# 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 2011). 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The EPA IRIS database (IRIS 2012) has withdrawn its cancer classification for radionuclides, but the EPA Office of Air and Radiation believes that all radionuclides, including radon and its radioactive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 (EPA 2012b). The EPA has not derived reference concentrations (RfCs) or reference doses (RfDs) for radon (IRIS 2012). EPA has not promulgated a maximum contaminant level (MCL) for radon in drinking water. In 1991, EPA proposed an MCL, but was directed in 1996 to withdraw it and did so in 1997. In 1999, EPA again proposed an MCL (EPA 1999b), but finalized the current radionuclides in drinking water rule in 2000 without a value for radon (EPA 2000) and this status has not changed. The EPA website contains a

wealth of information, including a publication entitled A Citizen's Guide to Radon (EPA 2009a). This guide includes information on the health risk from inhaling radon and its progeny, methods for radon testing in homes, methods and techniques for reducing the radon level, and a recommendation to use a certified radon mitigation specialist to ensure that appropriate methods are used to reduce radon levels. EPA recommends actions to take if the measured radon indoor level is ≥4 pCi/L and notes that radon levels <4 pCi/L still pose a health risk and can be reduced in many cases, and recommends not smoking as an additional way to reduce radon risk.

## 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 | | |
| | Nominal probability coefficient for radon- and radon-progeny-induced lung cancer | $5x10^{-4}$ per WLM (0.14 per J h $m^{-3}$) | ICRP 2010 |
| | Dose conversion convention, effective dose per unit of exposure | | ICRP 1994a |
| | 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/$m^3$ (2.7 pCi/L); annual average | |
| | Drinking water quality guidelines | | WHO 2004 |
| | Radon | 100 Bq/L (2,700 pCi/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 2011e |
| | Hazardous air pollutant | | EPA 2010b<br>42 USC 7412 |
| | Radon | Yes | |
| | Effective dose equivalent to public from $^{222}$Rn not to exceed 10 mrem/year | From operating uranium mine | EPA 2011i (40CFR61.22) |
| | | From a DOE facility | EPA 2011j (40CFR61.92) |
| | $^{222}$Rn emissions rate from soil not to exceed 20 pCi/m$^2$-second average for entire source | From a DOE facility | EPA 2011k (40CFR61.192) |
| | | From an inactive phosphogypsum stack | EPA 2011l (40CFR61.202) |
| | | From a non-operational uranium mill tailings pile | EPA 2011m (40CFR61.222) |
| | | From an existing uranium mill tailings pile | EPA 2011n (40CFR61.252) |
| | Standards for uranium byproduct materials shall apply to thorium byproduct materials | Provisions from soil for $^{222}$Rn from uranium byproduct materials are applicable to $^{220}$Rn from thorium byproduct materials | EPA 2011h (40CFR192.41) |
| | $^{210}$Po ($^{222}$Rn progeny) | Emissions from elemental phosphorus plant <2 Ci/year, or 4.5 Ci/year with scrubbers | EPA 2011o (40CFR61.122) |
| | Monitoring of radon in homes | | EPA 2009a |
| | 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 2011a<br>30 CFR 57.5038 |
| | Radon daughters | 4 WLM in any calendar year underground | |
| | Maximum permissible concentration | | MSHA 2011b<br>30CFR57.5039 |
| | Radon daughters | 1 WL in active workings underground | |
| NIOSH | REL (10-hour TWA) | No data | |

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

| Agency | Description | Information | Reference |
|---|---|---|---|
| NATIONAL *(cont.)* | | | |
| OSHA | OSHA adopted the 1971 version of USNRC regulatory limits in 10CFR20 Appendix B for exposure to radon in air. Applies to employers. OSHA states that following the current 10CFR20 App B is a *de minimis* violation. | Adult workers: $1x10^{-7}$ µCi/mL (100 pCi/L) averaged over 40-hour work week of 7 consecutive days | OSHA 2011 29 CFR 1910.1096; OSHA 1971; OSHA 2002 |
| | | Workers under 18 years of age: $3x10^{-9}$ µCi/mL (3 pCi/L) averaged over 40-hour work week of 7 consecutive days | OSHA 2011 29CFR1910.1096 (c)(2); OSHA 1971, OSHA 2002 |
| | | Surveys are required in order to comply | OSHA 2011, 29CFR1910.1096 (e)(4)ii |
| | | Post airborne radioactivity area signs when weekly average exceeds 25% of limit (i.e., 25 pCi/L adults, 0.75 pCi/L child workers) | OSHA 2011, 29CFR1910.1096 (e)(4)(i)(b) |
| USNRC | ALI for occupational exposure (values for oral ingestion) | | USNRC 2011 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) | $7x10^{-6}$ µCi/mL | |
| | $^{220}$Rn (with daughters present) | $9x10^{-9}$ µCi/mL (or 1.0 WL) | |
| | $^{222}$Rn (with daughters removed) | $4x10^{-6}$ µCi/mL | |
| | $^{222}$Rn (with daughters present) | $3x10^{-8}$ µCi/mL (or 0.33 WL) | |
| | Annual average effluent air concentration (no values provided for effluent water) | | |
| | $^{220}$Rn (with daughters removed) | $2x10^{-8}$ µCi/mL | |

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

| Agency | Description | Information | Reference |
|---|---|---|---|
| NATIONAL *(cont.)* | | | |
| | $^{220}$Rn (with daughters present) | $3x10^{-11}$ µCi/mL | |
| | $^{222}$Rn (with daughters removed) | $1x10^{-8}$ µCi/mL | |
| | $^{222}$Rn (with daughters present) | $1x10^{-10}$ µCi/mL | |
| b. Water | | | |
| EPA | Drinking water standards and health advisories for radon activity | None; EPA proposed an MCL for radon in 1991, withdrew it in 1997, and published the final rule in 2000 without a radon MCL | EPA 2011d, EPA 1997 |
| | National recommended water quality criteria | No data | |
| c. Food | | No data | |
| d. Other | | | |
| ACGIH | Carcinogenicity classification | No data | ACGIH 2007 |
| EPA | Carcinogenicity classification | | IRIS 2012 |
| | $^{222}$Rn | Withdrawn in 1993 | |
| | RfC | | |
| | $^{222}$Rn | Not established | |
| | RfD | | |
| | $^{222}$Rn | Not established | |
| | Superfund, emergency planning, and community right-to-know | | EPA 2011f<br>40 CFR 302.4 App B |
| | Designated CERCLA hazardous substance | | |
| | $^{220}$Rn[c] | 0.1 Ci | |
| | $^{222}$Rn[c] | 0.1 Ci | |
| NTP | Carcinogenicity classification | | NTP 2011 |
| | 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]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; 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; 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