7. REGULATIONS AND ADVISORIES

International, national, and state regulations and guidelines pertinent to human exposure to chromium are summarized in Table 7-1.

Chromium disposal is regulated by the Clean Water Act Effluent Guidelines for the following industrial point sources: textiles, electroplating, organic chemicals, inorganic chemicals, petroleum refining, iron and steel manufacturing, nonferrous metal manufacturing, steam electric, ferroalloy, leather tanning and finishing, asbestos, rubber, timber products processing, metal finishing, mineral mining, paving and roofing, paint formulating, ink formulating, gum and wood, carbon black, battery manufacturing, coil coating, porcelain enameling, aluminum forming, copper forming, electrical and electronic components, and nonferrous metals forming (EPA 1998b).

An MRL of 0.000005 mg chromium(VI)/m^3 has been derived for intermediate-duration inhalation exposure to chromium(VI) as chromium trioxide mist and other dissolved hexavalent chromium aerosols and mists. The MRL is based on a LOAEL of 0.002 mg chromium(VI)/m^3 for upper respiratory effects in humans in the occupational exposure study by Lindberg and Hedenstierna (1983) which spanned both intermediate and chronic durations.

In the 1998 Draft for Public Comment, an MRL of 0.0001 mg chromium(VI)/m^3 had been derived for both intermediate and chronic exposures as chromium trioxide mist and other dissolved hexavalent chromium aerosols and mists. This MRL was also based on the study Lindberg and Hedenstierna (1983), but an exposure level of 0.001 mg chromium(VI)/m^3 had been considered a NOAEL, and there had been no adjustment from intermittent to continuous exposure. Further evaluation of this study indicated that a NOAEL could not be clearly defined; therefore, the LOAEL of 0.002 mg chromium(VI)/m^3 was selected and adjusted for continuous exposure for the concern that the nasal lesions could accumulate at a greater rate than the repair mechanisms. The MRL of 0.000005 mg/m^3 no longer applies for chronic exposure because concern that carcinogenicity associated with chronic exposure to hexavalent chromium compounds takes precedence.

An MRL of 0.001 mg chromium(VI)/m^3 has been derived for intermediate-duration inhalation exposure to chromium(VI) as particulate hexavalent chromium compounds. The MRL is based on a benchmark concentration of 0.016 mg chromium(VI)/m^3 for increases in lactate dehydrogenase activity in bronchiolavage fluid from rats in the study by Glaser et al. (1990).

In the 1998 Draft for Public Comment, an MRL of 0.0005 mg chromium(VI)/m^3 had been derived for intermediate-duration inhalation exposure to chromium(VI) as particulate hexavalent chromium compounds, based on a LOAEL of 0.025 mg chromium(VI)/m^3 in the study by Glaser et al. (1985). However, ATSDR evaluated the determination of the benchmark concentration performed by Malsch et al. (1994) and found it to be a more appropriate basis for the MRL.

A chronic oral reference dose (RfD) of 0.003 mg chromium(VI)/kg/day has been derived and verified by EPA for soluble salts of chromium(VI) (e.g., potassium chromate, sodium chromate, potassium dichromate, and sodium dichromate) (IRIS 2000b). The RfD is based on a NOAEL for systemic effects in rats exposed to 2.5 mg chromium(VI)/kg/day as potassium chromate in the drinking water for 1 year in the study by MacKenzie et al. (1958).

A chronic inhalation RfC of 0.008 µg chromium(VI)/m^3 has been derived and verified by EPA for chromic acid mists and dissolved chromium(VI) aerosols (IRIS 2000b). The RfC is based on a LOAEL for nasal septum atrophy in workers exposed to 0.002 mg chromium(VI)/m^3 (Lindberg and Hedenstierna 1983).

A chronic inhalation RfC of 0.0001 mg chromium(VI)/m^3 has been derived and verified by EPA for chromium(VI) particulates (IRIS 2000b). The RfC is based on a benchmark concentration of 0.016 mg chromium(VI)/m^3 derived from data for lactate dehydrogenase activity in bronchoalveolar lavage fluid in rats exposed to sodium dichromate (Glaser et al. 1990).

A chronic oral RfD of 1.5 mg chromium(III)/kg/day has been derived and verified by EPA for insoluble salts of chromium(III) (e.g., chromium oxide and chromium sulfate) (IRIS 2000a). The RfD is based on a NOAEL for systemic effects in rats fed 1,800 mg chromium(III)/kg/day for 5 days/week for 600 feedings (840 total days) in the study by Ivankovic and Preussmann (1975). EPA has determined that the data are inadequate for the development of an RfC for chromium(III) due to the lack of relevant toxicity study addressing the respiratory effects of chromium(III) (IRIS 2000a).

The Committee on Dietary Allowances, Food and Nutrition of the National Research Council has recommended an estimated safe and adequate daily dietary intake of 50–200 µg/day for adults based on the absence of chromium-deficiency signs in the major part of the U.S. population consuming an average of 50 µg chromium/day (NRC 1989). ATSDR has adopted the upper range of the estimated safe and adequate daily dietary intake of 200 µg/day as provisional guidance for oral exposure to chromium(VI) and chromium(III).

Table 7-1. Regulations and Guidelines Applicable to Chromium

Agency	Description	Information	Reference
INTERNATIONAL Guidelines:			
IARC	Cancer classification		IARC 1990
	Chromium(0)	Group 3[a]	
	Chromium(III)	Group 3[a]	
	Chromium(VI)	Group 1[b]	
WHO	European standards for drinking water—chromium(VI)	0.05 µg/L	WHO 1970, 1988
NATIONAL Regulations and Guidelines:			
a. Air:			
ACGIH	TLV-TWA—Chromium, metal and inorganic compounds as Cr	0.5 mg/m^3	ACGIH 1999
	Metal and chromium(III) compounds	0.05 mg/m^3	
	Water soluble chromium(VI) compounds	0.01 mg/m^3	
	Insoluble chromium(VI) compounds		
EPA	Chromium(III)		IRIS 2000a
	RfC	Not available	
	Chromium(VI)		IRIS 2000b
	Carcinogenic risk from inhalation exposure	1.2x10^{-2} µg/m^3	
	Chromic acid mists and dissolved chromium(VI) aerosols		
	RfC	8x10^{-6} mg/m^3	
	Chromium(VI) particulates		
	RfC	1x10^{-4} mg/m^3	
NIOSH	REL 8-hour TWA		
	Chromium metal	0.5 mg/m^3	NIOSH 1999a
	Chromium(II)	0.5 mg/m^3	NIOSH 1999b
	Chromium(III)	0.5 mg/m^3	NIOSH 1999c
	Chromium(VI) carcinogenic	0.001 mg/m^3	NIOSH 1999d
	Chromyl chloride (carcinogenic)	0.001 mgCr(VI)/m^3	NIOSH 1999e

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
OSHA	8-Hour time weighted average		29 CFR
	Chromium(II)	0.5 mg/m^3	1910.1000
	Chromium(III)	0.5 mg/m^3	OSHA 1999a
	Chromium metal and insoluble salts	1.0 mg/m^3	
	Chromic acid and chromates	1.0 mg$CrO_3/10m^3$	
	8-Hour time weighted average for shipyard workers		29 CFR 1915.1000
	Chromium(II)	0.5 mg/m^3	OSHA 1999b
	Chromium(III)	0.5 mg/m^3	
	Chromium metal and insoluble salts	1.0 mg/m^3	
	Chromic acid and chromates	0.1 mg CrO_3/m^3	
	8-Hour time weighted average for construction workers		29 CFR 1926.55 OSHA 1999c
	Chromium(II)	0.5 mg/m^3	
	Chromium(III)	0.5 mg/m^3	
	Chromium metal and insoluble salts	1.0 mg/m^3	
	Chromic acid and chromates	0.1 mg CrO_3/m^3	
b. Water:			
EPA	MCL—Chromium	0.1 mg/L	40 CFR 141.62 EPA 1999f
	MCLG—Chromium	0.1 mg/L	40 CFR 141.51 EPA 1999e
	Maximum concentration for groundwater	0.05 mg/L	40 CFR 264.94 EPA 1999b
	Drinking water standards—Chromium	0.1 ppm	40 CFR 141.32 EPA 1999h
	Ambient water quality criteria (water and fish consumption)		EPA 1980, 1987b
	Chromium(III)	170 mg/L	
	Chromium(VI)	0.05 mg/L	

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
EPA (*cont.*)	Water quality criteria		EPA 1999i
	Chromium(III)		
	Freshwater:	74 µg/L	
	Saltwater:	No Value	
	Water and organism:	Not determined	
	organism only:	Not determined	
	Chromium(III)		
	Freshwater:	11 µg/L	
	Saltwater:	50 µg/L	
	Water and organism:	Not determined	
	organism only:	Not determined	
	Chromium(VI)		
	Freshwater:	11 µg/L	
	Saltwater:	50 µg/L	
	Water and organism:	Not determined	
	organism only:	Not determined	
	Health Advisories for Chromium(III+VI), total		EPA 1996c
	10-kg child		
	1 day	1.0 mg/L	
	10-days	1.0 mg/L	
	Longer term	0.2 mg/L	
	70-kg adult		
	Longer term	0.8 mg/L	
	Lifetime	0.1 mg/L	
	DWEL[c]	0.2 mg/L	
FDA	Bottled water limit for chromium	0.1 mg/L	21 CFR 165.110 FDA 1999a
c. Food:			
FDA	Reference daily intake for vitamins and minerals—chromium	120 µg	21 CFR 101.9 FDA 1999c
d. Other:			
ACGIH	Cancer classification		ACGIH 1999
	Metal and chromium(III) compounds	A4[d]	
	Water soluble chromium(VI) compounds	A1[e]	
	Insoluble chromium(VI) compounds	A1[e]	

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
	Biological exposure indices—Chromium (VI)		ACGIH 1999
	Total chromium in urine		
	Increase during shift	10 µg/g creatinine	
	End of shift and week	30 µg/g creatinine	
EPA	Chromium(III)		IRIS 2000a
	RfD (oral)	1.5 mg/kg/day	
	RfC	Not available	
	Cancer classification	D-not classified	
	Chromium(VI)		IRIS 2000b
	RfD (oral)	$3x10^{-3}$ mg/kg/day	
	Oral cancer classification	D—not classified	
	Carcinogenic risk from inhalation exposure	$1.2x10^{-2}$ µg/m^3	
	Inhalation cancer classification	A—known human carcinogen	
	Toxic chemical release reporting—effective date	1/1/87	40 CFR 372.65 EPA 1999a
	Reportable quantities of hazardous substances		40 CFR 302.4 EPA 1999d
	Chromium—designated CERCLA hazardous substance under sections 307(a) of the Clean Water Act	5,000 pounds	
	Chromic acetate—designated CERCLA hazardous substance under sections 311(b)(4) of the Clean Water Act	1,000 pounds	
	Chromic sulfate—designated CERCLA hazardous substance under sections 311(b)(4) of the Clean Water Act	1,000 pounds	
	Chromic acid—designated CERCLA hazardous substance under sections 311(b)(4) of the Clean Water Act	10 pounds	

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
	Calcium chromate— designated CERCLA hazardous substance under sections 311(b)(4) of the Clean Water Act and RCRA section 3001	10 pounds	
DHHS	Carcinogen classification chromium and certain chromium(VI) compounds (calcium chromate, chromium trioxide, lead chromate, strontium chromate, and zinc chromate)	Known human carcinogens	NTP 1989, 1991, 1992, 1998
STATE Regulations and Guidelines: a. Air:			
Idaho	Chromium(VI)		ID Dept Health Welfare 1999b
	Acceptable ambient concentration for a carcinogen	8.3×10^{-5} µg/m^3	
	Chromium, chromium(I), and chromium(III)	0.025 mg/m^3	
	Acceptable concentration occupational exposure level	0.5 mg/m^3	
Kansas	Concentration limits for hazardous air emissions:		KS Dept. Health Env 1998
	chromium and	5 tons/year	
	chromium(III)	0.002 tons/year	
	chromium(VI)		
Kentucky	Significant emission level		KY Div Air Quality 1998
	Chromium metal, chromium(II), and chromium(III)	1.276×10^{-4} pounds/hour	
		1.276×10^{-5} pounds/hour	
	Calcium chromate, lead chromate, lead chromate oxide, and zinc chromate chromium(VI)	2.76×10^{-6} pounds/hour	
Louisiana	Allowable emission rate chromium(VI)	25 pounds/year	LA Air Quality Div 1998

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
STATE *(cont.)*			
Maine	Ambient air quality standards Total chromium annual average 24-hour average	 0.3 µg/m^3 0.05 µg/m^3	ME Dept Env Protection 1996
Massachusetts	Allowable ambient level		MA Div Air Quality Control 1998
	Chromic acid annual average 24-hour average	 1x10^{-4} µg/m^3 3x10^{-3} µg/m^3	
	Chromium(metal) annual average 24-hour average	 0.68 µg/m^3 1.36 µg/m^3	
	Chromium(VI) annual average 24-hour average	 1x10^{-4} µg/m^3 3x10^{-3} µg/m^3	
	Calcium chromate annual average 24-hour average	 1x10^{-4} µg/m^3 3x10^{-3} µg/m^3	
New Hampshire	Ambient air limit Chromium	0.12 µg/m^3	NH Air Resources Div 1998
New Jersey	Unit risk factor—inhalation Chromium(VI)	1.2x10^{-2} µg/m^3	NJ Air Management 1998
New York	Annual guideline concentration Chromium(VI) Chromium(III) Chromium oxide Lead chromate Lead chromate oxide	 2x10^{-2} µg/m^3 0.1 µg/m^3 0.15 µg/m^3 1.2x10^{-4} µg/m^3 2.1x10^{-4} µg/m^3	NY Div Air Resources 1998
North Carolina	Acceptable ambient concentrations Chromium(VI)—annual average Sodium chromate Zinc chromate	 8.3x10^{-5} µg/m^3 1.3x10^{-2} pounds/day 5.6x10^{-3} pounds/year	NC Div Env Management 1998

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
STATE *(cont.)*			
North Dakota	Ambient air quality standards— 8-hour average		ND Env Health Sect 1998
	Chromium metal	$5x10^{-4}$ mg/m^3	
	Chromium(II) compounds as Cr	$5x10^{-3}$ mg/m^3	
	Chromium(III) compounds as Cr	$5x10^{-3}$ mg/m^3	
	Chromium(IV) water soluble compounds	$5x10^{-4}$ mg/m^3	
Rhode Island	Acceptable level—annual average Chromium and chromium compounds	$9x10^{-5}$ µg/m^3	RI Dept Env Management 1992
South Carolina	Maximum allowable concentration Chromium(VI)	2.5 µg/m^3	SC Bureau Air Quality 1998
Vermont	Ambient standards—annual average		VT Air Pollution Control Div 1998
	Chromium(VI)	$8.5x10^{-5}$ µg/m^3	
	Chromium	0.12 µg/m^3	
Washington	Acceptable source impact levels		WA Dept Ecology 1998
	Annual average Chromium(VI)	$8.3x10^{-5}$ µg/m^3	
	24-hour average		
	Chromium(II), Cr	1.7 µg/m^3	
	Chromium(III), Cr	1.7 µg/m^3	
	Chromium(metal)	1.7 µg/m^3	
	Lead chromate, Cr	$4x10^{-2}$ µg/m^3	
Wisconsin	Acceptable emission levels Chromium, chromium(II), and chromium(III)		WI Dept Natural Resources 1997
	<25 feet	0.04 pounds/hour	
	25 feet	0.17 pounds/hour	
Wisconsin	Emission rates Chromium(VI)	.017 lb/hour	WI Bureau Air Management 1998
b. Water:			
Alabama	Drinking water quality standards—Chromium	50 µg/L	FSTRAC 1995

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
STATE *(cont.)*			
	Aquatic life criteria— Chromium(VI):		AL Dept Env Management 1998
	Freshwater acute	16 µg/L	
	Freshwater chronic	11 µg/L	
	Marine acute	1,100 µg/L	
	Marine chronic	50 µg/L	
Alaska	Chromium	0.05 mg/L	FSTRAC 1990
Alaska	Maximum contaminant level	0.1 mg/L	AK Dept Environmental Conserv 1999
Arizona	Drinking water quality— Chromium		FSTRAC 1995
	standards	50 µg/L	
	guideline	120 µg/L	
Arizona	Human health based guidance levels (HBGLs) for ingestion of contaminents in drinking water		AZ Dept Health Services 1999
	Chromium, total		
	Oral HBGL	100 µg/L	
	MCL	100 µg/L	
	Chromium(III)		
	Oral HBGL	7000 µg/L	
	MCL	100 µg/L	
	Chromium(VI)		
	Oral HBGL	35 µg/L	
	MCL	100 µg/L	
Colorado	Human health based criteria for groundwater	0.1 mg/L	CO Dept Public Health Env 1999
Connecticut	Chromium	0.05 mg/L	FSTRAC 1990
Delaware	Chromium	0.05 mg/L	FSTRAC 1990
Florida	Chromium	0.05 mg/L	FSTRAC 1990
Georgia	Chromium	0.05 mg/L	FSTRAC 1990
Hawaii	Chromium	0.05 mg/L	FSTRAC 1990
	Health guidelines applicable to all water— chromium(VI):		HI Dept Health 1999a
	Freshwater		
	acute	16 µg/L	
	chronic	11 µg/L	
	Saltwater		
	acute	1,100 µg/L	
	chronic	50 µg/L	
	Fish consumption	NS[f]	

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
STATE *(cont.)*			
Hawaii *(cont.)*	MCL applicable to all public water systems—chromium	0.1 mg/L	HI Dept Health 1999b
Idaho	Chromium	0.05 mg/L	FSTRAC 1990
	Groundwater quality	0.1 mg/L	ID Dept Health Welfare 1999a
Illinois	Chromium	0.05 mg/L	FSTRAC 1990
Indiana	Chromium(VI)	0.05 mg/L	FSTRAC 1990
Iowa	Chromium(VI)	0.05 mg/L	FSTRAC 1990
Kansas	Chromium	0.05 mg/L	FSTRAC 1990
Kentucky	Chromium	0.05 mg/L	FSTRAC 1990
Maine	Drinking water quality guidelines—Chromium	100 µg/L	FSTRAC 1995
Maryland	Chromium	0.05 mg/L	FSTRAC 1990
Massachusetts	Chromium	0.05 mg/L	FSTRAC 1990
Minnesota	Drinking water quality guidelines		FSTRAC 1995
	Chromium	100 µg/L	
	Chromium(III)	20,000 µg/L	
Mississippi	Chromium(VI)	0.05 mg/L	FSTRAC 1990
Montana	Chromium	0.05 mg/L	FSTRAC 1990
Missouri	Chromium	0.05 mg/L	FSTRAC 1990
Nebraska	Chromium	0.05 mg/L	FSTRAC 1990
New Hampshire	Chromium	0.05 mg/L	FSTRAC 1990
New Jersey	Chromium	0.05 mg/L	FSTRAC 1990
	Groundwater quality chromium, total	100 µg/L	NJ Dept Environmental Protection 1993
New Mexico	Chromium	0.05 mg/L	FSTRAC 1990
New York	Chromium(VI)	0.05 mg/L	FSTRAC 1990
North Carolina	Chromium	0.05 mg/L	FSTRAC 1990
North Dakota	Chromium	0.05 mg/L	FSTRAC 1990
Ohio	Chromium	0.05 mg/L	FSTRAC 1990
Oklahoma	Chromium	0.05 mg/L	FSTRAC 1990

Table 7-1. Regulations and Guidelines Applicable to Chromium (*continued*)

Agency	Description	Information	Reference
STATE *(cont.)*			
Oklahoma	Aquatic life criteria acute chronic	 Not given 50.0 µg/L	OK Dept Environmental Quality 1997
Oregon	Chromium	0.05 mg/L	FSTRAC 1990
Puerto Rico	Chromium	0.05 mg/L	FSTRAC 1990
Rhode Island	Chromium	0.05 mg/L	FSTRAC 1990
South Carolina	Chromium	0.05 mg/L	FSTRAC 1990
South Dakota	Chromium	0.05 mg/L	FSTRAC 1990
	Maximum contaminant levels— apply to community and non-transient and non-community water systems	0.1 mg/L	SD Dept Environmental Natural Resources 1998
Tennessee	Chromium	0.05 mg/L	FSTRAC 1990
Texas	Chromium	0.05 mg/L	FSTRAC 1990
Utah	Chromium	0.05 mg/L	FSTRAC 1990
Vermont	Chromium	0.05 mg/L	FSTRAC 1990
Virginia	Chromium	0.05 mg/L	FSTRAC 1990
Washington	Chromium	0.05 mg/L	FSTRAC 1990
West Virginia	Chromium	0.05 mg/L	FSTRAC 1990
Wisconsin	Chromium	0.05 mg/L	FSTRAC 1990
c. Other:			
California	Cancer potency value Chromium(VI)	0.42 $(mg/kg/day)^{-1}$	State of California 1991

[a]Group 3: Not classifiable as to carcinogenic potential
[b]Group 1: Carcinogenic in humans
[c]DWEL: Drinking water equivalent level. A lifetime exposure concentration protective of adverse, non-cancer health effects, that assumes all of the exposure to a contaminant is from a drinking water source.
[d]A4: Not classifiable as a human carcinogen
[e]A1: Confirmed human carcinogen
[f]NS: no standard developed as yet

ACGIH = American Conference of Governmental Industrial Hygienists; DHHS = Department of Health and Human Services; EPA = Environmental Protection Agency; FDA = Food and Drug Administration; IARC = International Agency for Research on Cancer; MCL = maximum contaminant level; MCLG = maximum contaminant level goal; NIOSH = National Institute for Occupational Safety and Health; OSHA = Occupational Safety and Health Administration; PEL = permissible exposure limit; REL = recommended exposure limit; RfC = inhalation reference concentration; RfD = reference dose; RQ = reportable quantity; TLV = threshold limit value; TWA = time weighted average; WHO = World Health Organization