Keys to Complying With Combustible Dust Standards — Part I

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Explosion risks exist in many areas of a plant, but one of the most common locations is the dust collection system. How do you know if your dust collector complies? What do you do if it doesn't? Are your employees at risk? Part I of this two-part article talks about the responsible relevant agencies, the applicable standards, and how to evaluate if a facility is at risk.

Just about every manufacturing process generates dust, and the primary function of a dust collector is to capture this dust with a high enough removal efficiency to satisfy applicable Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) clean air regulations. To complicate matters, a great many of these dusts also are potentially explosive (See Figure 1); and in recent years, combustible dust standards have tightened along with air quality standards.

The most famous combustible dust explosion in the past decade, the February 2008 accident at the Imperial Sugar Company's Wentworth, GA, refinery, played a large part in refocusing the national spotlight on this issue. A dust cloud explosion triggered a fatal blast and fire that killed 13 workers and injured 42 others, generating a storm of media attention and government scrutiny.

In the U.S. alone, in the 25 years between 1980 and 2005, the Chemical Safety Board reported 281 explosions caused by ignited combustible dust. These explosions resulted in 199 fatalities and 718 injuries. Combustible dust explosions over the past decade in U.S. plants are blamed for well over 100 fatalities and hundreds more injuries. Sadly, experts believe these accidents could have been prevented if the companies involved had followed industry best practices for fire and explosion protection.

The Responsible Agencies

There are three key entities involved in combustible dust issues, each with its own particular area of responsibility:

• **The National Fire Protection Association (NFPA)**: The NFPA sets safety standards, amending and updating them on a regular basis. When talking about

Figure 1

Staged explosion of a dust collector. Upon startup, explosive dust is injected into the dust collector to create a flammable cloud. Within milliseconds, the explosion vent opens to divert the flame away from the dust collector, to a safe area.

combustible dust, there are several different documents that come into play. Together these standards add up to total protection to prevent an explosion, vent it safely, and/or ensure that it will not travel back inside a building.

Most insurance agencies and local fire codes state that NFPA standards shall be followed as code. Exceptions would be where the authority having jurisdiction, such as Factory Mutual, for example, specifies an alternative safety approach that might be even more stringent.

• **OSHA**: OSHA's role, together with local authorities, is to *enforce* the standards published by NFPA. In the aftermath of the Imperial Sugar Company explosion in 2008, OSHA reissued its 2007 Combustible Dust National Emphasis Program (NEP), outlining policies and procedures for inspecting workplaces that create or handle combustible dusts. As defined by OSHA, "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; bio-solids; other organic dust such as sugar, flour, paper, soap, and dried blood; and certain textile materials." The revised NEP, which OSHA reissued on March 11, 2008, was designed to ramp up inspections, focusing particularly on 64 industries with more frequent and serious dust incidents.

According to an October 2011 update on OSHA's Combustible Dust NEP, since the commencement of inspections under the 2008 program, more than 2,600 inspections have been conducted. More than 12,000 violations were found during this timeframe, including more than 8,500 classified as "serious." Federal penalties and fines for these violations totaled $22,738,909, with nearly another $1.6 million in state fines. (Figure 2) OSHA uncovered a variety of dust collection violations in these inspections, including dust collectors that were not equipped with proper explosion protection devices and systems that were not vented to safe locations.

• **U.S. Chemical Safety Board (CSB)**: The CSB is an independent federal agency responsible for investigating industrial chemical accidents. The CSB conducts thorough investigations of explosions, sifting through evidence to determine root causes and then publishing findings and recommendations. The organization has a wealth of information on its website (www.csb.gov), including educational videos depicting how combustible dust explosions occur.

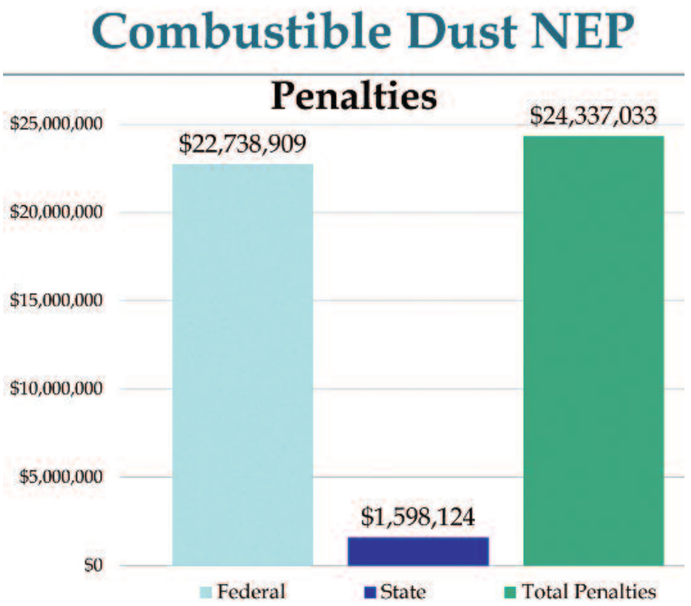
The CSB has become an outspoken advocate of the need for more stringent combustible dust regulations and enforcement. On Feb. 7, 2012, the fourth anniversary of the Imperial Sugar explosion, the CSB chairman issued a statement in which he applauded the progress made, to date, in dealing with combustible dust issues. He noted, however: "Completing a comprehensive OSHA dust standard is the major piece of unfinished business from the Imperial Sugar tragedy.... We believe such a standard is necessary to reduce or eliminate hazards from fires and explosions from a wide variety of combustible powders and dust." The CSB also has recommended that the International Code Council, which sets safety standards that are often adopted by state and local government, revise its standards to require mandatory compliance with the detailed requirements of the various NFPA standards relating to combustible dust.

• **Congress**: Some members of Congress also are advocating faster action by OSHA to implement a combustible dust standard. U.S. Rep. George Miller of California has been working to pass the Worker Protection Against Combustible Dust Explosions and Fires Act since 2011. He, together with co-sponsors John Barrow of Georgia and Lynn Woolsey of Cali-

Figure 2

Graph shows fines imposed from commencement of the OSHA Combustible Dust National Emphasis Program (NEP) in 2008 until October 2011.

(Image courtesy of www.oshalawupdate.com)



fornia, introduced the initial version (H.R. 522) in February 2011, and it died in committee. This past February, Miller and co-sponsors Barrow and Joe Courtney of Connecticut introduced the Worker Protection Against Combustible Dust Explosions and Fires Act of 2013 (H.R. 691). If enacted, it would require OSHA to issue an interim standard within one year of passage and the Secretary of Labor to issue a proposed rule 18 months later, with a final rule due within another three years. A similar bill passed the U.S. House in 2008 but never went to the Senate.

What are the relevant NFPA standards?

In trying to sort through the list of combustible dust standards, a good starting point is *NFPA 654*, the Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids. Simply stated, *NFPA 654* is an all-encompassing standard on how to design a safe dust collection system. This standard, which is regarded as the guiding dust document and the most general on the topic, will lead to other relevant documents.

Depending on the nature and severity of the hazard, *NFPA 654* will guide you to the appropriate standard(s) for explosion venting and/or explosion prevention:

- *NFPA 68* — Standard on Explosion Protection by Deflagration Venting: This document focuses on explosion venting — i.e., on devices and systems that vent combustion gases and pressures resulting from a deflagration within an enclosure for the purpose of minimizing structural and mechanical damage. The current edition, published in 2007, contains much more stringent requirements than past editions, essentially elevating it from a guideline to a standard.

- *NFPA 69* — Standard on Explosion Prevention Systems: This standard pertains to explosion protection of dust collectors when venting is not possible. The standard covers the following methods for prevention of deflagration explosions: control of oxidant concentration, control of combustible concentration, explosion suppression, deflagration pressure containment, and spark extinguishing systems.

The general document, *NFPA 654*, also directs the reader to appropriate standards for specific manufacturing industries. The NFPA recognizes that different industries and processes have varying requirements, and the organization relaxes or tightens aspects of its dust standards accordingly. Wood dusts, for example, tend to be high in moisture content, which makes for a potentially less explosive environment, resulting in a less stringent overall dust standard for that industry. Conversely, metal dusts can be highly explosive and are subject to more vigilant regulation.

The industry-specific standards most commonly employed are:

- *NFPA 61* — Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities

- *NFPA 484* — Standard for Combustible Metals

- *NFPA 664* — Standard for the Prevention of Fire and Explosions in Wood Processing and Woodworking Facilities

Using Performance-Based Codes

In 1995, the NFPA created a performance-based support team to assist NFPA Technical Committees with the transition to performance-based documents. Since that time, the NFPA has been incorporating performance-based options into its updated standards: The *NFPA 654* general dust document first adopted this concept in 2006, with the other, more specific, combustible dust standards following suit since that time. Using the newer performance-based codes, solutions no longer have to follow NFPA standards to the letter — *if the variance is backed by full-scale, real-world destructive test data*.

Performance-based provisions state specific life-safety objectives and define approved methods to demonstrate that designs meet those objectives. The codes give equipment manufacturers and environmental engineers greater flexibility by allowing methods to quantify equivalencies to existing prescriptive-based codes or standards, as long as the proposed solution demonstrates compliance.

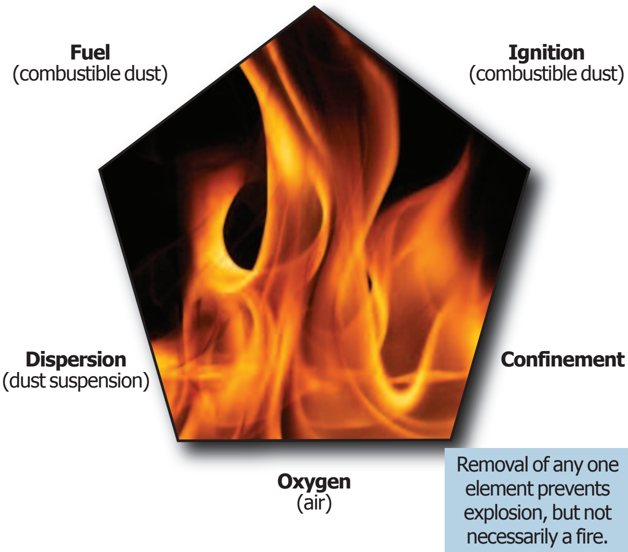
How do I know if my facility is at risk?

There is a common misconception that a facility's dust is not explosive because there has never been an incident. But, when talking about explosions, a good track record is no guarantee of future safety. In some cases, it may take many years for dust to accumulate to explosive levels.

Reviewing the five elements that comprise what's known as "the dust explosion pentagon" (Figure 3) can help provide a clearer understanding of the risks. These elements are: (1) combustible dust; (2) an ignition source; (3) oxygen in the air; (4) dispersion of the dust in sufficient concentration to be explosive; and (5) containment of the dust cloud within a confined or semi-confined vessel or area. All five of these elements may exist in an industrial facility, but all must be present at the same time for an explosion to occur If there is no containment, but the first four elements exist simultaneously, the possibility exists for a flash fire to erupt.

Figure 3

The dust explosion pentagon shows the five elements that must be present for a combustible dust explosion to occur.



In a closed vessel, such as a cartridge dust collection system, an explosion typically begins when an ignition source enters the dust collector. This ignition source can come from many things and, in most cases, is never identified. When a pulse cleaning event occurs, a suspended cloud of combustible dust is present in high concentration within the collector. This completes the five elements of a dust explosion and can initiate one.

Though some incidents involve a single explosion, the more common scenario is for a series of deflagrations to occur. The initial explosion can dislodge ignitable dust hidden on overhead surfaces or in other spaces over a large area. This can trigger a secondary explosion, ignited from the initial explosion or from other ignition sources. Historically, these secondary explosions are the ones that have caused the majority of injuries and damage to property.

A risk evaluation or hazard analysis is the only way to get a true reading on potential risks in your facility. The NFPA states that such an analysis is needed to determine the required level of fire and explosion protection. The analysis can be conducted internally or by an independent consultant, but either way the authority having jurisdiction will ultimately review and approve the findings.

With regard to explosion protection, the first step in a hazard analysis is determining whether your dust is explosive. Many commercial test laboratories offer a low-cost test to establish whether a dust sample is combustible. If the test is positive, then the explosive index (Kst) and the maximum pressure rise (Pmax) of the dust should be determined by ASTM E 1226-10, Standard Test Method for Explosibility of Dust Clouds.

Your dust collection equipment supplier will need the Kst and Pmax values in order to correctly size explosion venting or suppression systems. Failure to provide this information will increase your costs since the supplier will have to use worst-case estimates of Kst and Pmax values or may even refuse to provide the equipment. The liability to the manufacturer and to the equipment purchaser is too high to ignore the life-safety objectives.

Figure 4

Kst Values of Common Dusts.

Common Dusts	Micron	Kst Value
Activated Carbon	18	44
Aluminum Grit	41	100
Aluminum Powder	22	400
Asphalt	29	117
Barley Grain Dust	51	240
Brown Coal	41	123
Charcoal	29	117
Cotton	44	24
Magnesium	28	508
Methyl Cellulose	37	209
Milk Powder	165	90
Paper Tissue Dust	54	52
Pectin	59	162
Polyurethane	3	156
Rice Starch	18	190
Silicon	10	126
Soap	65	111
Soy Bean Flour	20	110
Sulphur	20	151
Tobacco	49	12
Toner	23	145
Wood Dust	43	102

The fact is, any dust above 0 Kst is now considered to be explosive, and the majority of dusts fall into this category. If OSHA determines that even a very low Kst dust is present in a facility with no explosion protection in place, a citation will result. This is one of the biggest changes to occur with the re-introduction of the OSHA NEP in 2008. Figure 4 shows the Kst values of a number of common dusts. **APC**

Resources

National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169; www.nfpa.org.

NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities (2008).

NFPA 68: Standard on Explosion Protection by Deflagration Venting (2007).

NFPA 69: Standard on Explosion Prevention Systems (2008).

NFPA 484: Standard for Combustible Metals (2012).

NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and handling of Combustible Particulate Solids (2006).

NFPA 664: Standard for the Prevention of Fire and Explosions in Wood Processing and Woodworking Facilities (2012).

OSHA Combustible Dust National Emphasis Program (Reissued) — Directive Number: CPL 03-00-008; effective date March 11, 2008.

OSHA Combustible Dust Standards, July 2008.

U.S. Chemical Safety and Hazard Investigation Board, 2175 K. St., NW, Suite 400, Washington, DC 20037; www.csb.gov.

The Library of Congress, 101 Independence Ave., SE, Washington, DC 20540; http://thomas.loc.gov/cgi-bin/query/z?c112:H.R.522: *H.R. 522: Worker Protection Against Combustible Dust Explosions and Fires Act of 2011*.

OSHA Law Update, a Hazard Communication, Epstein Becker Green, 1227 25th St., NW, Suite 700, Washington, DC 20037; http://www.oshalawupdate.com/: "2011 Rundown of OSHA's Combustible Dust National Emphasis Program and Rulemaking," Amanda R. Strainis-Walker and Eric J. Conn; Dec. 29, 2011.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428; www.astm.org; "ASTM E 1226-10, Standard Test Method for Explosibility of Dust Clouds," 2010.

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Part II of this article, which will appear in the June issue of *APC*, will examine technologies and general housekeeping practices for fire and explosion protection and the benefits of using a dust collector with high vessel strength.