Guide to Combustible Dust Safety & Compliance

Avoiding combustible dust losses with Dust Hazard Analysis and compliance

Global Risk Consultants®

White paper

Abstract

In a new update to NFPA 652, "Standard on the Fundamentals of Combustible Dust," completing a Dust Hazard Analysis (DHA) for existing processes and facilities will be required by September 2020. A DHA is one step towards protection for your personnel and facilities and to prevent these tragedies. In addition to a DHA, implementing a sound housekeeping program, installing engineered solutions and promoting awareness are all components of a comprehensive safety program. While NFPA 652 represents regulatory compliance, no one factor will prevent combustible dust explosions and fatalities; a comprehensive approach to safety, prevention, and protection is required.

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Contents

ABOUT THE TÜV SÜD GRC EXPERTS..... 3

1 OVERVIEW OF COMBUSTIBLE DUST HAZARDS..... 4

2 NFPA 652 COMPLIANCE & OTHER SAFETY STANDARDS..... 6

3 USE OF DUST HAZARD ANALYSIS (DHA) & EXPLOSION PROTECTION..... 7

4 ADDITIONAL LOSS CONTROL STRATEGIES..... 9

5 CONCLUSION..... 11

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1. Overview of combustible dust hazards

Combustible dusts are finely divided solids that present flash fire and combustion hazards under certain conditions. These dusts can be found in most industries and come in many forms including (but not limited to):

- Flours
- Grains
- Hops
- Sugars
- Charcoal
- Lactose
- Aluminum
- Wood dusts
- Rubber
- Etc.

Many natural and synthetic organic materials can form combustible dust, as do some metal dusts and compounds.

Combustible dust explosions form under a variety of conditions, but the following conditions are required to initiate a dust explosion:

1. Combustible dust must be present
2. The dust must be dispersed in the atmosphere at a concentration that can burn
3. The atmosphere must be able to support combustion
4. An ignition source must be present
5. There must be containment that allows a pressure wave to build up

If all five conditions are present, a dust explosion will occur; this is the initial explosion. The pressure wave from the first explosion will dislodge accumulated dusts in the area, including "fugitive" dusts that have concentrated on equipment, overhead beams, drop ceilings, the floor, etc. Once the fugitive dusts have been dispersed, they serve as secondary fuel sources to the initial explosion with the potential to further propagate the explosion. The second explosion is often more powerful than the first explosion, resulting in greater damage, additional injuries and fatalities.

The United States Chemical Safety and Hazard Investigation Board (CSB) concluded that between 1980 and 2005, there were 281 combustible dust incidents (not including grain-related dust explosions). These killed 119 workers, injured 718 workers, and severely damaged the industrial facilities affected.[1]

OSHA's Grain Handling Study reported that in the last 35 years there were over 500 explosions linked to grain handling dusts in the food and beverage industry alone. These resulted in 180 deaths and 675 injuries.[2]

In recent data, the 2019 Mid-Year Report highlights that between the months of January to June of 2019, 149 combustible dust incidents occurred, which injured 66 individuals and killed 13. Of the data, wood and food products made up approximately 45% of the materials involved in combustible dust fires and explosions.[3]

Although wood and food products have a similar proportion of incidents in general, the Global 2019 data suggests that food products have a higher percentage of explosions and produce more severe incidents.[4]



FIGURE 1: 2019 (JAN-JUN) COMBUSTIBLE DUST INCIDENT DATA: MATERIALS INVOLVED[5]

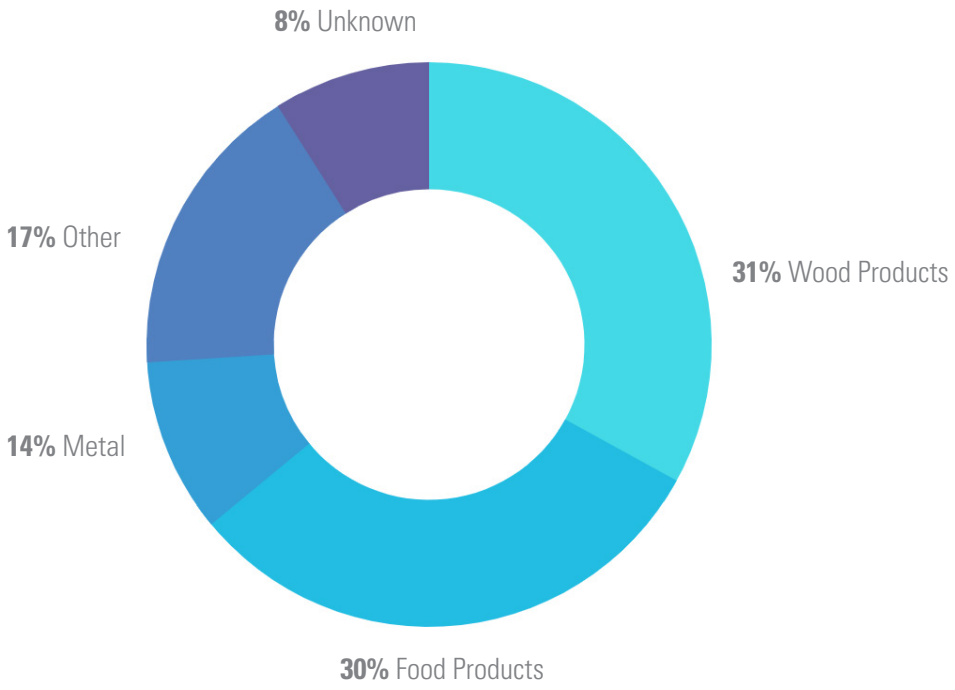
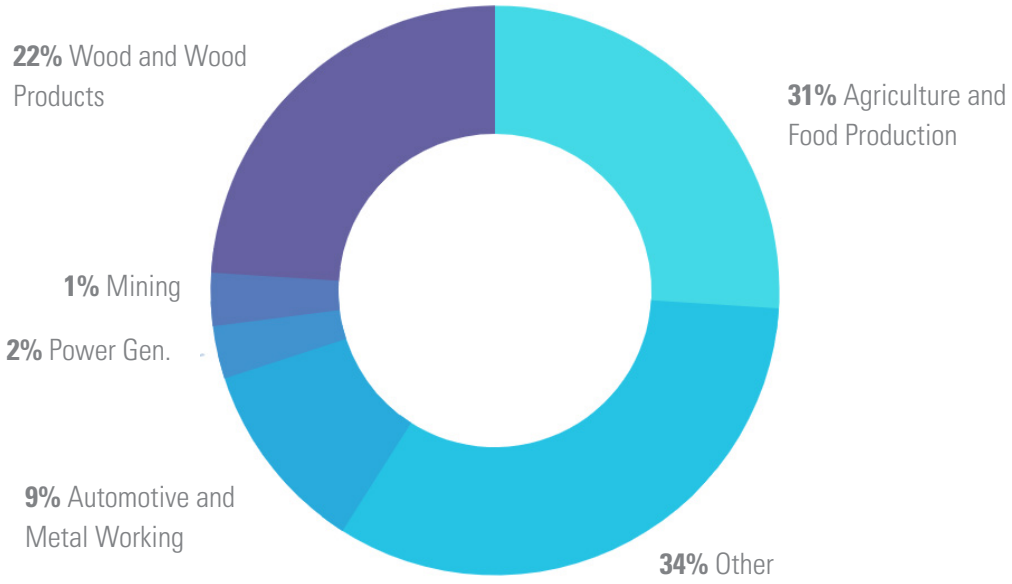


FIGURE 2: 2019 (JAN-JUN) COMBUSTIBLE DUST INCIDENTS BY INDUSTRY[6]



2. NFPA 652 compliance and other safety standards

There are four primary National Fire Protection Association (NFPA) codes that deal with and provide regulations for organic dusts:

NFPA 652: Standard on the Fundamentals of Combustible Dust (New Update)

NFPA 61: Standard for the Prevention of Fires and Dust Explosions in the Agricultural and Food Processing Industries

NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Solids

NFPA 664: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

NFPA 652, "Standard on the Fundamentals of Combustible Dust" was first developed in 2016, with the goal of creating standardized requirements for combustible dust safety across industries. The original standard developed a new regulatory component, Dust Hazard Analysis (DHA), which is a process that identifies and evaluates potential risks such as fires, flash fires, and explosions associated with combustible particulate solids within a facility.[7]

The key component of the 2019 update was to set a deadline for performing a DHA on existing processes and facilities. The update extended the deadline to September 7th, 2020, and incudes new requirements for various process equipment. These new components include air moving devices (AMDs), air materials separators (AMS), duct systems, bulk storage enclosures, pressure protection systems, & various other types of equipment.

OSHA's Grain Handling Facilities Standard (29 CR 1910.272) and its Combustible Dust National Emphasis Program (NEP) also endeavor to contribute towards reducing risk.

In October of 2018, the CSB issued a special "Call to Action: Combustible Dust" to gain more information on the state of dust management, control, training and other elements related to combustible dust across industries. The Call to Action (CTA) was released as part of the CSB's investigation into the Didion Corn Mill explosion, which occurred in May of 2017.[8] This renewed focus concentrates on misperceptions regarding combustible dust awareness and protection, as well as inconsistent safety methods across facilities and industries, leading to unsafe conditions.[9] The CTA also highlights the continued high risks that combustible dust incidents represent and the need to mitigate these dangers.

Did you know?

According to a 2019 update to NFPA 652, "Standard on the Fundamentals of Combustible Dust," a

Dust Hazard Analysis

will be required to be completed for existing processes & facilities by:

September 7th, 2020



3. Use of Dust Hazard Analysis (DHA) & explosion protection

The hazards of dust-related explosions are high; unsafe conditions can lead to a fire or explosion. A DHA, which is required or recommended by several of the standards mentioned, can identify these risks and aid in developing enginered solutions.



A DHA (which is similar in many ways to a Process Safety Analysis) is designed to identify and assess hazards associated with potentially combustible materials and environments, to evaluate failure modes and develop security and mitigation efforts to prevent combustible dust-related incidents.[10]

Compliance Update: Under NFPA 652, existing processes and facilities will be required to conduct DHAs by September 7, 2020.

Above all, a DHA is designed to ensure the safety of employees and facilities. A DHA typically includes:

- Dust testing to determine the relative hazards of dusts that are present in a representative sample
- A systemic review to identify and evaluate the potential fire, flash fire, and explosion hazards associated with the presence of one or more combustible particulate solids in a process or facility. This requires input from multiple members of staff including managers, engineering staff, maintenance and employees to provide their input.
- Identification of the hazard for each process, facility, and components, as well as pinpointing safe operating ranges and proper safeguards
- Data collection for system and performance requirements involving dust hazard testing
- Recommendations for combustible particulate solids management and documentation of all results

3.1 Explosion protection & ignition sources

For NFPA standards, the avoidance of ignition sources is not accepted as the only explosion protection measure; dust explosion protection systems are recommended or required, as is a DHA.

Whenever combustible dust is present in systems or processes, or has taken up residence as fugitive dust within the facility, it is critical that the facility implement protections against explosions. Removing ignition sources (i.e. speed controls, hazard monitoring devices on bucket elevators, etc.) and maintaining a high level of housekeeping significantly decreases the frequency of events, but not the consequences should an explosion occur. To accommodate this, each site should combine prevention and protections until it reaches an appropriate level of safety and an appropriate level of risk.

A significant milestone in protection against combustible dust in Europe came with the introduction of the ATEX Directive 2014/34/EU. Equipment, components and protective systems can only be placed on the European market if essential health and safety requirements, according to the ATEX Directive, have been met, and the required conformity assessment procedures for categories of equipment have been successfully completed. The ATEX Directive for all explosion-proof equipment and systems includes anything used within, or in conjunction with, potentially explosive atmospheres such as safety, control and regulation devices and protective components, equipment, and systems.

Simply put, this law pushes plants to conduct risk analyses and to install adequate protections accordingly. The philosophy of plants following the ATEX approach includes:

- Avoidance of any explosive atmosphere
- Control of ignition sources, according to the likelihood of occurrence of explosive atmospheres
- Constructive explosion protection measures must be taken only if the measures from the previous steps are not sufficient to avoid an explosion [11]

While standards and directives differ depending on the market, these explosion protection measures have significantly improved protections in plants and reduced losses. As an example of these successes, a major pharmaceutical group began investigating and installing dust explosion protection systems after several combustible dust explosions in their plants. During these assessments, all powders present at the site had been listed and analyzed; if necessary, they were tested for combustible dust explosion risk. For each powder present on site, documents summarized the dust explosion hazards, the amount of dust present in each step of production, and other factors to identify the adequacy of the installed protections and to initiate requests for further improvements. These measures helped combat combustible dust fires and explosions in the plants and show the importance of implementing explosion protection systems.

> "Whenever combustible dust is present in systems or processes...it is critical that the facility implement protections against explosions."

4. Additional loss control strategies

In addition to NFPA 652, safety standards, requirements and best practices have been expanding over the years and continue to be revised. Between 1977 and 2019, 41 research projects were completed and $3 million USD spent to provide more information about dust explosions and their prevention.[12] Yet, while the implementation of various standards has reduced the number of combustible dust incidents, recent losses have shown that these hazards are still prevalent in industry today, and implementation of multi-layered solutions is critical in preventing more tragedies.



Even minute levels of dust can present combustion hazards.
Courtesy of Thomas Arch, TÜV SÜD Global Risk Consultants.

4.1 Housekeeping and engineered solutions

At the heart of combustible dust safety lies minimizing fugitive dust and housekeeping. Most combustible dust-related incidents are caused by accumulations of dust above an acceptably safe level. The accumulation of fugitive dust as a result of inadequate controls and housekeeping is the principal contributor to favorable conditions for secondary explosions. A good rule of thumb denotes that dust should not be so thick on a surface as to obstruct the color of the surface.

NFPA 654 is one standard that provides comprehensive guidance on the control of this hazard and housekeeping recommendations. Guidance includes: [13]

- Minimizing the escape of dust from process equipment or ventilation systems (accumulations of this cause fugitive dust)
- Use of dust collection systems and listed collection devices (some combustible metals may require a specialized collection system)
- Utilization of surfaces that minimize dust accumulation and facilitates cleaning
- Providing access to all hidden areas to permit inspection
- Inspection for dust residues in open and hidden areas at regular intervals
- Cleaning of dust residues at regular intervals
- Use of cleaning methods that do not generate dust clouds if ignition sources are present
- Only using vacuum cleaners listed for dust collection

Cleaning of facilities is key to preventing accumulation of dust; it should be done at regular intervals, and in ways that do not produce dust clouds. Proper ventilation systems, as well as dust collection systems and filters, also minimize the chances of dust escaping into the facility.

Controlling what goes in and out of a facility is also a critical aspect to good housekeeping and ignition control. If fuels are stored within a facility, limiting of quantities should be considered, and proper storage is a must. Combustible materials such as paper, plastic and other packaging materials can present dangers if they come into contact with an open flame or explosion. These materials should also be stored at appropriate heights so as to not block sprinkler discharge in case of an incident.[14]

Engineered solutions such as appropriate wiring methods and electrical equipment, control of static electricity using grounding and bonding and separator devices assist in preventing hazardous situations. Some general recommendations include:

- Minimizing the escape of dust from process equipment or ventilation systems, using dust collection systems and filters
- Utilizing surfaces that minimize dust buildup and facilitate cleaning
- Locating relief valves away from dust hazard areas

4.2 The Human Element: Changing the culture



Human-element programs are critical, and often cost-effective in mitigating risk. Measures include: control of smoking, open flames and sparks, control of mechanical sparks and friction, proper use of industrial trucks, proper use of cartridge-activated tools and adequate maintenance of all tools and equipment. These practices can help prevent ignition of dust, and catastrophic occurrences.

Maintenance programs in particular are critical to sustaining safe conditions. This can include (but are not limited to):

- Testing of bonding and grounding systems
- Verifying duct airflow velocities and dust collector differential pressure
- Testing and calibrating monitoring devices such as bearing temperatures, conveyor and leg belt alignment and high speed equipment for vibration (such as grinders and pulverizes)
- Lubrication of equipment
- Management of Change (MOC) procedures

None of these programs will be effective unless company culture adopts them as high-priority measures. Establishing and enforcing standards for good loss control housekeeping is integral in building a safety-centered culture within any facility. Developing and implementing a hazardous dust inspection, testing, housekeeping and control program promotes awareness for these hazards, and encourages constant maintenance in mitigating these risks.

5. Conclusion

The September 2020 deadline to completing a Dust Hazard Analysis for existing processes and facilities is approaching. Compliance with regulatory compliance standards such as the 2019 update to NFPA 652 has brought further attention to the hazards and prevention of combustible dust.



During the year 2017, 169 combustible dust incidents occurred, injuring 163 and killing 13 individuals.[18] Due to the high potential severity of combustible dust incidents, the need for multi-layered solutions is critical in mitigating these incidents and their consequences within facilities.

Implementing engineered solutions, as well as a stringent housekeeping program, is paramount to preventing combustible dust incidents from occurring. In addition, adjusting company culture spreads awareness of this issue, and a DHA provides critical information on identification and control of these hazards. No one solution will prevent a combustible dust fire or explosion; loss prevention and control comes from the implementation of a multi-layered approach.

GLOSSARY OF ACRONYMS

DHA – Dust Hazard Analysis
GRC – Global Risk Consultants
NFPA – National Fire Protection Association
CPCU – Chartered Property Casualty Underwriter
CFPS – Certified Fire Protection Specialist
PE – Professional Engineer
CSP – Certified Safety Professional
CSB – United States Chemical Safety and Hazard Investigation Board
OSHA – Occupational Safety and Health Administration
NEP – National Emphasis Program
CTA – Call to action
MOC – Management of Change
USD – United States dollar

ENDNOTES

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