Understanding the Hazard

Combustible Dust

Understanding the Hazard
This series of publications is designed to help you understand the everyday hazards present at your company's facilities. For more information on how you can better understand the risks your business and operations face every day, contact your FM Global engineer.

UTH topic categories:

- Construction
- Equipment
- Fire Protection
- **Human Factor**
- Natural Hazards
- **Process Hazards**

Hazard or Risk?
Many production operations involve the handling of combustible dust. FM Global can help you evaluate combustibility and potential damage in the event of an explosion (the hazard). Once this information is known, we work with you to understand the consequences to your operations (the risk).

The Hazard

Combustible dust includes nearly all finely divided organic materials such as wood, paper, rubber, fiber, food and tobacco. FM Global Research maintains an extensive database with results of dust combustibility and explosion tests. These tests indicate that essentially all dust (including many types of freshly created metal dust) will burn when suspended in air or distributed on surfaces. A dust fire occurs when a combustible dust comes in contact with an ignition source in the presence of air (oxygen). A dust explosion requires two additional conditions: suspension of the dust so that it burns more quickly in air, and confinement that provides resistance, creating pressure buildup.

During the last 10 years, FM Global clients have experienced 455 fires or explosions involving combustible dust or fiber deposits, totaling an estimated US$483 million in damage to their facilities. The average gross loss for dust fires is US$1 million, and the average gross loss for dust explosions is US$1.6 million.

Although you may not be able to totally eliminate combustible dust from your process or your facility, there are prevention measures you can take to reduce the frequency of dust fires and explosions. Likewise, control measures can reduce the severity of a fire or explosion. Together, these can help you reduce the likelihood of property damage and business interruption.

Science of the Hazard

All organic materials will burn if enough heat is applied to them. As the particle size decreases, the amount of energy needed to ignite a material also decreases. In addition, the finer the particle, the more intense the burning velocity (i.e., faster fire spread or more powerful explosions). Decreased moisture content, increased turbulence, greater oxygen concentration, and presence of a flammable vapor or gas all serve to increase burning velocity. Surface properties, such as oxidation of a metal dust and surface roughness, can greatly affect burning velocity.

Dust collectors and collection systems are involved in many losses reported to FM Global. Dust collection systems are designed to draw small- to medium-sized particles, and then concentrate the particles. The air/dust mixture within most dust-handling equipment passes through the explosive range—where the concentration

What You Can Do at Your Facility

Control Ignition Sources

You can reduce the frequency of dust fires or explosions by establishing thorough programs to control ignition sources, and rigidly enforcing them in dust-handling areas. These programs include:

- A hot work permit system that applies to both employees and contractors to control the amount of hot work and the conditions under which it is performed
- Smoking control
- Electrical preventive maintenance to reduce the likelihood of sparks from electrical equipment (proper rating of electrical equipment should be reviewed regularly)
- Maintenance of dust-handling equipment to eliminate sparks from unaligned or otherwise malfunctioning conveyors, mixers, fans and other mechanical equipment
- Maintenance of all magnetic separators and any equipment used to convey the material past the magnets

of suspended dust can support a self-propagating explosion. Usually, parts of the interior volume pass through the explosive range several times during operation (i.e., reverse pulse bag cleaning), creating optimum conditions for dust explosions and fires. Sparks or metal objects released near pickup points are drawn to dust collectors and provide the ignition energy for a fire or explosion. Tramp metal can ignite dust inside a dust collector even if a spark suppression system is provided in the duct feeding the dust collector. If dust is allowed to settle in the feed duct, or if the duct operates within the combustible range, an explosion or fire can propagate, leading to extensive damage throughout the production area served by the dust collection system.

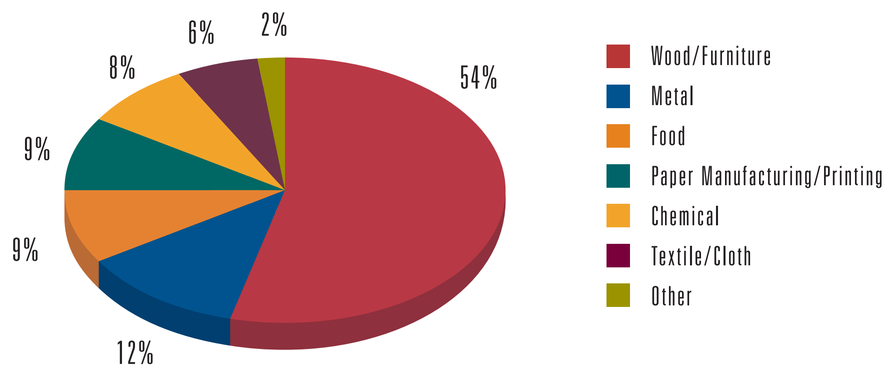
Room or building dust fires or explosions can occur if combustible dusts are allowed to accumulate on structures. Large areas of dust accumulations may ignite and spread a fire faster than sprinklers can operate. If the area covered by combustible dust is large, the sprinkler system may not achieve effective control, because it cannot surround such a fire. Many more sprinklers may open beyond the design area of the automatic sprinkler system, overtaxing the water supply. A large and damaging fire can result.

Large areas of dust accumulation above floor level create the potential for a severe secondary explosion hazard. If an explosion occurs at floor level (for example, due to the explosion of a vessel), the pressure wave dislodges dust on overhead structures. Just after the dust is blown into the air, the flame front of the primary deflagration reaches the area. This powerful ignition source causes a secondary, much larger and more powerful explosion that can collapse building walls, roofs and floors.

Loss Experience

Industries that process organic materials experience the largest number of losses, although dust explosions and fires can affect many industries.

FM Global Claims – Dust Fires and Explosions by Industry (1991-2000)



Source: FM Global clients

The sources of ignition for many dust fires and explosions reported to FM Global are unknown. The most common ignition sources are spontaneous ignition, metal impact, friction or static sparks, but finding evidence of the ignition source after a loss often is very difficult.

But What About…

…our process, which is inherently dusty? We can't prevent it.

You may not be able to eliminate dust, but you can take measures to control and contain it. For example, you can prevent dust escape by tightening equipment or making sure dust pickups are located over the equipment. Preventing dust escape is preferred to more frequent dust cleanup. Dust suppression (oil or water spray) can prevent traffic from sending dust accumulations from the floor into the air.

…good housekeeping? There is not enough dust to create an explosion hazard.

It takes very little dust to create a fire or explosion hazard in a room. Cleanings should be conducted to prevent accumulations on structures above the floor from exceeding 1/16 in. (1.5 mm) in thickness—the amount typically needed in a building to create the potential for a dust cloud after a small primary explosion.

…harmless dust? Most of the dust we handle is noncombustible or very difficult to ignite.

Can you be sure? Plant personnel at a sugar beet refinery believed the dust generated by a waste material drying process was noncombustible. The process equipment was not maintained in tight condition, and accumulations were cleaned up only after the annual production season. But testing by FM Global Research revealed the dust was combustible and could explode under the right conditions.

FM Global Research performs combustibility and explosion screening tests to verify the combustibility of a dust, or mixture of different types of dust. Although a small percentage of dust has been determined to be hard-to-ignite based on tests by FM Global Research, the majority of dust can be ignited by very common types of sparks. Ask your FM Global engineer about the specific dust handled at your facility.

…dust that is formed in very large particle-size volume? Isn't it true this dust can't explode?

Dust particles larger than 500 microns will burn, but not quickly enough to create explosion overpressures. Dust with particle sizes smaller than 500 microns burns quickly enough to create explosive overpressures if ignited while suspended in a confined area. A sieve-tray analysis by FM Global Research could identify the particle distribution and explosion potential you face.

…small quantities? Most of the dust we handle is very limited in volume, so it could not explode.

If the maximum amount of dust generated was expected to yield a concentration in air less than 0.03 oz./ft.^{3} (30 g/m^3)—the measured minimum explosive concentration (MEC)—then the explosion potential would be considered minimal. Process changes or changes to raw materials would have to be closely monitored to ensure particle-size distribution remains constant, and that dust particles are not being generated due to impact and circulation of air transport streams.

What You Can Do at Your Facility

Limit Dust Accumulation

- Prevent the escape of dust by tightening equipment or otherwise improving seals.
- Include regular cleaning of dust accumulations from buildings, especially at roof level. Vacuum, water wash, or use soft bristle brooms. Never blow dust off overhead structures using compressed air; this creates a dust cloud, which could ignite. If dust is to be blown off overhead structures, de-energize all electrical equipment in the area, and use a hot work permit system.
- Prevent spontaneous ignition of wet organic materials inside equipment by establishing a regular rigorous cleaning schedule.
- Inspect the inside of ductwork and remove accumulated dust. This is key to preventing propagation of a fire or explosion from one unit to the next.
- Incorporate control/protection techniques to minimize fire damage, and include automatic sprinkler protection inside equipment and transfer ducts where combustible dust accumulates. When combustible dust burns inside equipment, sprinklers will open at roof level. The fire is not controlled, however, because these areas are shielded from roof-level sprinkler discharge. Add sprinklers to trouble areas first. Also, add interlocks and manual emergency buttons to shut down transfer fans, conveyors or valves in the event of a fire to limit fire spread from the equipment of origin.

Need More Information?

Ask your FM Global engineer about the following:

- A video clip showing large-scale explosions involving coal dust and cornstarch
- Examples of explosion tests for various types of dust (FM Global's dust database)
- A list of common ignition sources, and advice on what you can do to prevent dust fires and explosions
- Best ways to control or mitigate dust fire or explosion potential
- FM Global's vent standards as compared with NFPA and VDI (German) standards
- FM Global's DustCalc Program for sizing explosion venting

Ordering Information

For Understanding the Hazard

For additional copies of Understanding the Hazard publications, contact your FM Global engineer or client servicing team.

For all other FM Global publications

All other FM Global brochures and educational materials can be found in the FM Global Property Loss Prevention Resource Catalog *and ordered online at www.fmglobal.com/store.*

Or, for personal assistance worldwide, contact our U.S.-based customer services team:

- *Toll-free: (1)877 364 6726 (Canada and United States)*
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Don't Let This Happen to You

In this loss, the dust explosion traveled back into the plant from the dust collector through the return-air ductwork, opening approximately 300 sprinklers. Accumulation of dust inside the building helped spread the fire. Luckily, there was no secondary room explosion. The photo at left shows damage to two dust collectors located just outside the plant. At right, water damage inside the plant is cleaned up after a fireball caused numerous sprinklers to open.