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COMBUSTIBLE DUST

**NFPA[®] 652 is Finally Here...
How Will It Affect
Flame-Resistant Clothing?**

04.26.16

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Combustible Dust

Overview

With the publication of NFPA® 652, *Standard on the Fundamentals of Combustible Dust*, new demands are being placed on safety managers as well as facility owners and operators. The arrival of this new standard means that many businesses which deal with the production or generation of dust through manufacturing or other processes will face significant changes in how they assess workplace hazards and protect their workers. This includes determining whether personal protective equipment (PPE), including flame-resistant (FR) clothing, is necessary and/or required and then implementing a policy for care and maintenance of that clothing.

Although combustible dust has long been a known hazard in agriculture and manufacturing, and the National Fire Protection Association (NFPA®) began addressing it with industry-specific standards as far back as 1920, NFPA® 652 is the first comprehensive standard to provide general requirements for the management of combustible dust fire and explosion hazards. It has been highly anticipated and provides much-needed guidance for employers, as well as workers, when it comes to dealing with combustible dust, meeting legal requirements, and complying with industry consensus standards.

How Combustible Dust is Different

The injuries and fatalities attributed to combustible dust are well-documented, but before getting into the specific ways that this new standard will affect businesses and the ways they manage workplace and worker safety, it is important to understand the combustible dust hazard itself and what regulations and standards were in place before NFPA® 652 was approved.

Combustible dust is defined as “a finely divided combustible particulate solid that presents a flash-fire hazard or explosion hazard when suspended in air or the process-specific oxidizing medium over a range of concentrations.”¹ That basically means that tiny

particles of material that might not normally be flammable, when suspended in a cloud, can burn in a fiery chain reaction if ignited. Industries affected by the combustible dust hazard include, but are not limited to, agriculture and food processing, woodworking and wood processing, sulfur extraction, coal-related operations, and metal production. Any industry that deals with the manufacture, processing, blending, conveying, packaging, or handling of combustible dust and particulate solids—whether as a primary output or as a byproduct—faces potential disaster.

For combustible dust to cause a flash fire or to explode, a number of elements must be present. Unlike the “Fire Triangle” which defines the 3 elements necessary for fire to occur—**heat, oxygen, and fuel**—the “Combustible Dust Pentagon” consists of those three, plus **dispersion** and **confinement**.

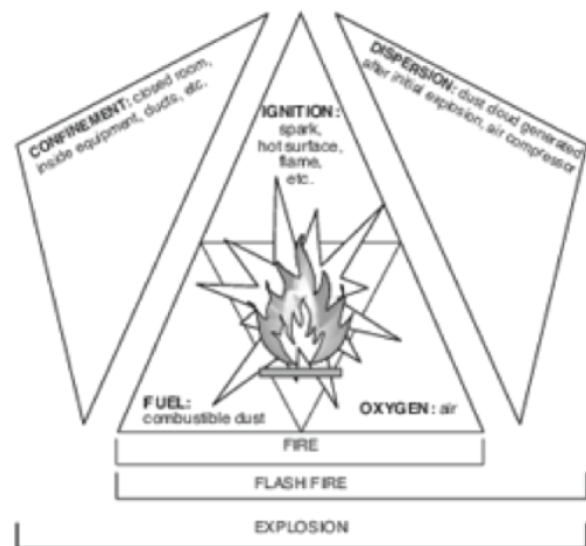


FIGURE A.5.2 Elements Required for Fires, Flash Fires, and Explosions.²

¹ NFPA® 654 *Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids*. (2013) (p. 8). Quincy, MA.

² Reprinted with permission from NFPA® 652-2016, *Standard on the Fundamentals of Combustible Dust*, Copyright © 2015, National Fire Protection Association, Quincy, MA. This reprinted material is not the complete and official position of the NFPA on the referenced subject, which is represented only by the standard in its entirety.



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These additional elements are the key to understanding combustible dust fires and explosions and why the combustible dust hazard should be thought of differently when compared to other hazards. When comparing and contrasting combustible dust events to other types of fires and explosions, there are three critical points to address.

First is the way combustible dust as a fuel source behaves differently than other flash fire fuels. Dust particles must be in a dispersed state in order to be ignited. The NFPA® definition of a flash fire is “a fire that spreads by means of a flame front rapidly through a diffuse fuel, such as dust, gas or the vapors of an ignitable liquid, without the production of damaging pressure.”³ Combustible dust, when dispersed or suspended in a cloud, is one such “diffuse fuel” that acts in the same way as any other flash fire fuel if ignited. However, the mere presence of combustible dust does not pose an immediate threat. Dust that gradually accumulates over time on machinery, on floors, on rafters, etc. can seem insignificant or routine and lead to complacency when it’s encountered in day-to-day operations. And, in a way, that complacency is understandable because, without dispersion, dust particles are not a flash fire hazard. It is when they are dispersed and ignited that the resulting flash fire could be as dangerous, or more dangerous, than flash fires caused by gases, fumes, or vapors.

This leads to the second point. Depending on the type of dust, the degree of accumulation and the concentration of dispersion, flash-fires and explosions resulting from combustible dust may produce more heat and pressure than those fueled by gases or fumes. The wide range of combustible dust types and their varying levels of combustibility present a challenge. Although materials such as salt and baking soda⁴ will not burn no matter how finely they are ground, most materials, both organic and air or the process-specific oxidizing medium over a range of concentrations.⁵ synthetic, are combustible when divided into fine particles. This includes foods, pharmaceuticals, and even metals.

Third, the nature of the combustible dust hazard is such that the pressure and concussion caused by an initial explosion can easily dislodge other nearby dust accumulations, which can then become suspended in the air and fuel secondary and tertiary explosions or fires, and this chain reaction can repeat throughout a facility. According to OSHA, the Occupational Safety and Health Administration,⁵ these subsequent events are typically more forceful than the initial one and usually cause the most damage.

When the right conditions are present and ignition occurs, the results are often catastrophic. Notable examples of these disastrous events include the Imperial Sugar explosion of 2008 and the West Pharmaceutical Services explosion of 2003, but the incidence of combustible dust fires and explosions in the United States alone is frequent, consistent, and deadly.

Dust Fires & Explosions: Addressing the Gaps

The combustible dust hazard has been documented for centuries—in fact, the first documented dust explosion occurred in 1785 when a lamp in an Italian bakery ignited flour dust.⁶ But in the United States there hasn’t been a comprehensive regulation or standard to help employers understand how to protect their workers, even though many employers have been held accountable. In most of those cases employers were deemed non-compliant based on OSHA’s General Duty Clause and the few standards and regulations that do address combustible dust.⁷ Every rule that OSHA has issued focuses on housekeeping, work processes, workplace construction, ventilation, etc., but they do not address personal protective equipment, specifically flame-resistant clothing. Where NFPA® had addressed combustible dust, prior to NFPA® 652, it did so based on industry-specific hazards and environments, and treated combustible dust as a flash fire hazard referring to NFPA® 2112, *Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire*.

³ NFPA® 921 Guide for Fire and Explosion Investigations. (2014) (p. 16). Quincy, MA.

⁴ Investigation Report: Combustible Dust Hazard Study. (2006) (p. 14). Washington, D.C. Retrieved from <http://www.csb.gov/combustible-dust-hazard-investigation/>

⁵ OSHA Hazard Alert: Combustible Dust Explosions. (2008) (p. 1). Washington, D.C. Retrieved from https://www.osha.gov/OshDoc/data_General_Facts/OSHAcombustibleDust.pdf

⁶ Grain Dust Peril. (1998). *Industrial Fire World*, (Vol. 13 Issue 4). Retrieved from <http://fireworld.com/Archives/tabid/93/articleType/ArticleView/articleId/86626/Grain-Dust-Peril.aspx>

⁷ Osha.gov. (2016). *Combustible Dust NEP Status Report - October 2009*. Retrieved 2 February 2016, from https://www.osha.gov/dep/combustible_dust/combustible_dust_nep_rpt_102009.html



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This regulatory void, and the issues surrounding inadequate governance were highlighted in a 2006 report published by the U.S. Chemical Safety and Hazard Investigation Board, or CSB, an independent federal agency charged with investigating and publishing findings on industrial accidents.⁸ In that investigation report, the “*Combustible Dust Hazard Study*,” the CSB noted that between 1980 and 2005 there were at least 281 fires and explosions caused by combustible dust, resulting in 119 deaths and 718 injuries. It also reported that while good engineering and safety practices for preventing dust explosions have existed for decades, no comprehensive federal standard requires adherence to those practices.⁹ In each of these documents cases investigators blamed a combination of inadequate housekeeping, poor facility design, dangerous work practices, and a lack of training and awareness of the combustible dust hazard.

In that 10-year-old report, the CSB pointed out that, “While combustible dusts present a serious explosion hazard in American industry, no comprehensive general industry OSHA standards exist to address these hazards. OSHA’s Grain Handling Facilities Standard, issued in 1987, addresses only the hazards of combustible grain dust in specific types of facilities, and several other OSHA standards partially address different limited aspects of the combustible dust problem.”¹⁰

Although the CSB report, along with the string of high profile incidents, have prompted OSHA to address combustible dust, at the time of publication (and to date), there is no federal standard to address this hazard across general industry.

In 2005, OSHA did produce a Safety and Health Information Bulletin (SHIB), *Combustible Dust in Industry: Preventing and Mitigating the Effects of Fire and Explosions*, but it had no corresponding outreach program to help at-risk companies and facilities locate and understand the potential risks they were facing.¹¹

In a video released by the CSB in June of 2009 titled

Combustible Dust: An Insidious Hazard, Chairman John Bresland said, “No company wants to see its facility blown up and destroyed and its employees killed, but they just don’t understand what the hazard is. They don’t realize that they have a hazard here, until that one day when the explosion occurs, it’s a terrible tragedy for them, and they look back and say, ‘If we’d only known...’”¹²

Amid growing concerns about the dangers of combustible dust, OSHA issued a robust National Emphasis Program (NEP) in 2007. This directive provided instruction for facilities across various industries that handle combustible dust, but following the Imperial Sugar explosion in 2008, OSHA updated it to cover more industries and provide inspectors and agents with a set of inspection guidelines for facilities with potential dust hazards. It also listed a number of “combustible dust-related” NFPA® standards and stated that inspectors should consult those standards “to obtain evidence of hazard recognition and feasible abatement methods.”¹³

It also required that regional offices keep current editions of those standards to “use as a resource to support research and enforcement activities during the inspection.”¹⁴

While this made the NFPA® requirements related to combustible dust the authority behind inspection and enforcement, OSHA did not provide any direction on how to manage the conflicting information and discrepancies among these mostly commodity-specific standards.

NFPA® 652 was needed because, before its publication near the end of 2015, OSHA inspectors were still forced to rely on the General Duty Clause, a handful of limited federal regulations, and a patchwork of industry-specific consensus standards when citing combustible dust violations. Typically, when OSHA inspectors issue citations, they reference an industry consensus standard as evidence that a particular hazard exists and to provide a means of abatement. The lack of a central federal rule, and the incongruous nature of the NFPA® standards that OSHA referenced, made regulation seem arbitrary and

⁸ *Csb.gov*. (2016). *Mission - About the CSB | the U.S. Chemical Safety Board*. Retrieved 2 February 2016, from <http://www.csb.gov/about-the-csb/mission/>

⁹ *Investigation Report: Combustible Dust Hazard Study*. (2006) (p. 68). Washington, D.C. Retrieved from <http://www.csb.gov/combustible-dust-hazard-investigation/>

¹⁰ *Investigation Report: Combustible Dust Hazard Study* (p. 58)

¹¹ *Investigation Report: Combustible Dust Hazard Study* (p. 66)

¹² U.S. Chemical Safety and Hazard Investigation Board. (2009). *Combustible Dust: An Insidious Hazard*. Retrieved from <http://www.csb.gov/videos/combustible-dust-an-insidious-hazard/>

¹³ OSHA Instruction: *Combustible Dust National Emphasis Program (Reissued)*. (2016) (p. 9). Washington, D.C. Retrieved from https://www.osha.gov/OshDoc/Directive_pdf/CPL_03-00-008.pdf

¹⁴ OSHA Instruction: *Combustible Dust National Emphasis Program (Reissued)* (p. A-1).



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inconsistent. Even when employers suspected they were facing a hazard, they didn't know how to address it in order to be OSHA compliant.

Prior to its SHIB in 2005 and the NEP of 2007 (updated in 2008), there were very few OSHA regulations related to combustible dust at all. In fact, an OSHA FactSheet published in 2008 titled *Hazard Alert: Combustible Dust Explosions lists the following as the only "Applicable OSHA Requirements:"*

- §1910.22 Housekeeping
- §1910.307 Hazardous Locations
- §1910.1200 Hazard Communication
- §1910.269 Electric Power Generation, Transmission and Distribution (coal handling)
- §1910.272 Grain Handling Facilities
- General Duty Clause, Section 5(a)(1) of the Occupational Safety and Health Act (Employers must keep workplaces free from recognized hazards likely to cause death or serious physical harm).¹⁵

NFPA® published a number of standards addressing the dangers of combustible dust in the workplace. However, except for one, they were all industry-specific. The exception, NFPA® 654, Standard for the Prevention of Fire and Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids did address Combustible Dust directly, but while it was more general, it focused broadly on the chemical processing industry. Even so, it was widely seen as filling the "everyone else" gaps between these other industry-specific standards:

- **NFPA® 61** Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities
- **NFPA® 484** Standard for Combustible Metals
- **NFPA® 655** Standard for the Prevention of Sulfur Fires and Explosions
- **NFPA® 664** Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities
- And others, such as **NFPA® 120** Standard for the Prevention and Control in Coal Mines

Although they all addressed the five elements required for a combustible dust event to occur, the CD pentagon, several of these standards did not directly address the use of PPE or FR clothing.

While NFPA® 654 (not to be confused with NFPA® 652) did address combustible dust as a distinct and separate hazard and requires that it be treated as a flash-fire hazard as described in NFPA® 2112, the prescriptive guidance it provided was focused on:

- Preventing the formation and/or accumulation of hazardous dust
- Preventing the ignition of dust
- Limiting the consequences of an explosion or fire (mitigation and control)

Initially, NFPA® 654 did not require PPE at all, but the committee quickly remedied that with language that appeared in a Tentative Interim Amendment and has been added to the most recent edition. Currently, NFPA® 654 does require PPE, specifically FR clothing, but the key sections that mention FR clothing are very general:

- 6.1.1.10 Personnel exposed to a dust flash fire hazard shall be protected in accordance with 11.2.2.
- 11.2.2 Operating and maintenance procedures shall address personal protective equipment (PPE), including flame-resistant garments, in accordance with the workplace hazard assessment required in NFPA® 2113, *Standard on Selection, Care, Use and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire*

The Impact of NFPA® 652 on Business

Now, although there is still no federal regulation to address combustible dust, the release of NFPA® 652, Standard on the Fundamentals of Combustible Dust represents a sea change in the ways that employers and employees will treat the combustible dust hazard.

In early 2012, the Technical Committee on Fundamentals of Combustible Dust stepped up to the task and began work on the new standard, despite the significant challenges it was facing. The difficulty in defining a comprehensive standard is well-illustrated in the 2009

¹⁵ OSHA Hazard Alert: Combustible Dust Explosions. (2008) (p. 2). Washington, D.C. Retrieved from https://www.osha.gov/OshDoc/data_General_Facts/OSHAcombustibledust.pdf



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CSB video, where Chairman John Bresland said, “We found in our study that the issue of combustible dust explosions is not focused on one particular industry. It happens across all industries, and industries where perhaps you wouldn’t expect an explosion.” And this combustible dust hazard appearing in so many diverse industries was even more recently recognized following the publication of the new standard. In a 2015 interview for the blog NFPA® Today, Susan Bershada, Senior Chemical Engineer in the Industrial and Chemical Engineering division at NFPA® and staff liaison for the Correlating Committee on Combustible Dusts for NFPA® 652 said, “The biggest challenge for the committee with NFPA® 652 was identifying those requirements that are fundamental to all facilities and processes where combustible dust hazards are possible.”

Bershada has conducted training events to prepare a wide range of roles—facility owners and operators, managers, designers and engineers, and insurers—for the arrival of NFPA® 652. She said, “NFPA® 652 provides the fundamental requirements for all industries with combustible dust hazards...NFPA® 652 now provides a baseline for all other industries, while, as a commodity-specific standard, NFPA® 654 contains additional requirements that go beyond those in NFPA® 652.”¹⁸

The impact that NFPA® 652 has on existing standards and regulations addressing combustible dust is clearly described in the document’s introduction, the “Origin and Development of NFPA® 652.” It states, “This new standard establishes the relationship and hierarchy between it and any of the industry- or commodity-specific standards, ensuring that fundamental requirements are addressed consistently across industries, processes, and dust types.”¹⁹

In **Chapter 1 Administration, the 1.4 Conflicts** section establishes a protocol for addressing discrepancies between the general, over-arching standard and the “commodity-specific” standards that are already in place. Specifically, it states:

- Where a specific standard prohibits a general standard, the specific is applied
- Where a specific standard differs from the general, the specific is applied
- Where a specific standard neither prohibits nor provides a requirement, the general is applied
- Where there is a conflict between specific and general, the specific applies²⁰

Not only does NFPA® 652 resolve contradictions among the commodity-specific standards, this standard also introduces new requirements that are likely to significantly affect businesses and facilities with a combustible dust hazard.

For example, in the same way that many other NFPA® standards refer to NFPA® 2113 in requiring a hazard risk assessment, section **8.6 Personal Protective Equipment** of NFPA® 652 also requires that “An assessment of workplace hazards shall be conducted as described in NFPA® 2113.”²¹ However, in the new standard there is also a preliminary requirement that the owner or operator of a facility that produces or handles dust first determine whether that particular dust is explosive or combustible.²² This determination must be made prior to conducting the hazard risk assessment, and the guidance for making that determination is strict and straightforward. While a dust that is known to be combustible, based on the history of the facility in question or on published information about the substance, does not have to be tested, “The absence of previous incidents shall not be used as the basis for deeming a particulate to not be combustible or explosive.”²³

Where the explosibility or combustibility of a dust is not known, the standard names several ASTM or equivalent testing options that the owner/operator must use. It also requires that the owner/operator prepare and document a sampling plan for testing the dust in question. And it provides detailed instruction with regard to dust mixtures, representative sampling, and dust sample collection.²⁴

¹⁸ Ryan, S. (2015). *NFPA® 652 - new combustible dust standard*. *NFPA Today*. Retrieved from <http://nfpatoday.blog.nfpa.org/2015/11/susan-bershada-is-a-senior-chemical-engineer-in-the-industrial-and-chemical-engineering-division-at-nfpa-and-is-also-the-sta.html>

¹⁹ NFPA® 652 Standard on the Fundamentals of Combustible Dust. (2016) (p. 1). Quincy, MA.

²⁰ NFPA® 652 (p. 6)

²¹ NFPA® 652 (p. 22)

²² NFPA® 652 (p. 12)

²³ NFPA® 652 (p. 13)

²⁴ NFPA® 652 (p. 12)



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If a dust is deemed combustible or explosive, a Dust Hazards Analysis, or DHA, must be conducted to determine whether existing workplace conditions could cause the dust to ignite and burn/explode.²⁵

Then, as with Hazard Identification, NFPA® 652 places responsibility for the Dust Hazards Analysis on the owner/operator. This requirement is applied retroactively, which means that for existing facilities, as well as new ones, a Dust Hazards Analysis must be conducted within three years (by September 7, 2018), and must cover material evaluation, process systems, and building or building compartments.

Also, unlike previous commodity-specific standards, which mention the use of PPE and/or FR clothing only by referring to NFPA® 2113, section 8.6 of NFPA® 652 addresses PPE and FR clothing more broadly. First, it requires employers to conduct a hazard assessment as described in NFPA® 2113, specifically in the context of combustible dust. Then, if FR garments are needed, the employer must provide them, and the standard lists a distinct set of considerations similar to what is required by NFPA® 2113.²⁶

NFPA® 652 specifically requires dust inspection of garments, and it mandates that “the employer shall implement a policy regarding care, cleaning, and maintenance for flame-resistant garments,”²⁷ and that the policy should address who will be responsible for cleaning, inspecting, repairing, and retiring FR garments.

Of particular interest is section **A.8.6.1.6** that reads, “If flame-resistant clothing becomes contaminated with combustible particulate solids, the protective performance of the garments could be compromised. Wearers should maintain an awareness of and take precautions against accumulation of combustible particulate solids on their protective clothing.”²⁸ It’s important that “wearers” are called out, and while ultimate responsibility lies with employers, a degree of responsibility is placed on workers for their own safety.

The other significant change that NFPA® 652 introduces is the emphasis on training and awareness. **Chapter 9 Management Systems** requires that facility owners and managers establish written procedures for conducting the operation of facilities and equipment in a manner that prevents, controls, mitigates, or minimizes combustible dust fires and explosions. Workers must undergo extensive and exhaustive training in hazard awareness, safe work practices, and the inspection, testing, and maintenance of equipment. This includes general training as well as job specific training, and the training requirement applies to temps, contractors, and visitors—not just employees. Refresher training must be conducted as required by the authority having jurisdiction, all training must be completed prior to an employee starting a task, and all training must be documented.

The reason for this intense focus on training is that, according to Susan Bershaw, “A leading cause of incidents involving combustible dust is a lack of awareness of the hazards. The new 652 standard contains the fundamental requirements for identifying and managing the hazards of combustible dust.”

The most significant takeaways from the new NFPA® 652 standard with the greatest impact are:

- The introduction of the hazard identification requirement
- The more detailed direction in hazard analysis
- The emphasis on training and awareness
- The fact that FR clothing requirements are very specific to this standard
- The fact that anyone who, based on a DHA, is exposed to a combustible dust hazard must wear only FR clothing
- The fact that employers must now implement a written policy for the care, cleaning, and maintenance of FR garments
- The term “FR” clearly covers FR daily wear, FR outerwear, and FR or non-melting undergarments³⁰

²⁵ NFPA® 652 Standard on the Fundamentals of Combustible Dust. (2016) (p. 15). Quincy, MA.

²⁶ NFPA® 652 (p. 22)

²⁷ NFPA® 652 (p. 22-23)

²⁸ NFPA® 652 (p. 55)

²⁹ NFPA® 652 (p. 25)

³⁰ NFPA® 652 (p. 22)



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Remaining Gaps

In the absence of a comprehensive federal regulation, NFPA® 652, Standard on the Fundamentals of Combustible Dust sheds much-needed light on how facilities and businesses across all industries address the combustible dust hazard. However, even with this new degree of detail and direction, there are a few points that the new standard does not fully address.

Throughout NFPA® 652, there are sections with significant sounding titles such as, Limitations of PPE Application (Flame-Resistant Garments), **Limitations of PPE to Combustible Dust Flash Fires, and Face, Hands, and Footwear Protection.** After each of these section headings, there's no additional text except the word "Reserved," indicating that there may be more to come and that the committee may come back and provide additional direction and guidance in these areas.

Also, while there is evidence that certain kinds of combustible particulates are more volatile than others and there is compelling evidence that some burn much hotter than others, no test data with regard to flame-resistant clothing and combustible dust exists to help establish categories or levels of protection specific to a DHA.

NFPA® 652 points out that there can be a wide ranging heat flux dependent upon the type, size, concentration, dispersion, etc. of the particulate fuel in question.³¹ These variables could cause some flash fires to burn hotter, slower, or longer than others, but there is no data to support any additional precautions when it comes to FR clothing.

As with any industry consensus standard, the relationship between standard laboratory testing methods and the conditions of actual field events is important to note. Standard tests are not meant or expected to replicate all of the possible scenarios that could occur in the field, and it would be impractical to attempt to anticipate the many variables that could contribute to a flash fire or explosion.

While there is always room (and a need) for more research, it doesn't mean that the learning to date shouldn't be applied. Promoting awareness, exercising

best practices in work processes, housekeeping, and design, and taking precautions by requiring personal protective equipment can (and will) save lives.

Conclusion

Although there is still much to be learned, it is abundantly clear that many more businesses and industries are affected by combustible dust than was previously thought, and it is critical that what is known about this hazard be shared, even with the expectation that more policy and rule changes are to come. The evolution of standards and regulations illustrates how the knowledge base surrounding the Combustible Dust hazard is expanding and improving, and as the technology and design of PPE improves, workers and workplaces will get safer. However, as is the case when implementing personal protective equipment program in the face of any known hazard, it's critical to level-set what flame-resistant clothing is for, what it can do, and what it can't do.

In the hierarchy of safety measures and precautions in any safety program, personal protective equipment is the last line of defense. FR clothing is designed to self-extinguish once the ignition source is removed, but it does not guarantee that the wearer will be unharmed in the event. FR clothing that meets the requirements of NFPA® 2112, *Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire* is designed to minimize personal injury in a flash fire. It is important to partner with market-proven suppliers to ensure not only that the proper garments are selected, but also that appropriate training on correct use, care, and maintenance is provided per NFPA® 2113, *Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel against Short-Duration Thermal Exposures from Fire* ensuring compliance with the requirements of the NFPA® 652 Standard.

³¹ NFPA® 652 Standard on the Fundamentals of Combustible Dust. (2016) (p. 31). Quincy, MA.



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