

8. REGULATIONS, ADVISORIES, AND GUIDELINES

MRLs are substance specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites.

An MRL of 5×10^{-6} mg chromium(VI)/m³ has been derived for intermediate- and chronic-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)/m³ for upper respiratory effects in humans in the occupational exposure study by Lindberg and Hedenstierna (1983), which spanned both intermediate and chronic durations.

An MRL of 0.0003 mg chromium(VI)/m³ 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)/m³ for increases in lactate dehydrogenase activity in bronchiolavage fluid from rats in the study by Glaser et al. (1990).

An MRL of 0.005 mg chromium(VI)/kg/day has been derived for intermediate-duration oral exposure to hexavalent chromium compounds for hematological effects (e.g., microcytic, hypochromic anemia) in rats using data from a study by NTP (2008a). Because several hematological parameters are used to define the clinical picture of anemia, the MRL is based on the average BMDL_{2sd} values for hemoglobin, MCV, and MCH of 0.52 mg chromium(VI)/kg/day.

An MRL of 0.001 mg chromium(VI)/kg/day has been derived for chronic-duration oral exposure to hexavalent chromium compounds. The MRL is based on a benchmark dose of 0.09 mg chromium(VI)/kg/day for diffuse epithelial hyperplasia of the duodenum in mice in a study by NTP (2008a).

An MRL of 0.005 mg chromium(III)/m³ has been derived for intermediate-duration inhalation exposure to insoluble trivalent chromium particulate compounds. The MRL is based on a minimal LOAEL of 3 mg chromium(III)/m³ for trace-to-mild septal cell hyperplasia and chronic interstitial inflammation of the lung in rats in the study by Derelanko et al. (1999).

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An MRL of 0.0001 mg chromium(III)/m³ has been derived for intermediate-duration inhalation exposure to soluble trivalent chromium particulate compounds. The MRL is based on a LOAEL of 3 mg chromium(III)/m³ for nasal and larynx lesions in rats in the study by Derelanko et al. (1999).

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 2008). 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)/m³ has been derived and verified by EPA for chromic acid mists and dissolved chromium(VI) aerosols (IRIS 2008). The RfC is based on a LOAEL for nasal septum atrophy in workers exposed to 0.002 mg chromium(VI)/m³ (Lindberg and Hedenstierna 1983).

A chronic inhalation RfC of 0.0001 mg chromium(VI)/m³ has been derived and verified by EPA for chromium(VI) particulates (IRIS 2008). The RfC is based on a benchmark concentration of 0.016 mg chromium(VI)/m³ 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 2008). 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 2008).

The Institute of Medicine (IOM) of the National Academy of Sciences (NAS) determined an adequate intake (e.g., a level typically consumed by healthy individuals) of 20–45 µg chromium(III)/day for adolescents and adults (IOM 2001)

The international and national regulations, advisories, and guidelines regarding chromium in air, water, and other media are summarized in Table 8-1.

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Table 8-1. Regulations and Guidelines Applicable to Chromium

Agency	Description	Information	Reference
<u>INTERNATIONAL</u>			
Guidelines:			
IARC	Carcinogenicity classification		IARC 2008
	Chromium, metallic	Group 3 ^a	
	Chromium (III) compounds	Group 3 ^a	
	Chromium (VI)	Group 1 ^b	
WHO	Air quality guidelines		WHO 2000
	Chromium (VI)	1 µg/m ³ for a lifetime risk of 4x10 ⁻²	
	Drinking water quality guidelines		WHO 2004
	Chromium (for total chromium)	0.05 mg/L ^c	
<u>NATIONAL</u>			
Regulations and Guidelines:			
a. Air			
ACGIH	TLV (8-hour TWA)		ACGIH 2007
	Calcium chromate (as Cr)	0.001 mg/m ³	
	Chromium and inorganic compounds (as Cr)		
	Metal and chromium (III) compounds	0.5 mg/m ³	
	Water-soluble chromium (VI) compounds	0.05 mg/m ³	
	Insoluble chromium (VI) compounds	0.01 mg/m ³	
	Lead chromate		
	As Pb	0.05 mg/m ³	
	As Cr	0.012 mg/m ³	
	Strontium chromate (as Cr)	0.0005 mg/m ³	
	Zinc chromates (as Cr)	0.01 mg/m ³	
	TLV basis (critical effects)		
	Calcium chromate (as Cr)	Lung cancer	
	Chromium		
	Metal and chromium (III) compounds	Upper respiratory tract and skin irritation	
	Water-soluble chromium (VI) compounds	Upper respiratory tract irritation and cancer	
	Insoluble chromium (VI) compounds	Lung cancer	

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Agency	Description	Information	Reference
NATIONAL (cont.)			
ACGIH	TLV basis (critical effects)		ACGIH 2007
	Lead chromate	Male reproductive damage, teratogenic effects, and vasoconstriction	
	As Pb		
	As Cr		
Strontium chromate (as Cr)	Cancer		
EPA	Zinc chromates (as Cr)	Nasal cancer	EPA 2007a EPA 2008a
	AEGL-1, -2, and -3	No data	
	Second list of AEGL priority chemicals for guideline development		
	Chromium (III) chloride	Yes	
EPA	Hazardous air pollutant		EPA 2007b 42 USC 7412
	Chromium compounds	Yes	
NIOSH	REL (8-hour TWA)		NIOSH 2005
	Chromium, metal, chromium (II), and chromium (III) compounds	0.5 mg/m ³	
	REL (10-hour TWA)		
	Chromium (VI) trioxide (as Cr) ^{d,e}	0.001 mg/m ³	
	IDLH		
	Chromium, metal (as Cr)	250 mg/m ³	
	Chromium (VI) trioxide (as chromium [VI]) ^e	15 mg/m ³	
	Target organs		
	Chromium, metal	Eyes, skin, and respiratory system	
	Chromium (VI) trioxide	Blood, respiratory system, liver, kidneys, eyes, and skin	
OSHA	Category of pesticides		NIOSH 1992
	Potassium chromate	Group 1 pesticide	
	Potassium dichromate	Group 1 pesticide	
	Sodium chromate	Group 1 pesticide	
	PEL (8-hour TWA) for general industry (ceiling limit)		OSHA 2007a 29 CFR 1910.1000, Table Z-2
Chromium (II) compounds (as Cr)	0.5 mg/m ³		
Chromium (III) compounds (as Cr)	0.5 mg/m ³		
Chromium metal and insoluble salt (as Cr)	1.0 mg/m ³		
	Chromium (VI) compounds	5 µg/m ³	OSHA 2007d 29 CFR 1910.1026

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Agency	Description	Information	Reference
<u>NATIONAL</u> (cont.)			
	PEL (8-hour TWA) for shipyard industry (ceiling limit)		OSHA 2007c 29 CFR 1915.1000
	Chromium (II) compounds (as Cr)	0.5 mg/m ³	
	Chromium (III) compounds (as Cr)	0.5 mg/m ³	
	Chromium metal and insoluble salt (as Cr)	1.0 mg/m ³	
	Chromium (VI) compounds	0.5 µg/m ³	OSHA 2007e 29 CFR 1915.1026
OSHA	PEL (8-hour TWA) for construction industry (ceiling limit)		OSHA 2007b 29 CFR 1926.55, Appendix A
	Chromium (II) compounds (as Cr)	0.5 mg/m ³	
	Chromium (III) compounds (as Cr)	0.5 mg/m ³	
	Chromium metal and insoluble salt (as Cr)	1.0 mg/m ³	
	Chromium (VI) compounds	0.5 µg/m ³	OSHA 2007f 29 CFR 1926.1126
b. Water			
EPA	Designated as hazardous substances in accordance with Section 311(b)(2)(A) of the Clean Water Act		EPA 2008b 40 CFR 116.4
	Ammonium dichromate	Yes	
	Calcium chromate	Yes	
	Chromium (III) sulfate	Yes	
	Potassium chromate	Yes	
	Strontium chromate	Yes	
	Drinking water standards and health advisories		EPA 2006a
	Chromium (total)		
	1-day health advisory for a 10-kg child	1 mg/L	
	10-day health advisory for a 10-kg child	1 mg/L	
	DWEL	0.1 mg/L	
	Lifetime	No data	
	National secondary drinking water standards		EPA 2003
	Chromium (total)		
	MCL	0.1 mg/L	
	Public health goal	0.1 mg/L	

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Agency	Description	Information	Reference
<u>NATIONAL</u> (cont.)			
	National recommended water quality criteria ^g	No data	EPA 2006b
	Chromium (III)		
	Freshwater CMC	570 µg/L	
	Freshwater CCC	74 µg/L	
	Chromium (VI)		
	Freshwater CMC	16 µg/L	
	Freshwater CCC	11 µg/L	
	Saltwater CMC	1,100 µg/L	
	Saltwater CCC	50 µg/L	
EPA	Toxic pollutants designated pursuant to Section 307(a)(1) of the Clean Water Act		EPA 2008i 40 CFR 401.15
	Chromium and compounds	Yes	
	Reportable quantities of hazardous substances designated pursuant to Section 311 of the Clean Water Act		EPA 2008c 40 CFR 117.3
	Chromium (III) sulfate	100 pounds	
	Potassium chromate	10 pounds	
	Strontium chromate	10 pounds	
c. Food			
EPA	Inert ingredients permitted for use in nonfood use pesticide products		EPA 2008e
	Chromium (III) oxide	Yes	
	Sodium chromate	Yes	
FDA	Bottled drinking water		FDA 2007a 21 CFR 165.110
	Chromium	0.1 mg/L	
	EAFUS ^h	No data	FDA 2008
	Indirect food additives: adhesives and components of coatings		FDA 2007b 21 CFR 175.105
	Sodium chromate	Yes	
	Recommended daily intake		FDA 2007c 21 CFR 101.9
	Chromium	120 µg	

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Agency	Description	Information	Reference
<u>NATIONAL</u> (cont.)			
d. Other			
ACGIH	Carcinogenicity classification		ACGIH 2007
	Calcium chromate (as Cr)	A2 ⁱ	
	Chromium		
	Metal and chromium (III) compounds	A4 ^j	
	Water-soluble chromium (VI) compounds	A1 ^k	
	Insoluble chromium (VI) compounds	A1 ^k	
	Lead chromate		
	As Pb	A2 ⁱ	
	As Cr	A2 ⁱ	
	Strontium chromate (as Cr)	A2 ⁱ	
Zinc chromates (as Cr)	A1 ^k		
ACGIH	Biological exposure indices		ACGIH 2007
	Chromium		
	Water-soluble chromium (VI) fume		
	Total chromium in urine at end of shift at end of workweek	25 µg/L	
	Total chromium in urine increase during shift	10 µg/L	
EPA	Carcinogenicity classification		IRIS 2008
	Chromium(III), insoluble salts	Group D ^l	
	Chromium (VI)		
	Inhalation route of exposure	Group A ^m	
	Oral route of exposure	Group D ^l	
	RfC		
	Chromium(III), insoluble salts	Not available	
	Chromium (VI)		
	Chromic acid mists and dissolved Cr (VI) aerosols	8x10 ⁻⁶ mg/m ³	
	Cr(VI) particulates	1x10 ⁻⁴ mg/m ³	
RfD			
Chromium(III), insoluble salts	1.5 mg/kg/day		
Chromium (VI)	3x10 ⁻³ mg/kg/day		
Master Testing List	Yes ⁿ	EPA 2008f	
RCRA waste minimization PBT priority chemical list		EPA 1998c 63 FR 60332	
Chromium	Yes		

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Agency	Description	Information	Reference
<u>NATIONAL</u> (cont.)			
	Standards for owners and operators of hazardous waste TSD facilities; groundwater monitoring list		EPA 2008d 40 CFR 264, Appendix IX
	Chromium (total)	Yes	
	Superfund, emergency planning, and community right-to-know		
	Designated CERCLA hazardous substance		EPA 2008j 40 CFR 302.4
	Ammonium dichromate	Yes ^o	
	Calcium chromate	Yes ^{o,p}	
	Chromium	Yes ^q	
	Chromium and compounds	Yes ^r	
	Chromium (III) sulfate	Yes ^o	
	Potassium chromate	Yes ^o	
	Strontium chromate	Yes ^o	
EPA	Superfund, emergency planning, and community right-to-know		
	Reportable quantity		EPA 2008j 40 CFR 302.4
	Ammonium dichromate	10 pounds	
	Chromium	5,000 pounds	
	Calcium chromate	10 pounds	
	Chromium and compounds	None ^s	
	Chromium (III) sulfate	1,000 pounds	
	Potassium chromate	10 pounds	
	Strontium chromate	10 pounds	
	Effective date of toxic chemical release reporting		EPA 2008h 40 CFR 372.65
	Chromium	01/01/1987	
	Extremely Hazardous Substances		EPA 2008g 40 CFR 355, Appendix A
	Chromium (III) chloride		
	Reportable quantity	1 pound	
	Threshold planning quantity	1,000 pounds	

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Agency	Description	Information	Reference
NATIONAL (cont.)			
NTP	Carcinogenicity classification		NTP 2005
	Chromium (VI) compounds	Known to be human carcinogens	
	Calcium chromate		
	Chromium (VI) trioxide		
	Ferrocchromite		
	Lead chromate		
	Strontium chromate		
	Zinc chromate		

^aGroup 3: The agent is not classifiable as to its carcinogenicity to humans.

^bGroup 1: The agent is carcinogenic to humans.

^cProvisional guideline value, as there is evidence of a hazard, but the available information on health effects is limited.

^dThe NIOSH REL (10-hour TWA) is 0.001 mg Cr(VI)/m³ for all hexavalent chromium (Cr(VI)) compounds. NIOSH considers all chromium (VI) compounds (including chromic acid, tert-butyl chromate, zinc chromate, and chromyl chloride) to be potential occupational carcinogens.

^eNIOSH potential occupational carcinogen.

^fGroup 1 pesticides: contains the pesticides that pose a significant risk of adverse acute health effects at low concentrations.

^gThe CMC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The CCC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect.

^hThe EAFUS list of substances contains ingredients added directly to food that FDA has either approved as food additives or listed or affirmed as GRAS.

ⁱA2: Suspected human carcinogen.

^jA4: Not classifiable as a human carcinogen.

^kA1: Confirmed human carcinogen.

^lGroup D: not classified as to its human carcinogenicity.

^mGroup A: known human carcinogen by the inhalation route of exposure.

ⁿChromium was recommended to the MTL by ATSDR in 1994 and the testing needs development is currently underway. The testing needs include acute toxicity, neurotoxicity, reproductive, and immunotoxicity health effects.

^oDesignated CERCLA hazardous substance pursuant to Section 311(b)(2) of the Clean Water Act.

^pDesignated CERCLA hazardous substance pursuant to Section 3001 of the Resource Conservation and Recovery Act.

^qDesignated CERCLA hazardous substance pursuant to Section 307(a) of the Clean Water Act.

^rDesignated CERCLA hazardous substance pursuant to Section 307(a) of the Clean Water Act and Section 112 of the Clean Air Act.

^sIndicates that no reportable quantity is being assigned to the generic or broad class.

ACGIH = American Conference of Governmental Industrial Hygienists; AEGL = acute exposure guideline levels; CCC = Criterion Continuous Concentration; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; CFR = Code of Federal Regulations; CMC = Criteria Maximum Concentration; DWEL = drinking water equivalent level; EAFUS = Everything Added to Food in the United States; EPA = Environmental Protection Agency; FDA = Food and Drug Administration; FR = Federal Register; GRAS = Generally Recognized As Safe; IARC = International Agency for Research on Cancer; IDLH = immediately dangerous to life or health; IRIS = Integrated Risk Information System; MTL = Master Testing List; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; PBT = persistent, bioaccumulative, and toxic; PEL = permissible exposure limit; RCRA = Resource Conservation and Recovery Act; REL = recommended exposure limit; RfC = inhalation reference concentration; RfD = oral reference dose; TLV = threshold limit values; TSD = transport, storage, and disposal; TWA = time-weighted average; USC = United States Code; WHO = World Health Organization