

**ALTERNATIVES TO OSHA'S DRAFT PROPOSED
HEXAVALENT CHROMIUM STANDARDS FOR GENERAL
INDUSTRY, MARITIME OPERATIONS, AND
CONSTRUCTION**

FINAL REPORT

For the U.S. Small Business Administration, Office of Advocacy

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The Office of Advocacy, an independent office within the U.S. Small Business Administration, has primary responsibility for government-wide oversight of the Regulatory Flexibility Act of 1980 (RFA), as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA). The principal goal of the RFA is to identify and, if possible, lessen the burdens federal regulations place on small entities. The Office of Advocacy sponsored this report under contract SBAHQ-00-D-0006. The report was created in connection with the SBREFA panel convened by OSHA on its draft proposed rulemaking on hexavalent chromium standards in general industry, maritime operations, and construction. The opinions and recommendations of the authors of this study do not necessarily reflect official policies of the SBA or other agencies of the U.S. government.

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Introduction

This report reviews the Occupational Safety and Health Administration's regulatory analysis in support of its draft proposed standards for hexavalent chromium [Cr(VI)] for general industry, maritime operations and construction and presents possible alternatives. If adopted, these alternative regulatory approaches would allow OSHA to achieve its regulatory objectives while imposing lower compliance costs on small businesses. Some of these alternatives are among the options that OSHA is now considering as possible amendments to the draft proposed standards. Other alternatives are unique to this document.

1.0 Critique of Small Business Compliance Costs

OSHA estimated the economic impacts of the proposed standards on small businesses for each of the five Permissible Exposure Limits (PELs). Jack Faucett Associates believes that the actual impacts would likely be more severe because (1) revenues and profits have declined since OSHA's baseline year and (2) compliance costs are likely to exceed OSHA's estimates.

1.1 OSHA Overestimates Revenues, Output, and Employment

OSHA utilized data from the 1997 *Economic Census* (e.g. Census of Manufactures) and *County Business Patterns, 2000* to estimate industry revenues.¹ OSHA's designation of 2000 as the base year for its economic analyses is problematic because the United States manufacturing sector has declined precipitously since then. From the beginning of the

¹ *Preliminary Initial Regulatory Flexibility Analysis (PIRFA) for a Draft OSHA Standard for Hexavalent Chromium* [hereinafter "PIRFA"] (OSHA Docket H054A, Ex. 33-4) (February 12, 2004), p. 39.

decline in manufacturing in 2000 until the first quarter of 2003, real earnings in manufacturing declined 14 percent in the United States.² Manufacturing employment plummeted 16 percent from June 2000 to September 2003 as output fell about 6 percent.³

Although manufacturing employment and output fluctuates with the economic cycle, the contraction of manufacturing in the United States since 2000 appears to be more severe than the downturn of the overall economy. If these are “structural” instead of “cyclical” losses, then recovery to the 2000-level of manufacturing output may take many years.

The Census Bureau’s most recent *Annual Survey of Manufactures* (2001) shows that many industries affected by OSHA’s Cr(VI) standards have declined more sharply than the U.S. manufacturing sector as a whole.⁴ Table 1 presents employment, total production hours, value added, and total value of shipments data for selected industries in which workers are exposed to Cr(VI).

² Timothy J. Bartik, “Thoughts on American Manufacturing Decline and Revitalization,” Employment Research (W.E. Upjohn Institute for Employment Research), Oct. 2003, p. 1. Real manufacturing earnings figures are derived from Regional Economic Information System of U.S. Bureau of Economic Analysis (BEA), divided by deflator from personal consumption component of GDP calculated by BEA.

³ Bartik, p. 1. Manufacturing employment and output figures are for period from June 2000, the peak in manufacturing production, until September 2003. The U.S. Bureau of Labor Statistics provided employment figures. Output figures are based on the manufacturing industry production index of the Board of Governors of the Federal Reserve System.

⁴ U.S. Census Bureau, *Annual Survey of Manufactures: Statistics for Industry Groups and Industries: 2001* (issued January 2003). Data for 2002 will be released in mid-2004 with the 2002 *Economic Census* reports.

**Table 1: Manufacturing Industry Statistics:
Change from 2000 to 2001**

NAICS Code	Industry	All Employees	Production Worker Hours	Value Added	Total Value of Shipments
31,33	Manufacturing	-4.64%	-6.71%	-6.06%	-5.66%
325131	Inorganic dye & pigment mfg	-9.75%	-18.85%	7.39%	-5.48%
325211	Plastics material & resin mfg	-7.33%	-8.57%	-17.46%	-12.92%
32551	Paint & coating mfg	-3.58%	-7.89%	6.51%	0.10%
325991	Custom compounding of purchased resin	-7.62%	-6.50%	-11.94%	-9.69%
331492	Other nonferrous metal secondary smelting, refining	-7.11%	-6.95%	-11.18%	-5.08%
332820	Electroplating	-6.90%	-5.87%	-10.58%	-10.03%
33661	Ship & boat building	-7.13%	-7.56%	-3.74%	-3.16%

Source: U.S. Census Bureau, 2001 *Survey of Manufactures*, Table 2.

Employment and production worker hours declined from 2000 to 2001 in all of the selected industries. Value added declined in all industries except inorganic dye and pigment manufacturing and paint and coating manufacturing. The only industry in which total value of shipments increased was paint and coating manufacturing, by a mere one-tenth of one percent. In many industries in which workers are exposed to Cr(VI), the losses outpaced the general manufacturing decline. For example, whereas total value of shipments for general manufacturing declined 5.7% from 2000 to 2001, the electroplating industry lost 10% of its total value of shipments.

1.2 OSHA Underestimates Compliance Costs

The selection of a PEL has enormous ramifications for thousands of small businesses. Jack Faucett Associates believes that the OSHA estimates of costs are too low; for some businesses the added costs would be too great to bear and result in shutdown of operations.

Aggregate Compliance Costs

Table 2 shows OSHA’s estimates of total compliance costs for each industry sector at the proposed PELs. OSHA estimates that total compliance costs for a PEL of 10 µg/m³ would be \$147 million for general industry/maritime and \$17.8 million for construction.⁵ If the PEL is set at 0.25 µg/m³, then total compliance costs would be \$538 million for general industry/maritime and \$291.3 million for construction. If wet cement work is included in the construction standard, then total compliance costs are estimated to be \$259 million at a PEL of 10 µg/m³ and \$811 million at a PEL of 0.25 µg/m³.⁶

Table 2: OSHA’s Estimates of Total Compliance Costs for Draft Cr(VI) Standards

Industry Sector	Permissible Exposure Limit (PEL) (µg/m ³)				
	10.0	5.0	1.0	0.5	0.25
General Industry/Maritime	\$ 146.8	\$ 168.6	\$ 354.0	\$ 439.5	\$ 538.5
Construction (w/o wet cement)	\$ 17.8	\$ 22.1	\$ 70.1	\$ 212.9	\$ 291.3
Construction (w/ wet cement)	\$ 258.9	\$ 263.1	\$ 311.2	\$ 454.0	\$ 810.7

Source: PIRFA, Tables 7 and 8.

Engineering costs are likely to be much higher than OSHA predicts because facility operators will over-comply by aiming for airborne concentrations that are one-half of the Action Level (one-quarter of the PEL). Businesses must keep airborne concentrations below the AL in order to avoid triggering imposition of a medical surveillance program and more frequent periodic monitoring. Consequently, a PEL of 10 µg/m³ actually translates into an effort to reduce airborne concentrations to below 2.5 µg/m³.

⁵ PIRFA, Tables 7 and 8.

⁶ PIRFA, Table 10.

Per-Entity Compliance Costs for Small Businesses

Per-entity compliance costs are difficult to summarize because small businesses in many industries would be affected by the proposed standards. At a PEL of $10 \mu\text{g}/\text{m}^3$, OSHA estimated that small businesses in many industries would each spend less than \$5,000 per year in compliance costs, including engineering costs, recordkeeping costs, and labor costs (less than three percent of profits).⁷ If the PEL were set at $0.25 \mu\text{g}/\text{m}^3$, then many small businesses would each spend less than \$25,000 per year and contribute less than 15 percent of profits, OSHA contends.

Compliance costs are likely to be much higher than OSHA's estimates. As explained in the following section, small electroplaters believe that OSHA has grossly underestimated their likely expenses.

1.3 Case Study: Likely Impact on Small Electroplaters

Jack Faucett Associates discussed the proposed Cr(VI) rulemaking with three electroplaters (hereinafter Electroplaters A, B, and C).⁸ These electroplaters, all small businesses,⁹ are classified under NAICS 332813 (Electroplating, Plating, Polishing, Anodizing, and Coloring).

⁷ PIRFA, Table 4.

⁸ Electroplating is designated as industry "1." in Shaw Environmental, Inc.'s *Industry Profile* report. Producers of electroplating flakes, powders, and solutions are classified separately as "11. Plating Mixture Production." Plating mixtures are generally in flake, crystal, or solution form. Since plating mixtures are consumed only in the electroplating industry, plating mixture producers would be affected by a decline in electroplating business in addition to their own expenses to comply with the Cr(VI) standards.

⁹ The SBA small business size standard for NAICS 332813 is 500 employees.

OSHA says that the typical small business in NAICS 332813 has annual revenue of \$1,538,970 and a profit of \$97,531. This translates into a profit margin of 6.3%. Table 3 shows OSHA's estimates of annual compliance costs for a small business in NAICS 332813.

Table 3: OSHA's Per-Small Entity Compliance Cost Estimates for NAICS 332813 (Electroplating)

PEL ($\mu\text{g}/\text{m}^3$)	Compliance Costs per Small Entity	Compliance Costs as a % of Revenues	Compliance Costs as a % of Profits
10	\$4,000	0.26%	4.10%
5	\$4,134	0.27%	4.24%
1	\$7,110	0.46%	7.29%
0.5	\$12,045	0.78%	12.35%
0.25	\$13,842	0.90%	14.19%

Source: PIRFA, Table 4.

OSHA contends that compliance costs for a small electroplater at a PEL of $10 \mu\text{g}/\text{m}^3$ would be \$4,000 (4.1% of profits).¹⁰ A PEL of $0.25 \mu\text{g}/\text{m}^3$ corresponds with \$13,842 in annual compliance costs (14.19% of profits). The interviews with small electroplaters indicate that OSHA has under-estimated the impacts because actual compliance costs would be higher and actual profit margins may be smaller.

Electroplater A: Decorative Chrome Job Shop

Electroplater A is a decorative chrome plater that meets the current Cr(VI) standard by adding fume suppressant chemicals to its two 500-gallon electroplating tanks. Fume suppressants are feasible engineering controls at decorative plating shops, but not at most

¹⁰ PIRFA, Table 4.

hard chrome plating facilities such as Electroplaters B and C. Electroplater A's tanks have no ventilation systems at present.

A PEL of $25 \mu\text{g}/\text{m}^3$ could be attained at Electroplater A at low cost because fume suppressants are sufficient to keep airborne concentrations of Cr(VI) comfortably below an Action Level of $12.5 \mu\text{g}/\text{m}^3$. However, a PEL of $10 \mu\text{g}/\text{m}^3$ would trigger nearly \$125,000 in capital costs per standard 3' x 8' tank in order to install a local exhaust ventilation (LEV) system. This includes: engineering costs of \$15,000 to \$20,000 [to design a system that meets OSHA and EPA standards], permitting costs of \$10,000 [to obtain "authority to construct" from local air pollution control authority], collection system equipment costs of \$50,000, cost of a fume scrubber to comply with EPA's chromium emissions regulation (\$25,000), installation cost of \$20,000 [which could be more if tanks need to be moved apart to make room for collection equipment], and testing costs of \$5,000 to \$10,000 [\$5,000 per test; two tests are often required per tank]. Since Electroplater A has two tanks, its capital costs of complying with a PEL of $10 \mu\text{g}/\text{m}^3$ would be nearly \$250,000.

In addition, Electroplater A would lose revenue during the days that the new engineering controls are installed. It could de-concentrate the economic impact by staggering the installation on each tank, but the revenue loss would still be thousands of dollars.

Electroplater A's engineering controls would also incur annual operating costs. The ventilation system's five to ten horsepower motor would be running constantly,

increasing utility bills. The draft proposed standard would also cause increased maintenance expenses. Since Electroplater A does not heat or cool its building, it would not experience increased temperature control bills due to the hex chrome standard; electroplaters elsewhere would incur such costs.

If the PEL is set at 0.25 or 0.5 $\mu\text{g}/\text{m}^3$, then Electroplater A worries that chrome electroplating would largely disappear in the United States. The owner of Electroplater A notes that the cadmium OSHA standard caused a phase-out of most cadmium electroplating in this country.¹¹ He says that even though a substitute such as cobalt nickel is technologically feasible, it would cost ten times as much as chromium. Electroplater A believes that its customers would send their business to Mexico and other countries where chrome plating would be cheaper.

Electroplater B: Hard Chrome Job Shop

Electroplater B is a job-shop hard chrome electroplater, providing plating, precision polishing, and finishing services to large manufacturing plants. Electroplater B said that revenues have declined by one-third since late 2001; consequently, profits have evaporated to a mere one-percent margin in 2003. The highest exposure reading at a recent Cr(VI) testing was about 3.2 $\mu\text{g}/\text{m}^3$; Electroplater B fears that if the PEL is set at 10 $\mu\text{g}/\text{m}^3$, then it runs the risk of triggering medical surveillance and periodic monitoring if readings reach the 5 $\mu\text{g}/\text{m}^3$ Action Level.

If the PEL is set at any level below 10 $\mu\text{g}/\text{m}^3$, then Electroplater B would need to upgrade its local exhaust ventilation (LEV) systems to comply. Use of fume suppressants as an

¹¹ CITE to cadmium standard, info regarding cadmium standard

engineering control is not an option for many hard chrome platers because the chemicals cause pitting and surface defects in the product. Many electroplaters, including Electroplater B, have already installed tank covers wherever feasible.¹²

Electroplater B disagrees with OSHA's cost figures; they are far too low. It would easily exceed them if the facility exceeds the Action Level and triggers imposition of periodic monitoring and a medical surveillance program. The upgraded exhaust fans would exceed the design air flow rate for Electroplater B's scrubber, decreasing its efficiency and increasing chromium emissions beyond EPA's MACT standard.¹³ As a consequence, Electroplater B would need to tear out existing hoods, duct work, and emission control devices and replace them with equipment that can handle the higher flow rate. Electroplater B presently has three roof-top scrubber units with a combined flow rate of 41,000 cubic feet/minute. It would need to upgrade to 50,000 cubic feet/minute; the new scrubber units alone would cost \$200,000 to \$250,000 (the rule of thumb is \$4-\$5 per cfm). The new hoods and duct work would cost extra. The stack testing alone would cost \$5,000 per stack – and Electroplater B has three of them. Operating costs of the scrubber system would increase from the current \$123,000 to \$150,000 (based on an estimate of \$3 per cfm per year); this figure includes electricity expenses and the cost of re-heating the plant's interior in winter. Scrubber pads are replaced on an eight-year cycle, depending on factors such as mineral content of the

¹² Tank covers are not feasible in all electroplating operations. In decorative chrome shops, parts are usually in the solution for just a few minutes. Opening and closing a cover frequently hinders efficient operations. Furthermore, fumes build up underneath the cover, causing a large release of Cr(VI) when it is opened. In some hard chrome facilities, large parts are hoisted in and out of the tanks. Design of a tank cover that does not interfere with hoist chains is difficult or impossible.

¹³ "National Emission Standards for Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks," 40 C.F.R. Part 63, Subpart N.

cleaning water used over the preceding years. The cost of pads is about \$65,000. On an annualized basis, the engineering controls and other direct costs associated with the OSHA standard plus engineering study, air dispersion modeling, environmental permit, construction permit, control equipment cost, installation costs, and stack testing required by EPA regulations would exceed OSHA's estimate several-fold.

Electroplater B contends that OSHA has also underestimated medical surveillance costs. The draft proposed standard theoretically limits medical surveillance to employees who are (1) exposed above the Action Level for 30 or more days a year, (2) exposed in an emergency, or (3) experiencing signs or symptoms of adverse health effects associated with Cr(VI) exposure. Theoretically, under normal circumstances, this would limit medical surveillance to personnel working near the electroplating tanks. However, in practice, Electroplater B believes that all personnel at the facility would undergo medical surveillance. Social pressure within the workplace, along with fears of future toxic tort litigation, would force employers to include everyone.

Although OSHA says that firms in NAICS 332813 enjoyed a 6.3 percent profit margin in 2000,¹⁴ Electroplater B's pre-tax profit margin in 2003 was one percent. When all of Electroplater B's labor, material, capital, and existing regulatory expenses are combined, it is barely able to remain a viable business. Electroplater B says, "Sadly, we are not unique in this regard, as other members in our trade organization have done much worse." Since the new Cr(VI)-related control activities would be impossible to finance

¹⁴ PIRFA, Table 4. The profit margin (6.3%) is calculated by dividing profits per entity (\$97,531) by revenues per entity (\$1,538,970).

on a one-percent profit margin, Electroplater B may be forced into permanently closing its doors.

Electroplater B is uncertain what OSHA means by “dust controls while chromic acid flakes are added to tanks” as an engineering control.¹⁵ One employee adds about 200 pounds of flakes to the tanks every two weeks.¹⁶ The flakes do not create much dust, Electroplater B says. If electroplaters were forced to switch to chromic acid solutions to eliminate dust, then this would increase their costs significantly because the weight would increase several-fold and suppliers would charge a premium for the medium (water).

Electroplater C: Hard Chrome Job Shop

Electroplater C is another job shop hard chrome plater. It primarily serves the tool and die industry and handles parts of all sizes in its 14 tanks, ranging in capacity from 400 to 8000 gallons. Electroplater C underscored that hard chrome and decorative platers are different. Whereas decorative platers bathe each part for mere minutes, parts are submerged in hard chrome baths for hours or days. Therefore the tanks at Electroplater C are in use 24 hours per day, seven days per week.

Electroplater C disagrees with OSHA’s assertion that hard chrome electroplaters can simply “tweak” their systems to comply with the proposed Cr(VI) standards with small

¹⁵ Electroplaters A and C were also uncertain what OSHA meant by “dust controls.” Electroplater A uses chromic acid flakes and solution. Electroplater C prepares its “baths” with chromic acid crystals ; they are added once per week to all tanks by an employee wearing a mask and gloves.

¹⁶ The approximate ratio of chromic acid flakes to bath water is two pounds per gallon. Flakes must be periodically added to replenish the chromium that is plated onto the immersed metal parts.

expenditures. Electroplater C confirmed through tests that fume suppressants and foam blankets are not viable engineering controls to meet OSHA standards because of product quality problems and shortened life spans of the plating baths.¹⁷ Quality problems are not tolerated in today's global marketplace, Electroplater C said. Tank covers are impractical at Electroplater C's facility because chains used to lower and lift parts from the electroplating baths would interfere with the cover. Electroplater C has considered work practice controls as possible means of complying with a lower PEL, but is uncertain of their cost and whether they are feasible in practice.¹⁸

Electroplater C has expanded despite the downturn in the U.S. manufacturing sector, compensating for lean years in the late 1990s. It believes that some of this growth may be due to shutdown of competitors. Nonetheless, expansion in output does not necessarily translate into increased revenues and profits. Electroplater C's automotive industry customers have demanded a five percent reduction in prices annually in recent years. Electroplater C has been forced to yield to these demands as energy, health insurance, and wage/salary costs have increased, while operating, maintaining, and investing in its production system. Expenses related to OSHA's new Cr(VI) standard would aggravate its cost burden.

Like the other electroplaters surveyed, Electroplater C says that a lower PEL would also affect its emissions control systems, incurring expenses which are not included in

¹⁷ Electroplater C noted that disposal of the bath solution is more costly than the cost of the solution itself. Disposal of the solution is subject to clean water and hazardous waste laws. Electroplater C says that baths can be maintained indefinitely if properly treated.

¹⁸ Possible work practice controls include: new method of removal of parts from tanks, new method of rinsing parts after they emerge from tanks (perhaps with different type of nozzle), new positions for employees to stand while working near tanks, and use of masks in designated areas near tanks. Possible engineering controls include diversion boards to channel fumes.

OSHA's cost estimates for the Cr(VI) standards. Whenever production processes change, EPA regulations require Electroplater C to re-test all four of its exhaust stacks at a cost of \$7,000 to \$10,000 per stack. The total of \$28,000 to \$40,000 includes consulting fees and testing. In addition, the facility would lose one day of productivity (total of \$10,000 to \$15,000) as "dummies" are placed into the tanks to simulate maximum loads on the emissions control systems; customer jobs could not be processed that day. Therefore, Electroplater C would need to pay \$38,000 to \$55,000 to comply with the new PEL regardless of its level and regardless of the cost of new engineering and work practice controls. This figure easily exceeds OSHA's cost estimates for all types of electroplaters at every PEL.

Electroplater C installed its four exhaust/emission control systems in the late 1990s to comply with EPA's chromium emissions MACT regulation.¹⁹ They cost \$40,000 to \$75,000 each and replaced an existing exhaust system. Electroplater C says that it is still recouping these costs to pay off the \$275,000 loan that financed these engineering controls. Electroplater C has not calculated the complete maintenance costs. They include occasional cleansing of the scrubbers with purified water. It has two sets of filters that it rotates every two to three months, incurring a labor cost of about \$5,000 per switch. Electroplater C expects to replace filters every seven to eight years; it is in the process of replacing them at a combined cost of \$50,000 to \$60,000 for all four systems –

¹⁹ This was Electroplater C's third air pollution control system since it installed its first in 1975. Previous systems were wet scrubbers. Wet scrubbers, even closed loop systems, are less feasible now because of wastewater regulations. At facilities that have wet scrubber systems, OSHA's lower PEL for Cr(VI) also has water pollution regulation ramifications.

installation costs (mainly labor) and lost productivity will be additional expenses. OSHA did not take these costs into account in compiling its estimates.

If a new air pollution control system is necessary, then Electroplater C may be forced into substantially remodeling its operation. Costs would escalate, for example, if tanks needed to be re-located to make space for a different type of ventilation ductwork. A faster exhaust ventilation rate would only intensify the winter-time problem of negative air pressure at the facility (more of an inconvenience than a hindrance) and further increase heating expenses.

Electroplater C is also concerned about medical costs related to dermal exposure to Cr(VI). It intends to meet the Action Level in order to avoid medical surveillance related to airborne Cr(VI), but prevention of dermal exposure is much less controllable.

Electroplater C says that drops of electroplating bath inevitably precipitate onto employees on a daily basis. It is worried that these drops could be regarded as “signs or symptoms of the adverse health effects associated with chromium (VI) exposure,” triggering imposition of a medical surveillance program. For example, a disgruntled former employee may cause medical surveillance to begin even though this type of dermal exposure is not hazardous.

The electroplating industry case study suggests that OSHA’s compliance cost data may not be conveying the true impacts that the proposed Cr(VI) standards would have on small businesses.

2.0 Regulatory Alternatives

Alternative 1: Conduct Separate Rulemaking to Establish Standard for Construction

Construction facilities currently must meet a Permissible Exposure Limit (PEL) of 100 $\mu\text{g}/\text{m}^3$, measured as CrO_3 (eight-hour time-weighted average). This translates into 52 $\mu\text{g}/\text{m}^3$ of Cr(VI). The draft proposed standard for construction lowers the PEL to 10, 5, 1, 0.5, or 0.25 $\mu\text{g}/\text{m}^3$, measured as Cr(VI) (eight-hour TWA). The construction industry standard should be set at a future date in a rulemaking process separate from the general industry/maritime standard because there is little, if any, significant exposure to hexavalent chromium in construction. Where the potential for exposure exists, other overlapping standards reduce those exposures to insignificant levels.

Discussion

Construction should be the subject of a separate rulemaking because of unique characteristics of the industry. Exposures to Cr(VI) vary considerably based on type of task, the work location (indoors vs. outdoors), and other factors. Due to the dynamic nature of construction sites, designation of “regulated areas” is difficult. Every construction worksite changes on a daily basis. Subcontractors and work crews constantly change as the work progresses. As a consequence, sampling, monitoring and medical surveillance costs are difficult to predict and become enormously expensive, especially when “regulated areas” are broadly defined.

OSHA’s list of exposures to Cr(VI) in construction includes: (1) welding [especially of stainless steel], (2) abrasive blasting of chrome-containing paints and coatings, (3) spray

application of chrome-containing paints and coatings, (4) skin contact with wet cement, and (5) handling of lumber treated with chromated copper arsenate [CCA].²⁰ As the following analysis will show, these construction activities cause little exposure to Cr(VI), or are effectively regulated by existing OSHA standards [e.g., welding in confined spaces], or pose health hazards because of other factors [wet cement].

(1) Construction Welding

Exposures to Cr(VI) from construction welding vary greatly. Most of the exposures occur during stainless steel welding and cutting. Exposure studies of welding demonstrate that airborne Cr(VI) concentrations from welding in non-confined spaces are much lower than in confined spaces. While 9 out of 16 data points in the NIOSH research data for welding in confined spaces exceeded $10 \mu\text{g}/\text{m}^3$, none of the 19 data points for non-confined spaces exceeded that threshold.²¹ At construction sites, natural air flow tends to dissipate Cr(VI) welding fumes to concentrations that are indisputably safe; all eight samples of shielded metal arc welding outdoors were $0.05 \mu\text{g}/\text{m}^3$ or less, or below the level of detection.²²

Welding in confined spaces is already subject to OSHA's welding, cutting, and brazing standard for general industry and construction (29 C.F.R. § 1910.252).²³ OSHA's

²⁰ *Industry Profile*, p. 31-2. The list also includes industrial rehabilitation and maintenance, hazardous waste site work, and refractory restoration and maintenance.

²¹ *Industry Profile*, p. 2-81.

²² *Industry Profile*, p. 2-74.

²³ In addition, OSHA has a separate standard for work in confined spaces in general industry (issued on January 14, 1993). See 29 C.F.R. § 1910.146. A separate standard for confined and enclosed spaces in shipyard employment is found at 29 C.F.R. § 1915, Subpart B. A general standard for confined spaces in construction is now under

standard is based on American National Standards Institute (ANSI) standard Z49.1, “Safety in Welding, Cutting and Allied Processes.” The OSHA welding standard requires that “[a]ll welding and cutting operations carried on in confined spaces shall be adequately ventilated.”²⁴ Where ventilation is impossible, airline respirators or hose masks must be used.²⁵ The welding standard has special provisions for welding affecting fluorine compounds, zinc, lead, beryllium, cadmium, mercury, and stainless steel. The provision for stainless steel welding requires that “[o]xygen cutting, using either a chemical flux or iron powder or gas-shielded arc cutting of stainless steel, shall be done using mechanical ventilation adequate to remove the fumes generated.”²⁶

Section (g) of the proposed Cr(VI) construction standard requires respiratory protection during (1) work operations for which all feasible engineering and work practice controls have been implemented and such controls are not sufficient to reduce exposures to or below the PEL, (2) periods when engineering and work practice controls are being installed or implemented, (3) maintenance and repair activities, and (4) emergencies. The Respiratory Protection Standard already applies to construction sites (as well as general industry and maritime) in these situations.²⁷

development, but small entity representatives to a recent SBREFA Panel on Confined Spaces in Construction indicated that they follow the requirements of the general industry standard. (*Report of the Small Business Advocacy Review Panel on the Draft OSHA Standard for Confined Spaces in Construction*, November 24, 2003, p. 8.) The Panel recommended, inter alia, that OSHA consider a construction standard more closely resembling the general industry standard than the OSHA draft. (Panel Report, p. 24.)

²⁴ 29 C.F.R. § 1910.252(c)(4)(i).

²⁵ 29 C.F.R. § 1910.252(c)(4)(ii).

²⁶ 29 C.F.R. § 1910.252(c)(12).

²⁷ See 29 C.F.R. § 1910.134. The Respiratory Protection Standard requires employers to “establish and implement a written respiratory protection program with worksite-specific procedures” for selection, use, cleaning, storage, and maintenance of respirators.

(2) Abrasive Blasting of Paints & Coatings

Abrasive blasting is used to remove old paint from bridges and other metal structures prior to the repainting. Steel surfaces of bridges, water towers, and industrial buildings have historically been painted with lead-, zinc-, and Cr(VI)-containing primers and/or paints. As usage of Cr(VI)-containing paints and coatings decreases, future abrasive blasting projects will be less likely to encounter Cr(VI). During the late 1970s and early 1980s, use of Cr(VI)-containing primers began to decline.

Since paint applied before the 1990s usually contained lead, removal of these coatings is currently subject to the lead construction standard.²⁸

(3) Spray Application of Paints & Coatings

OSHA's environmental study for the proposed Cr(VI) standards acknowledges that application of new paints and coatings is less hazardous than removal of old coatings: "[T]he highest potential for worker exposure to hexavalent chromium from painting in the construction industry is in the removal of old paint."²⁹ Use of lead-based primers, zinc chromate, and other chromate-based primers has declined since the early 1990s due to environmental and safety rules. Chromate primers have been replaced with alkyd primers in new construction and repair/refurbishing projects. Lead chromate pigments are no longer components of anticorrosive paints used in the construction industry.³⁰

²⁸ See C.F.R. § 1926.62.

²⁹ *Industry Profile*, p. 3-8.

³⁰ *Industry Profile*, p. 3-7.

(4) Wet Cement, Concrete, and Mortar

Cement work has been excluded from the draft proposed construction standard for Cr(VI). Allergic contact dermatitis is the chief Cr(VI)-related health risk associated with wet cement. However, this risk is not uniquely attributable to Cr(VI) exposure. Contact dermatitis may be caused by other factors, including the causticity of cement (high pH), lime, and other trace metals. Industry standards indicate that good hygiene and personal protective equipment (esp. gloves) can prevent many cases of contact dermatitis from wet cement.³¹

(5) Lumber Treated With Chromated Copper Arsenate (CCA)

As indicated by exposure studies, industry practice changes have reduced construction workers' exposure to Cr(VI) from CCA –treated lumber below the level of detection.

First, the amount of Cr(VI) in lumber decreases as a function of time after treatment with CCA. One study concluded that less than two percent of total chromium remained as Cr(VI) one month after treatment and no Cr(VI) was detected three months after treatment.³² A 1981 NIOSH investigation of a construction site found no Cr(VI) in wood samples or workers' gloves and jackets. OSHA cites the Decker study as evidence of construction worker exposure to Cr(VI) from lumber use. The full-shift personal exposure for an outdoor residential deck contractor was 0.08 $\mu\text{g}/\text{m}^3$, well below the lowest proposed PEL. Estimated full-shift personal exposures of Cr(VI) for indoor sanders exceeded 1 $\mu\text{g}/\text{m}^3$ in two samples and 10 $\mu\text{g}/\text{m}^3$ in another sample. However, as

³¹ See Operative Plasterers and Cement Masons International Association, "Save Your Skin: Tips on Preventing Skin Problems" (brochure).

³² Industry Profile, p. 26-7.

the OSHA report acknowledges, the total dust exposures in these samples far exceeded the OSHA PEL for wood dust and the median and average wood dust exposures.³³ Also, the Decker study measured total chromium; OSHA estimated the Cr(VI) exposures based on an assumption that two percent of total chromium is Cr(VI). OSHA concedes that “expressing two percent of total chromium as hexavalent chromium may be an exaggeration.”³⁴

Second, treatment of lumber with CCA will decrease substantially in the next few years. Wood preservative manufacturers voluntarily decided to eliminate CCA-treated wood for non-industrial uses by the end of 2003, mainly due to arsenic-related health risks.³⁵ As of December 31, 2003, CCA can no longer be used to treat lumber intended for most residential applications such as decks, fencing, landscaping, and play-sets. CCA treated lumber that was produced prior to that date can still be purchased and used without restriction until inventories are depleted (mid to late spring 2004 in some regions). CCA-treated lumber will continue to be used only in highway construction, salt water applications, utility poles, and pilings, where exposures are minimal. Since the subjects of the Decker study were residential deck contractors and indoor playground equipment manufacturers, those Cr(VI) measurements are now moot because lumber used in such projects is no longer treated with CCA.

³³ Industry Profile, p. 26-9.

³⁴ Industry Profile, p. 26-8.

³⁵ Industry Profile, p. 12-3.

Alternative 1: Compliance Cost Savings

If Alternative 1 were adopted, the construction industry would avoid tens of millions of dollars of compliance costs. OSHA estimates that the total cost to the construction industry at a PEL of $10 \mu\text{g}/\text{m}^3$ would range from \$17.2 million to \$17.8 million.³⁶ If the PEL is $0.25 \mu\text{g}/\text{m}^3$, then costs would range from \$290.6 million to \$291.3 million. The accuracy of these numbers has not been independently confirmed; actual costs to the construction industry likely would be higher.

These cost estimates assume that regulated areas are smaller than would occur on actual work sites; employers are likely to designate large regulated areas out of fear that smaller ones would not pass OSHA compliance inspections. Consequently, periodic monitoring costs are likely to be higher.

Also, medical surveillance costs estimates are too low at their existing predicted levels (ranging from \$5.1 million at a PEL of $10 \mu\text{g}/\text{m}^3$ to \$15.0 million at a PEL of $0.25 \mu\text{g}/\text{m}^3$). The estimates include the direct costs of the medical exams and the wages/salaries of employees consumed during the exams (at least 90 minutes per employee per exam).³⁷

Medical surveillance costs are underestimated for two reasons. First, the per-employee costs are likely to be higher than OSHA calculated. Since most small businesses lack an on-site occupational health physician, employees will need to travel to and from their

³⁶ PIRFA, Table 8.

³⁷ PIRFA, Table 7, p. 45.

medical exam locations at their employer's expense; travel time plus the medical exam would likely consume one-half of a workday. The employer will be responsible not only for these travel costs, but also for the employees' travel time. Substitute workers likely would be less productive than the regular employees, resulting in more costs to employers. OSHA does not include the aforementioned expenses in its cost model. Second, the number of employees covered by the medical surveillance program is likely to be higher than OSHA predicts. Employees adjacent to regulated areas and elsewhere on construction sites will likely demand medical surveillance coverage. As the size and number of regulated areas increases to assure regulatory compliance, medical surveillance costs increase as more employees are subject to the program.

Alternative 2: Establish a Separate Cr(VI) Standard for Maritime Operations

The proposed Cr(VI) standards subject the maritime industry to the same standard as general industry. OSHA should consider a separate Cr(VI) standard for maritime.

Discussion

Maritime is a unique industry that blends attributes of general industry and construction. It includes ship repairing, shipbuilding, and shipbreaking operations. Like general industry, maritime workers are employed at a fixed site for many years. However, the working environment changes on a daily or weekly basis, depending upon the types of the projects at the yard. On some days a welder may work in a confined space; on others

he or she welds outdoors. Since maritime involves a dynamic working environment, it is more akin to construction than a static factory floor.

To address worker safety issues in maritime, employers consult with both marine chemists and safety officers. Marine chemists are the primary personnel at shipyards who technically assess workspaces and issue “tickets” that categorize them as safe/unsafe for workers, safe/unsafe for “hot work” (e.g. welding), among other safety factors. The tickets usually include safety instructions such as “Ventilate for 36 hours before allowing entry.” Safety officers implement the marine chemists’ instructions and train workers to act in accordance with them and other safety regulations. A maritime industry source urged greater involvement from marine chemists in the Cr(VI) rulemaking.

The primary source of exposure to Cr(VI) is in welding or cutting operations.³⁸ OSHA already has a separate welding, cutting, and heating standard for shipyard employment.³⁹ In lieu of a separate Cr(VI) standard for maritime, OSHA could add chromium to the list of “metals of toxic significance” in § 1915.51(d).

Shipyard A: Small⁴⁰ Ship Repair Facility

Jack Faucett Associates consulted with a small ship repair facility (Shipyard A, 100 to 150 employees) regarding possible compliance measures that it would undertake if the Cr(VI) PEL were lowered to 10 $\mu\text{g}/\text{m}^3$ or below. Workers are exposed to Cr(VI) at

³⁸ PIRFA, Table A-1.

³⁹ “Ventilation and protection in welding, cutting and heating,” 29 C.F.R. § 1915.51.

⁴⁰ The SBA size standard for maritime facilities is fewer than 1000 employees, with the exception of boat building, where 500 employees is the standard

Shipyards A in stainless steel and other forms of welding (both from the metal and the coatings), in abrasive blasting to remove ship coatings, and from CCA-treated wood.⁴¹

Shipyards A contends that the maritime welding exposure profiles in OSHA reports supporting the new standard is out of date; Shipyards A's worker safety specialist says that welding techniques and ventilation systems have improved since NIOSH and other authorities conducted their Cr(VI) exposure profiles in the mid- and late 1990s. Shipyards A suggests that OSHA redo its exposure profile under working conditions that utilize the new welding technologies that now prevail in the industry.

Shipyards A says that monitoring and medical surveillance for Cr(VI) will pose challenges because Cr(VI) is a new issue to most of the maritime community. Although many shipyards now test for total chromium, presently very few are capable of monitoring for Cr(VI). Moreover, no laboratory in the region has equipment to complete the tests. In addition, Shipyards A's informal survey of industrial medical practitioners found none in the region who were familiar with Cr(VI) medical surveillance techniques.

Shipyards A's likely response to the new standard would be to install as much local exhaust ventilation (LEV) as possible to reduce airborne Cr(VI) concentrations. Welders would be instructed to only "burn" stainless steel and other chromium alloys outdoors. If the PEL is set at 0.25 $\mu\text{g}/\text{m}^3$, nearly all welders would be affected because chromium is a minute constituent of many metals. If the PEL is set at a level that requires respirators

⁴¹ Zinc chromate once was a common coating (as a metal primer) in maritime. Shipyards A now encounters it only once or twice per year. Many shipyards are entirely phasing it out, according to Shipyards A.

and LEV everywhere, then the sheer number of LEV and respirator hoses in the confined areas of shipbuilding and repair projects would pose a safety hazard.

The representative from Shipyard A underscored that the lower PELs would not only affect the workers directly exposed to Cr(VI) during welding and abrasive blasting, but also the employees engaged in support tasks, such as housekeeping. If the PEL is set at a level that requires respirators, then costs would be magnified if support personnel were also required to use them.

Shipyard A is troubled by the enormity of medical surveillance costs. Many of its existing employees would be subject to the initial medical screening; it would keep all new employees away from Cr(VI) “regulated areas” to reduce future medical surveillance costs. Lacking the resources to meet the requirements of the lower PEL, Shipyard A would then outsource as much as possible any tasks with exposure to Cr(VI), just as it outsources asbestos removal work. The premium that Shipyard A would pay for these outsourced employees will add significantly to its cost of business, yet it is not reflected in OSHA’s cost estimates. Shipyard A is also concerned that the Cr(VI) standard may trigger litigation against the industry and increase workers’ compensation insurance premiums, other “virtual costs” that are unacknowledged in OSHA’s economic analyses.

At a minimum, since maritime worksites are more akin to construction sites than to general industry, housekeeping requirements could be relaxed in the same way the proposed standard for construction exempts construction sites from housekeeping. The

PIRFA explains, “Because construction sites are likely to be dusty environments, it may be impractical to require that surfaces be kept free of accumulated Cr(VI) dust since it might not be possible to distinguish Cr(VI)-contaminated dusts from other dusts.”⁴²

Shipyards A says it is “almost impossible” for shipyards to comply with the general industry housekeeping standards.

Alternative 3: Establish Permissible Exposure Limit (PEL) of 23 $\mu\text{g}/\text{m}^3$

The existing PEL for Cr(VI) is 52 $\mu\text{g}/\text{m}^3$. The highest PEL in the draft proposed standards is 10 $\mu\text{g}/\text{m}^3$, an 81 percent reduction from the existing PEL. OSHA should consider a PEL of 23 $\mu\text{g}/\text{m}^3$, derived from the “threshold” for lung cancer suggested by the Luippold study.⁴³

Discussion

The Preliminary Initial Regulatory Flexibility Analysis (PIRFA) provides only a cursory explanation for why PELs higher than 10 $\mu\text{g}/\text{m}^3$ are not considered in the proposed standards. The PIRFA states,

Health risk data and analyses indicate that the risk of lung cancer associated with exposure to 10 $\mu\text{g}/\text{m}^3$ Cr(VI) over a working lifetime is of a magnitude that would be considered significant by the Agency. Although OSHA is still evaluating these risk analyses, OSHA has made a

⁴² PIRFA, p. 65.

⁴³ Another alternative would be a higher PEL for small businesses only. In the lead standard, for example, large nonferrous foundries must meet a PEL of 50 $\mu\text{g}/\text{m}^3$, but nonferrous foundries with fewer than 20 employees may satisfy a PEL of 75 $\mu\text{g}/\text{m}^3$. See 29 CFR 1910.1025. The PEL of 50 $\mu\text{g}/\text{m}^3$ was deemed not economically feasible for small foundries. *Federal Register*, 55:3146-67 (January 30, 1990). Given the state of the economy of several industries affected by this rule, as reported by the SERs, we have reason to believe an argument in support of economic infeasibility of the draft proposed rule would prevail. We therefore recommend that OSHA perform a new economic analysis using more recent data, and provide a higher PEL for small businesses in those industries in which it is determined that the PELs in the draft proposed rule are economically infeasible.

preliminary decision not to consider an alternative PEL greater than 10 $\mu\text{g}/\text{m}^3$.⁴⁴

If OSHA is “still evaluating” the risk analyses, then rejection of PELs above 10 $\mu\text{g}/\text{m}^3$ is premature. A closer look at these studies indicates that some PELs above 10 $\mu\text{g}/\text{m}^3$ may not pose serious health risks.

As a default assumption, OSHA and other agencies suppose that a linear relationship exists between cumulative exposure to airborne chromium and lung cancer risk.⁴⁵ In contrast, some scientists believe that the linear relationship does not exist at low exposure levels because of the ability of the lungs to expel low levels of chromium. A threshold may exist up to which chromium exposure is safe. In other words, some studies support the contention that OSHA may be overestimating risk of lung cancer at low Cr(VI) exposure levels.⁴⁶

The PIRFA concedes that the scientific basis for three of its proposed PELs (1, 0.5, and 0.25 $\mu\text{g}/\text{m}^3$) is uncertain because a linear relationship between cumulative exposure and lung cancer may be non-existent at those levels:

The risk estimates at the very lowest Cr(VI) exposure levels (e.g., 0.25 to 2.5) are considered to be more uncertain than those projected at the higher Cr(VI) levels because they involve risk model extrapolations below the range of exposures experienced by the workers in the Gibb et al. and Luippold et al. studies. Thus, the accuracy of these risk estimates at low exposure levels is dependent on the premise that lung cancer risk

⁴⁴ PIRFA, p. 4.

⁴⁵ PIRFA, p. 22.

⁴⁶ K.S. Crump Group, Inc., “Selection of an Appropriate Dose Metric for Chromium Carcinogenicity: Evaluation of Physiologic, Kinetic, and Mechanistic Data” (prepared for OSHA, Sept. 2000), p. 6.

continues to be linearly related to cumulative exposure at lower Cr(VI) air concentrations.⁴⁷

The Luippold study suggests that Cr(VI) may not be carcinogenic at low cumulative exposures.⁴⁸ Luippold supports the possibility of a threshold effect for Cr(VI)-induced lung cancer. If this threshold exists, cumulative exposures below 1,050 $\mu\text{g}/\text{m}^3$ -years would present very little cancer risk.⁴⁹ If a worker was exposed to Cr(VI) for his or her entire 45-year working life, then this worker would need to be exposed to more than 23 $\mu\text{g}/\text{m}^3$ of Cr(VI) every year during his or her working life in order to contract Cr(VI)-induced lung cancer. Moreover, few employees are exposed to Cr(VI) throughout their working lives.⁵⁰ In addition, many workers, including those who work for chromate pigment consumers, are exposed to Cr(VI) intermittently. Since this OSHA data indicates that 23 $\mu\text{g}/\text{m}^3$ is likely a safe level of exposure to Cr(VI), this supports a PEL and an Action Level greater than 10 $\mu\text{g}/\text{m}^3$, the highest PEL proposed under the new standards.

OSHA appears to take the position that even if lung cancer risk is low, the danger of nasal tissue damage remains serious if the PEL were to exceed 10 $\mu\text{g}/\text{m}^3$. For example, the PIRFA states, "Occupational surveys and medical examinations have found an elevated occurrence of nasal tissue damage among chromium production workers and chrome electroplaters exposed repeatedly to relatively high levels of Cr(VI) (e.g. 10 to 50

⁴⁷ PIRFA, p. 23.

⁴⁸ R.S. Luippold et. al., "Lung cancer mortality among chromate production workers," *Occup Environ Med* 2003; 60:451-57.

⁴⁹ The unit " $\mu\text{g}/\text{m}^3$ -years" is a measure of cumulative exposure: 1,050 $\mu\text{g}/\text{m}^3$ -years means exposure to airborne concentrations of 1,050 $\mu\text{g}/\text{m}^3$ for one year, 525 $\mu\text{g}/\text{m}^3$ for two years, 105 $\mu\text{g}/\text{m}^3$ for ten years, etc.

⁵⁰ The mean work years in the Gibb et al. study of a chromate production plant in Baltimore, Md. was 3.1 years. The median was 0.39 years. See Table II in Gibb et al., "Lung Cancer Among Workers in Chromium Chemical Production," *American Journal of Industrial Medicine*, 38:115-26 (2000).

$\mu\text{g}/\text{m}^3$) ... Some studies have reported nasal ulcerations in as many as 50 percent of exposed workers and nasal perforations in as many as 20 percent of exposed workers.’⁵¹ However, the PIRFA does not cite these studies. OSHA ought to provide evidence of recent examples of nasal tissue damage from Cr(VI) exposure in the United States. In addition, data should be provided about the severity of these maladies; they are not terminal conditions and likely have short recovery periods.

OSHA’s estimation of employee risk from exposure to Cr(VI) relies heavily on two epidemiological studies of workers at chromate production plants in Baltimore, Maryland (Gibb et al. 2000) and Painesville, Ohio (Luippold et al. 2003).⁵² OSHA also used data from four other epidemiological studies (from other chromate production workers, stainless steel welders, and aerospace workers) to a limited extent. The over-reliance on chromate production plant data is problematic because the data does not reflect Cr(VI)-related health risk in the present time in this or other industries. Just one chromate production plant remains operating in the United States and it functions differently than the Baltimore and Painesville plants did in the pre-OSHA era. The Painesville plant operated from 1931 to 1972, with airborne concentrations of Cr(VI) decreasing over the years.⁵³ The average airborne concentration in the indoor operating areas of the plant in the 1940s was $720 \mu\text{g}/\text{m}^3$. It decreased to $270 \mu\text{g}/\text{m}^3$ from 1957 to 1964, and declined to $39 \mu\text{g}/\text{m}^3$ from 1965 to 1972.

⁵¹ PIRFA, p. 20.

⁵² PIRFA, p. 22.

⁵³ D.M. Proctor et al., “Workplace Airborne Hexavalent Chromium Concentrations for the Painesville, Ohio, Chromate Production Plant (1943-1971),” *Applied Occupational and Environmental Hygiene*, Volume 18(6): 430-49 (2003).

Furthermore, OSHA apparently did not use any data in the risk assessment from electroplaters, painting and coating establishments, abrasive blasting businesses, and chromate pigment users, industries in which worker exposures to Cr(VI) are different. Since these industrial processes utilize a variety of Cr(VI) compounds at varying exposure levels, the health effects may differ greatly. In addition, the medium may result in differing health effects: consider the physical differences between dusts (abrasive removal of paints and coatings), fumes (stainless steel welding), and mists (electroplating). As discussed elsewhere, the water solubility of compounds is believed to have a major effect on their mutagenic effects.

The health effects of Cr(VI) in welding fumes are also uncertain. The Hansen study of Danish welders found that welders had a higher incidence of lung cancer than the general population, but risk appeared to be concentrated among mild steel welders as opposed to stainless steel welders.⁵⁴ This suggests that factors other than Cr(VI) were causing the carcinogenic effects of welding fumes. However, the utility of this study is limited by its lack of exposure estimates. The Moulin meta-analysis of lung cancer in welders also found a significantly increased lung cancer risk associated with welding.⁵⁵ It found roughly the same risk between mild steel and stainless steel welding, but its utility in the Cr(VI) context is limited because chromium exposure was not specifically addressed.

⁵⁴ Environ International Corp., *Review and Quantitative Analysis of Recent Epidemiological Studies of Lung Cancer Associated with Chromium Exposure*, p. 6.

⁵⁵ Environ International Corp., *Review and Quantitative Analysis of Recent Epidemiological Studies of Lung Cancer Associated with Chromium Exposure*, p. 14.

The interviews with the electroplaters underscored an important point that distinguishes small from large businesses on the issue of employee health. The owners of Electroplaters A, B, and C also operate their businesses. Blood relatives and in-laws work at the facilities. Electroplaters A and C inherited their businesses from their parents; they are formulating plans to pass the operations to their children. Close personal connections to daily operations give small businesses incentives to minimize hazardous workplace conditions.

Alternative 4: Establish Separate PELs for Specific Chromium Compounds

OSHA should consider separate PELs for chemically diverse chromium compounds. Since Cr(VI) compounds have different effects on human health, they ought not be regulated to a uniform, “one size fits all” standard. Various authorities already recognize these differences and provide for different approaches to regulating certain compounds.

Discussion

The American Conference of Governmental Industrial Hygienists (ACGIH) has published Threshold Limit Values (TLVs) that vary according to type of chromium compound. It suggests 50 $\mu\text{g}/\text{m}^3$ for chromium trioxide, 12 $\mu\text{g}/\text{m}^3$ for lead chromate, 10 $\mu\text{g}/\text{m}^3$ for zinc chromate, 1 $\mu\text{g}/\text{m}^3$ for calcium chromate, and 0.5 $\mu\text{g}/\text{m}^3$ for strontium chromate.⁵⁶ Since the ACGIH has offered different TLVs for various Cr(VI) compounds,

⁵⁶ “Exposure Limits,” <http://www.osha.gov/SLTC/hexavalentchromium/pel.html> (visited March 6, 2004).

OSHA should request data from industry and consider PELs that vary among Cr(VI) compounds.

In addition to its TLVs for specific compounds, ACGIH has recommended generic TLVs based on water solubility of Cr(VI) compounds. It recommends a TLV of 50 $\mu\text{g}/\text{m}^3$ for soluble Cr(VI) compounds and a TLV of 10 $\mu\text{g}/\text{m}^3$ for insoluble Cr(VI) compounds.⁵⁷

The water solubility of Cr(VI) compounds may have a significant effect on incidence of lung cancer. Whereas highly soluble chromium compounds tend to be absorbed by lung tissue and reduced into trivalent chromium, sparingly soluble compounds tend to linger in the lungs, increasing their likelihood of damaging cells and causing cancer. Less soluble chromate salts (such as zinc, calcium, and strontium chromate) are more potent carcinogens in the respiratory tract than highly soluble chromate salts (such as sodium, potassium, and ammonium chromate).⁵⁸ The differential in health risks justifies a higher PEL for chromium compounds with relatively high water-solubility.

OSHA acknowledges in the PIRFA that water solubility likely is related to carcinogenic effect: “Most of the scientific evidence indicates that the highly water-soluble Cr(VI) compounds (e.g., sodium chromate/dichromate, chromic acid) are probably less carcinogenic than the slightly water-soluble (e.g., calcium chromate, strontium chromate)

⁵⁷ ACGIH, “Chromium Metal and Inorganic Compounds.” ACGIH’s recommended TLV for chromium metal and trivalent chromium is 500 $\mu\text{g}/\text{m}^3$.

⁵⁸ K.S. Crump Group, p. 10.

and insoluble compounds (e.g., lead chromate, zinc chromate).”⁵⁹ However, OSHA argues that all Cr(VI) compounds are nevertheless mutagens:

Since the chromate production workers in the Gibb et al. and Luippold et al. studies were primarily exposed to less carcinogenic highly water-soluble sodium chromate and dichromate, OSHA preliminarily believes that the lung cancer risk to workers exposed to equivalent levels of other Cr(VI) compounds will be of a similar magnitude, or at least as great as the risks projected in OSHA’s preliminary quantitative risk assessment.⁶⁰

The PIRFA indicates that OSHA plans to continue to evaluate the relative carcinogenic potency of Cr(VI) compounds, especially the highly insoluble and encapsulated lead chromate pigments and other inorganic color pigments.

Water Solubility-Based Standard: The California-OSHA Model

In 2000, Cal-OSHA lowered the PEL for water insoluble Cr(VI) compounds to 10 $\mu\text{g}/\text{m}^3$ yet retained a PEL of 50 $\mu\text{g}/\text{m}^3$ for water soluble Cr(VI) compounds.⁶¹ However, Cal-OSHA’s standard is not an ideal one. First, the relationship between chromium compound solubility and mutagenic effect may not be a direct one. Some chromium compounds with very low solubility may have less mutagenic effect than compounds that are slightly soluble or have intermediate solubility. As discussed in Alternative 5, lead chromate has very low solubility yet some authorities believe that it does not have a mutagenic effect.

⁵⁹ PIRFA, p. 25. See Alternative 4, below, for discussion about the carcinogenicity of lead chromates, which are highly insoluble. Some authorities contend that lead chromates are less carcinogenic than zinc chromates and other Cr(VI) compounds that are more soluble.

⁶⁰ *Id.*

⁶¹ 8 Cal. Code of Regs. § 5155 (Table AC-1). The Cal-OSHA Standards Board held a public hearing on the revised PELs on May 11, 2000 and adopted them on November 16, 2000. The revised PELs took effect on February 3, 2001.

Second, Cal-OSHA did not set an Action Level or require medical surveillance. In these respects, Cal-OSHA's Cr(VI) standard is dissimilar to U.S. OSHA standards. Therefore, the experience of regulated entities under Cal-OSHA's 10 µg/m³ PEL does not offer a realistic preview of impact on industry if the U.S. OSHA standard were set at the same PEL.

Third, Jack Faucett Associates was unable to locate any businesses in California that have been directly affected by the lower PEL for insoluble Cr(VI) compounds. A representative for the California Paint Council was unaware of the hexavalent chromium issue; air quality regulations regarding volatile organic compounds and other factors have severely curtailed paint and coating manufacturing in California, he said. The Cal-OSHA Research and Standards Division has not studied the effects of the lower PEL on industry.

Alternative 5: Establish Higher PELs for Chromate Pigments

Chromate pigments are used in many industries, including paint manufacturing, plastic colorant manufacturing, ink manufacturing, leather processing, and textile production. OSHA should consider a higher PEL for users of chromate pigments.

Discussion

OSHA concedes that risks associated with employee exposure to chromate pigments are unproven: "OSHA plans to continue to evaluate the scientific evidence on the relative carcinogenic potency of Cr(VI) compounds, particularly for the highly insoluble and

encapsulated lead chromate pigments and other inorganic color pigments.”⁶² OSHA lacks data about the actual health effects of Cr(VI) in chromate pigments; the agency must better demonstrate that exposure to chromate pigments causes a material impairment to worker health before it subjects chromate pigment users to a lower PEL.

Most businesses that use chromate pigments are “batch” processors; they use chromate pigments to fulfill particular orders and not on a daily basis. Since many chromate pigment consumers use Cr(VI) compounds intermittently, employees are not exposed continuously. If such facilities were required to install expensive engineering controls in order to continue use of chromate pigments, many would eliminate chromate pigments from their production processes.

This alternative depends on whether exposure to chromate pigments imposes a significant health risk. By design, chromate pigments have low solubility in water; otherwise they would be more likely to leach out of the products that contain them. Although some scientists assume that chromium compounds with low solubility in water are carcinogenic, not all induce lung cancer. Lead chromate has very low solubility; it is thousands of times less soluble in water than known carcinogenic chromates of zinc, strontium, and calcium.⁶³ Some authorities contend that lead chromate’s extremely low solubility makes it less biologically available to enter cells of the human body and cause mutagenic effects. For example, the Levy rat implantation study found no increased incidence of tumors resulting from exposure to lead chromate, but some chromates with

⁶² PIRFA, p. 25.

⁶³ *Handbook of Chemistry and Physics* (53rd edition).

greater solubility exhibited varying degrees of carcinogenicity.⁶⁴ The Wise study argues that lead chromate particles, although considered to be highly insoluble, can enter mammalian cells and cause mutagenic effects.⁶⁵ However, Cantox Health Sciences has independently reviewed the Wise study and concluded that it does not provide evidence for the bioavailability or carcinogenicity of lead chromate.⁶⁶

It is difficult to isolate the health effects of lead chromate pigments from zinc chromate pigments because both types of pigments are often manufactured or consumed at the same facilities. However, in factories that made only lead chromate pigments, there was no evidence to indicate that lead chromate caused an increased incidence of cancer.⁶⁷ An epidemiological study of lead chromate workers in Japan also concluded that lead chromate pigments did not cause an excess risk for malignant tumors.⁶⁸

Lead chromate pigments appear to be even less mutagenic when they are encapsulated in silica. The Connor and Pier study found lead chromate pigments and their silica-encapsulated counterparts to be non-mutagenic.⁶⁹

⁶⁴ L.S. Levy, P.A. Martin, P.L. Bidstrup, "Investigation of the Potential Carcinogenicity of a Range of Chromium Materials on Rat Lung," *British Journal of Industrial Medicine*, Vol. 43, No. 4, pp. 243-56 (1986).

⁶⁵ J.P. Wise Sr. et al., "The Cytotoxicity and Genotoxicity of Particulate and Soluble Hexavalent Chromium in Human Lung Cells," *Mutation Research*, 517, pp. 221-29 (2002).

⁶⁶ Letter, Dr. Earle R. Nestmann, Principal and Vice President, Cantox Health Sciences International, to Alan Gray, Dominion Colour Corporation, October 14, 2003. The Cantox Health Sciences conclusions have not been peer-reviewed.

⁶⁷ J.M. Davies, "Lung Cancer Mortality Among Workers Making Lead Chromate Pigments At Three English Factories," *British Journal of Industrial Medicine*, 41:158-69 (1984); W.C. Cooper, *An Epidemiological Study of Lead Chromate Plants*, Equitability Environmental Health, Inc. for the Dry Color Manufacturers' Association, March 1983.

⁶⁸ Kano, Katsumi, et al., "Lung Cancer Mortality Among a Cohort of Male Chromate Pigment Workers in Japan," *International Journal of Epidemiology*, Volume 2, No. 1, pp. 16-22.

⁶⁹ T.H. Connor, S.M. Pier, "Reduction of the Mutagenicity of Lead Chromate-Based Pigments by Encapsulation with Silica," *Mutation Research*, 245, pp. 129-33 (1990).

OSHA should consider retaining the current PEL for users of lead chromate pigments. No full-shift personal exposure exceeds $3 \mu\text{g}/\text{m}^3$ at printing ink production facilities.⁷⁰ For the paint and coatings manufacturing industry, a site visit by IT Corporation found that no full-shift personal exposure exceeds $1 \mu\text{g}/\text{m}^3$ and most were under $0.1 \mu\text{g}/\text{m}^3$.⁷¹

Table 4 shows that most establishments that consume chromate pigments have fewer than 500 employees:

Table 4: Employee Exposure to Hexavalent Chromium from Chromate Pigments (partial list of affected business types)

NAICS Code	Business Type	Employment Size by Establishment	Establishments	Firms	Employees
3261	Paint & Coatings Manufacturing	Total	1,441	53,235	1,155
		1-19	885	6,083	773
		20-499	550	36,375	319
		500+	6	10,777	63
3261	Plastic Colorant User	Total	13,588	11,291	845,187
		1-19	6,149	5,950	49,016
		20-499	7,271	4,720	664,600
		500+	168	621	131,571
325910H	Printing Inks, n.e.c.	Total	20	979	9
		1-19	13	224	5
		20-499	7	755	3
		500+	-	-	1

Source: *Industry Profile* report, Tables 8-1, 9-2, and 10-1.

Alternative 6: Maintain Current PEL for Facilities with Intermittent Exposure (Fewer Than 30 Days per Year)

OSHA should consider retaining the current PEL for establishments where employees are exposed to Cr(VI) above the PEL fewer than 30 days per year.

⁷⁰ Industry Profile, pp. 9-8 (Tables 9-4 and 9-5) and 9-10 (Table 9-6).

⁷¹ Industry Profile, p. 8-8 (Table 8-3).

Discussion

This alternative is modeled after OSHA's cadmium standard, but stops short of the complete exemption for intermittent exposure under that standard: "The requirement to implement engineering and work practice controls to achieve the PEL ... does not apply where the employer demonstrates the following: the employee is only intermittently exposed; and the employee is not exposed above the PEL on 30 or more days per year (12 consecutive months)."⁷² Similar language can be incorporated into OSHA's hexavalent chromium standards to cover such workplaces as

- users of chromate pigments
- operations involving only occasional welding of stainless steel or other chromium-containing products
- small electroplaters that add a couple of hundred pounds of chromic acid flakes or crystals to their tanks every two weeks. These tasks usually require one worker for a fifteen-minute period.
- decorative platers who could otherwise satisfy the PEL with fume suppressant chemicals in lieu of local exhaust ventilation systems.

This alternative would spare such facilities the expense of installing engineering controls solely for this task because workers would be exposed fewer than 30 days per year.

⁷² 29 CFR 1910.1027(f)(1)(iii). The wording of the cadmium standard for construction is slightly different: "The requirement to implement engineering controls to achieve the PEL does not apply where the employer demonstrates the following: The employee is only intermittently exposed; and [t]he employee is not exposed above the PEL on 30 or more days per year (12 consecutive months)." 29 CFR 1127(f)(1)(ii).

Alternative 7: Extend Phase-in Period and Reduce Recordkeeping Requirements for Small Businesses

Recordkeeping-Option 1 and Effective Dates-Option 1 are among the official alternatives discussed in the PIRFA. Recordkeeping-Option 1 would exempt businesses with fewer than twenty employees from maintaining records of employee exposure measurements, medical examinations, and training. Effective Dates-Option 1 would “delay start-up and effective dates for employers with fewer than 20 employees in order to give small entities more time to achieve compliance with more costly provisions.”⁷³ OSHA should consider allowing small businesses, as defined by SBA, a longer phase-in period for compliance with the new Cr(VI) standard and reducing their recordkeeping requirements.

Discussion

It is more costly for small businesses to comply with governmental regulation than for large businesses. Small businesses spend 60 percent more per employee than do their larger counterparts.⁷⁴ Small businesses are less likely to have full-time employees dedicated to regulatory compliance and have less access to capital and smaller cash flow to finance engineering controls at short notice. As a result, many environmental and worker safety regulations allow small businesses additional time to comply with changes.

As discussed elsewhere in this report, changes to engineering controls generally require construction permits and reviews by state and/or local environmental protection agencies. Electroplater A says that the permitting process takes nearly a year. Therefore,

⁷³ PIRFA, p. 133.

⁷⁴ *The Impact of Regulatory Costs on Small Firms*, Office of Advocacy, SBA, 2002.

businesses of all sizes would be unable to comply with the lower Cr(VI) standards on short notice.

As currently written, the proposed Cr(VI) standards do not provide small businesses with longer phase-in periods. Section (n) of the general industry/maritime standard requires all businesses to comply 150 days after the standard is published in the *Federal Register*. All business will have another nine months to install change rooms and another 21 months to implement the engineering controls.

If the rule allows small businesses additional time to comply with the proposed Cr(VI) standards, two issues must be resolved. First, the types of eligible “small businesses” must be defined, and second, the duration of additional time must be established.

The SBA definition of “small business” ought to be used. SBA generally defines a “small business” as a firm with 500 or fewer employees. Effective Dates-Option 1 advocates a small business definition of “fewer than 20 employees;” this is too stringent.

The duration of the extended phase-in period for small businesses could be an additional year to install change rooms and an additional two years to implement engineering controls. The longer phase-in period would permit small businesses to comply on a timeframe that recognizes their limited ability to finance and implement changes in business operations at short notice.

The definition of small business for delayed phase-in could also be applied to the recordkeeping requirements. Entities that meet this definition would not be required to maintain records of employee exposure measurements, medical examinations, and training during the phase-in period.

Jack Faucett Associates's interviews with facilities affected by the proposed standards confirmed that a delayed phase-in period would be beneficial to many small businesses. As explained above in Section 1, the United States manufacturing sector has declined severely since 2000. Many businesses are uncertain whether this is cyclical downturn or a permanent loss, Small Entity Representatives noted. They are uncertain if their businesses will remain viable even if no regulatory burdens are imposed. A delayed phase-in period would permit small businesses additional time to consider market conditions and assess if they can effectively "internalize" the costs of OSHA new regulations. Although a longer phase-in would merely "delay the inevitable" closure for some small businesses, others would find it helpful.

Alternative 8: Extend Phase-in Periods at Facilities That Have Installed Engineering Controls To Satisfy Other Regulations in Past 10 Years

The new Cr(VI) standard should not take immediate effect at facilities that have installed engineering controls to comply with other regulations in the past decade. By allowing such facilities to recoup the costs of existing control equipment before removing it to satisfy OSHA's standard, this alternative functions as a "credit;" it helps businesses to minimize total regulatory compliance costs. These facilities would be required to comply

with the OSHA's new Cr(VI) standard at the planned replacement date for the existing engineering controls.

Discussion

The proposed Cr(VI) standard is just one among the many governmental regulations with which general industry, maritime, and construction firms must comply. It requires implementation of engineering controls within two years after the standards take effect. The two-year timeframe for the Cr(VI) rule is problematic for establishments that would need to re-vamp engineering controls related to other environmental and worker safety regulations. If such establishments were required to tear out these controls before their planned replacement dates, these businesses would not only bear the costs of the new Cr(VI) control technology, but also lose the value of the prematurely-discarded engineering controls for other regulations. OSHA's cost estimates for the Cr(VI) standards do not include these expenses.

Electroplating establishments may especially benefit from this alternative. Electroplaters B and C, introduced above in Section 1.3, provided information about how the Cr(VI) standard would affect existing engineering controls for other regulations. Electroplaters B and C stressed the intertwined effects of a change in an OSHA standard on EPA emissions compliance. They feared that a lower Cr(VI) PEL would cause their sites not to comply with EPA's MACT chromium emissions regulations.⁷⁵ When EPA published

⁷⁵ "National Emission Standards for Chromium Emissions from Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks," 40 C.F.R. Part 63, Subpart N.

the final rule for chromium emissions from electroplaters in 1995,⁷⁶ Electroplater B spent \$250,000 on a scrubber. If OSHA lowers the Cr(VI) PEL to below 10 $\mu\text{g}/\text{m}^3$, then Electroplater B would likely need to spend more than \$75,000 on improved local exhaust ventilation systems at each electroplating tank. Since the increased air flow would exceed the existing scrubber's capacity, Electroplater B would also expend hundreds of thousands of dollars more to permit, install, test, and operate additional scrubbers. Electroplater C also stated that its air pollution control system would likely need to be overhauled, but was uncertain of the costs. "You don't over- or under-build your air system," Electroplater C said. Hence, OSHA's PEL choice has an expensive ripple effect that extends beyond compliance with OSHA's own standard.

OSHA should allow Electroplaters B and C to delay installation of engineering controls related to the Cr(VI) standard until they have recouped a substantial portion of the costs of existing engineering controls associated with other regulations, especially EPA's chromium regulation. One interviewed electroplater says that it is still re-paying its \$275,000 loan for the scrubber system installed in the mid-1990s to comply with EPA's chromium regulation. The end of the cost recoupment period would coincide with the planned replacement date of control equipment. Electroplater B stated that its scrubber pads are replaced approximately every eight years; the pad replacement date would be a possible time to install engineering controls to satisfy OSHA's Cr(VI) standard.

⁷⁶ *Federal Register*, January 25, 1995.

Alternative 9: Combine Cr(VI) Standards Compliance with Lead Rule Compliance Measures Wherever Possible

The Cr(VI) standards could be made less burdensome to facilities that are also affected by other standards, such as the lead standard.⁷⁷ For example, medical surveillance exams could be combined for lead and Cr(VI), whenever feasible. If employees must use respirators to comply with another standard, then it makes little sense to require employers to institute engineering and work practice controls to reduce Cr(VI) airborne concentrations, when those employees cannot be exposed to unsafe levels of Cr(VI).

Discussion

The maritime sector in particular is subject to many overlapping standards, and can minimize its compliance costs with no threat to employee safety. Maritime workers are exposed to lead in welding, painting, and abrasive blasting tasks. Although lead has largely been eliminated on modern ships, lead is found on most ships from the 1940s, 50s, and 60s and on foreign vessels. Many maritime workers presently use respirators as protection from airborne lead concentrations in sandblasting and needle gun tasks. These activities also expose workers to Cr(VI) as chromium-containing paint and coating particles are released into the air. Alternative 9 would allow shipyards to avoid installation of expensive engineering controls to meet the Cr(VI) PEL when the airborne concentrations of other hazardous substances would still require use of personal protective equipment.

⁷⁷ OSHA also ought to explore how the proposed Cr(VI) standards would interface with other standards, such as for cadmium.

Alternative 10: Separate Engineering Control Airborne Limits (SECALs) and Require Less Frequent Monitoring in Areas with Full-Time Respirator Use

Employees always use respirators in some regulated areas. The airborne concentrations of chemicals other than Cr(VI) are so high that engineering controls and work practice controls are not technologically or economically feasible to reduce all airborne contaminants to their PELs. A requirement that such businesses use expensive engineering controls to reduce airborne Cr(VI) would be extremely costly, sometimes with little reduction in health risk to employees. For example, many spray painters and abrasive blasters of chromium-containing paints and coatings currently use respirators at all times to protect themselves against exposure to volatile organic compounds, lead, particulate matter, and other hazards.

Discussion

Using the cadmium standard as a model, OSHA should set a separate engineering control airborne limit (SECAL) that would relieve facilities of installing more comprehensive engineering controls to meet the PEL for Cr(VI) where employees always use respirators. The proposed standards require periodic monitoring of airborne concentrations of Cr(VI) every three months if concentrations exceed the PEL. Since the facilities would concede that levels of Cr(VI) and possibly other chemicals are unsafe, such frequent monitoring would be a costly exercise to confirm the obvious. Instead, regulated areas subject to this SECAL would be subject to periodic monitoring every six months or once per year.

As called for in the “respiratory protection” section of the proposed standards, employers would need to institute a respiratory protection program in accordance with 29 CFR § 1910.134, if they have not already done so for exposure to other chemicals. This regulation requires tests of respirator effectiveness, medical evaluations, and recordkeeping. Employers would also need to comply the “protective work clothing and equipment” and “hygiene areas and practices” provisions of the proposed Cr(VI) standards.

This alternative would cover only the regulated areas where respirators are used. A particular facility would need to fully comply with the Cr(VI) standards in other regulated areas.

Although this would reduce some of the costs of engineering controls and monitoring and testing in some regulated areas, employers would still need to comply with other provisions of the Cr (VI) standard. For example, at some jobsites workers now use respirators without other personal protective equipment. The proposed Cr(VI) standards would require protective clothing to be worn with respirators whenever airborne concentrations exceed the PEL.

Establishing a SECAL would also permit use of respirators for short-term activities in lieu of costly engineering controls. Employees would be allowed to work under these conditions for up to five or ten minutes per day, which would be useful in regulated areas that are seldom occupied by employees. For example, packaging of some Cr(VI)-containing powders is generally an automated process in a special room. However,

occasionally an employee is required to enter the room for 4 to 5 minutes to adjust filling equipment or to perform other tasks that are impossible or extremely costly to automate. It is not cost-effective to install additional engineering controls to reduce airborne concentrations of Cr(VI) to lower levels. In addition to the cost of installing the high-powered ventilation systems and the expense of emissions control equipment that can tolerate the high air flow, the facility's production process would be delayed for one hour or more as the ventilation system reduces the airborne concentration of Cr(VI). The cost-effective solution would be to require the facility to meet a SECAL before allowing the worker to enter the room with a respirator.

This SECAL would reduce compliance costs at facilities that consume pigments.

Employees who handle the dry pigments would use respirators in lieu of installing very-high power LEV systems.