WHITE PAPER

Dangerous Dusts in Manufacturing: Knowing the Facts Helps Protect Your People and Facilities

Many dusts can be dangerous when they are produced in a manufacturing or processing setting. When allowed to accumulate into the air or on surfaces, they can quickly cause various hazards. This white paper briefly discusses a variety of dangerous dusts including combustible, silica, hex chrome, berrylium, mining, and metalworking dusts.

Contents:

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AIR POLLUTION CONTROL

The Dangers of Combustible Dust

Combustible dust explosions are a risk in many areas of a plant, but one of the most common locations is the dust collection system.

The National Fire Protection Association (NFPA) sets standards and codes to protect buildings against fire and explosion risks, and the Occupational Safety & Health Administration (OSHA) is applying these standards with increasing vigilance.

The last decade: a look back

In January 2003, an explosion at the West Pharmaceutical facility in Kingston, North Carolina killed six workers and injured 38 others, including two firefighters. The culprit: inadequate control of dust hazards at the plant. Only a month later, in February 2003, another explosion and fire damaged the CTA Acoustics manufacturing plant in Corbin, Kentucky, fatally injuring seven workers. Investigators found that resin dust, accumulated in a production area, was likely ignited by flames from a malfunctioning oven, triggering the explosion.

The most famous combustible dust explosion in the past decade – and the one responsible for re-focusing the national spotlight on this issue – was the February 2008 accident at the Imperial Sugar Company's Wentworth, Georgia refinery. 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.

These are by no means the only fatal explosions to occur in U.S. manufacturing plants, though they are the three deadliest to be investigated. More recently, in December 2010, two brothers lost their lives in a chemical explosion at the New Cumberland, West Virginia plant of AL Solutions. And during 2011, three deadly fires and explosions occurred at a Hoeganaes Corp. plant in Gallatin, Tennessee.

These dust collectors are equipped with passive and active controls. Passive controls are an explosion vent and ducting that control the pressure and flame direction, and a rotary valve that contains the flame in the hopper. The active control is a chemical isolation system mounted on the inlet duct. Triggered by a pressure/flame detector, it will extinguish a flame front passing through the inlet pipe before it goes back into the plant.

Investigators found that accumulations of fine iron powder in the facility led to the explosions.

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 best practices for fire and explosion protection such as the methodologies described in this white paper.

Relevant NFPA Standards

In trying to sort through the list of combustible dust standards, a good starting point for every plant engineer or manager 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. It is regarded as the guiding dust document and the most general on the topic, and it will lead you 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, as follows:

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 covers explosion protection of dust collectors when venting is not possible. It 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.

At the startup of a staged explosion, explosive dust is injected into the dust collector to create a flammable cloud.

About 50 milliseconds later, the dust ignites and the vent opens.

The flame is diverted away from the dust collector to a safe area.

The smoke quickly clears. The whole event took about 150 milliseconds.

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 it relaxes or tightens some aspects of its dust standards accordingly. Wood dusts, for example, tend to contain high moisture content that make 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 subject to more vigilant regulation.

Technologies for explosion protection

There are many types of devices and systems used to comply with NFPA standards for the explosion protection of dust collection systems, but they fall into two general categories: passive and active. Passive systems react to the event, while active systems detect and react prior to or during the event.

The goal of a passive system is to control an explosion so as to keep employees safe and minimize equipment damage in the plant. An active system, by contrast, can prevent an explosion from occurring. An active system involves much more costly technology and typically requires re-certification every three months.

Passive devices include:

- **Explosion venting:** Designed to be the "weak" link of the dust collector vessel, an explosion vent opens when predetermined pressures are reached inside the collector, allowing the excess pressure and flame front to exit to a safe area. It is designed to minimize damage to the collector and prevent it from blowing up in the event of a deflagration, thereby reducing the hazard. (Figure 2)

- **Flameless venting:** Designed to install over a standard explosion vent, a flameless vent extinguishes the flame front exiting the vented area, not allowing it to exit the device. This allows conventional venting to be accomplished indoors where it could otherwise endanger personnel and/or ignite secondary explosions. (Figure 3)

- **Passive float valve:** Designed to be installed in the outlet ducting of a dust collection system, this valve utilizes a mechanical barrier to isolate pressure and flame fronts caused by the explosion from propagating further through the ducting. The mechanical barrier reacts within milliseconds and is closed by the pressure of the explosion.

Figure 2: A dust collector explosion vent designed in accordance with NFPA standards.

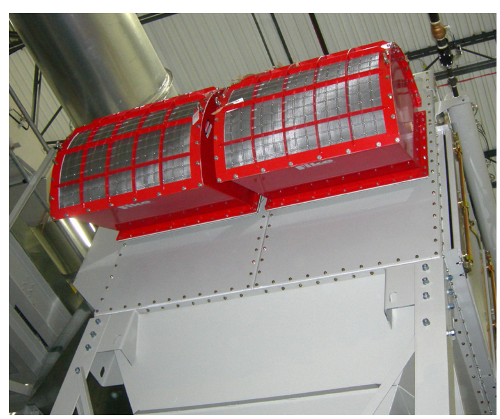


Figure 3: Flameless venting device

Figure 4: Example of horizontally-mounted dust collector filters on a high dust loading application

- **Flow operated flap valve:** This is a mechanical back draft damper positioned in the inlet ducting. It utilizes a mechanical barrier that is held open by the process air and is slammed shut by the pressure forces of the explosion. When closed, this barrier isolates pressure and flame fronts from being able to propagate further up the process stream.

- **Flame front diverters:** These devices divert the flame front to atmosphere and away from the downstream piping. Typically, these devices are used between two different vessels equipped with their own explosion protection systems. The flame front diverter is used to eliminate "flame jet ignition" between the two vessels that could overpower the protection systems installed.

Active devices include:

- **Chemical isolation:** Designed to react within milliseconds of detecting an explosion, a chemical suppression system can be installed in either inlet and/or outlet ducting. Typical components include explosion pressure detector(s), flame detector, and a control panel. This system creates a chemical barrier that suppresses the explosion within the ducting and reduces the propagation of flame through the ducting and minimizes pressure increase within connected process equipment.

- **Chemical suppression:** Whereas chemical isolation is used to detect and suppress explosions within the ducting, chemical suppression protects the dust collector itself. It is often used, together with isolation, when it is not possible to safely vent an explosion or where the dust is harmful or toxic. The system detects an explosion hazard within milliseconds and releases a chemical agent to extinguish the flame before an explosion can occur.

- **Fast acting valve:** Designed to close within milliseconds of detecting an explosion, the valve installs in either inlet and/or outlet ducting. It creates a mechanical barrier within the ducting that effectively isolates pressure and flame fronts from either direction, preventing them from propagating further through the process.

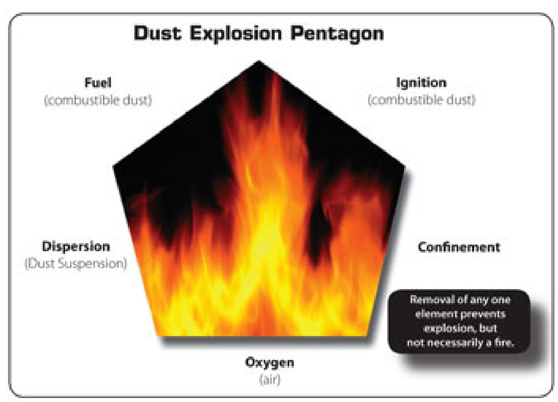


Figure 5: Dust explosion pentagon shows the elements that must be present for a combustible dust explosion to occur.

- **High-speed abort gate:** The gate is installed in the inlet and /or outlet ducting of a dust collection system and is used to divert possible ignition hazards from entering the collector, preventing a possible explosion from occurring and preventing flame and burning debris from entering the facility through the return air system. A mechanical barrier diverts process air to a safe location. Abort gates are activated by a spark detection system located far enough upstream to allow time for the gate to activate.

When planning explosion protection, don't overlook additional devices and materials that can help reduce fire risk within the dust collection system. For spark-generating applications, a range of features and technologies are available, from flame-retardant and carbon anti-conductive filter media to spark arrestors in the form of drop-out boxes, perforated screens or cyclone device installed at the collector inlet. Fire sprinkler systems may also be required with some installations.

A dust collector that uses vertically-mounted filter cartridges can also reduce fire and explosion risks. With horizontally-mounted cartridges on high loading applications, dust becomes trapped in the pleats in the upper third of the filters (Figure 4). This dust will become dispersed during a deflagration providing unnecessary excessive amounts of extra fuel for the event. Vertically-mounted filters use baffle systems to segregate much of the dust into the hopper, which reduces the load on the filters and helps eliminate these problems.

Mistakes, misconceptions and pitfalls

A wide range of problems can contribute to explosion risk in a facility, but some common denominators exist. Based on years of field experience, the ones we have most commonly encountered are:

Lack of a risk evaluation or hazard analysis: Failure to conduct a hazard analysis is an all too common oversight. The NFPA states that a hazard analysis is needed to assess risk and 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.

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

Figure 6: Kst values of common dusts

Regarding 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 the 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.

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 6 shows the Kst values of a number of common dusts.

Bargain-hunting: Every plant engineer and manager is acquainted with the benefits of basing purchasing decisions on life-cycle cost – sometimes called "total cost of ownership" – over choosing equipment with the lowest price tag. A dust collector is no exception. A well-designed dust collection system can pay for itself rapidly in energy and maintenance savings, costing far less to operate than a unit with a low initial price.

A high-quality, heavy duty collector can also offer a less obvious advantage in the event of a combustible dust problem. As documented both in full-scale testing and field experience, in the event that a dust explosion occurs in the collector, a "bargain" model will more than likely require total replacement. A collector made of thicker-gauge metal with higher ves-

Photos of a factory taken before and after installation of a dust collection system show how effectively the collector cleans up hazardous dust and fumes.

sel strength, however, will survive an explosion and can often continue in service with only the explosion vent and filter cartridges needing to be replaced.

Using non-compliant devices: A close cousin to the bargain-hunting issue involves the use of non-compliant or uncertified explosion protection devices. As an example, sometimes products such as back flap dampers may be reverse-engineered by suppliers that do not have any expertise in explosion protection or have chosen not to perform the required testing to satisfy the standards and/or the performance-based provisions. No testing exists to prove that the device will comply with current standards.

If an OSHA inspector finds this situation in the field, the plant will have to replace the device and may be subject to a fine. Worse yet, if a combustible dust problem should occur, there is no guarantee that the device will perform as expected.

It is also worth noting, there is no such thing as an "NFPA-approved" device. A supplier may correctly state that a device "carries CE and ATEX certifications" and/or is "manufactured in accordance with NFPA standards" – but test data must be available to support these claims. Such a device might cost more than its non-compliant counterpart, but in the long run it can save money, headaches, and even lives.

Housekeeping problems: In an October 2011 update on the Combustible Dust NEP, OSHA reported that one common violation encountered during inspections involved "hazardous levels of dust accumulation in the workplaces due to poor housekeeping practices".

When it comes to the dust col-

Storage drum prevents dust from backing up in the hopper and creating an explosion hazard.

This heavy duty dust collector with explosion vent is designed to survive a combustible dust explosion with minimal damage.

lector, a simple but important housekeeping requirement is to change filters when airflow through the system reaches a differential pressure limit as prescribed by the manufacturer or when the pressure drop across the collector is negatively affecting the ability of the dust collection system to capture the dust, thus allowing it to escape into the facility. Some long-life cartridge filters available today can operate for two years or even longer between change-outs; but for heavy dust-loading applications, filter replacement might be considerably more frequent.

Another housekeeping misstep is storing dust in the dust collector’s hopper. The hopper should be equipped with a device that discharges the dust into a separate drum or storage container after it is pulsed off the filters during the cleaning process. Equally important, this storage container must be emptied regularly, or dust can back up into the hopper. Dust sitting in a hopper creates a potential fire or explosion risk, and may also affect performance of the dust collection system. This will lead to loss of airflow which will reduce conveying velocities, allowing build-up of dust in the ducting and emissions of dust at the process hoods.

Misunderstanding risks involved with “open” style dust collectors: Some plant managers mistakenly believe that open type dust collection systems, such as those incorporated into bag-dump stations, downdraft tables and booths, are not a hazard. While these collectors admittedly differ from traditional dust collectors in that they do not take the form of a tightly contained vessel, at least four of the five ingredients of the explosion pentagon may still be present: combustible dust, an ignition source, oxygen, and dispersion of the dust in sufficient concentration to pose a hazard.

Thus, there is still a risk of flash fire directed by a pressure front – a potentially fatal risk, given that workers are in close proximity in these environments. If you are using an open type dust collector, you must still test and evaluate the combustibility of the dust and equip the area with fire and/or explosion protection equipment as required.

What everyone *does* seem to acknowledge is that more drastic action is necessary to prevent combustible dust tragedies from continuing to occur.

By following the guidelines in this article, and securing the help of engineering consultants and equipment suppliers with a proven track record in combustible dust applications and performance-based solutions, you can minimize risk factors and maximize combustible dust safety in your facility.

Industrial Silica Exposure

Crystalline silica is one of the most abundant minerals on the planet. It is estimated that silica makes up 59 percent of the earth's crust and is found in nearly all known rocks. It has three main crystalline forms, of which quartz is by far the most prevalent. It is therefore not surprising that silica dust turns up in a wide range of industrial processes and applications.

These include but are not limited to abrasive blasting processes used in construction, maritime work and general industry; cement production; pottery, structural clay, stone and concrete products manufacturing; asphalt pavement manufacturing; foundry production; electronics manufacturing; production of abrasives, paints, soaps, and glass; shipbuilding; filtration in food and beverage production (where silica-containing diatomaceous earth is often used); and hydraulic fracturing.

Given silica's abundance in nature, exposure can sometimes exist where you least expect it. So even if your manufacturing operation does not fall into any of the above categories, there is still a chance you are at risk. To determine if your facility is at risk, a good starting point is to review the Material Safety Data Sheets (MSDS) for the materials that you are using. A standard MSDS will list hazardous ingredients in Section 2. The dust might be identified as crystalline silica, silicon dioxide, quartz, cristobalite or tridymite. Silicon carbide and fly ash are examples of substances that may contain respirable silica. The percentage of silica in the product will affect the OSHA exposure limit that you need to maintain.

High efficiency cartridge dust collector contains fugitive silica dust at a batching plant used in the manufacture of paving stones.

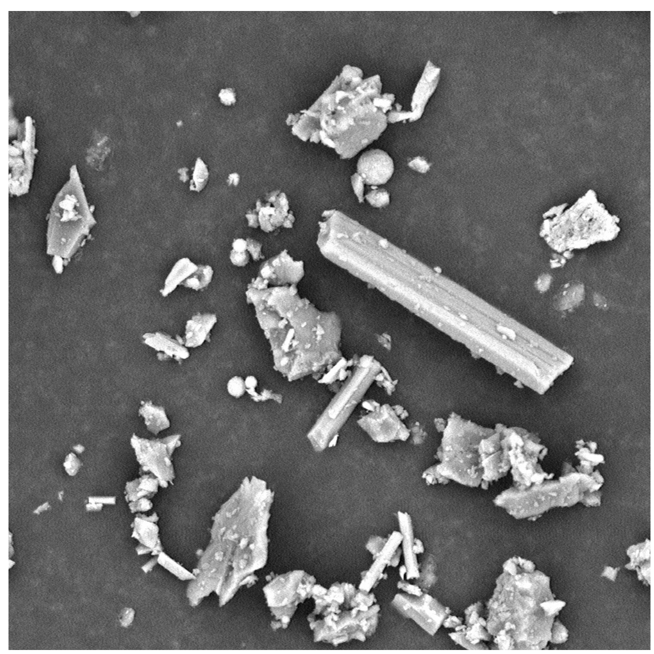


Photo of silica dust, magnified to 6000 times its original size, shows the jagged shape of the particles.

Silica exposure and health risks

Respirable crystalline silica causes silicosis, a progressive and often fatal disease of the lungs and is also classified as a human carcinogen that causes lung cancer. Silica particles of 10 microns and less are small enough to enter the lungs when a worker breathes dust-laden air. These tiny silica particles have jagged edges that embed in the lungs and do not dissolve. Over time, the body's natural reaction is to create scar tissue or fibrosis over the embedded lung tissue, so the particles remain in the lungs and more layers of silica and scar tissue build up over years of exposure. This reduces the lungs' ability to extract oxygen from the air, creating difficulty breathing and eventually causing other symptoms such as fatigue, appetite loss, severe shortness of breath, chest pain and respiratory failure.

Silicosis cannot be cured, so prevention – accomplished by minimizing human exposure – is the best and only strategy. Chronic silicosis usually occurs after 10 or more years of exposure, though acute silicosis may develop after short periods of exposure to very high levels of the dust. Exposure is also linked to an increased risk of lung cancer, tuberculosis, chronic obstructive pulmonary disease and kidney disease.

Key Provisions of OSHA's Industrial Silica Rule

Reduced exposure limit: The new OSHA Permissible Exposure Limit (PEL) for respirable crystalline silica has been reduced to 50 micrograms per cubic meter of air, averaged over an 8-hour time-weighted average (TWA) work shift. This limit is two to five times stricter than the previous threshold limits of 100 micrograms per cubic meter of air for general industry and 250 micrograms for construction. The new more stringent PEL is expected to enhance worker protection by sharply reducing both short-term and long-term exposure to respirable silica dust.

Engineering controls: OSHA requires employers to use engineering controls such as water to keep the dust down, and/or dust collection (ventilation) to capture airborne particulate and keep worker exposure below the 50 microgram PEL. While engineering controls are the preferred approach, employers are required to provide personal respiratory protection when engineering controls are not able to limit exposures to the permissible level.

Exposure control plan: Employers are required to develop a written exposure control plan (hazard plan) to show how compliance will be achieved. The plan should also limit access to high-exposure areas and incorporate training of workers on silica risks and basic safety practices so they can recognize how to limit their own exposure.

Medical surveillance: Medical exams, lung health monitoring and recordkeeping are required for employees who have been identified as "highly exposed workers". Exposures above 25 micrograms per cubic meter in an 8-hour TWA over 30 days per year represents an action level where the medical surveillance is required. Effective engineering controls are often capable of maintaining silica dust concentrations below this action level.

Deadline for compliance: Companies in general industry have until June 23, 2018 to implement engineering controls and other requirements set forth in the new standard. Companies involved in hydraulic fracturing have until June 23, 2021 to comply.

Cutaway view shows airflow pattern through a typical cartridge dust collector.

How to determine if you are in compliance

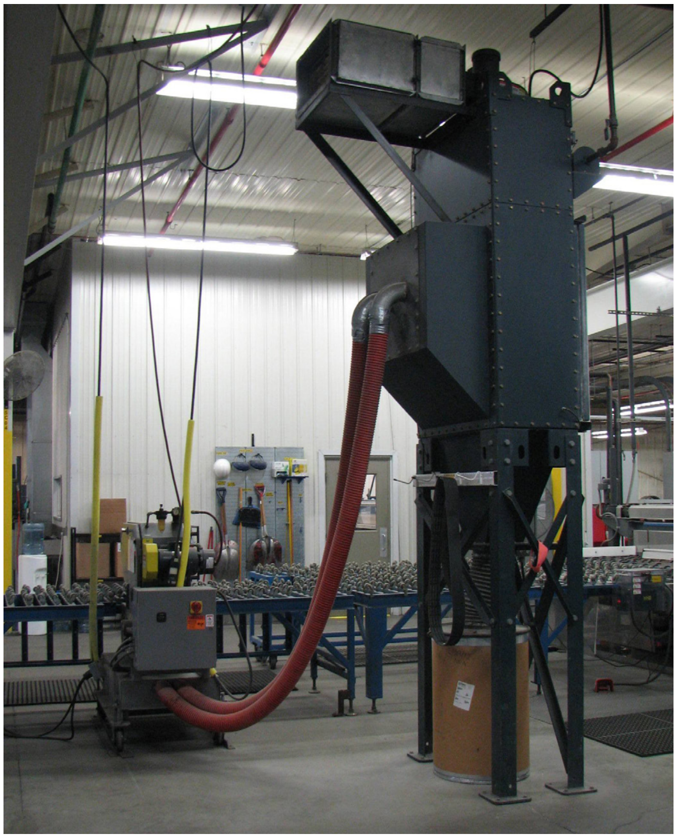
Are your workers exposed to harmful levels of silica? Wherever a process generates crystalline silica dust, OSHA states that air monitoring must be performed to determine a worker's 8-hour TWA exposure.

OSHA has stated in its general provisions that "the first and best strategy is to control the hazard at its source. Engineering controls do this, unlike other controls that generally focus on the employee exposed to the hazard." OSHA goes on to say that when a hazard cannot be removed or enclosed completely to isolate it from the workplace, the solution is to "establish barriers or local ventilation to reduce exposure to the hazard in normal operations". These principles apply not only to crystalline silica but to all hazardous dusts.

A well-designed dust collector is an accepted and proven engineering control that will filter hazardous contaminants to make indoor environments safer and healthier. Dry media dust collectors containing high efficiency cartridge filters along with HEPA secondary filters are the best control for respirable particulate, ensuring that it will not spread and be inhaled by workers in other areas of the plant.
The new OSHA crystalline silica PEL of 50 micrograms per cubic meter is achievable using this technology. Cartridge dust collectors with secondary HEPA filtration are effective in controlling hazardous dusts that have PEL limits of 5 micrograms per cubic meter, or 10 times lower than this limit.

The importance of dust testing

The collection and lab testing of dust samples is a long-established practice to help plant engineers and safety managers make informed dust collection decisions, especially where hazardous dusts are involved. The first step of lab testing silica dust is particle size analysis. This allows proper selection of filter media with regard to the efficiency required at various particle sizes. Testing also determines moisture content of the dust, which can have an impact on the performance of a dust collector.



In a glass fabrication shop, high-speed silicon carbide belts are used to take sharp edges off cut glass. A source capture system conveys the silicon carbide and glass dusts directly to the adjacent collector.

Silica is an inert mineral and therefore does not pose fire or explosion risks. As a result, in most applications it will not be necessary to test the dust for explosibility properties. However, if there is anything in the MSDS to indicate a mixed dust that may contain other combustible ingredients, you may need to request explosivity testing as stated in NFPA 652: Standard on the Fundamentals of Combustible Dust.

Dust collection system design considerations

There are many factors that impact the proper design of the dust collection system. Lab testing of dust samples, as noted above, can play an important role in guiding this design process by identifying the properties of the dust. Environmental factors also have an impact on equipment decisions. Here are the main points to consider as you set out to design a dust collection system for crystalline silica dust control:

Type of capture system: Source capture is the most effective control for dust emissions from any manufacturing process, whether the dust is hazardous like silica or just a nuisance. With source capture, some form of hood or enclosure is used to control the dust at the point of generation so it never has the chance to become airborne into the factory. Negative air pressure is maintained on the enclosures to help ensure containment of the dust. Ambient air cleaning systems, by contrast, work much like HVAC filtration where all the air in the room is cleaned from remote pick-up points. It is not considered a viable option for silica control because it does not prevent the dust from becoming airborne and dispersed throughout the work space. Workers would be required to wear personal protective equipment (PPE) at all times.

Particle size: Filter media efficiency performance is selected based on the dust particle size and distribution. For particles greater than 1.0 micron in size, a standard cellulose-polyester blend cartridge filtration media will usually suffice. But if very fine submicron particles are present, a higher efficiency media will be required. For these applications, a high efficiency nano fiber media can be a good option. When a layer of nano fibers is applied on top of the base filter media, the nano coating promotes surface loading of fine dust, preventing the fine dust from penetrating deeply into the base media and thereby reducing emissions.

A reputable filtration manufacturer should provide you with a written guarantee of emissions performance for the dust collection system you purchase, so it's a good idea to obtain that documentation. However, a manufacturer's guarantee does not constitute proof of compliance to OSHA: Air sampling must be performed, as above, to ensure that factory air is below the required threshold for silica exposure.

Wetted silica dust takes on the characteristics of mud, as shown in these samples. A dry environment should be maintained whenever possible to prevent the muddy dust from clogging filters.

Particle shape: Silica dust is very abrasive due to the particles' sharp edges and jagged shapes. This is an important consideration, as the entire dust collection system must be designed for maximum resistance to abrasion to prevent operational problems and excessive wear and tear to components. The air inlet should be designed to slow down and uniformly distribute the airflow to prevent abrasive particles from entering the system at high velocity. If not accounted for, abrasive dust can cause enough wear over time that holes develop in the filter media, creating a leak path for harmful dust to escape into the workplace. Secondary HEPA filters are recommended in silica applications to protect the factory from very fine particulate emissions that may pass through the less efficient primary filters, and the pressure monitor will alert you to a leak due to wear.

HEPA safety monitoring filters are integrated on top of this dust collector, eliminating the costs of additional ductwork. Mounted downstream of the HEPA filters, the fan is protected against wear and tear from exposure to abrasive silica particles.

The effects of moisture: Silica dust is hygroscopic, meaning it will absorb moisture from the air. It is not a difficult dust to collect if the air remains dry. If the air is moist or humid, however, the dust takes on the characteristics of mud and becomes packed in the filter pleats, reducing filter life. In some instances, where moisture is introduced for the intent of cooling, lubricating or otherwise aiding a process, a dry filter may not work. The authors recently encountered such an

Fugitive silica dust, generated as material is poured into storage silos, is captured at the source and conveyed to an outdoor dust collector through this ductwork system.

application where water was used in a granite-cutting process. Lab testing of a dust sample determined that dry dust collection was not a viable option because the process dust was simply too moist for cartridge filters to handle.

In northern climates with hygroscopic dust applications, condensation can cause problems with dry media filtration. Facilities in these climates are advised to locate the dust collector indoors or use a heater and/or insulated enclosure if the collector must be outside. Unless these precautions are taken, as warm moist air from indoors reaches the cold outdoor collector, water vapor will condense on all surfaces inside the collector including the filters and be absorbed by the dust, leading to premature filter failure.

Air recirculation: Recirculating the air from a dust collector back into the factory has financial advantages. Recirculation can have a very positive impact on the bottom line, since it is the single best way to save energy and maximize return on investment with a dust collector. By recirculating heated or cooled air back through the building, you reduce the need for costly make-up air that's required when you vent the air outdoors. Facilities in all regions report five- to six-figure annual energy savings, with the greatest savings seen in northern climates which experience longer, colder winters. Recirculation also reduces the negative pressures in the facility that make doors hard to open and cause them to slam shut behind you as you move from one space to another.

Recirculation requires secondary filtration to ensure that dust does not get into the factory. Secondary filters may be remotely mounted, which requires ducting to convey the air from the collector to the HEPA filters and into the factory. If an upset condition should occur, cleaning out a long duct run between the two stages of filtration is costly and time-consuming. Newer designs actually integrate the HEPA filters into or on top of the dust collector. This configuration prevents contamination of the return air ducting and the associated cost to clean the duct if a hazardous dust is leaked from the primary filters.

Type of cartridge collector: Another design consideration involves the mounting position of the filter cartridges. Depending on the collector brand and type, filters may be installed horizontally or vertically. With horizontally-mounted systems, a heavy dust such as silica, a mineral with the density of rock, builds up on top of the filters and is not dislodged by pulse cleaning. To address this problem, manufacturers of dust collectors with horizontally-mounted cartridges recommend that you rotate the filters periodically for high dust loading applications. This unnecessarily increases employee exposure to silica dust. Vertical mounting allows the high density silica dust to release uniformly from the filter pleats, since it doesn't have to fight gravity. This reduces the load on the filters, helps extend filter life, and reduces exposure since the filter compartment only has to be opened when it is time to replace the filters.

Hex Chrome Threats

Hexavalent chromium – also known as hex chrome or Cr(VI) – is a carcinogenic substance produced in a variety of industrial processes, e.g. during welding or other types of "hot work" on stainless steel and other metals that contain chromium. Here are some of the most important facts you need to know about hex chrome and OSHA compliance.

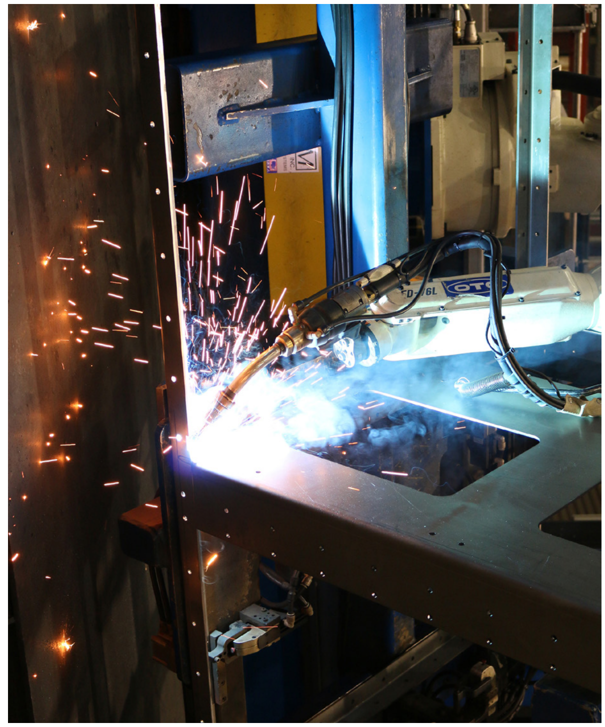
How hex chrome exposure occurs

A number of industrial processes used in the manufacture of stainless steel parts carry a risk of hex chrome exposure, including welding; thermal spray (including plasma, electric arc and combustion); plasma and laser cutting; dip-tanks, anodizing and plating lines; spray painting; and smelting of ferro-chromium ore.

Exposure can occur in a number of ways. Workers can inhale hex chrome or absorb it through the skin. Improper hand-washing hygiene can lead to swallowing through food, tobacco or cosmetics.

A carcinogen with multiple health risks

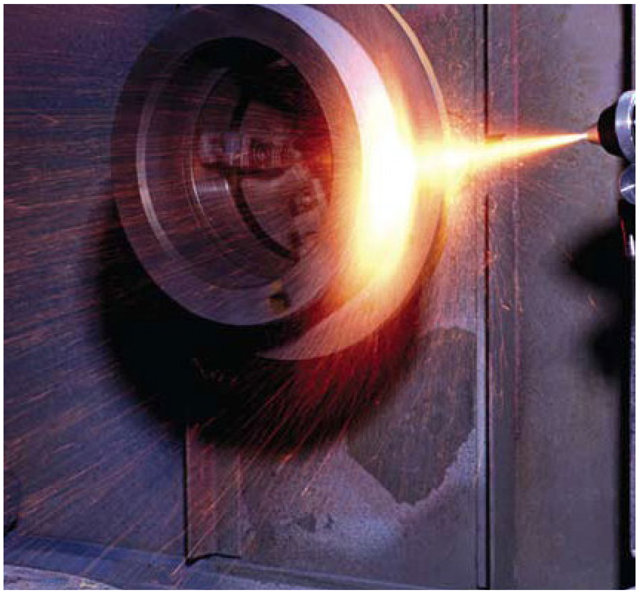
The greatest health danger associated with hex chrome exposure is lung cancer. Other major health effects include nasal septum ulcerations and perforations, skin ulcerations, and allergic and irritant contact dermatitis.



Hex chrome is produced during welding and other types of "hot work" on stainless steel and other metals that contain chromium.

Once in the body, hex chrome typically targets some of the body's organs. Respiratory tract problems can include inhalation damage to mucus membranes, perforation of septum tissue between the nostrils of the nose, and damage to the lungs. In addition, there may be injury to the eyes, skin, liver and kidneys. A worker exposed to hex chrome may also experience symptoms such as sinus irritation, nosebleeds, stomach and nose ulcers, skin rash, chest tightness, wheezing and shortness of breath.

According to the National Institute for Occupational Safety and Health (NIOSH), "an estimated 558,000 U.S. workers are exposed to airborne hex chrome compounds in the workplace. Some of the industries in which the largest numbers of workers are exposed to high concentrations of airborne Cr(VI) compounds include electroplating, welding, and painting."



Thermal spray operations are another common source of hex chrome exposure.

OSHA standards for compliance

In May 2006, OSHA published a new rule for hex chrome exposure which drastically reduced the permissible level of exposure in the workplace, from 52 to 5 micrograms per cubic meter (µg/m3) – a tenfold reduction. More specifically, the current Permissible Exposure Level (PEL) is 5 µg/m3 time-weighted average (TWA) in an 8-hr shift. The most recent document on this topic is the OSHA Standard on Hexavalent Chromium (OSHA Standard 3373-10) published in 2009.

Engineering controls contained in OSHA Standard 3373-10 fall into three main categories: substitution (i.e., using a different, less toxic material to reduce exposure; isolation (i.e., completely enclosing or encapsulating the source of exposure; and ventilation (the use of exhaust and dust collection/filtration equipment to capture airborne hex fume particles near the source of generation). Though the standard does set forth these three options, it is not OSHA's role to prescribe solutions or recommend specific technologies. It is the employer's responsibility to understand the hazards and engineer the Best Available Control Technology (BACT) into their operations, while OSHA's job is to enforce the hex chrome standard and monitor compliance in industrial workplaces.

The importance of air monitoring

OSHA stipulates that every company with a process that generates hex chrome must use monitoring to determine the 8-hour TWA exposure for each worker who is affected. OSHA offers two options for determining exposure – a scheduled monitoring option, or a performance-oriented option. The standard spells out both options in detail.

Monitoring is accomplished through personal air sampling: The worker wears a small air pump and filter attached in the breathing zone, and the pump draws a measured volume of air at a steady flow rate through the system to simulate the respiratory rate of the worker. The material collected in the filter provides an accurate snapshot of operator exposure to hex chrome, with exposure defined as the concentration of contaminant to which an employee would be exposed without benefit of personal protective equipment, such as a respirator.

To monitor air quality, workers wear a small air pump and filter attached in the breathing zone.

In some cases, OSHA will require an employer to monitor all exposed workers, while in other cases it will be sufficient to perform "representative" sampling – e.g., when several workers perform the same task under the same conditions. Whatever approach is determined to be the best for your situation, you will need to keep an accurate record of all air monitoring performed to comply with the standard.

The advantages of cartridge-style dust collection/filtration equipment

The best type of filtration system for hex chrome capture will be a high efficiency cartridge-style dust collection system. Older-style baghouse collectors and electrostatic precipitators do not typically offer the very high filtration efficiencies needed to remove this toxic contaminant to the required level.

There are three general types of cartridge collection systems used to clean up welding and other processes that generate metallic dust and fumes:

a) Source capture systems are popular for applications involving small parts and fixture welding. They will typically utilize a flexible source capture arm or a complete enclosure around the operation, such as a glass enclosure around a robotic weld cell. This approach is usually limited to smaller envelopes of around a 5-ft cube or less.

b) Hoods, another form of source capture, are often utilized if the footprint area is a medium size such as 12-ft x 20-ft or less. The hood should be positioned as closely as possible to the source of generation to prevent toxic contaminant from escaping and ducted to the cartridge collector.

c) Ambient or general air-cleaning systems that filter all the air in the shop using a central system are often chosen to serve larger areas because they allow a facility involved in multiple operations to capture all the fumes. Though popular for general welding applications, ambient systems are generally not suited to applications involving hex chrome because of the risk that toxic particles will migrate through the air, possibly requiring the use of personal respiratory protection for workers in the area. Multiple smaller collectors with source capture arms or hoods, as above, provide a better solution for large areas.

Whatever type of cartridge dust collection system you use must also be equipped with a HEPA safety monitoring filter – sometimes called a final filter, secondary filter or after-filter. In section 8 (below), we will discuss the important role of a safety monitoring filter in achieving emission thresholds.

Entrained dust on horizontal filters on high dust loading applications can shorten filter life and provide a dusty surface for sparks to ignite.

Comparing filter efficiencies

There are several different measures of filter efficiency, and it is important to understand the basic differences when selecting filters for the capture of hex chrome.

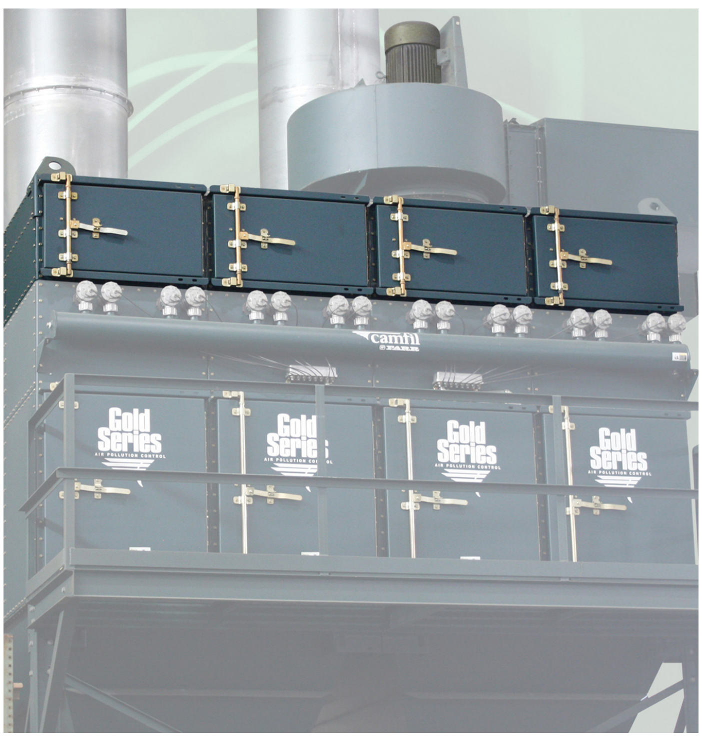
FIGURE 1: MERV RATINGS

MERV Rating	Efficiency	Particle Size
1-4	<20%	>10 microns
5-8	<20 to 35%	3 to 10 microns
9-12	40 to 75%	1 to 3 microns
13	80 to 90%	0.3 to 1 micron
14	90 to 95%	0.3 to 1 micron
15-16	95% +	0.3 to 1 micron

Removal efficiencies of filters with various MERV designations

Minimum efficiency reporting value, commonly known as *MERV*, is a measurement scale designed in 1987 by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to compare the effectiveness of air filters.

The MERV scale, which goes from 1 to 16, is designed to represent the worst-case performance of a filter when dealing with particles in the range of 0.3 to 10 microns. Higher MERV ratings correspond to a greater percentage of particles captured on each pass, with a MERV 16 filter capturing more than 95 percent of particles over the full range. **Figure 1** shows the removal efficiencies of filters with various MERV designations.



An integrated safety monitoring filter with HEPA filters is mounted on top of a cartridge dust collector.

Though the MERV scale is a useful tool for comparing filters, don’t rely on MERV alone in selecting a dust collector filter. **Mass Density Efficiency,** defined as the weight per unit volume of air, is a more relevant predictor of OSHA compliance. For example, using this measurement, a filter manufacturer might guarantee that emissions will not exceed 5 milligrams per cubic meter at the discharge of the dust collector using high efficiency nano fiber media.

Particle Count Efficiency is another measure based on particle count, and is very useful in evaluating filters at the higher (e.g., HEPA) filtration efficiency ranges. For example, a HEPA filter rated at 99.97 percent efficiency at 0.3 micron will capture 9,997 of 10,000 same-sized particles in the airstream.

Welding Fumes and Dusts

Keeping welding fumes to a minimum in the shop is essential for protecting people, property and productivity. Assuming you have some type of collection/extraction system in place to capture weld fumes, one or more of the following conditions will signal that this equipment is not doing an adequate job:

Though some degree of visible fumes will occur during welding, a dense fume cloud signals that the extraction system is not doing its job.

1) Visible fume and dust emissions: Some degree of visible fumes is inevitable during welding; but with a properly functioning extraction system, you should only see fairly light fumes through most of the shift. For example, in an ambient system that filters all the air in the shop, a light cloud may be visible during working hours but dissipate during break times or lunch when work ceases. If the cloud grows denser and denser throughout the day, there is probably an issue. It may be that you've outgrown the fume extraction system because of increased production, that it was improperly sized at the original time of installation, or that the equipment is malfunctioning.

2) Worker complaints: Welders complaining of health and discomfort problems are likely being exposed to an excessive level of fumes. Weld fumes are linked to a startling array of both short- and long-term health effects which are summarized in the next section of this article. Complaints should always be taken seriously and addressed as promptly as possible.

3) Failure to meet established air quality standards: Air quality testing using air sampling techniques is often performed to ensure that a shop is in compliance with OSHA regulations. OSHA has established permissible exposure limits (PELs) based on 8-hour time weighted average for hundreds of dusts, including the numerous metals contained in welding fumes. For further information, a good starting point is the OSHA Fact Sheet, *"Controlling Hazardous Fume and Gases during Welding"* (https://www.osha.gov/Publications/OSHA_FS-3647_Welding.pdf). By the time a shop fails an air quality test, heavy fume clouds and worker complaints will already be in evidence.

4) Premature plugging of filters and related equipment issues: If the filters in your fume extraction system are failing prematurely and requiring frequent change-out, the culprit may be excessive airflow for the filter media area. The collector may be too small for the job, or the filter pulse-cleaning system may not be working properly. The diaphragm and solenoid valves that regulate pulsing are critical for proper cleaning, so proper valve operation is something to monitor during preventive maintenance inspections.

The compressed air system is another potential source of trouble. If compressed air pressure is too low, the pulse cleaning system will not clean the filters properly. If the compressed air moisture content is too high, filter plugging or solenoid and diaphragm valve problems may result. Moisture problems in compressed air systems are especially prevalent when equipment located outside in winter climates experiences below freezing temperatures.

Health Problems for Welding Fumes

Overexposure to weld fumes caused by equipment malfunctions can cause a wide range of health problems from the following:

- **Metal dust particles** in welding fumes are an eye irritant and a leading cause of eye injuries in factories.

- **Manganese,** the primary metal in welding wire, can cause workers to feel exhausted, apathetic, weak or headachy. Chronic overexposure to such fumes leads to a condition known as "manganism", which is characterized by neurological and neurobehavioral health problems.

- **Hexavalent chromium** or **hex chrome** is a carcinogenic substance produced during welding or other types of "hot work" on stainless steel and other metals that contain chromium. Hex chrome overexposure can result in short-term upper respiratory symptoms, eye or skin irritations. Long-term, the greatest health danger associated with hex chrome exposure is lung cancer. Other major health effects include damage to the upper respiratory system, and allergic and irritant contact dermatitis. Respiratory tract problems can include inhalation damage to mucus membranes, perforation of septum tissue between the nostrils of the nose, and damage to the lungs. In addition, there may be injury to the eyes, skin, liver and kidneys.

  Once in the body, hex chrome typically targets some of the body's organs. A worker exposed to hex chrome may also experience symptoms such as sinus irritation, nosebleeds, stomach and nose ulcers, skin rash, chest tightness, wheezing and shortness of breath. The current OSHA PEL for hex chrome is extremely stringent, at 5.0 µg/ m3 (micrograms per cubic meter).

This weld shop uses a recirculating system that recycles clean air through the workplace downstream of the fume extraction process. It has been independently tested to produce emissions far below OSHA Personal Exposure Limits (PELs) for the metals contained in welding fumes.

- **Zinc oxide** is a pollutant generated by hot work on galvanized steel. Exposure can result in a condition known as “metal fume fever”, a short-term illness in which severe flu-like symptoms occur after a break from work, such as after a weekend or during a vacation. Due to the delayed reaction, it is often confused with regular influenza and many cases go undiagnosed.

- **Welding fumes** can also cause headaches. A factory employing 60 welders received daily complaints of headaches from the workers. The problem disappeared upon installing an ambient fume removal system.

This integrated safety monitoring filter prevents collected dust from re-entering the workspace if there should be a leak in the dust collector’s primary filtering system.

It is imperative to know and follow OSHA exposure guidelines for these and other metals, particularly where workers are at risk for long-term health effects.

But employee health is not the only concern. Welding fume or “smoke” consists of hot dust particles that rise to the ceiling. What most people don’t know is that these particles lose their buoyancy when they cool, falling to settle on floors, desks, office equipment, furniture and paperwork. No one wants to work in a dirty shop.

Machinery in the shop also suffers when weld fumes and dust get out of hand. Virtually every piece of equipment today – welding machines, cranes, robots, plasma cutters, etc. – contains a computer. When metal dust accumulates on sensitive electronic componentry, it can cause premature failure due to overheating and short circuiting. Equipment control cabinets with computers often have multiple small cooling fans on which dust buildup can cause reduced airflow as well as fan failures. This, in turn, leads to increased repair bills and costly, unexpected downtime. Fume and dust buildup in electrical power components can also cause arc flashes which are extremely dangerous and potentially fatal to personnel.

Fume Removal Options

In the past, when weld fumes became excessive, the simple solution was to open the shop door and exhaust the fumes outside. Due to today’s more stringent EPA regulations, that is no longer an option. If visible fumes are exhausted outdoors, the air is subject to stringent monitoring under EPA National Emission Standard for Hazardous Air Pollutants (NESHAP) Rule 6x. This rule went into effect in 2011 and is highly applicable to welding shops.

A high efficiency cartridge dust collector with top mount motor fan and silencer reduced floor space requirements and installation costs in this welding shop.

Example of a well-designed fume extraction system using high efficiency filtration, a custom ducting lay-out, and curtains to help containcontaminants within the process area.

Within this standard are materials that contain 0.1% by weight cadmium, chromium, lead, or nickel; or 1.0% by weight manganese. Manganese is the material of widest concern to the welding industry, as it is virtually a universal component of welding wire.

Under the new EPA guidelines, if you opt to exhaust the air straight outdoors, you must take an EPA Method 22 Fugitive Emission test. Method 22, which is conducted to provide a visual determination of fugitive emissions from material sources, is performed by a trained observer who observes an exhaust stack during a 15-minute timed test. If opacity – defined as the quality of a particle that makes it impervious to light – is observed during 20 percent or more of the test (i.e., three minutes), Rule 6x applies. Involvement of an environmental engineering consultant is recommended to conduct the Method 22 test and provide third-party confirmation of whether a facility is in compliance.

If Rule 6x applies and a company has failed the Method 22 test; you must take these actions:

1) Notify the EPA.
2) "Tier 1" response: Change the process to eliminate the HAP. This might be accomplished by experimenting with different materials and/or different settings to reduce emissions. Whatever changes are made, equipment must always be operated in accordance with manufacturer's instructions.
3) Conduct another Method 22 Emissions test.
4) "Tier 2" response: If the second test fails, "Corrective action must take place immediately after the failed Method 22 test" per the Federal Register, page 42985, Welding compliance, Tier 2.

If air is contained indoors rather than exhausted outside, it is subject to OSHA requirements as above. The collector may also require safety monitoring filters (also called after-filters) for added filtration and backup protection.

If you factory air is conditioned, air recirculation is the single best way to save energy and maximize return on investment with a dust collector. By recirculating heated or air conditioned air back through the plant instead of venting it outdoors, the cost to replace that conditioned air is eliminated. Facilities in all regions report five- to six-figure annual energy savings, with the greatest savings seen in northern climates which experience longer, colder winters. In addition, the U.S. Department of Energy offers public utility-sponsored rebates and incentives for facilities that used recycled heated or air conditioned air.

The role of cartridge dust and fume collection

Whether you opt to exhaust air outdoors or recirculate air indoors, one strategy that offers multiple benefits is the use of a dust and fume collector with high efficiency cartridge filtration. Cartridge filtration is identified under Rule 6x as an acceptable control device to eliminate visible emissions, and will in many cases be the solution of choice.

A well-designed cartridge system will properly filter welding fumes and other hazardous contaminants, and the filtered air can either be exhausted outside or recirculated back into the facility for significant energy savings. These systems use self-cleaning mechanisms that pulse dirt off the filters, allowing units to run for extended periods between filter change-outs.

There are three general types of cartridge dust and fume collection systems used to clean up welding processes:

a) **Source capture** systems are popular for applications involving small parts and fixture welding. They will typically utilize a flexible source capture arm or a complete enclosure around the operation, such as an enclosure around a robotic weld cell.

b) **Canopy hoods** are often utilized if the footprint area is a medium size such as 12-ft x 20-ft or less. Curtains or hard walls may be added to the sides to create a booth or enclosure, although the ability to use such barriers may be limited by workspace requirements or the presence of other equipment or processes in the area.

c) **Ambient** systems that filter all the air in

Robotic weld cells are equipped with individual hoods and ducting. A central fume extraction system keeps the area clean while providing the needed mobility.

the shop using a central system or multiple smaller collectors are often chosen to serve larger areas because they allow a facility involved in multiple operations to capture all the fumes.

Being proactive about weld fume control

There are several other proactive steps you can take to ensure that your fume extraction equipment is doing the best possible job.

Schedule regular inspections and perform periodic service. Verify that dampers are in position, valves are working and pulse cleaning systems are functioning properly. Check pressure drop on filters to make sure it has not exceeded the manufacturer's recommended limit. Check compressed air pressure and purge the compressed air header, looking for signs of moisture. If you are located in a cold climate, make sure that your compressed air has a dew point that is below the lowest temperatures your equipment will be exposed to.

Test your dust. If you're having issues or complaints, bring in an environmental engineer to perform air sample testing. This will allow you to pinpoint what pollutants are occurring and to determine whether you are below OSHA PEL thresholds. Also, if you haven't tested your dust for flammability and explosivity, NFPA guidelines call for you to do so. An environmental engineer or your fume collection equipment supplier can connect you with a lab that specializes in explosion testing.

Find a qualified equipment supplier. If you are performing preventive inspections and basic maintenance but still encountering problems, chances are the fume extraction system is undersized or inadequately designed for the application. Bring in an air pollution control supplier who is experienced in welding filtration system applications; who is knowledgeable about OSHA, NFPA and EPA requirements; and who has the technical resources to develop an engineered solution to the problem. This supplier should also offer a full range of equipment so as to offer unbiased advice on the right type of system for your shop.

Keeping weld fumes under control is needed for regulatory compliance and to keep workers healthy and productive. Good indoor air cleaning also prevents buildup of nuisance dust on electrical components, machinery and employee work stations.

Taking a proactive approach to weld fume control will still enable you to have a positive impact on your workers' health– while avoiding the fines or shutdowns that can result from non-compliance. When you add energy savings from air recirculation to the equation, you achieve the trifecta of compliance, health/ wellness and energy savings.

Exposure to Beryllium Dust

The Occupational Safety and Health Administration (OSHA) has issued a final rule that updates regulation established 40 years ago to prevent chronic beryllium disease and lung cancer in American workers by limiting their exposure to beryllium and beryllium compounds.

The new rule reduces the permissible exposure limit, establishes a new short-term exposure limit and requires employers to use engineering and work practice controls to limit exposure.

BERYLLIUM PROPERTIES
- Lightweight
- High strength
- Retains form under stress
- Durable
- Conductive
- Easily welded
- Corrosion-resistant
- Formable

What is beryllium and how it is used in industry?

Beryllium is a lightweight but extremely strong metal used in the aerospace, defense, telecommunications, automotive, electronics and medical specialty industries. Beryllium-copper alloys are widely used because of their electrical and thermal conductivity, hardness and good corrosion resistance. Welding provides the highest strength bond when joining copper beryllium to itself or to other metals.

Another form is beryllium oxide, which provides heat conductivity, high strength and hardness and electrical insulation. It is used in components such as ceramics, electrical insulators, microwave oven components, military vehicle armor, laser structural components and automotive ignition systems. Beryllium oxide ceramics are used to produce sensitive electronic items such as lasers and satellite heat sinks. Pure beryllium metal is used in a range of products such as X-ray transmission windows, nuclear reactor neutron reflectors, nuclear weapons, precision instruments, rocket propellants, mirrors and computers.

How are workers exposed to Beryllium?

Approximately 62,000 workers are exposed to beryllium on the job every year. Exposures occur when beryllium and beryllium-containing materials are processed in a way that releases airborne beryllium dust, fume or mist into the workplace air.

INDUSTRIES THAT USE BERYLLIUM
- Aerospace
- Defense
- Telecommunications
- Automotive
- Electronic
- Medical

Beryllium dusts are created during operations where beryllium is cut, machined, crushed, ground or otherwise mechanically sheared. Mists can also form during operations that use machining fluids. Beryllium fume can form while welding with or on beryllium components, and from hot processes such as those found in metal foundries. Occupational exposure to beryllium can also occur from skin, eye and mucous membrane contact with beryllium particulate or solutions.

Worker exposure occurs in foundry, smelting and refining operations; fabricating, turning, extruding, machining and grinding beryllium metal and alloys; beryllium and beryllium oxide ceramics production; and dental laboratory work. In addition, workers at coal-fired power plants may encounter beryllium when handling fly ash residue from the coal burning process. In the construction and shipyard industries, abrasive blasters and support personnel may be exposed to beryllium from slags. In these operations, significant beryllium exposures may occur because of the high dust levels generated despite the low beryllium content.

What are the health risks of beryllium?

Inhaling or contacting beryllium can cause an immune response that results in an individual becoming sensitized to beryllium. Individuals with beryllium sensitization are at risk for developing a debilitating disease of the lungs called chronic beryllium disease (CBD) if they inhale airborne beryllium after becoming sensitized.

Some workers may develop severe CBD symptoms very quickly, while others may not experience signs and symptoms until months or years after their exposure to beryllium. CBD can continue to progress even after a worker has been removed from exposure. Beryllium-exposed workers may also develop lung cancer.

Prevention by minimizing human exposure is the best strategy to protect workers from these devastating pulmonary diseases. OSHA estimates that the implementation of this rule will save 90 lives per year from beryllium-related diseases and prevent 46 new cases each year.

Key provisions and significant aspects

Facilities affected by the standard must comply with most of the requirements by March 12, 2018. They have until March 2019 to provide any required change rooms and showers and March 2020 to implement engineering controls.

Reduced exposure limit

This new, more stringent rule is expected to enhance worker protection by sharply reducing both short-term and long-term beryllium exposure. It reduces the OSHA permissible exposure limit (PEL) for beryllium to 0.2 micrograms per cubic meter of air (µg/ m3) over an eight-hour time-weighted average (TWA) work shift. It establishes a short-term exposure limit (STEL) for beryllium of 2.0 µg/m3 over a 15-minute sampling period.

Employers must use engineering and work practice controls to prevent excessive beryllium from becoming airborne where workers can breathe it in. In addition, they must limit access to high-exposure areas, provide respiratory protection when necessary and provide personal protective clothing when high exposures or skin contact is possible.

Engineering controls
OSHA will require employers to use engineering controls in areas that release airborne beryllium. These controls include wet methods and/or ventilation to capture airborne beryllium and keep worker exposure below the new PEL.

Exposure control plan
Employers are required to develop a written exposure control plan to demonstrate how they will achieve compliance. The plan should include procedures for minimizing cross-contamination, keeping surfaces as free as practicable of beryllium; minimizing the migration of beryllium from work areas to other locations within or outside the workplace. It must also list the engineering controls in practice to prevent exposure.

Medical surveillance
Medical exams, health monitoring and recordkeeping are required for employees who have been exposed at or above the PEL or who show signs of beryllium-related health effects. Effective engineering controls are often capable of maintaining airborne beryllium exposure below this action levels.

Determining compliance

Wherever a process releases airborne beryllium dust, fume or mist into the workplace air, OSHA states employers must assess the airborne exposure of each employee who is or may reasonably be expected to be exposed to airborne beryllium. The rule provides two assessment methods. The performance option requires the employer to assess the eight-hour TWA exposure and the 15-minute short-term exposure for each employee on the basis of any combination of air monitoring data and objective data sufficient to accurately characterize airborne exposure to beryllium.

Maintaining compliance using dust, fume and mist collection systems

A dust collector designed specifically of your operation is an accepted and proven engineering control that will filter hazardous contaminants to make indoor environments safer and healthier. Dry media dust collectors containing high efficiency cartridge filters along with high efficiency secondary filters are the best control for respirable particulate, ensuring that it will not spread and be inhaled by workers in other areas of the plant.

# # #

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