
  - OSHA has begun to establish activities in the areas of outreach and training, specifically focused on providing employers with proper documentation, information, procedures, and resources needed to educate employers
  - Establishing cooperative ventures to enhance enforcement, protecting valued employees and assets

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## Monitoring, Measuring and Management:

- OSHA
  - If the facility that is being inspected is *not* a grain handling facility, citations under 29 CFR 1910.22 or 29 CFR 1910.176 can be issued if:
    1. Lab results indicate that the dust is combustible
    2. Combustible dust accumulations are not contained within dust control systems or other containers, such as storage bins, that are adequate enough to prevent a deflagration, explosion, or other fire hazard

## Monitoring, Measuring and Management:

- OSHA - NEP
  - Inspect facilities that generate or handle these combustible dusts
  - Examine locations for the presence of any other oxidizing medium over a range of concentrations,
    - regardless of particle size or shape, which can contribute to deflagrations, leading to explosions

## Monitoring, Measuring and Management:

- OSHA
  - Non-grain handling workplaces where combustible dust hazards exist within dust control systems or other containers, citations under section 5(a) (1) of the OSH Act can be issued for deflagration or explosion hazards.
  - If the workplace is classified as a Class II location, then citations under 29 CFR 1910.307 may be issued to employers having electrical equipment that do not meet standard requirements

# Good Housekeeping: Procedures and Devices

- Chilworth Technology, Inc., states
  - “The safe processing of flammable materials (dusts, gases or vapors) is facilitated by either preventing the conditions required for an explosion to occur, or protecting the plant and personnel from the effects of any such explosion. The combination of measures required to achieve such safe conditions is referred to as the “Basis of Safety”. A “Basis of Safety” is the effective safeguards in place to manage explosion risks”
- A “Basis of Safety”
  - Should be established for the metallizing industry by adopting some good housekeeping initiatives
  - **However, the NFPA standards and OSHA regulations should be followed accordingly to ensure proper handling and housekeeping of combustible dusts if present**

# Good Housekeeping: Procedures and Devices

- Suggested Housekeeping Action Items
  - Clean aluminum dust accumulations on a regular basis, making sure to document regular scheduled maintenance, while frequently checking the accumulations for explosibility
  - Prevent the accumulation of the combustible aluminum dust from exceeding the thickness established by a ratio of the bulk density of the accumulation sample dust to wood dust
  - Clean light aluminum dust accumulations by hand often to prevent suspension or the formation of an explosible dust cloud



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# Good Housekeeping: Procedures and Devices

- Suggested Housekeeping Items
  - Utilization of approved vacuums is preferred over compressed air cleaning to reduce the chance of generating a dust cloud
    - Should be properly rated for the classification of the location
    - Typically industrial grade for typical wet/dry shop vacuums are not acceptable
    - Vacuums utilized for cleaning used near machinery, equipment, or flammable substances should be rated for Class I, Division 1 or 2
    - Vacuum cleaners utilized in locations classified as Class II, Division 1 or 2 areas like a metallizing facility, should be listed for use only in those designated areas

# Good Housekeeping: Procedures and Devices

- Cleaning procedures should be carried out in a manner that ultimately minimizes the dispersion of the explosive aluminum combustible dust into the air
  - the element of suspension is removed from the explosion pentagon
  - **follow NFPA standards and protocols**
- Use proper dust collection systems and filters for aluminum dust
  - minimizing the escape of dust from process equipment or ventilation systems
  - **Follow NFPA standards for further recommendations on additional cleaning devices**

# Formulate an Action Plan

- Action Plan
  - Be proactive with safety
  - Issue a standard procedure
    - Implement a hazardous dust inspection, housekeeping, testing, and control program to prevent combustible dust fires and explosions in general
  - Base the standard procedure on current National Fire Protection Association (NFPA) dust explosion standards (including NFPA 654 and NFPA 484), and include at least:
    - hazard assessment
    - engineering controls
    - housekeeping
    - building design
    - explosion protection
    - operating procedures
    - worker training

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**"I'm not procrastinating. I'm proactively delaying the implementation of the energy-intensive phase of the project until the enthusiasm factor is at its maximum effectiveness."**

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# Formulate an Action Plan

- Revise the internal standards and MSDS
  - Include clarification on how much, if any, aluminum combustible dust is generated during the metallizing process, including other materials that may reasonably be anticipated to generate combustible dusts through downstream processing or handling
- Establish and provide a training program
  - All employees need to be aware of hazards present
- Identity internal risks and establish an action plan to minimize risks
- **Ultimately, it is the responsibility of plant managers, engineers, maintenance associates, safety coordinators, and all associates in our industry to see that a policy is established for managing a hazardous environment and see that it is carried out on a daily basis to ensure the safety of all employees**

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# References

- U.S. Chemical Safety and Hazard Inspection Board (CSB). *Investigation Report: Combustible Dust Hazard Study*, Report NO. 2006-H-1, November 2006.
  - <http://www.chemsafety.gov/>
  - [http://www.chemsafety.gov/assets/document/Dust\\_Final\\_Report\\_Website\\_11-17-06.pdf](http://www.chemsafety.gov/assets/document/Dust_Final_Report_Website_11-17-06.pdf)
- Occupational Safety and Health Administration (OSHA). *Combustible Dust National Emphasis Program (NEP)*, Directive Number: CPL 03-00-008, 3/11/2008.
  - [http://www.osha.gov/OshDoc/data\\_General\\_Facts/OSHAcombustibledust.pdf](http://www.osha.gov/OshDoc/data_General_Facts/OSHAcombustibledust.pdf)
  - [http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=DIRECTIVES&p\\_id=3830](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=3830)
- National Fire Protection Agency (NFPA) Standards and Regulations
  - <http://www.nfpa.org/>
  - NFPA 61, "Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Products Facilities"
  - NFPA 68, "Guide for Venting of Deflagrations"
  - NFPA 69, "Standard on Explosion Prevention Systems"
  - NFPA 77, "Recommended Practice on Static Electricity."
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  - NFPA 499, "Recommended Practice for the 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"
- Exponent® Engineering and Scientific Consulting
  - <http://www.exponent.com/explosions/>
- Chilworth Technology, Inc.: A Professional Process Safety Firm. *Handling Dusts & Powders Safely: A Strategic Guide to Hazard Characterization & Understanding*. Chilworth Technology Inc. 250 Plainsboro Rd., Bldg. #7 Plainsboro, NJ 08536 Tel: 609 799 4449
  - [www.chilworth.com](http://www.chilworth.com)

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