Combustible Dust
Fact Sheet

Introduction:
In 2008, there's been over 155 combustible dust related fires and explosions in the manufacturing, grain, and utility sectors. Municipal and volunteer fire departments respond to these incidents on numerous occasions.

In many instances fire departments are repeatedly returning to facilities that have reoccurring combustible dust related fires. At times the return call is in response to a combustible dust explosion. Any combustible dust fire is a precursor to an eventual dust explosion.

Fire-fighters are sustaining a large percentage of injuries in combating combustible dust fires and explosions. Most recently at a **coal-fired co-generation plant** in Stockton, California, in September 2008, a news account reported, "*five firefighters were just inside the building and one just outside the building on stairs when the explosion occurred. The sixth firefighter on the stairs was the firefighter who suffered the worst of the injuries*."

Two weeks prior to this incident, another firefighter sustained facial burns at a Garden Grove, California aluminum extruded product manufacturing facility while combating a metal dust fire when a fireball erupted. If the incident commanders were aware of the combustible dust hazards prior to responding to the incident the probability and severity of the injuries might have been minimized.

Currently, there is no uniform standardized training for firefighters concerning identifying, evaluating and controlling combustible dust fires and explosions. It's mostly on the job training with lessons learned.

Industries that handle combustible dusts include, but are not limited to:
• Agriculture
• Food Products
• Chemicals
• Textiles
• Forest and furniture products
• Metal processing
• Tire and rubber manufacturing plants
• Paper products
• Pharmaceuticals
• Wastewater treatment
• Recycling operations (metal, paper, and plastic.)
• Coal dust in coal handling and processing facilities

These dusts include, but are not limited to:
• 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

Dust Combustibility
The primary factor in a process hazard analysis **o**f dust hazards is whether the dust is in fact combustible. Any "material that will burn in air" in a solid form can be explosive when in a finely divided form.[6] Combustible dust is defined by NFPA 654 a**s: "Any finely divided solid material that is 420 microns or smaller in diameter (material passing a U.S. No. 40 Standard Sieve)** and presents a fire or explosion hazard when dispersed and ignited in air." The same definition is used for combustible metal dust in NFPA 484, Standard for Combustible Metals, Metal Powders, and Metal Dusts. One possible source for information on combustibility is the Material Safety Data Sheet (MSDS) for the material. In some cases, additional information such as test results will be available from chemical manufacturers.

Note: *MSDS's do not provide the crucial information on ignition sensitivity and explosion severity of combustible dust. Subsequently, fire-fighters do not have the vital information in combating and suppressing combustible dust fires.*

Different dusts of the same chemical material will have different ignitability and explosibility characteristics, depending upon many variables such as particle size, shape, and moisture content. Additionally, these variables can change while the material is passing through process equipment. For this reason, published tables of dust explosibility data may be of limited practical value. In some cases, dusts will be combustible even if the particle size is larger than that specified in the NFPA definition, especially if the material is fibrous.[7]

Industrial settings may contain high-energy ignition sources such as welding torches. In these situations, test methods for dust ignition and explosion characteristics from ASTM International (originally the American Society for Testing and Materials) would be of value.

Elements of a Dust Explosion

Elements Needed for a Fire (the familiar "Fire Triangle"):

1. Combustible dust (fuel);
2. Ignition source (heat); and,
3. Oxygen in air (oxidizer).

Additional Elements Needed for a Combustible Dust Explosion:

4. Dispersion of dust particles in sufficient quantity and concentration; and,
5. Confinement of the dust cloud.

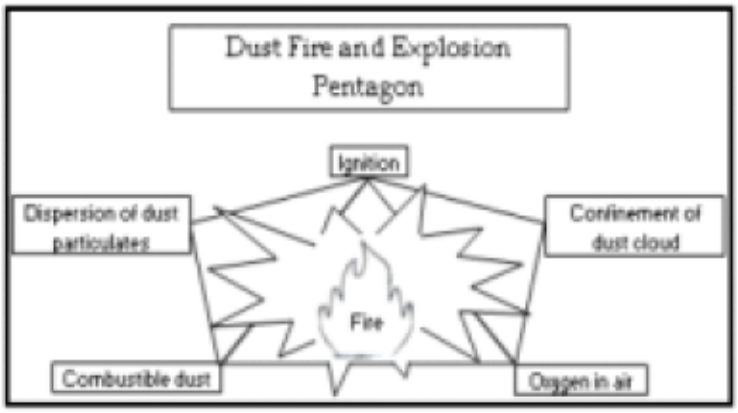

Figure 1

The addition of the latter two elements to the fire triangle creates what is known as the "explosion pentagon" (see Figure 1). If a dust cloud (diffused fuel) is ignited within a confined or semi-confined vessel, area, or building, it burns very rapidly and may explode. **The safety of fire-fighters is threatened by the ensuing fires, additional explosions, flying debris, and collapsing building components.**

An **initial (primary) explosion** (see Figure 2) in processing equipment or in an area were fugitive dust has accumulated may shake loose more accumulated dust, or damage a containment

system (such as a duct, vessel, or collector). As a result, if ignited, the additional dust dispersed into the air may cause one or **more secondary explosions** (see Figure 2). These can be far more destructive than a primary explosion due to the increased quantity and concentration of dispersed combustible dust.

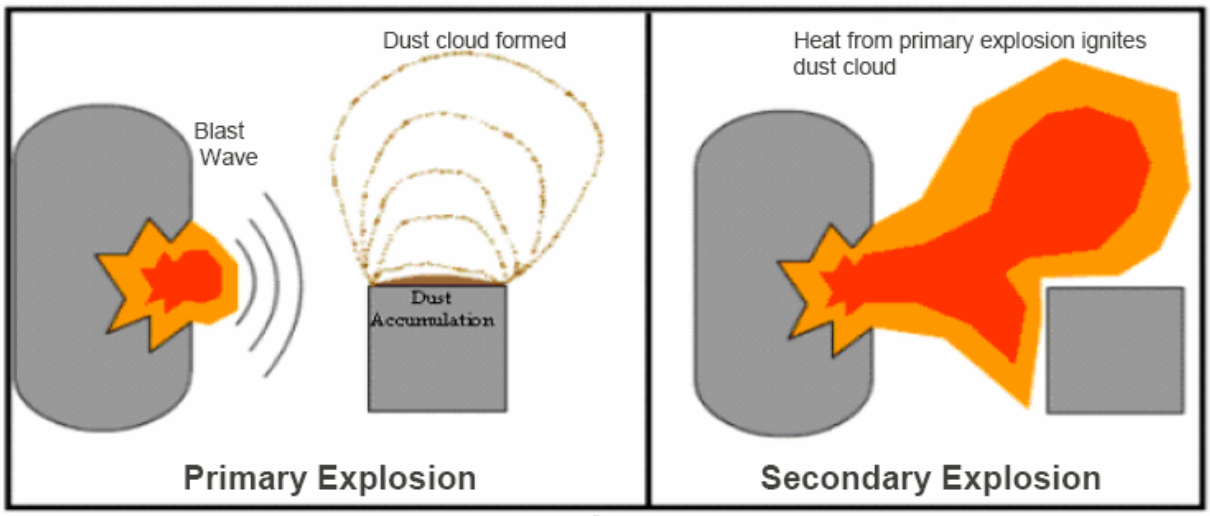

Figure 2

If one of the elements of the explosion pentagon is missing, a catastrophic explosion can not occur. Two of the elements in the explosion pentagon are difficult to eliminate: oxygen (within air), and confinement of the dust cloud (within processes or buildings). However, the other three elements of the pentagon can be controlled to a significant extent, and will be discussed further in this document.

Damage Control

NFPA 654, Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, contains comprehensive guidance to minimize the danger and damage from an explosion. The following are some suggested protection methods:

- Separation of the hazard (isolate with distance);
- Segregation of the hazard (isolate with a barrier);
- Deflagration venting of a building, room, or area;
- Pressure relief venting for equipment;
- Provision of spark/ember detection and extinguishing systems;
- Explosion protection systems (also refer to NFPA 69, Standard on Explosion Prevention Systems);
- Sprinkler systems; and
- The use of other specialized suppression systems.

Note : *Many manufacturing facilities' do not utilize protection methods as outlined in NFPA 654 such as deflagration venting, spark/ember detection and extinguishing systems, or sprinkler systems.*

Additional Resources

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD
INVESTIGATION REPORT REPORT NO. 2006-H-1 **COMBUSTIBLE DUST HAZARD STUDY** .pdf

CSB **Combustible Dust Hazard Investigation** October 1, 2004-website

OSHA Combustible Dust National Emphasis Program .pdf

HazardAlert: Combustible Dust Explosions .pdf

Combustible Dust Explosions and Fires-ATEX-website

NFPA 654:Combustible Dust Standard online viewing