

WHITE PAPER

Ten Things You Need to Know About Hex Chrome and OSHA Compliance

Hexavalent chromium is a carcinogenic substance produced in a variety of processes. Is your facility impacted? Are you taking the proper steps to protect employees? This white paper will discuss important facts about hex chrome, health issues, methods and processes that produce hex chrome, and acceptable engineering controls for compliance.



*By Brian Richardson
Technical Departments Manager
Camfil APC*

 **camfil**
AIR POLLUTION CONTROL

1. Hex chrome is a major problem in the workplace, and exposure can occur in many ways.

According to the National Institute for Occupational Safety and Health (NIOSH), “an estimated 558,000 U.S. workers are exposed to airborne hexavalent chrome Cr(VI) compounds in the workplace.” Workers can be harmed from this exposure and the level of exposure depends upon the dose, duration, and work being done.

“Exposure generally occurs during ‘hot work’ such as welding on stainless steel and other alloy steels containing chromium metal.” A number of industrial processes used to manufacture 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
- Smelting of ferrochromium ore



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

Workers can be exposed to hex chrome in a number of ways. They can inhale it or it can be absorbed through their skin. They can also swallow it if they use improper hand-washing hygiene.

2. Hex chrome is a known carcinogen that carries multiple health risks.

NIOSH considers all Cr(VI) compounds to be occupational carcinogens. Lung cancer is the greatest health danger associated with hex chrome exposure. Other major health effects include nasal septum ulcerations and perforations, skin ulcerations, and allergic and irritant contact dermatitis.

Once in the body, hex chrome typically targets the body’s organs, especially the respiratory tract. Breathing in high levels of hexavalent chromium can cause irritation to the nose and throat. Symptoms may include runny nose, sneezing, coughing, itching and a burning sensation. Repeated or prolonged exposure can cause sores to develop in the nose and result in nosebleeds. Other problems can include damage to mucous membranes, perforation of septum tissue between the nostrils of the nose, and damage to the lungs. Some employees become allergic to hexavalent chromium so that inhaling chromate compounds can cause asthma symptoms such as wheezing and shortness of breath.

Workers can also develop an allergic skin reaction, called allergic contact dermatitis. This occurs from handling liquids or solids containing hexavalent chromium. Once an employee becomes allergic, brief skin contact causes swelling and a red, itchy rash that becomes crusty and thickened with prolonged exposure. Allergic contact dermatitis is long-lasting and more



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

severe with repeated skin contact. Contact with cuts and open sores can also lead to chrome ulcers, which heal slowly and leave scars.

3. OSHA sets the standard and enforces compliance, but does not prescribe solutions.

OSHA's May 2006 rule drastically reduced the permissible level of exposure to hex chrome in the workplace. It changed from 52 to 5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), a tenfold reduction.

More specifically, the current Permissible Exposure Level (PEL) is 5 $\mu\text{g}/\text{m}^3$ time-weighted average (TWA) in an 8-hour

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:

1. **Substitution** – using a different, less toxic material to reduce exposure
2. **Isolation** – completely enclosing or encapsulating the source of exposure
3. **Ventilation** – using exhaust and dust collection/filtration equipment to capture airborne hex fume particles near the source of generation

Though the standard sets forth these three options, OSHA does not prescribe solutions or recommend specific technologies. The employer is responsible for understanding the hazards and engineering the Best Available Control Technology (BACT) for their operations. OSHA's job is to enforce the hex chrome standard and monitor compliance in industrial workplaces.

4. You must perform air monitoring to determine if you are in compliance.

OSHA stipulates that every company that has a process that generates hex chrome must use monitoring to determine the 8-hour TWA exposure for each affected worker. OSHA offers two options for determining exposure, which are spelled out in detail in the standard:

1. A scheduled monitoring option; or
2. A performance-oriented option

If the scheduled monitoring option is used, exposure monitoring must be performed initially and periodically. For exposures that are determined to be at or above OSHA's PEL of 5 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) (8-hour TWA), exposure monitoring must be performed at least every three months. For exposures that are determined to be at or above OSHA's Action Level of 2.5 $\mu\text{g}/\text{m}^3$ (8-hour TWA), exposure monitoring must be performed every six months. Additionally, exposure

monitoring must be performed whenever there is a change in work processes or materials that may result in new or additional exposures to Cr(VI).

Scheduled monitoring is accomplished through personal air sampling. Workers wear 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 their respiratory rate. The material collected in the filter provides an accurate snapshot of operator exposure to hex chrome. Exposure is defined as the concentration of contaminant to which an employee would be exposed without using personal protective equipment like a respirator.

Alternatively, OSHA allows the “performance-oriented option” where exposures can be estimated using any combination of air sampling, historical monitoring data or objective data. Objective data means information such as air monitoring data from industry-wide surveys or calculations based on the composition or chemical and physical properties of a substance demonstrating the employee exposure to Cr(VI) associated with a particular product or material or a specific process, operation or activity. The data must reflect workplace conditions closely resembling the processes, types of material, control methods, work practices and environmental conditions in the employer’s current operations.

Whichever approach is determined to be the best for your situation, the standard requires you to keep an accurate record of all air monitoring performed.

5. Cartridge-style dust collection/filtration equipment offers the best available control technology.

A high-efficiency cartridge-style dust collector is the type of filtration system that best captures hex chrome. Older-style baghouse collectors and electrostatic precipitators do not typically offer high enough filtration efficiencies to remove this toxic contaminant to the required level.

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

1. **Source-capture systems** are popular for applications involving small parts and fixture welding. These systems typically use 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 cubic feet or less.



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



2. **Hoods** also capture dust and fumes at their source. They are typically used for medium-sized areas (12 ft x 20 ft or less). Hoods should be positioned as close as possible to the source of the hex chrome to prevent toxic contaminants from escaping, and they should be ducted to the cartridge collector.

3. **Ambient or general air-cleaning systems** filter all the air in the shop using a central system. These systems are often chosen to serve larger areas because they enable a facility to capture fumes from multiple operations. Though popular for general welding applications, ambient systems are generally not suited to hex chrome applications. This is because toxic particles can 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 provide a better solution for large areas.



Hoods over work area captures dust and fumes .

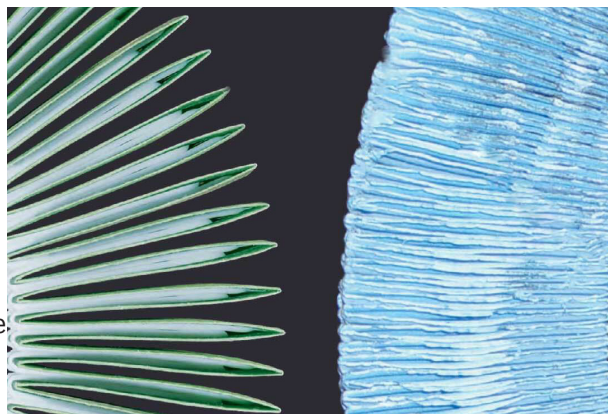
Whichever type of cartridge dust collection system you use must also be equipped with a HEPA safety monitoring filter – sometimes called a final filter, secondary filter or after-filter. Item #8 discusses the important role of a safety monitoring filter to achieve emission thresholds.

6. Filters provide widely different cleaning and removal characteristics.

We recommend long-life filters that use open-pleat, nanofiber media instead of conventional pleated filters. An open-pleat design allows more media to be exposed to the airstream and better airflow through the cartridge. This provides lower pressure drop and more energy-efficient performance. Open pleating also results in better cleaning characteristics, extending filter life. The fine-pored nanofibers act as a pre-filter to the base media, capturing most of the dust at the surface before it imbeds in the filter. This pleating technology further increases the filter's efficiency, cleanability and service life.

Extended filter life is always an attractive performance feature because of the obvious reductions in maintenance and replacement costs. However, in applications involving hex chrome, extended filter life is especially desirable because it reduces worker's exposure time to contaminated filters during change-out.

In addition, some dust collectors use horizontally mounted filters, while others use vertically mounted filters. Filters installed vertically are more effective because dust doesn't collect on the top of them and become entrained. They also have a reduced dust load and allow more efficient pulse cleaning, which extends filter service life between change-outs.



A view from below shows wide-pleat style cartridge filter media on the left, and standard, tightly-packed media on the right.

7. Pay close attention to filter efficiency ratings.

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

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.

Though the MERV scale is a useful tool, don't rely on MERV alone to select dust collector filters. The reason is that MERV ratings apply only to new filters, and the efficiency of dust collector filters changes a lot during actual use. As a dust collector runs, dust loads onto the filters, increasing their efficiency up to a point. When too much dust is loaded, airflow becomes restricted, forcing the dust collector to work harder and increasing the filter pressure. At that point, the pulse-cleaning system is triggered, knocking off the dust cake and starting the process over.

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 nanofiber 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.



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

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

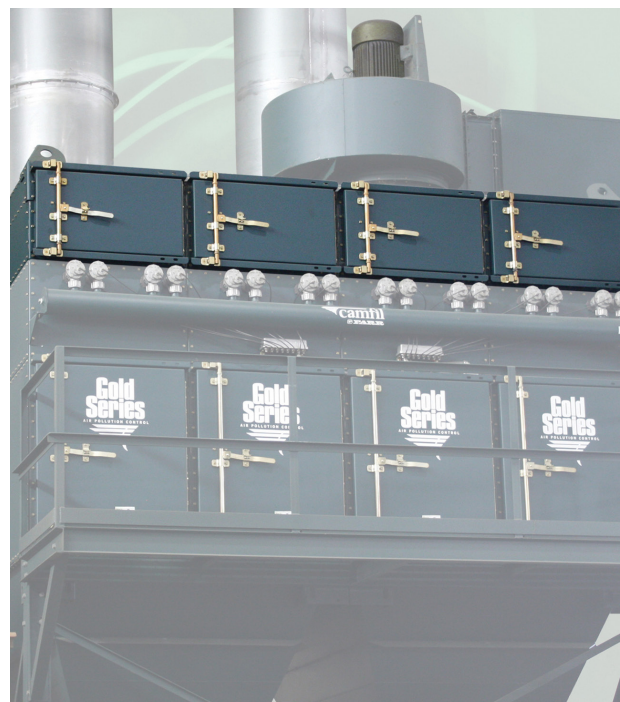
The best way to measure filter efficiency is to use ASHRAE Standard 199 testing, which challenges the filters inside the dust collector in ways that mimic real-life use. This testing provides performance data on emissions, pressure drop, compressed air usage, and energy consumption that is based on true operating conditions.

8. Why HEPA filtration is necessary: The math tells the story.

A filter rated at MERV 15-16 will filter airborne particulates down to 5 milligrams per cubic meter. This level of filtration efficiency will satisfy the great majority of general indoor air quality requirements. However, the PEL for hex chrome under the OSHA standard is 5 *micrograms* (not milligrams) per cubic meter – 1,000 times stricter than a MERV 16 air filter can reliably produce.

As a result, for processes involving hazardous metals, it is recommended that you use:

- A high-efficiency nanofiber media dust collector filter that delivers tested efficiency of MERV 15 per ASHRAE 52.2:2007. This represents best available control technology to provide the first line of filtration.
- A HEPA-rated secondary or safety monitoring filter tested to provide 99.97 percent particle removal efficiency at 0.3 micron. The HEPA filter is needed to protect employees at a level required to meet the hex chrome standard. It will also prevent collected dust from re-entering the workspace if there should be a leak in the dust collector's primary filtering system. Because of the heightened level of filtration, a safety monitoring filter also makes it possible to recycle air downstream of the collector. By recirculating heated or cooled air back through the plant, the cost to replace that conditioned air is eliminated, with rapid paybacks in energy savings.



Gold Series X-Flo with Integrated Safety Monitoring Filter (iSMF) on top

9. Ask the filter manufacturer for performance guarantees.

As noted above, filter efficiency ratings are useful for comparing like products, but they do not guarantee OSHA compliance. Ask your filtration product vendor to provide a written guarantee that the system will keep emissions at or below 5 micrograms per cubic meter at the fan discharge – i.e., downstream of the secondary HEPA filter. Your vendor should also be willing to guarantee the emissions performance of the primary dust collector filters. Be wary of vendors who will not provide a written guarantee, or who tell you it is unnecessary to use a HEPA filter for hex chrom applications.

Remember, a filter performance guarantee is not a substitute for the air quality monitoring procedures required under the OSHA hex chrome standard. However, it can help to ensure that you will achieve the results you're looking for.

10. An even more stringent exposure limit may be implemented.

As a final note, NIOSH published a report in 2013 that included recommendations for a far more stringent hex chrome limit. NIOSH's Recommended Exposure Limit (REL) to all airborne Cr(VI) compounds is 0.2 µg/m³ for an 8-hr TWA exposure – far below the current 5 µg/m³ threshold. The NIOSH report says: “The REL is intended to reduce workers’ risk of lung cancer associated with occupational exposure to Cr(VI) compounds over a 45-year working lifetime. It is expected that reducing airborne workplace exposures to Cr(VI) will also reduce the nonmalignant respiratory effects of Cr(VI) compounds, including irritated, ulcerated, or perforated nasal septa and other potential adverse health effects.”

The NIOSH report serves as an important reminder that hex chrome is an extremely serious health hazard. It cannot be known at this time whether the PEL of 0.2 µg/m³ will eventually be enacted as law. Until such a time comes, the current PEL of 5 µg/m³ will continue to serve as the basis for determining recommended engineering practices.

#

ABOUT THE AUTHOR

Brian Richardson, Technical Departments Manager, has been with Camfil Air Pollution Control since 2008 and has worked in and around manufacturing facilities for almost 25 years. He started as a Research and Development engineer, and progressed through various management positions where he was tasked with troubleshooting and servicing dust collectors and training personnel on the maintenance and construction aspects of the equipment. In his current role, Brian is a liaison between the manufacturing areas, sales and engineering departments and helps manage the company's maintenance and local community training programs. Camfil APC is a leading global manufacturer of dust collection equipment and is part of Camfil, the largest air filter manufacturer in the world. For further information, contact (800) 479-6801 or (870) 933-8048, e-mail **filterman@camfil.com**, or visit **www.camfilapc.com**.

REFERENCES

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), 1791 Tullie Circle, N.E. Atlanta, GA 30329; www.ashrae.org; “ASHRAE STANDARD 52.2-2007: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size,” 2007.

Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, 1600 Clifton Rd. Atlanta, GA 30333; www.cdc.gov/niosh; “Criteria for a Recommended Standard: Occupational Exposure to Hexavalent Chromium”, DHHS (NIOSH) Publication No. 2013–128, 2013

Occupational Safety & Health Administration (OSHA), 200 Constitution Avenue, Washington, DC 20210; www.osha.gov.

- OSHA Standard on Hexavalent Chromium (OSHA Standard 3373-10), 2009.
- OSHA Fact Sheet: Controlling Hazardous Fume and Gases during Welding, 2013.

Pharmaceutical Engineering, ISPE, 600 N. Westshore Blvd., Suite 900, Tampa, FL 33609; www.pharmaceuticalengineering.org/; “OSHA Limits Stainless Welding Fume Exposure to 5 micrograms/cubic meter. What will it take to be compliant”, Jan/Feb 2007.

© Copyright 2019 Camfil APC