



Combustible Dust & the Flash Fire Hazard

The combustible dust hazard has gained a much higher national profile since the Imperial Sugar incident in 2008, which tragically killed 14 people and injured 36. OSHA's National Emphasis Program has since issued citations at 87% of sites visited, totaling over 1,000. Recent fines have averaged several hundred thousand dollars, not including the Imperial Sugar fine, which at \$8.8 million was the largest OSHA fine ever imposed.

The general consensus among people familiar with the intent and direction of combustible dust hazards is that it is not a matter of if OSHA will create a standard, but rather how encompassing it will be and how soon it will be issued.

The rulemaking process started with a series of meetings held across the country beginning last December to seek public comment on scope, requirements, economic impact and the use of existing consensus standards. While it is too soon to know exactly what will be included and exactly

when it will be issued, it is an excellent time to learn more about combustible dust hazard analysis, mitigation and protection. Before we can do this, defining the concern is helpful; OSHA defines combustible dust as:

“organic or inorganic dust particles that are finely ground and pose a deflagration or other fire hazard when suspended in air or another oxidizing medium over a range of concentrations.”

A huge number of dusts are combustible, and many people are surprised by some of the substances included, such as metals and other inorganics; common combustible dusts include woods, foods, metals, plastics and coal. The variety of substance types, particle sizes and concentrations makes precise quantification of the hazard extremely difficult, but reasonable generalizations are possible. One of the key metrics is known as Kst; it is expressed as a single number which relates to the probability and power of an explosion of the tested dust. The higher the Kst value, the more dangerous the substance. There are four Kst categories, numbered 0-3. Cat zero dusts are not explosive, while Cat 1 dusts have Kst values below 200, Cat 2 dusts have Kst values from 200-300, and Cat 3 dusts record Kst values over 300. It is very important to be aware that a low Kst number does not mean a given dust is safe; a significant

and disproportionate number of high casualty events have been caused by dusts in Cat 1, with relatively low Kst values.

Once a determination has been made that combustible dust is present in sufficient quantities to be a concern, the first line of defense (as with most workplace hazards) is mitigation. How much dust is enough to warrant concern? OSHA tells us there are many variables – the particle size of the dust, the method of dispersion, ventilation system modes, air currents, physical barriers and the volume of the area in which the dust cloud exists or may exist. As a result, simple rules of thumb regarding accumulation (such as writing in the dust or visibility in a dust cloud) can be subjective and misleading. The hazard analysis should be tailored to the specific circumstances in each facility and the full range of variables affecting the hazard.

Mitigation is a combination of process controls, housekeeping and training. There are a number of standards which cover combustible dust, but one emerging as the primary go-to document is NFPA 654 Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids. 654 covers procedures to reduce and manage dust, including:

- Dust collection systems
- Minimize escape of dust from equipment
- Surfaces which minimize dust accumulation and facilitate cleaning.
- Access to hidden areas to permit inspection (e.g. above drop ceilings)
- Inspect and clean at regular intervals, using methods that do not generate dust clouds
- Train employees to recognize and report hazards

After the above controls are enacted, ignition sources should be examined and controlled. 654 also contains comprehensive guidance on the control of ignition sources to prevent explosions. Some of its recommendations include:

- Use appropriate electrical equipment and wiring methods
- Control static electricity, including bonding of equipment to ground
- Control smoking, open flames and sparks
- Control mechanical sparks and friction
- Use separator devices to remove foreign materials capable of igniting combustibles from process materials
- Separate heated surfaces from dusts
- Separate heating systems from dusts
- Proper use and type of industrial trucks
- Proper use of cartridge activated tools
- Adequately maintain all the above equipment

Much has been written about mitigation strategies and procedures, but a critical aspect of the hazard is sometimes overlooked. Engineering, process controls and housekeeping can reduce the probability or severity of an event, but cannot eliminate it. The National Safety Congress is drafting a document on combustible dust, and the remediation section states:

specifically included dust as a fuel source for over a decade. OSHA, NPFA, NSC and others reference the 2112 & 2113 Flash Fire standards, and NFPA 654 has recently incorporated them for protection of personnel once a combustible dust event occurs. The 2112 standard essentially evaluates protective performance of flame resistant (FR) fabrics in flash fires, and 2113 assists in specification, care and

“Even if controls are put in place as required for all types of operations listed the potential for dust explosions still exists. With such a case protection of employees and property is still required to minimize the impacts. Property damage control is usually accomplished through a combination of engineering installations designed to direct any pressure increase out of the building or suppress it and isolate the explosion to one area of a process. Protection of employees in affected areas is accomplished through use of appropriate PPE such as Flame Resistant (FR) clothing, and an ongoing training program.”

Processes will continue to generate combustible dusts, and so incidents will continue to occur. Much like other hazards such as flash fires in the refinery industry and arc flashes in the electrical industry, engineering and process controls are the first line of defense, but must be paired with protection of workers should an event occur. The last line of defense when a combustible dust event occurs is appropriate PPE. The nature of the hazard and relevant standards are important considerations when a safety program is being put in place for exposed workers; combustible dust incidents are flash fires. They involve a diffuse fuel suspended in air, a moving flame front, and a brief duration in any given location (brief because the fuel source is limited and very quickly consumed). In fact, the NFPA 2112 Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire definition of flash fire has

use of garments. These two standards are excellent resources to use when implementing the final layer of combustible dust hazard mitigation.

FR clothing is an important tool because the significant majority of catastrophic injuries and fatalities are caused by clothing ignition, not by the flash fire itself. Once clothing ignites, it will continue to burn long after the flash is over, and spread burn injury over larger areas of the body surface, increasing both the degree and extent of injury. It is this combination of severity and TBSA (Total Body Surface Area) that most closely predicts probability of survival. FR clothing protects workers in two major ways; it will not continue to burn after the flash is over, thus limiting the percent of the skin surface burned, and it can provide sufficient insulation from second degree burn to provide some escape time.

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Two different FR implementation strategies seem to be emerging to protect workers. One approach is task-based, and provides FR garments primarily to workers directly engaged in critical processes and maintenance or housekeeping activities. The other approach recognizes that combustible dust flash fires often affect large areas of facilities and therefore potentially large numbers of workers outside the task-specific areas, and requires FR garments as daily wear fence to fence. This more conservative approach was selected by Imperial Sugar in the aftermath of their fire, as well as by a number of other facilities after suffering worker casualties as a result of a combustible dust event.

Safety and facilities management professionals from a broad array of industries are carefully observing OSHA's progress and beginning to take steps in

anticipation of the final rule. Best practices dictate a series of four steps to ensure that combustible dust is mitigated to the extent possible. These steps include testing of dusts present to identify hazards, engineering controls to reduce and handle dust with as little worker exposure as practical, housekeeping and maintenance procedures to find and remove dust before it can accumulate to dangerous levels, and use of FR clothing and other PPE to protect workers. Combustible dust events will likely never be completely eliminated, but available equipment, procedures and PPE can dramatically reduce the frequency and consequences.

This article has been featured in *Safety + Health, ISHN and EHS Today* magazines.

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