CHAPTER 7. REGULATIONS AND GUIDELINES

Pertinent international and national regulations, advisories, and guidelines regarding thorium in air, water, and other media are summarized in Table 7-1. This table is not an exhaustive list, and current regulations should be verified by the appropriate regulatory agency.

ATSDR develops MRLs, which are substance-specific guidelines intended to serve as screening levels by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be of concern at hazardous waste sites. See Section 1.3 and Appendix A for detailed information on MRLs and the rationale for not deriving MRLs for thorium.

Table 7-1. Regulations and Guidelines Applicable to Thorium

Agency	Description	Information	Reference
	Air		
EPA	RfC	No data	IRIS 2017
WHO	Air quality guidelines	No data	WHO 2010
NRC	Dose limits for individual members of the public		NRC 2017c
	Radiation		
	Total effective dose equivalent	0.1 rem (1 mSv) in a year	
IAEA	Recommended dose limits for the public		IAEA 2014
	Radiation		
	Effective dose	1 mSv in a year	
	Lens of the eye equivalent dose	15 mSv in a year	
	Skin equivalent dose	50 mSv in a year	
	Hands and feet equivalent dose	No data	
	Water & Food		
EPA	Drinking water standards and health advisories		EPA 2012
	Gross alpha particle activity		
	10^{-4} Cancer risk	15 pCi/L	
	National primary drinking water regulations		EPA 2009
	Alpha and beta/photon emitters		
	Alpha emitters		
	MCL	15 pCi/L	
	Public health goal	zero	
	Beta/gamma emitters		
	MCL	4 mrem/year	

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Agency	Description	Information	Reference
EPA	RfD	No data	IRIS 2017
WHO	Drinking water quality guidelines		WHO 2017
	^{228}Th, ^{230}Th, or ^{232}Th	1 Bq/L	
FDA	EAFUS	No data[a]	FDA 2013
	Allowable level in bottled water		FDA 2017
	Gross alpha particle activity	15 pCi/L	
	Cancer		
HHS	Carcinogenicity classification		NTP 2016
	Thorium dioxide	Known to be a human carcinogen	
EPA	Carcinogenicity classification	No data	IRIS 2017
IARC	Carcinogenicity classification		IARC 2012
	^{232}Th (as Thorotrast)	Group 1[b]	
	Occupational		
OSHA	PEL (8-hour TWA) for general industry, shipyards and construction	No data	OSHA 2016a, 2016b, 2017
NIOSH	REL (up to 10-hour TWA)	No data	NIOSH 2016
NRC	Lung clearance class[c]		NRC 2017a
	Thorium oxides and hydroxides	Y	
	All other thorium compounds	W	
	Occupational ALIs and DACs for inhalation		

Isotope	Class[c]	ALI (µCi)[d]	DAC (µCi/mL)
^{226}Th	W	$2x10^{2}$	$6x10^{-8}$
	Y	$1x10^{+2}$	$6x10^{-8}$
^{227}Th	W	$3x10^{-1}$	$1x10^{-10}$
	Y	$3x10^{-1}$	$1x10^{-10}$
^{228}Th	W	$1x10^{+2}$ bone surface ($2x10^{-2}$)	$4x10^{-12}$
	Y	$2x10^{-2}$	$7x10^{-12}$
^{229}Th	W	$9x10^{-4}$ bone surface ($2x10^{-3}$)	$4x10^{-13}$
	Y	$2x10^{-3}$ bone surface ($3x10^{-3}$)	$1x10^{-12}$
^{230}Th	W	$6x10^{-3}$ bone surface ($2x10^{-2}$)	$3x10^{-12}$
	Y	$2x10^{-2}$ bone surface ($2x10^{-2}$)	$6x10^{-12}$
^{231}Th	W	$6x10^{3}$	$3x10^{-6}$
	Y	$6x10^{3}$	$3x10^{-6}$
^{232}Th	W	$1x10^{-3}$ bone surface ($3x10^{-3}$)	$5x10^{-13}$
	Y	$3x10^{-3}$ bone surface ($4x10^{-3}$)	$1x10^{-12}$
^{234}Th	W	$2x10^{2}$	$8x10^{-8}$
	Y	$2x10^{2}$	$6x10^{-8}$

Table 7-1. Regulations and Guidelines Applicable to Thorium

Agency	Description	Information	Reference
	Occupational ALIs for ingestion		
	Isotope	ALI (µCi)[d]	
	^{226}Th	$5x10^{3}$ stomach wall ($5x10^{3}$)	
	^{227}Th	$1x10^{2}$	
	^{228}Th	$6x10^{0}$ bone surface ($1x10^{1}$)	
	^{229}Th	$6x10^{-1}$ bone surface ($1x10^{0}$)	
	^{230}Th	$4x10^{0}$ bone surface ($9x10^{0}$)	
	^{231}Th	$4x10^{3}$	
	^{232}Th	$7x10^{-1}$ bone surface ($2 x10^{0}$)	
	^{234}Th	$3x10^{2}$ lower large intestine wall ($4x10^{2}$)	
NRC	Quantity of radioactive material requiring licensing		NRC 2017a
	Isotope	Activity (Ci)	
	^{226}Th	10	
	^{227}Th	0.01	
	^{228}Th	0.001	
	^{229}Th	0.001	
	^{230}Th	0.001	
	$^{23`}$Th	100	
	^{232}Th	100	
	^{234}Th	10	
	Thorium (natural)	100	
NRC	Occupational dose limits		NRC 2017b
	Radiation		
	Adults		
	Annual limit, the more limiting of:		
	Total effective dose equivalent	5 rem (0.05 Sv) in a year	
	-or-		
	Sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye	50 rem (0.5 Sv) in a year	
	Lens of the eye dose equivalent	15 rem (0.15 Sv) in a year	
	Shallow-dose equivalent to the skin of the whole body or to the skin of any extremity	50 rem (0.5 Sv) in a year	
	Minors	10% of the annual dose limits specified for adult workers	
	Embryo/fetus, dose equivalent during entire pregnancy for a declared pregnant woman	0.5 rem (5 mSv)	

Table 7-1. Regulations and Guidelines Applicable to Thorium

Agency	Description	Information	Reference
IAEA	Recommended occupational dose limits		IAEA 2014
	Radiation		
	Effective dose	20 mSv per year, averaged over 5 consecutive years, and not to exceed 50 mSv in any single year	
	Lens of the eye equivalent dose	20 mSv per year, averaged over 5 consecutive years, and not to exceed 50 mSv in any single year	
	Skin equivalent dose	500 mSv in a year	
	Hands and feet equivalent dose	500 mSv in a year	
	Recommended public dose limits		
	Radiation		
	Effective dose	1 mSv in a year	
	Lens of the eye equivalent dose	15 mSv in a year	
	Skin equivalent dose	50 mSv in a year	
	Emergency Criteria		
EPA	AEGLs-air	No data	EPA 2016
DOE	Protective Action Criteria (PACs)-air		DOE 2016b
	Thorium		
	PAC-1[e]	30 mg/m^3	
	PAC-2[e]	330 mg/m^3	
	PAC-3[e]	2,000 mg/m^3	
	Thorium hydroxide		
	PAC-1[e]	30 mg/m^3	
	PAC-2[e]	330 mg/m^3	
	PAC-3[e]	2,000 mg/m^3	
	Thorium dioxide		
	PAC-1[e]	30 mg/m^3	
	PAC-2[e]	330 mg/m^3	
	PAC-3[e]	2,000 mg/m^3	
	Thorium(IV) nitrate		
	PAC-1[e]	2.9 mg/m^3	
	PAC-2[e]	32 mg/m^3	
	PAC-3[e]	190 mg/m^3	
	Thorium nitrite		
	PAC-1[e]	30 mg/m^3	
	PAC-2[e]	330 mg/m^3	
	PAC-3[e]	2,000 mg/m^3	

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Agency	Description	Information	Reference
	Thorium oxalate		
	PAC-1[e]	30 mg/m^3	
	PAC-2[e]	330 mg/m^3	
	PAC-3[e]	2,000 mg/m^3	

[a]The EAFUS list of substances contains ingredients added directly to food that FDA has either approved as food additives or listed or affirmed as GRAS.
[b]Group 1: carcinogenic to humans
[c]Class refers to the retention (approximately days, weeks, or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times of <10 days for D, 10–100 days for W, and >100 days for Y.
[d]When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses.
[e]Definitions of PAC terminology are available from U.S. Department of Energy (DOE 2016a).
PAC-1 values are based on the applicable AEGL-1, ERPG-1, or TEEL-1 values
PAC-2 values are based on the applicable AEGL-2, ERPG-2, or TEEL-2 values
PAC-3 values are based on the applicable AEGL-3, ERPG-3, or TEEL-3 values

AEGL = acute exposure guideline levels; ALI = annual limit on intake; DAC = derived air concentration; DOE = Department of Energy; EAFUS = Everything Added to Food in the United States; EPA = Environmental Protection Agency; FDA = Food and Drug Administration; GRAS = generally recognized as safe; HHS = Department of Health and Human Services; IAEA = International Atomic Energy Agency; IARC = International Agency for Research on Cancer; IRIS = Integrated Risk Information System; MCL = maximum contaminant level; NIOSH = National Institute for Occupational Safety and Health; NRC = Nuclear Regulatory Commission; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; PAC = Protective Action Criteria; PEL = permissible exposure limit; REL = recommended exposure limit; RfC = inhalation reference concentration; RfD = oral reference dose; TLV = threshold limit values; TWA = time-weighted average; WHO = World Health Organization