

## 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.

ATSDR has derived an acute-duration inhalation MRL of  $0.03 \mu\text{g Cd/m}^3$  for cadmium. This MRL is based on a LOAEL of  $0.088 \text{ mg Cd/m}^3$  (LOAEL<sub>HEC</sub> of  $0.01 \text{ mg Cd/m}^3$ ) for respiratory effects in rats exposed to cadmium oxide 6.2 hours/day, 5 days/week for 2 weeks (NTP 1995) and an uncertainty factor of 300 (10 for the use of a LOAEL, 3 for extrapolation from animals to humans with dosimetric adjustments, and 10 for human variability).

ATSDR has derived a chronic-duration inhalation MRL of  $0.01 \mu\text{g Cd/m}^3$  for cadmium. This MRL is based on the 95% lower confidence limit of the urinary cadmium level associated with a 10% extra risk of low molecular weight proteinuria (UCDL<sub>10</sub>) estimated from a meta-analysis of environmental exposure data. An air concentration that would result in this urinary cadmium level ( $0.5 \mu\text{g/g creatinine}$ ), assuming a dietary cadmium intake of  $0.3 \mu\text{g/kg/day}$ , was estimated using biokinetic models. The estimated air concentration of  $0.1 \mu\text{g Cd/m}^3$  was divided by an uncertainty factor of 3 for human variability and a modifying factor of 3.

The EPA has not established a reference concentration (RfC) for cadmium.

ATSDR has derived an intermediate-duration oral MRL of  $0.5 \mu\text{g Cd/kg/day}$  for cadmium. This MRL is based on a BMDL<sub>std1</sub> of  $0.05 \text{ mg Cd/kg/day}$  for skeletal effects in young female rats exposed to cadmium chloride in drinking water for 6, 9, or 12 months (Brzóška and Moniuszko-Jakoniuk 2005d) and an uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability).

ATSDR has derived a chronic-duration oral MRL of  $0.1 \mu\text{g Cd/kg/day}$  for cadmium. This MRL is based on the UCDL<sub>10</sub> for low molecular weight proteinuria estimated from a meta-analysis of environmental exposure data. A cadmium intake that would result in the UCDL<sub>10</sub> ( $0.5 \mu\text{g/g creatinine}$ ) at age 55 was estimated using pharmacokinetic models. The cadmium intake of  $0.33 \mu\text{g/kg/day}$  was divided by an uncertainty factor of 3 for human variability.

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The EPA has established a reference dose (RfD) of  $5 \times 10^{-4}$  mg/kg/day in water and  $1 \times 10^{-3}$  mg/kg/day in food (IRIS 2012). The RfD is based on a chronic intake that would result in a kidney concentration of 200  $\mu\text{g/g}$  ww.

The international and national regulations, advisories, and guidelines regarding cadmium in air, water, and other media are summarized in [Table 8-1](#).

Cadmium compounds are included on the list of 189 chemicals listed as hazardous air pollutants under Section 112 of the Clean Air Act as amended (EPA 2007). Cadmium also is on the list of chemicals appearing in the Emergency Planning and Community Right-To-Know Act of 1986 (EPA 2008g). Under Title III of this statute, owners and operators of facilities that manufacture, import, process, or otherwise use the chemicals on this list of report annually their release of those chemicals to any environmental media.

Cadmium and cadmium chloride are designed as hazardous substances under Section 311 of the Clean Water Act; any discharge of these chemicals over a specified threshold level into navigable waters is subject to reporting requirements (EPA 2008c).

Cadmium is a hazardous waste under the Resource Conservation and Recovery Act (RCRA) under several circumstances. Groundwater monitoring is required at municipal solid waste landfills (EPA 2008d) and cadmium is considered a priority persistent, bioaccumulative, and toxic (PBT) chemical under RCRA waste minimization chemical listing (EPA 1998).

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**Table 8-1. Regulations, Advisories, and Guidelines Applicable to Cadmium**

Agency	Description	Information	Reference
<u>INTERNATIONAL</u>			
Guidelines:			
IARC	Carcinogenicity classification Cadmium and cadmium compounds	Group 1 <sup>a</sup>	IARC 2008
WHO	Air quality guidelines Cadmium <sup>b,c</sup>	5 ng/m <sup>3</sup>	WHO 2000
	Drinking water quality guidelines Cadmium	0.003 mg/L	WHO 2004
<u>NATIONAL</u>			
Regulations and Guidelines:			
a. Air			
ACGIH	Biological exposure indices Cadmium and inorganic compounds Cadmium in urine Cadmium in blood	5 µg/g creatinine 5 µg/L	ACGIH 2007
	TLV (8-hour TWA) Cadmium	0.01 mg/m <sup>3</sup>	
	Hazardous air pollutant Cadmium compounds	Yes	EPA 2007 42 USC 7412
NIOSH	REL (10-hour TWA) Cadmium <sup>f</sup> Cadmium oxide	Potential occupational carcinogens Potential occupational carcinogens	NIOSH 2005
	IDLH Cadmium (as Cd) Cadmium oxide (as Cd)	9 mg/m <sup>3</sup> 9 mg/m <sup>3</sup>	
	Category of pesticides Cadmium carbonate Cadmium chloride Cadmium sulfate	Group II pesticide <sup>g</sup> Group I pesticide <sup>h</sup> Group II pesticide <sup>g</sup>	NIOSH 1992b

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Agency	Description	Information	Reference
<b>NATIONAL (cont.)</b>			
OSHA	PEL (8-hour TWA) for general industry Cadmium (as Cd)	5 µg/m <sup>3</sup>	OSHA 2007a 29 CFR 1910.1027
	PEL (8-hour TWA) for shipyard industry Cadmium (as Cd)	5 µg/m <sup>3</sup>	OSHA 2007b 29 CFR 1915.1027
	PEL (8-hour TWA) for construction industry Cadmium (as Cd)	5 µg/m <sup>3</sup>	OSHA 2007c 29 CFR 1926.1127
<b>b. Water</b>			
EPA	Designated as hazardous substances in accordance with Section 311(b)(2)(A) of the Clean Water Act		EPA 2008b 40 CFR 116.4
	Cadmium chloride	Yes	
	Drinking water standards and health advisories		EPA 2011b
	Cadmium		
	1-day health advisory for a 10-kg child	0.04 mg/L	
	10-day health advisory for a 10-kg child	0.04 mg/L	
	DWEL	0.02 mg/L	
	Lifetime	0.005 mg/L	
	National primary drinking water standards		EPA 2009b
	Cadmium		
MCL	0.005 mg/L		
Public health goal	0.005 mg/L		
Reportable quantities of hazardous substances designated pursuant to Section 311 of the Clean Water Act			EPA 2008c 40 CFR 117.3
Cadmium chloride	10 pounds		
Toxic pollutants designated pursuant to Section 307(a)(1) of the Clean Water Act			EPA 2008h 40 CFR 401.15
Cadmium and compounds	Yes		
<b>c. Food</b>			
FDA	Bottled drinking water Cadmium	0.005 mg/L	FDA 2007 21 CFR 165.110
	EAFUS	No data	FDA 2008

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<u>NATIONAL</u> (cont.)				
d. Other				
ACGIH	Carcinogenicity classification		ACGIH 2007	
	Cadmium	A2 <sup>j</sup>		
	Cadmium compounds (as Cd)	A2 <sup>j</sup>		
EPA	Carcinogenicity classification		IRIS 2012	
	Cadmium	Group B1 <sup>k</sup>		
	Inhalation unit risk			
	Cadmium	1.8x10 <sup>-3</sup> per µg/m <sup>3</sup>		
	RfC			
	Cadmium	No data		
	RfD			
	Cadmium			
	Food	1x10 <sup>-3</sup> mg/kg-day		
	Water	5x10 <sup>-4</sup> mg/kg-day		
	RCRA waste minimization PBT priority chemical list			EPA 1998 63 FR 60332
	Cadmium	Yes		
	Standards for owners and operators of hazardous waste TSD facilities; groundwater monitoring list			EPA 2008d 40 CFR 264, Appendix IX
	Cadmium	Yes		
	Superfund, emergency planning, and community right-to-know			
Designated CERCLA hazardous substance		EPA 2008e 40 CFR 302.4		
Cadmium	Yes <sup>l,m</sup>			
Cadmium and compounds	Yes <sup>n</sup>			
Cadmium chloride	Yes <sup>o</sup>			
Reportable quantity				
Cadmium	10 pounds			
Cadmium and compounds	None <sup>p</sup>			
Cadmium chloride	10 pounds			

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Agency	Description	Information	Reference
<b>NATIONAL (cont.)</b>			
EPA	Superfund, emergency planning, and community right-to-know		
	Effective date of toxic chemical release reporting		EPA 2008g 40 CFR 372.65
	Cadmium	01/01/1987	
	Cadmium compounds <sup>q</sup>	01/01/1987	
	Extremely Hazardous Substances		EPA 2008f 40 CFR 355, Appendix A
	Cadmium oxide		
	Reportable quantity	100 pounds	
	Threshold planning quantity	100/10,000 pounds	
NTP	Carcinogenicity classification		NTP 2011
	Cadmium and cadmium compounds	Known to be human carcinogens	

<sup>a</sup>Group 1: The agent is carcinogenic to humans.

<sup>b</sup>The guideline value is based on the prevention of a further increase of cadmium in agricultural soils, which is likely to increase the dietary intake.

<sup>c</sup>TWA based on effects other than cancer or odor/annoyance using an averaging time of 1 year.

<sup>d</sup>Respirable fraction.

<sup>e</sup>Higher current priority chemical for guideline development.

<sup>f</sup>REL applies to all cadmium compounds (as Cd).

<sup>g</sup>Group II pesticide: Contains the pesticides that pose as significant risk of carcinogenic, teratogenic, neurotoxic, or reproductive effects

<sup>h</sup>Group I pesticide: Contains the pesticides that pose as significant risk of adverse acute health effects at low concentrations

<sup>i</sup>The 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.

<sup>j</sup>A2: Suspected human carcinogen.

<sup>k</sup>Group B1: Probable human carcinogen based on limited evidence of carcinogenicity in humans.

<sup>l</sup>Designated CERCLA hazardous substance pursuant to Section 307(a) of the Clean Water Act.

<sup>m</sup>No reporting of releases of this hazardous substance is required if the diameter of the pieces of the solid metal released is larger than 100 micrometers (0.004 inches).

<sup>n</sup>Designated CERCLA hazardous substance pursuant to Section 307(a) of the Clean Water Act and Section 112 of the Clean Air Act.

<sup>o</sup>Designated CERCLA hazardous substance pursuant to Section 311(b)(2) of the Clean Water Act.

<sup>p</sup>Indicates that no reportable quantity is being assigned to the generic or broad class.

<sup>q</sup>Cadmium compounds: Includes any unique chemical substance that contains cadmium as part of that chemical's infrastructure.

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; IARC = International Agency for Research on Cancer; IDLH = immediately dangerous to life or health; IRIS = Integrated Risk Information System; MCL = maximum contaminant level; 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 = treatment, storage, and disposal; TWA = time-weighted average; USC = United States Code; WHO = World Health Organization