Combustible dust hazards have come into greater focus over the past several years with the development of new compliance standards. Even so, misconceptions remain that stand in the way of companies taking the appropriate actions to protect their workers and their facilities. This article briefly reviews current combustible dust compliance requirements, clears up the most common misconceptions, and provides guidance on how to keep workers and facilities safe via proper housekeeping.

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The dangers of combustible dust have been known since at least 1785, when dry flour dust caught fire and exploded at Giacomelli’s Bakery Warehouse in Italy. Two workers were injured and the very first combustible dust incident report was written. Now, more than 230 years later, combustible dust incidents continue to happen. In 2018, there were 158 fires and 36 explosions attributable to combustible dust in the United States alone. Those incidents resulted in 39 injuries, one death, and many millions of dollars in losses.

Understanding that these are just the reported incidents is also important. Near misses, such as fires that are put out before they cause a deflagration or small primary explosions that occur in a part of the plant where dust dispersion is minimal, happen in processing facilities every day. In other words, many manufacturers are just lucky they haven’t yet had a catastrophic incident.

One of the main reasons facilities are still at risk is a lack of compliance with dust control standards, combined with a failure to implement proper housekeeping procedures. This usually isn’t willful (though sometimes it is) but is rather a result of plant managers and engineers not knowing what standards are applicable or what housekeeping procedures provide the dust control required to keep workers and facilities safe.

Know what standards apply in your jurisdiction

One reason for the confusion surrounding combustible dust compliance is that there isn’t a single source of truth. On the workforce safety side, OSHA had been moving toward a combustible dust standard, but in July 2017 the agency removed this initiative from its regulatory agenda. However, this doesn’t mean that OSHA doesn’t issue combustible dust citations. It does, and the fines can be quite high. Currently, there are 15 federal OSHA standards for general industry that are mandatory and address different aspects of combustible dust hazards. In addition, the agency makes frequent use of the General Duty Clause, which requires employers to keep workers safe from “recognized hazards.” OSHA also has a Combustible Dust National Emphasis Program (NEP), which has been in effect since 2008. NEPs are temporary programs that focus the agency’s resources on particular hazards and high-hazard industries.

The closest thing to a single source of truth is NFPA 652: Standard on the Fundamentals of Combustible Dust. First released in 2016, with an update earlier in 2019, NFPA 652 harmonizes combustible dust standards across industries. It also, for the first time, requires any facility where dust is present to have that dust tested. If the dust is combustible, the company must conduct a dust hazards analysis (DHA) and develop a plan to mitigate the risks. NFPA 652 isn’t officially in enforcement yet — the 2019 update extended the DHA completion deadline until September 7, 2020. But you shouldn’t wait until then to take the necessary steps. There have already been reports of OSHA citing companies under this standard using the agency’s General Duty Clause.

While OSHA standards tend to get all of the attention, they aren’t the only ones with which companies need to be concerned. Many states, counties, and municipalities have adopted building codes and fire codes that also address combustible dust hazards. Most of these are based on standards from the International Code Council (ICC). Fortunately, the ICC has adopted NFPA 652 into the 2018 edition of the International Fire Code, which means there’s considerable
Kst values: The second dangerous misconception becomes apparent when dust test results come in. Several parameters are assessed in a dust test. The two most important are the explosion severity indices $Kst$ and $P_{max}$:

- $Kst$ indicates explosion severity using the rate of pressure rise during a combustible dust event.
- $P_{max}$ indicates the maximum explosion pressure of a dust cloud.

Together, these two values tell you how bad an explosion is likely to be.

Kst is the value that gets the most attention. That’s because OSHA uses this value to classify combustible dusts into four explosion classes:

- $Kst \leq 0 = \text{Explosion class St} \ 0 = \text{No explosion}$
- $Kst > 0 \text{ to } 200 = \text{Explosion class St} \ 1 = \text{Weak explosion}$
- $Kst > 200 \text{ to } 300 = \text{Explosion class St} \ 2 = \text{Strong explosion}$
- $Kst > 300 = \text{Explosion class St} \ 3 = \text{Very strong explosion}$

Will OSHA accept ATEX certification?

Many equipment manufacturers sell ATEX-certified equipment for combustible dust applications. While this equipment is most likely safe, it doesn’t necessarily meet OSHA’s requirements and may result in citations under the General Duty Clause.

OSHA requires that all equipment to be used in potentially explosive atmospheres in the US be tested and certified by a nationally recognized testing laboratory (NRTL). ATEX is a European Union directive, which is similar to an OSHA standard but is only applicable in Europe. ATEX certification means that the equipment has been designed and tested according to specific guidelines for reducing the risk of causing an explosion in a hazardous environment.

NRTL and ATEX certifications overlap, but they’re not the same:

- Under ATEX, equipment manufacturers can self-certify their equipment in some cases. OSHA doesn’t allow self-certification.
- Pneumatic vacuum equipment can be ATEX-certified, but not NRTL-certified. This is because NRTL certifications are issued based on electrical codes and standards.

ATEX-certified vacuum equipment is widely available in the US market, but it doesn’t meet OSHA inspection requirements. To both ensure your vacuum equipment is safe for collecting combustible dust and avoid an OSHA citation, you should always purchase NRTL-certified equipment.
The misunderstanding relates to materials that come back rated as St 1. Many facilities falsely conclude that this result means they’re in the clear. However, at least in recent combustible dust history, some of the most devastating explosions have been caused by a low-Kst-value dust. Most notably, the 2008 Imperial Sugar explosion, which killed 14 people just months after OSHA announced the Combustible Dust NEP, was caused by sugar, a material that has a Kst value of 35 and is, thus, classified as St 1.

The important thing to understand about Kst value is that it’s not a hard-and-fast indicator of what a dust will do. According to OSHA, “Kst provides the best ‘single number’ estimate of the anticipated behavior of a dust deflagration.” There are other factors that impact how severe an explosion actually will be. These include the material’s particle size, shape, and moisture content, as well as how much dust has been allowed to accumulate. In the Imperial Sugar case, the primary explosion was caused by sugar dust that had accumulated inside an enclosed steel belt conveyor. The primary explosion caused sugar dust on the floors and elevated horizontal surfaces to loft into the air, which provided fuel for the secondary explosions. The company president and CEO at the time said that the dust had acted like gunpowder.

The lesson from both of these misconceptions is that you shouldn’t make assumptions about your risk. If your dust is combustible (rated anything other than St 0), take the proper measures to ensure you’re controlling that dust. That’s what we’ll address in the next section.

**Implement a good housekeeping plan**

There are multiple aspects to effective dust control. The best plan for your application will depend on your facility, the results of your dust test, and a variety of other factors. Good housekeeping is the bedrock of any dust control plan.

**Select the right vacuum**

Vacuuming is the preferred method of cleaning for facilities where combustible dust is present. In powder and bulk solids processing, just like in your home, effective vacuuming starts with a high-quality vacuum cleaner. NFPA 652 establishes seven requirements for portable vacuum cleaners used to collect combustible dust:

1. The materials of construction must be conductive, except in a few specific circumstances.
2. Hoses must be conductive or static dissipative.
3. All conductive components, including wands and attachments, must be bonded and grounded.
4. The fan or blower must be on the clean side of the primary filtration media or wet separation chamber. (In other words, dust-laden air must not pass through the fan or blower.)
5. Electrical motors must not be in the dust-laden airstream unless listed for Class II, Division I, locations.
6. Paper filter elements aren’t allowed for picking up liquids or wet materials.
7. Cleaners used for metal dusts must meet the requirements of NFPA 484, which is the standard for combustible metals.

Per 652, vacuum cleaners used in Class II electrically classified (hazardous) locations should be listed for that purpose, and if flammable vapors or gases are present, vacuum cleaners must be listed for both Class I and Class II hazardous locations.

Finally, in addition to any standards’ requirements (see sidebar on OSHA vs. ATEX), think about your cleaning workforce. If the equipment is difficult to use, your staff won’t want to use it — and as much as we don’t like to admit it, when people aren’t motivated, things don’t get done. To increase the likelihood that your staff will adhere to your housekeeping plan, purchase equipment that’s simple to use. That means it’s easy to maneuver (not too heavy), has an ergonomic design, isn’t too loud and has an intuitive interface. The best way to make sure your cleaning team approves of the equipment is to have vendors visit your facility to do an on-site demo before you make any purchasing decisions.

**Best practices for effective dust control through housekeeping**

NFPA 652 specifies that scheduled housekeeping should occur frequently enough to prevent fugitive dust from exceeding the accumulation limit, and unscheduled housekeeping should occur as necessary to clean up dust spills or transient releases. Follow these best practices to ensure your housekeeping program effectively controls the dust in your facility.

**Never use compressed air to remove dust that has accumulated on surfaces or to clean up spills.** Using compressed air in these situations is prohibited by NFPA 652 because compressed air kicks up dust, which can then settle on surfaces even higher up, where it’s more difficult to reach. In fact, blowdown using compressed air is only permitted after a surface has been vacuumed, swept, or washed down with water.

**Regularly clean overhead pipes and surfaces.**

The typical threshold for fugitive dust accumulation is no more than \( \frac{1}{64} \) inch over more than 5 percent of the floor. In this case, “floor” doesn’t just mean the area underfoot. Overhead surfaces like pipes, the tops of equipment, and lighting fixtures should also be included in this calculation. Remember that the
secondary explosions in the Imperial Sugar catastrophe were fueled by dust that had settled on elevated surfaces. Look for equipment with accessories like wheeled floor nozzles, wall and pipe brushes, and crevice nozzles for hard-to-reach areas.

Regularly clean or change the vacuum filter. Follow the manufacturer’s recommendations and instructions for cleaning or changing the vacuum filter. This will keep it from getting clogged and impacting performance.

Maintain a safe means of dust collection. Combustible dust becomes a problem when it accumulates, regardless of whether that’s on surfaces, in process equipment, or in a vacuum cleaner. Select a machine with a collection container that’s large enough so you can clean your facility without interruption but not so large that a dangerous level of dust accumulates. We recommend a container no larger than 8 cubic feet. If the container is above this threshold, NFPA 652 requires the use of explosion protection solutions, such as venting for example. For collecting hot metal with combustible dust or collecting metal dust, use an immersion separator, which renders Group E metal dusts (aluminum, magnesium, and other commercial alloys) in an inert fluid bath. Finally, empty the vacuum regularly — NFPA requires some equipment (metal dust immersion separators for example) to be emptied daily.

Combustible dust is an underappreciated hazard in many facilities, but the fires and explosions it causes can be disastrous. Don’t wait until it’s too late to get a handle on your compliance requirements. Take the appropriate steps now to keep your facility and your workers safe.

For further reading
Find more information on this topic in articles listed under “Dust collection and dust control” in Powder and Bulk Engineering’s article index in the December 2018 issue or the Article Archive on PBE’s website www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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References