Table VIII-3. Estimated Number of Hexavalent Chromium-Exposed Workers Requiring Respirators after Application of Engineering and Work Practice Controls (by Industry and Alternative PEL)

Industry	Total No. of Exposed Employees	Number of Employees Requiring Respirators and Percentage of All Exposed Employees					
		0.25	0.5	1	5	10	20
		PEL (µg/m^3)					
Electroplating	66,859	10,171	5,701	964	0	0	0
		15.2%	8.5%	1.4%	0.0%	0.0%	0.0%
Welding - General Industry (stainless steel)	45,326	23,328	17,627	12,360	7,230	1,862	189
Welding –Maritime (stainless steel)	21,029	5,735	2,220	1,547	940	787	23
Welding – Construction (stainless steel)	60,450	28,756	20,721	14,377	5,875	2,261	840
Welding – Government (stainless steel)	942	407	302	224	93	36	13
Welding Stainless Steel Grand Total	*127,746*	*58,225*	*41,982*	*28,509*	*14,353*	*5,009*	*1,066*
		45.6%	*32.9%*	*22.3%*	*11.2%*	*3.9%*	*0.8%*
Welding - General Industry (carbon steel)	60,600	32,784	13,147	5,511	920	0	0
Welding – Maritime (carbon steel)	629	468	246	103	17	0	0
Welding - Construction (carbon steel)	80,404	32,784	17,275	7,241	1,208	0	0
Welding Carbon Steel Grand Total	*141,633*	*72,273*	*30,668*	*12,856*	*2,145*	*0*	*0*
		51.0%	*21.7%*	*9.1%*	*1.5%*	*0.0%*	*0.0%*
Painting - General Industry	37,543	11,037	10,802	1,350	810	704	432
Painting – Construction	33,408	17,120	15,978	5,543	1,460	326	815
Painting – Maritime	3,155	1,839	1,518	1,518	321	321	321
Painting – Government	8,147	4,278	3,993	1,385	366	81	203
Grand Total Painting	*82,253*	*34,274*	*32,291*	*9,796*	*2,957*	*1,432*	*1,771*
		41.7%	*39.3%*	*11.9%*	*3.6%*	*1.7%*	*2.2%*
Producers of Chromates	150	75	**21**	**21**	0	0	0
		50.0%	14.0%	14.0%	0.0%	0.0%	0.0%
Chromate Pigment Producers	52	39	**18**	**18**	**6**	**6**	**6**
		75.0%	**34.6%**	**34.6%**	**11.5%**	**11.5%**	**11.5%**
Chromated Copper Arsenate Producers	27	6	0	0	0	0	0
		22.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium Catalyst Producers	313	125	85	**85**	0	0	0
		39.9%	27.2%	**27.2%**	0.00%	0.00%	0.00%
Paint and Coatings Producers	2,569	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table VIII-3, contd. Estimated Number of Hexavalent Chromium-Exposed Workers Requiring Respirators after Application of Engineering and Work Practice Controls (by Industry and Alternative PEL)

Printing Ink Producers	112	85	**85**	**0**	0	0	0
		75.9%	**75.9%**	**0.00%**	0.00%	0.00 %	0.00 %
Plastic Colorant Producers and Users	492	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Plating Mixture Producers	118	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ferrochromium Producers	63	7	0	0	0	0	0
		11.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Steel Mills – Stainless Steel	9,276	1,236	1,180	0	0	0	0
Steel Mills – Carbon Steel	29,368	3,230	3,207	0	0	0	0
Downstream (Forging/Hot Rolling Mills)	1,076	0	0	0	0	0	0
Steel Mills – Grand Total	*39,720*	*4,466*	*4,387*	*0*	*0*	*0*	*0*
		11.2%	*11.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*
Iron and Steel Foundries	30,222	2,577	0	0	0	0	0
		8.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium Dye Producers	104	**103**	**103**	**103**	**64**	**58**	**45**
		99.0%	**99.0%**	**99.0%**	**61.5%**	**55.8 %**	**43.3 %**
Chromium Sulfate Producers	11	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chemical Distributors	3,572	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Textile Dyeing	25,341	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Producers of Glass	5,384	612	612	612	177	177	177
		11.4%	11.4%	11.4%	3.3%	3.3%	3.3%
Printing	6,600	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Chromium Catalyst Users	949	**705**	**705**	**705**	0	0	0
		74.3%	**74.3%**	**74.3%**	0.0%	0.0%	0.0%
Producers of Refractory Brick	90	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wood Working	14,780	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table VIII-3, contd. Estimated Number of Hexavalent Chromium-Exposed Workers Requiring Respirators after Application of Engineering and Work Practice Controls (by Industry and Alternative PEL)

Solid Waste Incinerations	2,391	0	0	0	0	0	0
		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Non-Ferrous Metallurgical Uses of Chromium	2,164	39	39	0	0	0	0
		1.8%	1.8%	0.0%	0.0%	0.0%	0.0%
Construction – Other[1]	4,069	90	0	0	0	0	0
		2.2%	0.0%	0.0%	0.0%	0.0%	0.0%
All Industries	*558,431*	*191,290*	*116,697*	*53,123*	*19,702*	*6,682*	*3,065*
		34.3%	*20.9%*	*9.5%*	*3.5%*	*1.2%*	*0.6%*

Bold numbers indicate intermittent use.

[1]"Construction – Other" includes industrial rehabilitation and maintenance, hazardous waste site work, and refractory restoration and maintenance.

Source: U.S. Dept. of Labor, OSHA, Directorate of Standards and Guidance, 2006.

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In determining technological feasibility OSHA has used the median to describe the exposure data. Since the median is a statistical term indicating the central point of a sequence of numbers (50 percent below and 50 percent above) it best describes exposures for most people. The median is also a good substitute for the geometric mean for a log normal distribution which often describes exposure data. As described by the Color Pigments Manufacturers Association, Inc. (CPMA) in an economic impact study by IES Engineers:

> The exposure distribution (assuming it is log normal) can be characterized by the geometric mean and standard deviation. The median (not the average) is a reasonable estimate of the geometric mean (Ex. 47–3, p. 54).

In contrast, the use of an arithmetic mean (or average) may tend to misrepresent the exposure of most people. For example, if there are a few workers with very high exposures due to poor engineering or work practice controls, the arithmetic mean will be artificially high, not representing realistic exposures for the workers.

The technological feasibility chapter of the FEA is broken down into five main parts: Introduction, Exposure Profile, Baseline Controls, Additional Controls and Substitution. The first part is an introduction to the application group, which outlines the major changes in the analysis between the Preliminary Economic Analysis and the Final Economic Analysis and addresses comments specific to the application group.

The next part of the technological feasibility analysis is the exposure profile. The exposure profile describes the prevailing exposures in each application group on a job-by-job basis. The exposure profile represents exposure situations that may be well controlled or poorly controlled. The data used to determine the current exposures were obtained from any of the following sources: OSHA site visits; the OSHA compliance database, Integrated Management Information System (IMIS); NIOSH site visits; NIOSH control technology or health hazard evaluation reports (HHE); information from the U.S. Navy; published literature; submissions by individual companies or associations; or, in a few cases, by consideration of analogous operations. While the exposure profile was developed from current exposures and is not intended to demonstrate feasibility, there were a few instances where the exposure profile was used as ancillary support for technological feasibility if there were a significant number of facilities already meeting the PEL. An example of this case can be seen in the production of colored glass, where over 90 percent of the exposure data were below 0.25 $\mu g/m^3$.

In the cases where analogous operations were used to determine exposures, OSHA used data from industries or operations where materials and exposure routes are similar. OSHA also tended to be conservative (over-estimating exposures). For example, exposure data for the bagging of pigments were used to estimate exposures for the bagging of plastic colorants. In both cases the operation consists of bagging a pigmented powder. However, exposures would tend to be higher for bagging pigments due to the fact that in pigments there is a higher percentage of Cr(VI) and the pigments tend to consist of finer particles than those in plastic colorants where the Cr(VI) particles are diluted with other ingredients. As Mr. Jeff Cox from Dominion Colour Corporation stated:

> Exposure of packers in the pigment industry, who are making a fine powder, is very much higher than packers in the plastics colorants industry, who are basically packing pellets of encapsulated product which are a few millimeters in diameter (Tr. 1710).

The use of operations that are more difficult to control to estimate analogous operations would result in an overestimate of exposures, subsequently resulting in an overestimate of the controls needed to reduce the exposures to Cr(VI) in those analogous operations.

The next section of OSHA's analysis of technological feasibility in the FEA describes the baseline controls. OSHA determined controls to be ''baseline'' if OSHA believed that such controls are commonly used in the application group. This should not be interpreted to mean that OSHA believes that all firms use these controls, but rather that the controls are common and widely