Combustible dust—An explosive topic

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What is combustible dust? Do we have it in our plant? Who is in charge of safety? Can a combustible dust explosion happen in my facility? What are the guidelines for prevention? These and other questions are answered in this article.

Combustible dust consists of fine particles that present an explosion hazard when suspended in air under certain conditions. However, according to the OSHA Combustible Dust ANPR (Advance Notice of Proposed Rulemaking) (1), "No single, universally accepted definition of combustible dust is available. Even among standards promulgated by the same standards-developing organization, the definitions vary significantly."

Do you have combustible dust in your plant?

It is important to determine if you have a combustible dust hazard in your workplace. Combustible dusts cover a wide range of industries, including agricultural products such as sugar and wood flour, carbonaceous dusts such as charcoal and coal, chemical dusts such as calcium acetate and sulfur, metal dusts such as aluminum (for rocket fuel) and magnesium, and plastic dusts such as melamine and PVC. Under certain conditions, these dusts are potentially combustible and thus present an explosive dust hazard. Other dusts, such as granite and common table salt, are not explosive dust hazards because they can't combust. Determining explosive dust hazards also involves the dust's explosiveness, including particle size, shape, moisture, and environment. If you have any doubt about the safety of your dust, you must send it to be tested by a certified facility. There are various testing options, including a comprehensive test designed to meet OSHA's guidelines.

Additionally, the K_{st} value (maximum rate of pressure rise) can be used as a determining factor in the deflagration or explosiveness of your dust. The higher the K_{st} value, the greater the explosion characteristic of the dust. For example, wood flour has a K_{st} value of 200 to 300, which indicates that it has a strong explosion characteristic. There is also a dust explosion class rating system that ranges from St 0 to St 3 (2). The dust explosion class rating simply categorizes dusts on the basis of their K_{st} value. The dust explosion class of wood flour is St 2. Additionally, rating combustible fine particles by size can be useful. For wood flour, the St classification would mean that it is less than 420 microns and has a moisture content of less than 25 percent. Another way to measure particle size is to see whether the material will pass through U.S. No. 40 standard sieve, which is approximately the size of fairly coarse sand, according to NFPA 664 (3.3.24.2) (3).

In March 2011, the National Fire Protection Association (NFPA) revised *NFPA 654 Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids 2006 Edition* via a TIA (Tentative Interim Amendment) to help better define where a dust deflagration hazard exists and lowered the surface dust layer depth from 1/32 inch (0.8 mm) to 1/64 inch (0.4 mm) or where surface colors are readily discernible (4).

What causes a dust explosion?

To start a fire, you must have fuel, ignition, and oxygen, the three main elements of the *classic fire triangle.* However, for a combustible dust explosion to occur, you must add dispersion and confinement. These five elements make up the *dust explosion pentagon.* (Editor's note: Please see page 11 in this issue to see the dust explosion pentagon diagram.) Without all five elements present, an explosion can't occur, but a fire is still possible.

This wood flour is the "fuel" for the fire, as shown in the dust explosion pentagon.

The primary issue is the initial explosion. However, the second issue is the secondary explosion that comes from formerly stagnant, undisturbed dust that becomes dispersed and suspended due to the disturbance caused by the initial explosion. This is what happened at the Imperial Sugar explosion in Port Wentworth, Georgia, in 2008. The initial explosion happened at one point within the facility and was so dramatic that it shook other sections of the building, releasing and suspending previously settled dust and creating dust clouds that exploded as fire spread throughout the building.

Who is in charge?

OSHA originally issued the Combustible Dust National Emphasis Program (NEP) in 2007. After the cataclysmic Imperial Sugar explosion and a U.S. Chemical Safety Board (CSB) investigation, they reissued the initiative in 2009 to heighten their focus on combustible dust. Simply put, the initiative ensured that OSHA offices throughout the country understood that they needed to focus on combustible dust issues and the potential catastrophes they can cause. The NEP is focused on 64 industries that generate combustible dust. While OSHA does not have a specific standard on combustible dust, they currently use the General Duty Clause, which allows them flexibility in classifying violations. However, the NEP is the first step to OSHA acknowledging the issue and the potential need for a specific regulation. This led them to consider rulemaking in the spring of 2009 and to issue an ANPR on combustible dust in October 2009, in which they asked for feedback on the 69 questions by January 19, 2010.

As part of the ANPR, OSHA held a series of Combustible Dust Stakeholder Meetings from late 2009 through mid-2010. According to Jordan Barab, Deputy Assistant Secretary of Labor for Occupational Safety and Health, the goal of a potential OSHA standard regulating combustible dust hazards is to protect workers, but he also noted that the "rulemaking process is slow and painful."

During this process, Congress has continued to use the "Worker Protection Against Combustible Dust Explosion and Fire Act," introduced three times (once per session since 2008) by U.S. Representative John Barrow (Georgia). The Act ensures that OSHA creates a combustible dust standard and requires the Secretary of Labor to promulgate an interim final standard regulating occupational exposure to combustible dust hazards." (5)

There is much discussion about the development of an NFPA Combustible Dust Standard. One major concern is that OSHA is a government agency and NFPA is a nonprofit organization. Having an OSHA standard is one thing, but having it refer to an NFPA standard complicates matters significantly. NFPA has five NFPA standards that cover combustible dust: 61, 484, 654, 655, and 664. Additionally, each standard refers to several other standards. For example, NFPA 654 refers to approximately 36 standards ranging from NFPA 10 (Standard for Portable Fire Extinguishers, 2002) to NFPA 2001 (Standard on Clean Agent Fire Extinguishing Systems, 2004). Each standard has an associated edition date and is periodically reviewed and updated, which adds to the complexity of fully understanding which standard applies. Typically, chapter 2 of each NFPA standard lists referenced publications and continues by stating, "documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document."

One important question is: "Who is really in charge?" For example, according to NFPA 654, Authority Having Jurisdiction (AHJ) is "responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure." But under OSHA, an inspector is responsible. So who would be responsible if the OSHA regulation were to refer to the NFPA standard?

Additionally, if an OSHA regulation were to refer to an NFPA standard, a copy of the NFPA standard must be obtained and reviewed. NFPA charges for physical copies or to download and print. While the cost for one standard might be $30, each standard refers to other standards. Continuing to use NFPA 654 as an example, 36 standards at approximately $30 per standard equals $1,080. This cost can easily become the first economic burden to compliance, especially for a small business. More than the cost of the standards is the cost in terms of time to digest and fully understand all the data in the various standards, even more of a burden for a small busi-

nessperson who has many other roles to fill. For a standard to be effective, it must be easy to understand and implement.

Another important factor is ensuring that the most current NFPA standard is being followed. NFPA periodically updates its standards as issues arise between the release date and revision dates, forcing the organization to issue a Tentative Interim Amendment (TIA), as it did earlier this year for NFPA 654. It is ultimately the responsibility of the end user to check whether any TIAs have been issued since the current standard was introduced.

The NFPA understands that there may be a problem with having five documents that cover combustible dust, and it is reviewing the possibility of combining NFPAs 61, 484, 654, 655, and 664. In 2010, NFPA issued a request seeking input on combining documents.

To complicate the matter, insurance companies have their own guidelines that further blur companies' attempts to be in compliance.

Can an explosion occur in my facility?

According to the U.S. Chemical Safety Board (CSB), "three of the four deadliest accidents ever investigated were determined to be combustible dust explosions," most recently involving a powdered metal explosion in Gallatin, Tennessee, in May 2011. This was preceded by a combustible aluminum dust explosion, also in May 2011, at a factory in Chengdu, China, that manufactured products for Apple computers. More importantly, however, is prevention, which is what CSB and OSHA are currently focused on. As CSB reported at a news conference following the Gallatin explosion, "Accidents can be prevented if we find out what happened and share the findings with industry and the public." With combustible dust on OSHA's radar screen, inspections have increased substantially, as have the actual penalties. During the period of February 2011 to April 2011, OSHA announced several combustible dust–related inspections, and just seven of them with combustible-related infractions have a total of over $617,000 in fines. OSHA is taking this matter seriously, as evidenced by the NEP, and is using the general duty clause in classifying combustible dust violations. One combustible dust violation alone had a $117,000 penalty, because according to OSHA, "The employer did not furnish employment and a place of employment which were free from recognized hazards that were causing or likely to cause

Combustible dust fires have caused three-alarm industrial fires, such as the one shown here.

death or serious physical harm to employees in *that employees were exposed to fire and explosion hazards caused by the presence of combustible dust."*

What are the guidelines for prevention?

How do you prevent a combustible dust explosion or an OSHA combustible dust violation? Prevention is the best medicine. Reviewing the NEP and the ANPR gives good insight into what OSHA is looking for in inspections.

Eight main areas are highlighted in the NEP:

- Hazard recognition/assessment
- Engineering controls
- Administrative controls
- Housekeeping
- Building design
- Explosion protection
- Operating procedures
- Worker training.

Hazard recognition/assessment involves determining whether dust is combustible via dust explosion testing, which may include particle size and moisture analysis and explosion severity testing that measures the K_{st} value and Minimum Explosible Concentration (MEC). Hazard recognition/assessment also covers communication and possible inclusion of hazard communication and the "right to know," which requires material safety data sheets (MSDS) to address issues with chemicals. The potential combustible dust regulation may require MSDS sheets on combustible materials. However, how can a piece of wood, for example, which is not a chemical, have an MSDS? Who creates the MSDS? And if the piece of wood is only combustible if it is 420 microns or

smaller, has less than 25 percent moisture, and is contained within a dust explosion pentagon, does it require an MSDS? The ANPR states on page 31: "In some cases, the hazards of certain dust are widely known (for example, wood dust). In these cases, basic testing to determine whether the dust is explosive may not be necessary." Hazard recognition/assessment also covers issues related to NFPA as discussed earlier, as well as potential application of state and local codes including the role of the AHJ, such as a fire marshal or building inspector.

Engineering controls are "controls built into a facility or processing equipment to remove or minimize a hazard." A primary engineering control includes the building or facility and focuses on prevention of dust accumulation on beams and other surfaces. This is where good housekeeping is imperative. Secondary engineering controls focus on equipment such as dust collection systems, or prevention devices, such as spark detectors and sprinklers systems. These devices may be in the open air or within ductwork or equipment.

"Document, document, document" is probably the most important role in *administrative controls.* Just as with any other OSHA regulation, OSHA wants written rules and procedures for combustible dust and wants to ensure that its policies are fully understood and practiced by employees. For example, is there a method to prevent the escape of dust? If dust does escape, is there a policy to regularly remove fugitive dust from surfaces?

The single most important thing any facility can do is fully engage in housekeeping and fugitive dust control. According to the latest TIA from NFPA 654, dust layers greater than 1/64 of an inch or where the underlying surface colors are not readily discernable, could very well cause a dust deflagration hazard. *If you can see dust, do not ignore it.* Clean it up, but do not blow it off with an air gun, as this simply releases and rearranges the dust. It's best to use a vacuum to collect dust, then investigate to determine the source of the dust. For example, if the ductwork is not airtight, seal the joints to prevent the release of dust. When inspecting the workplace for dust accumulations, consider all flat surfaces, including rectangular ductwork, overhead beams, flat-surfaced lighting fixtures, and invisible areas such as hung or suspended ceilings. Just because you can't see it doesn't mean it's not there.

Additional areas of focus in prevention include building design, explosion protection, operating procedures, and worker training. For more information on these, consult OSHA, or refer to other articles in *Air Pollution Control.*

The topic of combustible dust is increasingly on the forefront as regulatory agencies continue to investigate ongoing issues while trying to mitigate future issues. Awareness is the best line of defense in dealing with this very important subject. Continue to read *Air Pollution Control* for future updates as they become available.

References

1. Occupational Safety and Health Administration, 29 CFR Part 1910, Combustible Dust; Proposed Rule, http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=FEDERAL_REGISTER&p_id=21152.
2. Hazard Communication Guidance for Combustible Dusts. U.S. Department of Labor, OSHA 3371-08 2009.
3. National Fire Protection Association. http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=664 NFPA 664 (3.3.24.2).
4. National Fire Protection Association. http://www.nfpa.org/Assets/files/AboutTheCodes/654/TIA654-06-1.pdf.
5. H.R. 522: Worker Protection Against Combustible Dust Explosions and Fires Act of 2011, http://www.govtrack.us/congress/bill.xpd?bill=h112-522&tab=summary.

Additional Resources

NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, (2008), National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555; fax 617-770-0700 (www.nfpa.org).

NFPA 484: Standard for Combustible Metals, (2009). National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555; fax 617-770-0700 (www.nfpa.org).

NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids, (2006). National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555; fax 617-770-0700 (www.nfpa.org).

NFPA 655: Standard for Prevention of Sulfur Fires and Explosions, (2007). National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555; fax 617-770-0700 (www.nfpa.org).

NFPA 664: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities, (2007). National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471; 800-244-3555; fax 617-770-0700 (www.nfpa.org).

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