Chapter H 57

RADIATION PROTECTION CODE

H 57.01 Public policy. Since ionizing radiations and their sources can be instrumental in the improvement of the health and welfare of the public if properly utilized, and may be destructive or detrimental to life or health if carelessly or excessively employed or may detrimentally affect the environment of the state if improperly utilized, it is hereby declared to be the public policy of this state to encourage the constructive uses of radiation and to prohibit and prevent exposure to ionizing radiation in amounts which are or may be detrimental to health. The rules adopted in the interest of radiation safety, in general, conform to nationally accepted standards.

History: Cr. Register, January, 1966, No. 121, eff. 2-1-66.

H 57.02 Definitions. (1) ABSORBED DOSE. Energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest. The unit of absorbed dose is the rad.

(2) ACTIVITY. The number of atoms decaying per unit of time.

(3) ALUMINUM EQUIVALENT. The thickness of aluminum affording the same attenuation, under specified conditions, as the material in question.

(4) ADDED FILTER. Filter added to the inherent filtration.

(5) ATTENUATION. Decrease in exposure rate of radiation caused by passage through material.

(6) BARRIER. See *protective barrier*.

(7) BOARD. The State Board of Health.

(8) BYPRODUCT MATERIAL. Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

(9) COMMISSION. The Industrial Commission.

(10) CONCRETE EQUIVALENT. The thickness of concrete based on a density of 2.35 grams per cubic centimeter (147 pounds per cubic foot) affording the same attenuation, under specified conditions, as the material in question.

(11) CONSTANT POTENTIAL (cp). In radiological practice, this term is applied to a unidirectional potential (or voltage) which has little, or no, periodic variation. The periodic component is called the ripple potential (or ripple voltage).

(12) CONTROLLED AREA. A defined area in which the occupational exposure of personnel to radiation or to radioactive material is under the supervision of an individual in charge of radiation protection. (This implies that a controlled area is one that requires control of access, occupancy, and working conditions for radiation protection purposes.)

(13) CURIE (c). A unit of activity defined as the activity of a quantity of any radioactive nuclide in which the number of disintegrations per second is 3.700×10^{10}.

(a) *Millicurie* is 1/1000 of a curie.

(b) *Microcurie* is 1/1,000,000 of a curie.

(14) DEADMAN SWITCH. A switch so constructed that a circuit closing contact can only be maintained by continuous pressure by the operator.

(15) DIAGNOSTIC-TYPE PROTECTIVE TUBE HOUSING. A shockproof x-ray tube housing so constructed that the leakage radiation at a distance of 1 meter from the target cannot exceed 100 milliroentgens in 1 hour when the tube is operated at any of its specified ratings.

(16) DOSE EQUIVALENT (DE). Dose equivalent is the product of absorbed dose D, quality factor (QF), dose distribution factor (DF), and other necessary modifying factors. (DE) = D (QF) (DF).

Note: The term RBE dose has been used in the past, in both radiobiology and radiation protection. This term is now reserved for radiobiology only and is replaced by dose equivalent (DE) for radiation protection.

(a) *Quality factor* (QF). The linear-energy-transfer-dependent factor by which absorbed doses are to be multiplied to obtain for radiation protection purposes, a quantity that expresses on a common scale for all ionizing radiations, the irradiation incurred by exposed persons.

(b) *Dose distribution factor* (DF). The factor used to express the modification of biological effect due to nonuniform distribution of internally deposited isotopes.

(17) EXPOSURE DOSE. The exposure dose of X- or gamma radiation at a certain place is a measure of the radiation that is based upon its ability to produce ionization. The unit of exposure dose is the roentgen. (When the meaning is clear, this term may be shortened to "exposure".)

(18) EXPOSURE DOSE RATE (exposure rate, intensity). Exposure dose per unit time.

(19) FILM BADGE. A pack of appropriate photographic film and filters used to determine radiation exposure.

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

Element (atomic number)	Isotope[1]	Table I		Table II	
		Column 1 Air (μc/ml)	Column 2 Water (μc/ml)	Column 1 Air (μc/ml)	Column 2 Water (μc/ml)
mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours	Sub	1×10^{-6}		3×10^{-8}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours		3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission		6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

[1]Soluble (S); Insoluble (I).

[2]"Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix D for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixturer may not exceed "T" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C_A, C_B, and C_C, and if the applicable MPC's, are MPC_A, and MPC_B, and MPC_C respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \frac{C_C}{MPC_C} \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix D shall be:

a. For purposes of Table I, Col. 1—6×10^{-12}

b. For purposes of Table I, Col. 2—4×10^{-7}

c. For purposes of Table II, Col. 1—2×10^{-14}

d. For purposes of Table II, Col. 2—3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix D for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix D are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix D for any radionuclide which is not known to be absent from the mixture; or

STANDARDS FOR PROTECTION AGAINST RADIATION
APPENDIX D

Concentrations in Air and Water Above Natural Background
(See notes at end of appendix)

c. Element (atomic number) and isotope	Table I		Table II	
	Column 1	Column 2	Column 1	Column 2
	Air (μc/ml)	Water (μc/ml)	Air (μc/ml)	Water (μc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	----------	9×10^{-5}	----------	3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248 Cf 254, and Fm 256 are not present	----------	6×10^{-5}	----------	2×10^{-6}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present	----------	2×10^{-5}	----------	6×10^{-7}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present	----------	3×10^{-4}	----------	1×10^{-7}
**If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 240, and Bk 249 are not present	3×10^{-9}	----------	1×10^{-10}	----------
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}	----------	1×10^{-11}	----------
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}	----------	1×10^{-12}	----------
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249 and Cf 251 are not present	3×10^{-12}	----------	1×10^{-13}	----------

**ERRATUM: This line should read: "210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not"

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Col. 1—1×10^{-10} μc/ml gross alpha activity; or 2.5×10^{-11} μc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1—3×10^{-12} μc/ml gross alpha activity; or 8×10^{-12} μc/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration limit for that radionuclide specified in Table II of Appendix D (MPC_A) does not exceed 1/10, (i.e. $\frac{C_A}{MPC_A} \leq \frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed ¼ i.e.

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \text{------} \leq \frac{1}{4}).$$

History: Cr Reg Sept 1971, No. 189, eff 10-1-71.

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