CrVI: New Regulations and Detection Methods

The pending OSHA regulations affect general industry more than construction or shipyards.

by Jeffrey Duffy

Hexavalent chromium (CrVI) compounds are used in a variety of industries where potential exposures may occur. Metal plating, the use of pigments containing CrVI, and chemical synthesis where CrVI is used as a catalyst or as an ingredient can result in worker exposure. Welding on CrVI-painted surfaces can also result in the generation of CrVI. Exposure to CrVI has been shown to be associated with major health effects such as lung cancer, asthma, nasal septum, and skin ulcerations, and as allergic and contact dermatitis.

In January 2006, the new OSHA regulation on CrVI is supposed to go in effect (Occupational Exposure to Hexavalent Chromium, 29 CFR Parts 1910, 1915, 1918, and 1926). The most current version of the chromium rule was published as a Notice of Proposed Rulemaking (NPRM) in the October 4, 2004 *Federal Register*. The NPRM proposed three separate standards that cover exposure to CrVI in general industry, construction, and shipyards. By a court order mandate, the rule is supposed to be implemented by January 2006.

The financial impact of this rule will be quite significant, both from a perspective of capital investment as well as increased costs associated with additional worker training programs and an increase in time it will take to complete tasks working with materials containing chromium. This rule will have a particularly significant impact on the aerospace industry, where chromium-based primers are used extensively. It is estimated the initial annual costs of implementation of the new regulation will be approximately $18,000 per employee. For those aerospace facilities employing several thousand people, the result will be an initial financial outlay of tens of millions of dollars per facility.

Overview of the New Regulation

There are several fundamental changes proposed in the new regulation that will affect how occupational exposure to CrVI is managed. First, OSHA is proposing to drop the permissible exposure limit (PEL) from 52 to 1 microgram of CrVI per cubic meter (m^3) of air. Additionally, OSHA proposes other provisions for employee protection, including exposure control and monitoring, methods of compliance, protective clothing, respiratory protection, medical surveillance, the establishment of dedicated hygiene areas, new housekeeping recommendations, recordkeeping, and hazard communication. OSHA has tailored proposed regulatory texts separately for general industry, construction, and shipyards so the requirements can address varied circumstances found in each of these sectors. The regulations affect general industry to a greater extent than construction or shipyards.

The current PEL was established by OSHA in 1971 at a limit of 1 mg chromium trioxide per 10 m^3 of air, which corresponds with a concentration of 52 micrograms of CrVI per m^3. OSHA proposed the new PEL based on its analysis that showed exposure to CrVI at the current level results in a significant risk of lung cancer among exposed workers. It should be noted, however, that this analysis was based on workers primarily exposed to highly water-soluble chromium compounds, such as sodium chromate and sodium dichromate. Exposure to other, less soluble forms of CrVI is likely to present a much lower risk to exposed workers.

Another aspect of the new rule is a requirement of exposure monitoring. The monitoring will be used to determine the extent and degree of exposure at the work site; identify and prevent employee overexposure; identify the sources of exposure to CrVI; collect exposure data so the employer can select the proper control methods to be used; and evaluate the effectiveness of those selected methods. The rule requires employers to characterize the exposure of each employee potentially exposed to CrVI unless it can be shown that several employees are performing essentially the same tasks. When there are several employees performing the same tasks, the rule allows for monitoring of representative employees.

Establishing regulated areas is also required by the new rule. A regulated area is established wherever an employee's exposure to airborne concentrations of CrVI is, or can be expected to be, in excess of the PEL. The regulated areas are to be demar-

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cated from the rest of the workplace in a manner that adequately establishes boundaries and limits access to these areas only to authorized personnel.

Engineering and work practice controls have been established by the standard as the primary means of reducing and maintaining employee exposures to CrVI to levels that are at or below the PEL, unless the employer can demonstrate such controls are not feasible, or if employees are not exposed above the PEL for 30 or more days per year. Engineering controls are grouped into three main categories: substitution, isolation, and ventilation. It should be noted the rule prohibits the use of employee rotation as a means of limiting individual employees' exposure at levels above the PEL to 30 days or less.

When engineering and work practice controls are not sufficient to maintain CrVI concentration levels below the PEL, the rule requires that employers protect their employees through the use of respirators. The rule states respirators would be required as supplementary protection to reduce exposures during implementation of engineering and work practice controls or when engineering and work practice controls are not feasible, or when all feasible controls have been implemented but are insufficient to reduce and maintain the levels of CrVI to below the PEL.

Protective clothing and equipment also are to be provided by the employer at no cost to the employee. Examples of protective clothing and equipment given in the rule include, but are not limited to, gloves, aprons, coveralls, foot coverings, and goggles. Ordinary street clothes do not constitute protective clothing. No regulatory airborne concentration standard has been established for when protective clothing will be required because adverse health effects have been shown to occur as a result of dermal contact to relatively low concentrations of CrVI.

Medical surveillance is required to be provided by the employer for all employees exposed to CrVI at or above the PEL for 30 days or more per year. This medical surveillance must be performed by or under the supervision of a physician or other licensed health care professional. The rule states the purpose of the medical surveillance is to determine whether an individual can be exposed to CrVI present in his or her workplace without experiencing adverse health effects; to identify CrVI-related adverse health effects so appropriate intervention measures can be taken; and to ensure the employee is fit to use personal protective equipment, such as respirators. The employer will be required to provide medical examinations whenever an employee shows signs or symptoms of CrVI exposure or within 30 days after a health care professional's written medical opinion recommends an additional examination. In addition, examinations will be required within 30 days after an initial assignment unless the employee received a medical examination within the past 12 months.

The standard requires communication of the hazards of CrVI to employees through the use of signs, labels, and employee information and training. The standard also requires the employer to maintain records of exposure monitoring, medical surveillance, and training.

Finally, provisions in the new rule require the employer to provide hygiene facilities that serve to minimize exposure to CrVI and to maintain surfaces as free as practicable of CrVI, to promptly clean CrVI spills and leaks, to use appropriate cleaning methods, and to properly dispose of CrVI-contaminated waste. The rules states the housekeeping provisions are exceptionally important because they minimize additional sources of exposure that engineering controls generally are not designed to address. Good housekeeping is a cost-effective method of reducing employee exposure by removing CrVI from surfaces, thereby preventing re-introduction into the atmosphere, which would increase an employee's potential for inhalation exposure. Additionally, surface contamination of CrVI can greatly increase the likelihood of adverse health effects due to dermal exposure.

Of note in the rule, OSHA states the housekeeping requirement is similar to that provided in the rules for lead in construction (29 CFR 1926.62) and cadmium in construction (29 CFR 1926.1127) but differs in that the CrVI dusts generally will not be as easily identified as lead- or cadmium-contaminated dusts. To that end, new methods have recently been developed to quickly and economically determine CrVI contamination on skin and surfaces.

Colorimetric Determination of CrVI Contamination on Surfaces and Skin

Simple, straightforward, on-the-spot techniques have been developed using colorimetric chemistry to determine CrVI contamination on surfaces and skin. While there are no specific acceptable surface or skin contamination levels given in the new CrVI rule, colorimetric wipes and swabs can be used to determine which work practices and housekeeping are sufficiently protecting the employees working with CrVI. Semi-quantitative levels of CrVI can be determined down to as low as 0.05 μg per unit surface area.

In just a few minutes, the direct-reading site wipes and skin swabs can provide an indication of the presence or absence of CrVI. With an operating temperature range of 4-60°C and an operating humidity range of 10-98 percent RH for surface wipes and 10-90 percent RH for skin wipes, the surface wipes and skin swab can be used in virtually any working environment.

The surface wipes also are designed to prevent dirt or other dark substances from preventing the user from seeing a color change. The wipes are constructed with a collection matrix that can trap dirt, allowing the target substance to diffuse to the sensor chemical and allowing the user to observe the specified easy-to-interpret color change from the opposite side of the swiping surface, irrespective of any dirt or dark substances. To sample for contamination, the wipe is simply moistened with deionized water, wiped across the surface of interest, and color developed with a developing solution.

Similarly, skin swabs can be used to determine dermal contamination of CrVI. For the skin test, a wetted swab is wiped across the skin and the swab is then placed in a microcentrifuge tube to which a developing solution is added. The microcentrifuge tube is then placed in a quantitative color comparison chart and the relative mass of CrVI is read directly from the color chart.

Both sampling techniques have been shown to be highly selective with few interferences. They have been tested with various concentrations of aluminum, calcium, cadmium, chromium III, copper, iron, mercury, magnesium, nickel, and lead. The specificity of the CrVI tests was shown to not be

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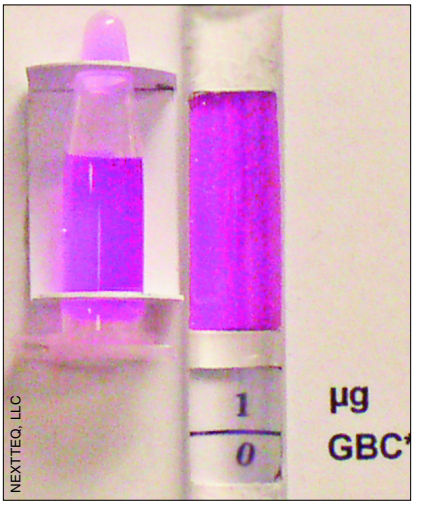
affected by these compounds over a relatively high mass range when compared to



the detection limits for CrVI.

The wipes and swabs allow the industrial hygienist to quickly and easily evaluate the safety and health programs, assess controls' effectiveness, determine the effectiveness of cleaning and decontamination procedures, and perform hazard assessments to comply with OSHA's new CrVI standard. With surface and skin wipes, the industrial hygienist also can monitor non-controlled areas of the working environment and evaluate the effectiveness of gloves and protective garments. ■

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