

COLLECTING DUST

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**NFPA 68 Standard: Explosion
venting requirements for
dust collectors**



The risk of explosion in manufacturing, processing and metalworking plants is real, and it can even stem from an improperly protected dust collection system. The National Fire Protection Association (NFPA) 68 – Standard on Explosion Protection by Deflagration Venting focuses on explosion venting of combustion gases and pressures resulting from a deflagration within an enclosure or dust collector.

The life safety objective of the standard for occupied enclosures (i.e., buildings or rooms) is to prevent structural failure of the enclosure and minimize injury to personnel in adjacent areas outside of the enclosure (i.e., dust collector or

ducting). Because the rule is highly applicable to the metalworking industry, we'll look at key points, compliance requirements and how to meet them.

IS YOUR DUST COMBUSTIBLE?

In describing the standard's scope in Chapter 1, NFPA 68 says that it "applies to the design, location, installation, maintenance, and use of devices and systems that vent the combustion gases and pressures resulting from a deflagration within an enclosure so that structural and mechanical damage is minimized" (NFPA 68 1.1) and "the standard applies where the need for deflagration venting has been established" (NFPA 68 1.3).

The important point here is to determine whether your application requires deflagration venting. And that, in turn, requires you to determine whether your dust is considered explosive. A dust's explosive power is the dust cloud's deflagration index (that is, the rate of pressure rise), denoted as "Kst." NFPA 68 uses this value in formulas to calculate the amount of explosion vent area required for a dust collector.

NFPA 68 advises that all dusts be tested, and the standard clearly dictates that the end user, and not the equipment supplier, is responsible for establishing the dust's Kst value. Your dust collector supplier can provide a list of dust testing facilities for this purpose. Typically, a dust explosibility test is performed that involves two parts: 1) Go/no go for explosibility, and if explosive, then 2) determination of Kst and Pmax. See ▶

Combustible Dust Properties

- **Kst** – Deflagration index (bar m/s)
- **Pred** – Reduced pressure after venting (bar)
- **Pstat** – Vent static burst pressure (psi)
- **Pmax** – Max pressure for an unvented dust explosion (bar)
- **(dp/dt)** Rate of pressure rise (bar/s or psi/s)
- **Pes** – Enclosure strength = 2/3 of yield strength of weakest part or 2/3 of ultimate strength if deformation is allowed

Figure 1. List of combustible dust properties.

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NFPA classifies dusts according to their explosibility – that is, their Kst values. Class 1 dusts are rated below 200 Kst, Class 2 dusts range from 200 to 300 Kst and Class 3 dusts are rated above 300 Kst. As a rule, when dusts approach 600 Kst, they're so explosive that wet collection methods are recommended.

In addition to Kst, other important measurements that factor into the standard include "Pmax," the maximum pressure developed in a contained explosion (or in a contained deflagration of an optimum mixture) and "Pred," the maximum pressure developed in a vented enclosure during a vented deflagration.

The need for explosion venting can be dismissed only when a dust is known to be inert (that is, it has a 0 Kst value). Limestone, fume silica and rock dust are examples. Even Class 1 dusts with relatively low Kst values (such as 50) are considered explosive. Therefore, if your dust's Kst value is greater

than zero, you must follow NFPA 68 requirements and use explosion venting in your dust collector. You also need to be aware of the required inlet and outlet deflagration isolation and flame front diverters that are covered in NFPA 69.

The explosibility properties of some metals are listed in Table 1. For a more complete list, see [NFPA 484: Standard for Combustible Metals, Table A.1.1.3\(b\)](#).

For a comprehensive compendium of combustible dusts, visit the European database known as [Gestis-Dust-Ex](#), which includes a searchable database of combustion and explosion characteristics of more than 4,000 dusts from virtually all industry sectors.

When you prepare to update existing or install new dust collection equipment, your equipment supplier may ask you to do one of two things: 1) supply in writing the Kst value of your dust, or 2) supply a report of the dust's Kst value based on your dust tests.

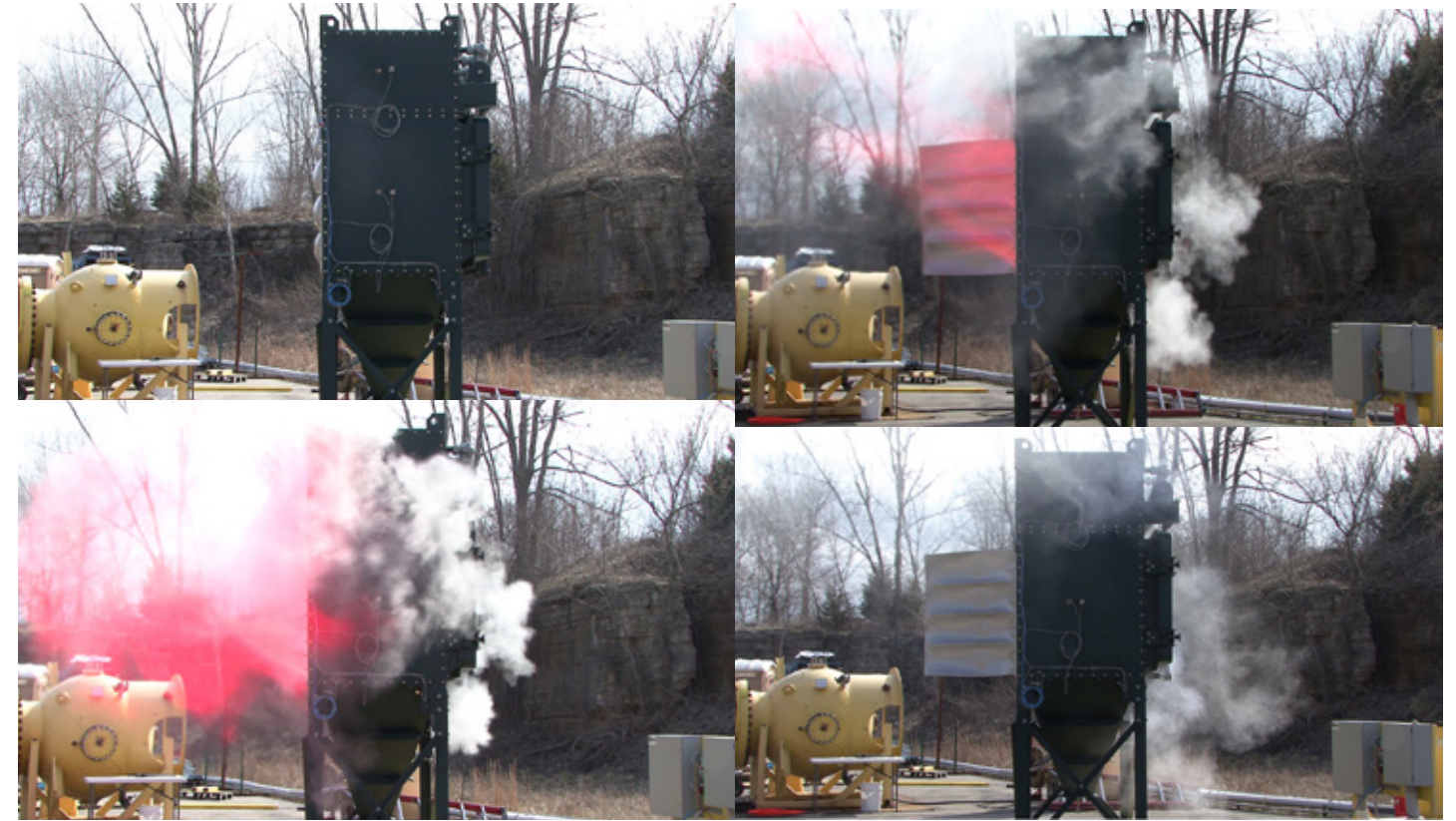


Figure 2a (top left), b (bottom left), c (top right) and d (bottom right). Staged deflagration in a cartridge dust collector with explosion venting.

Therefore, you need to determine whether your dust is explosive. In a closed vessel, such as a dust collector, an explosion usually begins when a suspended cloud of combustible dust is present in high concentration inside the collector. As the fan draws in large volumes of air, an outside spark or ember can be sucked into the collector and collide with the dust cloud under

pressure, triggering an explosion. The spark's source may be a production process, a cigarette butt thrown into a dust capture hood or a static electricity discharge from improperly grounded nearby equipment.

ANALYZE, INSPECT, DOCUMENT

We recommend that you commission a hazard analysis of your dust collection ▶

[With an explosion], the collector can sustain major internal damage. Nonetheless, if personnel remain safe, the explosion venting equipment has done its job.

system. Chapter 4 in NFPA 68 states “the design basis deflagration hazard scenario shall be identified and documented” (4.2.3.1) and “a documented risk evaluation acceptable to the authority having jurisdiction shall be permitted to be conducted to determine the level of protection to be provided” (4.2.3.2).

This means that you’ll have to commission a hazard analysis (also

called risk evaluation) of your plant’s dust collection system and keep the report on file to show to the local fire marshal or other authority having jurisdiction at a moment’s notice.

A hazard analysis isn’t the only documentation required by NFPA 68. In section 11.2, the standard lists 19 documents that you must maintain on file to satisfy the local fire marshal or other authority

having jurisdiction. Some of these – such as suppliers’ equipment data sheets and drawings, instruction manuals and specifications – can be readily obtained. Obtaining others – including a combustible material (dust) properties test report, user documentation of conformity with applicable standards and employee training requirements – presents a more substantial challenge to you, the plant or safety engineer in charge.

Chapter 11 also stipulates that your explosion venting equipment must be inspected at least annually and possibly more often, based on your documented operating experience. This inspection’s objective is simply to determine that all the system’s components are operating correctly.

The chapter outlines a 16-point vent inspection with this objective in mind (11.4.4). Your plant owner or operator must also verify in writing that your process material has not changed since the last inspection (11.4.5). You must file the inspection reports with your other required documentation (11.2). For inspections

and documentation, responsibility again rests with the end user. This can be especially challenging for smaller metalworking or welding facilities that do not have a dedicated safety engineer.

EXPLOSION VENTING DESIGN

A well-designed explosion vent functions as an important element in the equipment’s pressure envelope, relieving internal combustion pressure (back pressure) to keep the collector from blowing up into pieces. The vent’s function is illustrated in Figure 2, a series of photos showing a staged deflagration in a cartridge dust collector equipped with an explosion vent.

Typically, the collector is located outside and designed to vent away from buildings and populated locations, as shown in Figure 3. While explosion venting usually saves the dust collector from being a total loss, the collector can still sustain major internal damage. Nonetheless, if personnel remain safe, the explosion venting equipment has done its job. ▶

If it's not feasible to duct an explosion to the outside through a wall or ceiling in your dust collection application, you'll need an explosion suppression or suppression-isolation system.



Figure 3. Cartridge dust collector with venting to expel explosion away from building.

NFPA 68 includes several chapters with detailed information on design requirements for explosion venting equipment. Let's focus on a few of the most important areas.

Chapter 5 in NFPA 68 describes a performance-based design option, which specifies that if another method for protecting your dust collector from explosions is acceptable to the authority having jurisdiction, you can use that method instead of one specified in NFPA 68. You must, however, document and maintain this optional design method and its data sources over the collector's service life.

An example of a performance-based design option is conducting actual explosion tests of your dust collector to show that it will stand up to certain pressure conditions, instead of using the back-pressure calculations for collectors in NFPA 68.

Some dust collector suppliers can provide this testing using a combination of field tests and full-scale dust collector laboratory tests. This approach can sometimes yield more

accurate real-world performance data than the calculations provided in NFPA 68.

SIZING VENTS AND DUCTS

Chapters 7 through 9 of NFPA 68 provide the calculations you must use for properly sizing explosion vents, vent discharge ducts (also called vent ducts) and other components. A reputable dust collector supplier will follow the vent sizing equations in Chapter 8 and can supply a calculations sheet that becomes part of the documentation you keep on file to prove your plant's compliance.

Regarding vent discharge ducts, Chapter 6 stipulates that "vent ducts and nozzles with total lengths of less than one hydraulic diameter, relative to the calculated installed vent area, shall not require a correction to increase the vent area" (6.8.4). (Hydraulic diameter expresses a noncircular opening's area.)

This means, for example, that if you have an explosion vent with a hydraulic diameter of 40 in., you can use a 40-in.-long vent discharge ▶

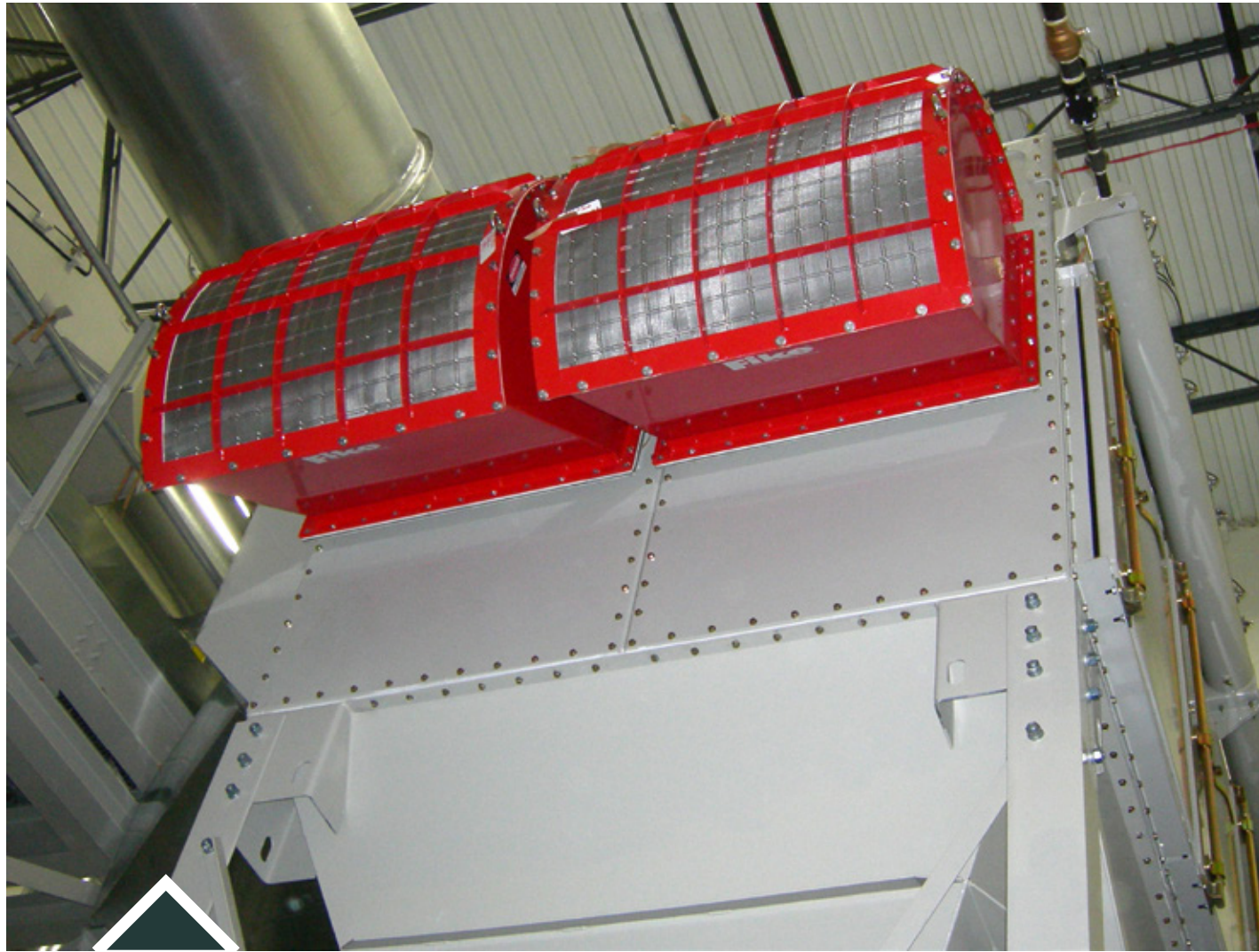


Figure 4. Flameless explosion vents.

duct without risking damage to the collector from increased back pressure. However, for a duct more than 40 in. long (or whatever length is equivalent to the vent's hydraulic diameter), you must follow much more stringent calculations for vent size to compensate for the estimated increase in back pressure to the collector.

Therefore, when you require longer vent discharge ducts – such as when the collector will be located inside – and the standard calculations no longer apply, you'll have to work with your supplier to verify your dust's K_{st} value, vent discharge duct length and strengthening requirements.

When designing a collector for such an application, the performance-

based design option may come into play. Chapter 6 also notes that “to prevent snow and ice accumulation, where the potential exists, and to prevent entry of rainwater and debris, the vent or vent duct exit shall not be installed in the horizontal position, unless any of the alternative methods in 6.5.2.3.1 are followed” (6.5.2.3). This means that if your dust collector has horizontally mounted filter cartridges and horizontally mounted explosion vents, you may need to take extra steps to achieve compliance.

The accepted “alternative methods” for protecting horizontal vents are fixed rain hats, weather covers mounted at an angle to shed snow and de-icing devices such as heated vent closures (pressure-relieving covers). If you use one of these methods, your vent may require additional safety components and testing.

For example, if you use a weather cover, the standard says you must use restraints and design and test the cover to prevent it from becoming a free projectile in an explosion. The other option is to eliminate horizontal

explosion vents altogether by using a dust collector with vertically installed cartridge filters and vertically mounted explosion vents.

OTHER PROTECTION METHODS

NFPA 68 allows flameless venting inside buildings when venting outdoors is not feasible or desirable (6.9). Flameless venting devices allow you to vent an explosion safely indoors without allowing any flame (or pressure front) to escape from the collector.

Devices that meet this standard are commercially available in various configurations. A flameless device for quenching explosions, as shown in Figure 4, is a viable option to ducted explosion vents, but it's not recommended for toxic dust applications because of the risk that dust can be released into the room where venting occurs.

If it's not feasible to duct an explosion to the outside through a wall or ceiling in your dust collection application, you'll need an explosion ►

Material	Median Diameter (µm)	Kst (bar-m/s)	Pmax (bar g)
Aluminum	<10	515	11.2
Bronze	18	31	4.1
Iron	12	50	5.2
Iron (carbonyl)	<10	111	6.1
Manganese (electrolytic)	16	157	6.3
Magnesium	28	508	17.5
Magnesium	240	12	7
Niobium	80	238	6.3
Niobium	70	326	7.1
Silicon	<10	126	10.2
Silicon (from dust collector)	16	100	9.4
Tantalum	100	149	6.0
Tantalum	80	97	3.7
Tantalum	50	108	5.5
Tantalum	65	129	5.8
Titanium	~25	---	4.7
Titanium	10	---	4.8
Zinc (from collector)	<10	125	6.7
Zinc (from collector)	10	176	7.3
Zinc (from Zn coating)	19	85	6

Table 1. Explosibility properties of common metals.

suppression or suppression-isolation system. A system like this may cost more than the dust collector itself.

Suppression methods are covered in a separate document, [NFPA 69: Standard on Explosion Prevention Systems](#). NFPA 69 extends beyond explosion venting to address the whole dust collection system – that is, inlet and outlet ducting, spark-extinguishing systems and methods for preventing an explosion from traveling back into the building.

QUESTIONS FOR SUPPLIERS

Given NFPA 68's many requirements for explosion venting, here are some useful questions to ask when working with a dust collector supplier and installing contractor:

- Is the explosion venting equipment manufactured in accordance with NFPA 68 by a company that specializes in such equipment and provides all documentation?
- Will the supplier provide a calculations sheet on vent sizing and vent discharge ducting?

- Does the supplier have the engineering and testing capabilities to use the performance-based design option where needed?
- Can the supplier perform a hazard analysis or recommend a qualified consultant for this task?
- Does the supplier have access to, and familiarity with, alternative protection technologies, such as flameless venting and explosion suppression?
- Is the installing contractor familiar with NFPA 68? There's no formal supplier certification for this, so you'll have to inquire about the supplier's specific experience and capabilities.

You can view or purchase a copy of the [full current edition](#) of the standard, published in 2013, from NFPA's website. ■

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