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Property risk solutions

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INSIDE THIS ISSUE

Welcome to this edition of the Property safety solutions newsletter. This quarterly publication focuses on fixed fire protection and human element safety solutions for property and boiler/machinery exposures.

In this edition we will be discussing combustible dusts and the related exposures and controls.

- Have you ever thought of your operations as one that poses a risk of combustible dust explosions?
- What are the financial impacts associated with combustible dust explosions?
- Just how do you determine if you have a combustible dust hazard?
- How do you reduce the risks associated with combustible dusts?
- What's your risk?
- Combustible dust hazard checklist
- Where can I find additional information about combustible dust?

Have you ever thought of your operations as one that poses a risk of combustible dust explosions?

A combustible dust hazard can exist in a wide variety of industries, including food (e.g., sugar, starch, flour, grain), plastics, wood working, rubber, furniture manufacturing, textiles, pesticides, pharmaceuticals, dyes, coal, metals, and fossil fuel power generation. Most natural and synthetic organic materials, as well as some metals, can form combustible dust.

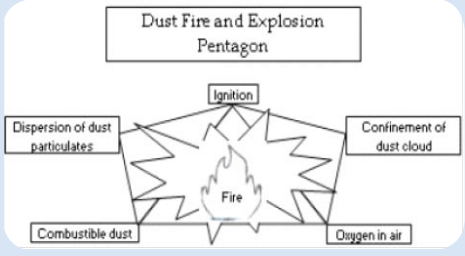
Did you know that when suspended in air, fine particles of combustible dusts can present an explosion hazard?

When a process involves a flammable liquid, the exposure is easy to recognize and understand. The flammable liquid can release flammable vapors into the air, which can be ignited. There is no mistaking the presence of the hazard, and no mistaking the need for controls.

The hazard associated with a combustible dust, on the other hand, is not always so apparent. The hazard is only visible when there is a force present to disperse the dust into the atmosphere. Unfortunately, the severe hazard associated with combustible dust will not be realized until the right conditions come together resulting in a dust explosion. For a dust explosion to happen, five conditions need to be present:

1. A combustible dust
2. Dispersion of the dust into a cloud within an explosive range
3. Sufficient oxygen concentration (air)
4. Confinement within an enclosure
5. An ignition source

The building itself can be the enclosure but most dust explosions start within processing equipment such as dust collectors, dryers, pneumatic conveying systems, mills, and grinders. If the processing areas are not kept clean and combustible dust is allowed to accumulate overhead on the building's structural members and equipment, the initial small dust explosion in the equipment can cause the formation of a combustible dust cloud within the building. This condition can lead to a series of larger explosions that can cascade through the facility.



Dust Fire and Explosion Pentagon

Source: OSHA Safety and Health Information Bulletin - SHIB 07-31-2005, "Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions"

http://www.osha.gov/dts/shib/shib073105.html

Applicable NFPA Standards

- **NFPA 61:** "Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities"
- **NFPA 68:** "Standard on Explosion Protection by Deflagration Venting"
- **NFPA 69:** "Standard on Explosion Prevention Systems"
- **NFPA 70:** "National Electrical Code"
- **NFPA 499:** "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"
- **NFPA 664:** "Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

A heightened awareness of combustible dusts hazards along with a good understanding of the hazard controls is the first step in helping reduce combustible dust explosions.

What are the financial impacts associated with combustible dust explosions?

More than 150 combustible-dust related fires and explosions occurred in the US in 2008, according to research carried out by the Combustible Dust Policy Institute. These dust explosions almost always lead to financial losses in terms of damaged facilities, equipment down time and employee injury. The direct costs associated with a dust explosion can easily exceed the million dollar mark, with some of the more catastrophic explosions reaching ranges well into the hundreds of millions of dollars. Some of the direct and indirect costs associated with an explosion can include, but are not limited to:

- Potential for injury or death
- Entire plant rebuild or shutdown
- Equipment replacement
- Process restructuring
- Production downtime
- Supply chain disruptions
- Market share decline
- Loss revenue and profits
- Regulatory fines (OSHA, EPA)
- Litigation

Just how do you determine if you have a combustible dust hazard?

A starting point is to evaluate the materials being processed or handled. Consider both the type and form of the material. If the material is organic, carbonaceous, or metallic and handled in a finely divided form such as a dust or powder, then there is reason for possible concern.

Examples of combustible dust sources

Organic, natural	Agricultural grains, sugar, wood
Organic, synthetic	Plastics, organic pigments, pesticides
Carbonaceous	Anthracite coal, western coal, carbon black
Metal	Magnesium, aluminum, iron, zinc

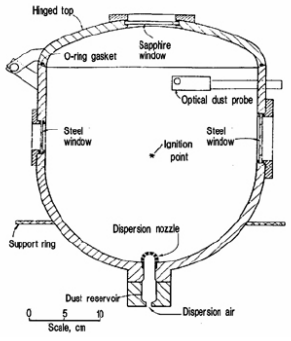
For more examples of materials that may pose a combustible dust hazard, see the Occupational Safety and Health Administration (OSHA) combustible dust poster at the following URL: http://www.osha.gov/Publications/combustibledustposter.pdf.

The presence of a finely divided combustible dust does not automatically mean that a combustible dust hazard exists; however, the hazard should be assumed until testing verifies otherwise.

Confirming a hazard does exist only requires one positive test. Confirming a hazard does not exist may require multiple tests.

What types of combustible dust tests are available?

Combustible dust testing can include a number of tests. The objective is to pursue the appropriate tests for the process conditions and desired basis of safety. Often, different tests are needed to understand the exposures at different points in a process.



20-liter sphere test apparatus

Source: OSHA Directive Number - CPL 03-00-008: Combustible Dust National Emphasis Program (Reissued)"

http://www.osha.gov/OshDoc/Directive_pdf/CPL_03-00-008.pdf

Qualitative test

Where there is a question as to whether a dust is combustible, an initial Explosibility Screening Test can be conducted. This test produces an A/B classification where the "Type A" dust is exposable and the "Type B" dust is

non-exposable. This test is only needed if the combustible nature of a dust is not known.

Quantitative test

Once it is established that a dust is combustible, an Explosion Severity Test should be conducted. This test is typically conducted in the 20-liter sphere test apparatus.

How do you reduce the risks associated with combustible dusts?

Fugitive dust control

There are two key steps to reduce a catastrophic series of cascading secondary dust explosions.

The first step is to keep the combustible dust within the processing equipment. Malfunctioning processing equipment can allow combustible dust to form a cloud within the processing area. This dust will eventually settle on overhead building structural members and equipment. Operating instructions should require that malfunctioning equipment be shut down and repaired immediately if the equipment is producing a dust cloud. Buildings housing combustible dust hazards should be configured to minimize surfaces that permit dust accumulations.

The second step is to frequently clean dust accumulations from production areas. Specific attention should be given to overhead areas and hidden inaccessible areas in the building. Cleaning should be by vacuum systems with a proper hazardous duty electrical classification, sweeping, or wet power washing. The use of compressed air to blow down dirty areas should not be allowed unless additional precautions are completed. Precautions include cleaning as much of the area by normal methods and de-energizing electrical equipment prior to using compressed air to clean only areas that are not accessible to normal cleaning methods.

Ignition control

Ignition sources require careful attention in areas handling combustible dusts. During a process upset, four legs of the Dust Fire and Explosion Pentagon may suddenly be present – namely, air, fuel, dispersion and confinement. If ignition sources are not controlled at all times, a fire or explosion can immediately follow any system failure where dust is released.

Ignition sources can include smoking materials, open flames, spark producing tools, building heat systems, hot surfaces, fixed and portable electrical equipment, and static electric discharges.

It is important to recognize that it is difficult to totally eliminate all potential sources of ignition. That effort alone is not considered sufficient to avoid a combustible dust explosion.

Actions to consider in regard to controlling ignition sources include:

- Enforcing a "No Smoking" policy in hazard areas.
- Implementing programs to help control the introduction of open flames into the hazard area. An example would be a hot work program.
- Training employees in the dangers associated with spark producing tools. This includes any tools with ferrous metal parts.
- Eliminating hot surfaces in the hazard area that could approach either the Minimum Ignition Temperature (MIT) of the combustible dust that will be present.
- Controlling fixed and portable electrical equipment permitted in the hazard area. All electrical equipment should be either "dust explosion proof" or intrinsically safe.
- Providing bonding and grounding facilities to help avoid the accumulation of static electric charge in the hazard area.

Damage control

Explosion relief – Buildings

Where NFPA Standards require explosion relief in a building, NFPA 68 "Explosion Deflagration Venting" should be used to design the explosion relief system. Building areas that commonly have explosion relief include: production areas with milling or grinding equipment; production areas with mixing or blending equipment, and areas above and below storage silos.

Applicable OSHA standards

- Combustible Dust National Emphasis Program: CPL 03-00-008
- 29 CFR 1910.22 – Housekeeping
- 29 CFR 1910.176 (c) – Housekeeping in Storage Areas
- 29 CFR 1910.272 – Grain Handling Facilities
- 29 CFR 1910.307 – Hazardous (classified) locations

Ignition sources require careful attention in areas handling combustible dusts.

Explosion protection methods – Processing equipment

Process equipment can be protected from the affects of explosion using alternative methods that include:

- Explosion relief
- Explosion relief with ducting
- Explosion relief with flameless venting
- Explosion suppression systems

Explosion relief – Processing equipment

The most common type of processing equipment to use explosion relief for protection is the dust collector (called an air separator in NFPA Standards). In addition to dust collectors, bucket elevators may also use explosion relief for protection.

Generic photo of a dust collector with explosion relief

Source: Glen Mortensen – Zurich Services Corporation Risk Engineering

The preferred location for equipment protected with explosion relief is outside of a building at a location where the effects of an explosion, pressure and flame can be freely released. It is essential that suitable controls be provided to help keep personnel a safe distance from any explosion relief vent.

Explosion relief with ducting – Processing equipment

If equipment is located inside a building and explosion relief is to be used, direct the explosion relief vent into ductwork that is straight, not more than 20 feet in length, and terminated outside. Ductwork should be designed so that the explosion pressure will not rupture the ductwork or the collector. Explosion relief should be provided in accordance with NFPA 68 "Explosion Deflagration Venting".

Explosion relief with flameless venting – Processing equipment

Equipment located within a building that cannot be equipped with explosion relief ducted to the outside, as described above, can be protected with Listed Flameless Venting explosion mitigation devices. These devices are intended to diffuse pressure and quench flame associated with and explosion so that the effects are greatly reduced outside of the equipment.

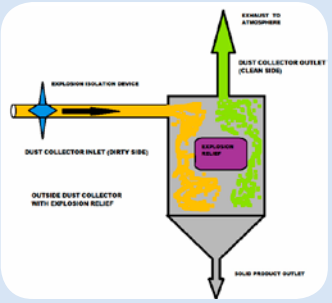
Explosion suppression systems – Processing equipment

Another option for helping to protect equipment is the use of an explosion suppression system in accordance with NFPA 69 "Explosion Prevention Systems". An explosion suppression system is an extremely fast fire suppression system that senses the initial pressure rise of an explosion and within micro seconds and releases an extinguishing agent that help prevent the explosion from propagating into a force that can damage the equipment. In addition to protecting indoor dust collectors, explosion systems are also frequently used to protect dryers, mills and grinding systems.

Where an explosion suppression system is to be used, verify the protected equipment has adequate strength. The equipment must be able to withstand all force associated with the operation of the explosion suppression system. The forces may include a pressure drop (vacuum pressure) should there be a sudden reduction in temperature within the equipment.

Explosion isolation – Processing equipment

Once an explosion occurs in a vessel, the resulting flame front can spread to other vessels through any unrestricted interconnection such as a pipe, scroll conveyor, or other enclosed conveyor. Once the flame front reaches a second vessel, it becomes the source of ignition for an explosion within the second vessel.



Outside dust collector with explosion isolation

Source: Glen Mortensen – Zurich Services Corporation Risk Engineering (Diagram)

When the explosion occurs in the second vessel, the protection features such as an explosion relief vent will be overwhelmed for two reasons. The explosion in the first vessel has already

created an elevated pressure within the second vessel, and the source of ignition for the second vessel will be a large flame front rather than a small spark. These two conditions can lead to an explosion that overwhelms any protection features that might reasonably be provided for the second vessel.

To decrease a chance of a cascading series of explosions, explosion isolation devices should be provided between equipment forming systems that handle combustible dusts. Explosion isolation devices include:

- Rotary valves
- Inclined screw conveyors with product chokes
- Baffle plates in scroll conveyors with product chokes
- Listed explosion isolation devices such as fast acting valves and chemical suppressors

The figure above shows an outside dust collector with the inlet equipped with a listed explosion isolation device that will rapidly isolate the dust collector from the inside process equipment if an overpressure is detected within the dust collector

Combustible Dust Exposure Policy

A written Standard Operating Procedure and Cleaning Standard for production processes and operations that process combustible dust should be established. The procedures should be strictly followed. The program should include the following:

- Productions areas should be frequently cleaned so that there are no dust accumulations on overhead equipment. Management should frequently inspect and verify that areas are free of accumulations of combustible dust.
- Processing equipment should not be allowed to operate if the equipment is releasing any combustible dust into the production area. Operators should be given the authority to shut-down a process that is releasing combustible dust immediately. Management should frequently inspect and verify that production machinery is operating properly and not releasing combustible dust.
- Processing equipment should not be allowed to operate if ignition sources are present. Ignition sources include hot work and the presence of normal duty electrical equipment.

What's your risk?

While manufacturing processes and materials can differ widely, the five basic conditions that can trigger a tragic dust explosion remain the same. Many manufacturers remain unaware they are at high risk to combustible dust hazards. They are also unaware that solutions exist to avoid combustible dust explosions before they can occur. What's your risk?

Performing a thorough hazard assessment of your processes is the key component in identifying and eliminating the common risk factors that may contribute to a combustible dust explosion. Both the NFPA and OSHA standards have requirements for the handling of combustible dusts exposures. Both of these standards describe a systematic approach for identifying combustible dust hazards and implementing controls (Stop, Clean, Fix). This systematic approach generally involves:

- Understanding the explosion characteristics of the dust(s)
- Identifying locations where fugitive combustible dust could be present
- Identifying potential ignition sources that could be present under both normal and abnormal conditions
- Implementation of proper process and facility design to eliminate and/or minimize the occurrence of dust explosions and protect people and facilities against their consequences
- Adequate maintenance of facilities to minimize dust release
- Documented procedures and employee training

A qualified team should be selected and trained in completing the hazard analysis and made responsible for developing a prevention and protection scheme tailored to the operation.

Zurich Services Corporation Risk Engineering can provide assistance with the hazard analysis process. The Zurich Hazard Analysis (ZHA) is a

Key message

Stop – Stop the process if it is releasing a combustible dust.

Clean – Clean up the area prior to resuming production.

Fix – Fix the problem so that the process does not release a combustible dust any longer.

A written Standard Operating Procedure and Cleaning Standard for production processes and operations that process combustible dust should be established.

powerful methodology to systematically identify, address and manage all types of hazards or vulnerabilities and to address and manage the corresponding risks. We have been successfully applying and using it within our own company and with our customers from various industries for over 20 years.

For additional information about ZHA services, software and team leader training, please visit our website at www.zurich.com/riskengineering.

Combustible dust hazard checklist

Stop – Stop the process if it is releasing a combustible dust.

- ✓ What processes have a fugitive combustible dust exposure?
- ✓ Are there fugitive combustible dust accumulation of 1/32 inch thick, or greater, on the floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams around these processes?

Clean – Clean up the area prior to resuming production.

- ✓ Has a housekeeping program with regular cleaning frequencies been established for floors and horizontal surfaces, such as ducts, pipes, hoods, ledges, and beams, to minimize dust accumulations within operating areas of the facility?
- ✓ Are cleaning methods used that do not generate dust clouds (i.e. vacuum rather than blow or dry sweep. Only use vacuum cleaners approved for dust collection. Locate relief valves away from dust hazard areas)?
- ✓ Are inspections for combustible dust residues being completed for hidden areas, and are these areas cleaned at regular intervals?

Fix – Fix the problem so that the process does not release a combustible dust any longer.

- ✓ Can the escape of dust from process equipment or ventilation systems be minimized through the use of dust collection systems and filters?
- ✓ Are current dust-containing systems (ducts and dust collectors) designed and maintained in a manner that fugitive dusts are not allowed to accumulate in the work area?
- ✓ If combustible dust hazards exist in rooms, buildings, or other enclosures, are such areas provided with explosion relief venting distributed over the exterior walls of buildings and enclosures?
- ✓ Are appropriate electrical equipment and wiring methods approved for the hazard classification?
- ✓ Are duct systems, dust collectors, and dust-producing machinery bonded and grounded to minimize accumulation of static electrical charge? Also, are these systems provided with separator devices that can remove foreign materials capable of igniting combustibles from process materials?
- ✓ Are controls in place that prevent smoking, open flames, mechanical sparks and friction, including the proper use and type of industrial trucks, and the proper use of cartridge-activated tools?
- ✓ Has a hazard control program been developed and implemented for hazardous dust inspection, testing, and housekeeping, that establishes, in writing, the method and frequency of these steps?
- ✓ Are employees who are involved in operating, maintaining, and supervising operations that produce combustible dust trained in the related hazards?

Where can I find additional information about combustible dust?

http://www.csb.gov/videoroom/ – US Chemical Safety Board - Combustible Dust: An Insidious Hazard Video (Free online video)

http://www.osha.gov/dsg/combustibledust/ – OSHA – Safety & Health Topic: Combustible Dust

http://www.osha.gov/Publications/combustibledustposter.pdf – OSHA - Combustible Dust Poster

Contact Us

If you would like further information on any of the topics discussed above or if you have any questions, please feel free to e-mail us at risk.engineering@zurichna.com.

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