8. REGULATIONS, ADVISORIES, AND GUIDELINES

Recommendations for radiation protection for people in the general population as a result of exposure to radon in the environment are found in the International Commission on Radiological Protection (ICRP) Publication 65 (ICRP 1994a). National guidelines for occupational radiation protection are found in the "Federal Radiation Protection Guidance for Occupational Exposure" (EPA 1987b). The guidance presents general principles for the radiation protection of workers and specifies the numerical primary guides for limiting occupational exposure. These recommendations are consistent with the ICRP (ICRP 1994a).

The basic philosophy of radiation protection is the concept of ALARA (As Low As Reasonably Achievable). As a rule, all exposure should be kept as low as reasonably achievable and the regulations and guidelines are meant to give an upper limit to exposure. Based on the primary guides, guides for Annual Limits on Intake (ALIs) have been calculated (USNRC 2008b). The ALI is defined as "that activity of a radionuclide which, if inhaled or ingested by Reference Man (ICRP 1975), will result in a dose equal to the most limiting primary guide for committed dose" (EPA 1988).

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.

No inhalation or oral MRLs were derived for radon.

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

The EPA IRIS database (IRIS 2008) has withdrawn its cancer classification for radionuclides, but the EPA Office of Air and Radiation believes that all radionuclides, including radon and its radioactive progeny, should be considered to be known carcinogens, and has assigned them to Group A. The EPA has not derived reference concentrations (RfCs) or reference doses (RfDs) for radon (IRIS 2008), but has proposed a maximum contaminant level (MCL) of 300 pCi/L and an alternative maximum contaminant level (AMCL) of 4,000 pCi/L for radon and a 10^{-4} cancer risk at 150 pCi/L (EPA 2006a).

The EPA website contains a publication called A Citizen's Guide to Radon (EPA 2007k) that includes information regarding radon hazards, methods for testing radon levels in the home, ways to lower radon levels, and a recommendation to use a certified radon mitigation specialist to ensure that appropriate methods are used to reduce radon levels. EPA recommends fixing your home if measured indoor levels of radon are ≥4 pCi/L and notes that radon levels <4 pCi/L still pose a health risk and can be reduced in many cases.

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

Agency	Description	Information	Reference
INTERNATIONAL			
Guidelines:			
IARC	Carcinogenicity classification		IARC 2008
	^{222}Rn and its decay products	Group 1[a]	
ICRP	Summary of values recommended		ICRP 1994a
	Nominal fatality and detriment coefficient at home and at work	$8x10^{-5}$ (mJ h m^{-3})$^{-1}$	
	Dose conversion convention, effective dose per unit of exposure		
	At home	1.1 mSv (mJ h m^{-3})	
	At work	1.4 mSv (mJ h m^{-3})	
	Action level (dwellings)		
	Radon concentration	200–600 (Bq m^{-3})[b]	
	Annual effective dose	3–10 mSv	
	Action level (workplace)		
	Radon concentration	500–1,500 (Bq m^{-3})[b]	
	Annual effective dose	3–10 mSv	
	Occupational annual limit on exposure		
	Per year, averaged over 5 years	14 (mJ h m^{-3})	
	In a single year	35 (mJ h m^{-3})	
WHO	Air quality guidelines		WHO 2000
	Risk estimates and recommended action level for radon progeny for exposure to 1 Bq/m^3		
	Lung cancer excess lifetime risk estimate	$3–6x10^{-5}$	
	Recommended level for remedial action in buildings	≥100 Bq/m^3 (annual average)	
	Drinking water quality guidelines		WHO 2004
	Radon	100 Bq/L	
NATIONAL			
Regulations and Guidelines:			
a. Air			
ACGIH	Guidelines for exposure to ionizing radiation		ACGIH 2007
	Radon daughters	4 WLM/year	

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

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
EPA	AEGL-1, -2, and -3	No data	EPA 2007a
	Hazardous air pollutant		EPA 2007b 42 USC 7412
	Radon	Yes	
	Radiation dose to public from ^{222}Rn not to exceed 10 mrem/year	From operating uranium mine	EPA 2007c (40CFR61.22)
		From a DOE facility	EPA 2007d (40CFR61.92)
	^{222}Rn emissions rate from soil not to exceed 20 pCi/m^2-second	From a DOE facility	EPA 2007e (40CFR61.192)
		From an active phosphogypsum stack	EPA 2007f (40CFR61.202)
		From a non-operational uranium mill tailings pile	EPA 2007g (40CFR61.222)
		From an existing uranium mill tailings pile	EPA 2007h (40CFR61.252)
	^{220}Rn emissions rate from soil	Provisions from soil for ^{222}Rn from uranium mill tailings are applicable to ^{220}Rn from thorium mill tailings	EPA 2007j (40CFR192.41)
	^{210}Po (^{222}Rn progeny)	2 Ci/year elemental phosphorus plant emissions	EPA 2007i (40CFR61.122)
	Monitoring of radon in homes		EPA 2007k
	No action necessary	<4 pCi/L, 0.02 WL	
	Take necessary action to decrease indoor radon levels	≥4 pCi/L	
MSHA	Annual exposure limits		MSHA 2007 30 CFR 57.5037
	Radon daughters	4 WLM in any calendar year	
	Maximum permissible concentration		
	Radon daughters	1 WL in active workings	
NIOSH	REL (10-hour TWA)	No data	
OSHA	Exposure limits of individuals to ionizing radiation in restricted areas (rem per calendar quarter)		OSHA 2007 29 CFR 1910.1096
	Whole body: head and trunk; active blood-forming organs; lens of eyes; or gonads	1.25 rem	
	Hands and forearms; feet and ankles	18.75 rem	
	Skin of whole body	7.5 rem	

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

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
USNRC	ALI for occupational exposure (values for oral ingestion)		USNRC 2008b 10 CFR 20, Appendix B
	^{220}Rn (with daughters removed)	Not listed	
	^{220}Rn (with daughters present)	Not listed	
	^{222}Rn (with daughters removed)	Not listed	
	^{222}Rn (with daughters present)	Not listed	
	ALI for occupational exposure (values for inhalation)		
	^{220}Rn (with daughters removed)	20,000 µCi	
	^{220}Rn (with daughters present)	20 µCi (or 12 WLM)	
	^{222}Rn (with daughters removed)	10,000 µCi	
	^{222}Rn (with daughters present)	100 µCi (or 4 WLM)	
	Derived air concentrations for occupational exposure (values for inhalation)		
	^{220}Rn (with daughters removed)	7×10^{-6} µCi/mL	
	^{220}Rn (with daughters present)	9×10^{-9} µCi/mL (or 1.0 WL)	
	^{222}Rn (with daughters removed)	4×10^{-6} µCi/mL	
	^{222}Rn (with daughters present)	3×10^{-8} µCi/mL (or 0.33 WL)	
	Annual average effluent air concentration (no values provided for effluent water)		
	^{220}Rn (with daughters removed)	2×10^{-8} µCi/mL	
	^{220}Rn (with daughters present)	3×10^{-11} µCi/mL	
	^{222}Rn (with daughters removed)	1×10^{-8} µCi/mL	
	^{222}Rn (with daughters present)	1×10^{-10} µCi/mL	
b. Water			
EPA	Drinking water standards and health advisories for gross alpha particle activity		EPA 2006a
	Radon		
	Proposed MCL	300 pCi/L	
	Proposed AMCL	4,000 pCi/L	
	10^{-4} lifetime cancer risk	150 pCi/L	

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

Agency	Description	Information	Reference
NATIONAL *(cont.)*			
EPA	Cancer classification		
	Radon	Group A[c]	
	National recommended water quality criteria	No data	EPA 2006b
c. Food		No data	
d. Other			
ACGIH	Carcinogenicity classification	No data	ACGIH 2007
EPA	Carcinogenicity classification		IRIS 2008
	^{222}Rn	Withdrawn	
	RfC		
	^{222}Rn	No data	
	RfD		
	^{222}Rn	No data	
	Superfund, emergency planning, and community right-to-know		EPA 2008a 40 CFR 302.4
	Designated CERCLA hazardous substance		
	^{220}Rn[d]	0.1 Ci	
	^{222}Rn[d]	0.1 Ci	
NTP	Carcinogenicity classification		NTP 2005a
	Ionizing radiation (includes ^{220}Rn and ^{222}Rn)	Known to be a human carcinogen	

[a]Group 1: carcinogenic to humans
[b]Assuming 7,000 hours/year indoors or 2,000 hours/year at work and an equilibrium factor of 0.4.
[c]Group A: known human carcinogen
[d]Designated CERCLA hazardous substance pursuant to Section 112 of the Clean Air Act.

ACGIH = American Conference of Governmental Industrial Hygienists; AEGL = Acute Exposure Guideline Levels; ALI = annual limit on intake; AMCL = alternative maximum contaminant level; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; CFR = Code of Federal Regulations; EPA = Environmental Protection Agency; IARC = International Agency for Research on Cancer; ICRP = International Commission on Radiological Protection; MCL = maximum contaminant level; MCLG = maximum contaminant level goal; MSHA = Mine Safety and Health Administration; NAS = National Academy of Sciences; NIOSH = National Institute for Occupational Safety and Health; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; REL = recommended exposure limit; RfC = inhalation reference concentration; RfD = oral reference dose; TWA = time-weighted average; USC = United States Code; USNRC = U.S. Nuclear Regulatory Commission; WHO = World Health Organization; WL = working level; WLM = working level months