

## Department of Energy

## § 835.2

### APPENDIX E TO PART 835—VALUES FOR ESTABLISHING SEALED RADIOACTIVE SOURCE ACCOUNTABILITY AND RADIOACTIVE MATERIAL POSTING AND LABELING REQUIREMENTS

AUTHORITY: 42 U.S.C. 2201; 7191.

SOURCE: 58 FR 65485, Dec. 14, 1993, unless otherwise noted.

### Subpart A—General Provisions

#### § 835.1 Scope.

(a) *General.* The rules in this part establish radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities.

(b) *Exclusion.* Except as discussed in paragraph (c) of this section, the requirements in this part do not apply to:

(1) Activities that are regulated through a license by the Nuclear Regulatory Commission or a State under an Agreement with the Nuclear Regulatory Commission, including activities certified by the Nuclear Regulatory Commission under section 1701 of the Atomic Energy Act;

(2) Activities conducted under the authority of the Director, Naval Nuclear Propulsion Program, as described in Pub. L. 98-525;

(3) Activities conducted under the Nuclear Explosives and Weapons Surety Program relating to the prevention of accidental or unauthorized nuclear detonations;

(4) Radioactive material transportation as defined in this part;

(5) DOE activities conducted outside the United States on territory under the jurisdiction of a foreign government to the extent governed by occupational radiation protection requirements agreed to between the United States and the cognizant government; or

(6) Background radiation, radiation doses received as a patient for the purposes of medical diagnosis or therapy, or radiation doses received from participation as a subject in medical research programs.

(c) Occupational doses received as a result of excluded activities and radioactive material transportation, as listed in paragraphs (b)(1) through (b)(5) of this section, shall be considered when

determining compliance with the occupational dose limits at §§ 835.202 and 835.207, and with the limits for the embryo/fetus at § 835.206. Occupational doses resulting from authorized emergency exposures and planned special exposures shall not be considered when determining compliance with the dose limits at §§ 835.202 and 835.207.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59679, Nov. 4, 1998]

#### § 835.2 Definitions.

(a) As used in this part:

*Accountable sealed radioactive source* means a sealed radioactive source having a half-life equal to or greater than 30 days and an isotopic activity equal to or greater than the corresponding value provided in appendix E of this part.

*Airborne radioactive material or airborne radioactivity* means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

*Airborne radioactivity area* means any area, accessible to individuals, where:

(1) The concentration of airborne radioactivity, above natural background, exceeds or is likely to exceed the derived air concentration (DAC) values listed in appendix A or appendix C of this part; or

(2) An individual present in the area without respiratory protection could receive an intake exceeding 12 DAC-hours in a week.

*ALARA* means “As Low As is Reasonably Achievable,” which is the approach to radiation protection to manage and control exposures (both individual and collective) to the work force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical, and public policy considerations. As used in this part, ALARA is not a dose limit but a process which has the objective of attaining doses as far below the applicable limits of this part as is reasonably achievable.

*Annual limit on intake (ALI)* means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man (ICRP

Publication 23) that would result in a committed effective dose equivalent of 5 rems (0.05 sievert) or a committed dose equivalent of 50 rems (0.5 sievert) to any individual organ or tissue. ALI values for intake by ingestion and inhalation of selected radionuclides are based on Table 1 of the U.S. Environmental Protection Agency's Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988. This document is available from the National Technical Information Service, Springfield, VA.

*Background* means radiation from:

- (i) Naturally occurring radioactive materials which have not been technologically enhanced;
- (ii) Cosmic sources;
- (iii) Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices);
- (iv) Radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and
- (v) Consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation.

*Bioassay* means the determination of kinds, quantities, or concentrations, and, in some cases, locations of radioactive material in the human body, whether by direct measurement or by analysis, and evaluation of radioactive materials excreted or removed from the human body.

*Calibration* means to adjust and/or determine either:

- (i) The response or reading of an instrument relative to a standard (e.g., primary, secondary, or tertiary) or to a series of conventionally true values; or
- (ii) The strength of a radiation source relative to a standard (e.g., primary, secondary, or tertiary) or conventionally true value.

*Contamination area* means any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed the removable surface contamination values specified in appendix D of this part, but do not exceed 100 times those values.

*Contractor* means any entity under contract with the Department of Energy with the responsibility to perform activities at a DOE site or facility.

*Controlled area* means any area to which access is managed by or for DOE to protect individuals from exposure to radiation and/or radioactive material.

*Declared pregnant worker* means a woman who has voluntarily declared to her employer, in writing, her pregnancy for the purpose of being subject to the occupational dose limits to the embryo/fetus as provided at § 835.206. This declaration may be revoked, in writing, at any time by the declared pregnant worker.

*Derived air concentration (DAC)* means, for the radionuclides listed in appendix A of this part, the airborne concentration that equals the ALI divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2400 m<sup>3</sup>). For the radionuclides listed in appendix C of this part, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud. The value is based upon the derived airborne concentration found in Table 1 of the U.S. Environmental Protection Agency's Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988. This document is available from the National Technical Information Service, Springfield, VA.

*Derived air concentration-hour (DAC-hour)* means the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the DAC for each radionuclide) and the time of exposure to that radionuclide, in hours.

*DOE activity* means an activity taken for or by DOE in a DOE operation or facility that has the potential to result in the occupational exposure of an individual to radiation or radioactive material. The activity may be, but is not limited to, design, construction, operation, or decommissioning. To the extent appropriate, the activity may involve a single DOE facility or operation or a combination of facilities and

operations, possibly including an entire site or multiple DOE sites.

*Entrance or access point* means any location through which an individual could gain access to areas controlled for the purposes of radiation protection. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

*General employee* means an individual who is either a DOE or DOE contractor employee; an employee of a subcontractor to a DOE contractor; or an individual who performs work for or in conjunction with DOE or utilizes DOE facilities.

*High contamination area* means any area, accessible to individuals, where removable surface contamination levels exceed or are likely to exceed 100 times the removable surface contamination values specified in appendix D of this part.

*High radiation area* means any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

*Individual* means any human being.

*Member of the public* means an individual who is not a general employee. An individual is not a "member of the public" during any period in which the individual receives an occupational dose.

*Minor* means an individual less than 18 years of age.

*Monitoring* means the measurement of radiation levels, airborne radioactivity concentrations, radioactive contamination levels, quantities of radioactive material, or individual doses and the use of the results of these measurements to evaluate radiological hazards or potential and actual doses resulting from exposures to ionizing radiation.

*Nonstochastic effects* means effects due to radiation exposure for which the severity varies with the dose and for which a threshold normally exists (e.g., radiation-induced opacities within the lens of the eye).

*Occupational dose* means an individual's ionizing radiation dose (external

and internal) as a result of that individual's work assignment. Occupational dose does not include doses received as a medical patient or doses resulting from background radiation or participation as a subject in medical research programs.

*Person* means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency, any State or political subdivision of, or any political entity within a State, any foreign government or nation or other entity, and any legal successor, representative, agent or agency of the foregoing; provided that person does not include the Department or the United States Nuclear Regulatory Commission.

*Radiation* means ionizing radiation: alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation as used in this part, does not include non-ionizing radiation, such as radio- or micro-waves, or visible, infrared, or ultraviolet light.

*Radiation area* means any area accessible to individuals in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.005 rem (0.05 millisievert) in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.

*Radioactive material area* means any area within a controlled area, accessible to individuals, in which items or containers of radioactive material exist and the total activity of radioactive material exceeds the applicable values provided in appendix E of this part.

*Radioactive material transportation* means the movement of radioactive material by aircraft, rail, vessel, or highway vehicle when such movement is subject to Department of Transportation regulations or DOE Orders that govern such movements. Radioactive material transportation does not include preparation of material or packagings for transportation, monitoring required by this part, storage of material awaiting transportation, or application of markings and labels required for transportation.

*Radiological area* means any area within a controlled area defined in this section as a “radiation area,” “high radiation area,” “very high radiation area,” “contamination area,” “high contamination area,” or “airborne radioactivity area.”

*Radiological worker* means a general employee whose job assignment involves operation of radiation producing devices or working with radioactive materials, or who is likely to be routinely occupationally exposed above 0.1 rem (0.001 sievert) per year total effective dose equivalent.

*Real-time air monitoring* means measurement of the concentrations or quantities of airborne radioactive materials on a continuous basis.

*Respiratory protective device* means an apparatus, such as a respirator, worn by an individual for the purpose of reducing the individual’s intake of airborne radioactive materials.

*Sealed radioactive source* means a radioactive source manufactured, obtained, or retained for the purpose of utilizing the emitted radiation. The sealed radioactive source consists of a known or estimated quantity of radioactive material contained within a sealed capsule, sealed between layer(s) of non-radioactive material, or firmly fixed to a non-radioactive surface by electroplating or other means intended to prevent leakage or escape of the radioactive material. Sealed radioactive sources do not include reactor fuel elements, nuclear explosive devices, and radioisotope thermoelectric generators.

*Source leak test* means a test to determine if a sealed radioactive source is leaking radioactive material.

*Stochastic effects* means malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity, is regarded as a function of dose without a threshold for radiation protection purposes.

*Very high radiation area* means any area accessible to individuals in which radiation levels could result in an individual receiving an absorbed dose in excess of 500 rads (5 grays) in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

*Week* means a period of seven consecutive days.

*Year* means the period of time beginning on or near January 1 and ending on or near December 31 of that same year used to determine compliance with the provisions of this part. The starting and ending date of the year used to determine compliance may be changed provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

(b) As used in this part to describe various aspects of radiation dose:

*Absorbed dose (D)* means the energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

*Committed dose equivalent ( $H_{T,50}$ )* means the dose equivalent calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body. It does not include contributions from radiation sources external to the body. Committed dose equivalent is expressed in units of rem (or sievert).

*Committed effective dose equivalent ( $H_{E,50}$ )* means the sum of the committed dose equivalents to various tissues in the body ( $H_{T,50}$ ), each multiplied by the appropriate weighting factor ( $w_T$ )—that is,  $H_{E,50} = \sum w_T H_{T,50}$ . Committed effective dose equivalent is expressed in units of rem (or sievert).

*Cumulative total effective dose equivalent* means the sum of all total effective dose equivalent values recorded for an individual, where available, for each year occupational dose was received, beginning January 1, 1989.

*Deep dose equivalent* means the dose equivalent derived from external radiation at a depth of 1 cm in tissue.

*Dose* is a general term for absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined in this part.

*Dose equivalent (H)* means the product of absorbed dose (D) in rad (or gray) in tissue, a quality factor (Q), and other modifying factors (N). Dose equivalent

**Department of Energy**

**§ 835.2**

is expressed in units of rem (or sievert) (1 rem = 0.01 sievert).

*Effective dose equivalent* ( $H_E$ ) means the summation of the products of the dose equivalent received by specified tissues of the body ( $H_T$ ) and the appropriate weighting factor ( $w_T$ )—that is,  $H_E = \sum w_T H_T$ . It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this part, deep dose equivalent to the whole body may be used as effective dose equivalent for external exposures. The effective dose equivalent is expressed in units of rem (or sievert).

*External dose or exposure* means that portion of the dose equivalent received from radiation sources outside the body (i.e., “external sources”).

*Extremity* means hands and arms below the elbow or feet and legs below the knee.

*Internal dose or exposure* means that portion of the dose equivalent received from radioactive material taken into the body (e.g., “internal sources”).

*Lens of the eye dose equivalent* means the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm.

*Quality factor* ( $Q$ ) means the modifying factor used to calculate the dose equivalent from the absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate quality factor.

(i) The quality factors to be used for determining dose equivalent in rem are as follow:

**QUALITY FACTORS**

Radiation type	Quality factor
X-rays, gamma rays, positrons, electrons (including tritium beta particles) .....	1
Neutrons, $\leq 10$ keV .....	3
Neutrons, $> 10$ keV .....	10
Protons and singly-charged particles of unknown energy with rest mass greater than one atomic mass unit .....	10
Alpha particles and multiple-charged particles (and particles of unknown charge) of unknown energy .....	20

When spectral data are insufficient to identify the energy of the neutrons, a quality factor of 10 shall be used.

(ii) When spectral data are sufficient to identify the energy of the neutrons,

the following mean quality factor values may be used:

**QUALITY FACTORS FOR NEUTRONS**

[Mean quality factors,  $\bar{Q}$  (maximum value in a 30-cm dosimetry phantom), and values of neutron flux density that deliver in 40 hours, a maximum dose equivalent of 0.1 rem (0.001 sievert). Where neutron energy falls between listed values, the more restrictive mean quality factor shall be used.]

Neutron energy (MeV)	Mean quality factor	Neutron flux density ( $\text{cm}^{-2}\text{s}^{-1}$ )
$2.5 \times 10^{-8}$ thermal .....	2	680
$1 \times 10^{-7}$ .....	2	680
$1 \times 10^{-6}$ .....	2	560
$1 \times 10^{-5}$ .....	2	560
$1 \times 10^{-4}$ .....	2	580
$1 \times 10^{-3}$ .....	2	680
$1 \times 10^{-2}$ .....	2.5	700
$1 \times 10^{-1}$ .....	7.5	115
$5 \times 10^{-1}$ .....	11	27
1 .....	11	19
2.5 .....	9	20
5 .....	8	16
7 .....	7	17
10 .....	6.5	17
14 .....	7.5	12
20 .....	8	11
40 .....	7	10
60 .....	5.5	11
$1 \times 10^2$ .....	4	14
$2 \times 10^2$ .....	3.5	13
$3 \times 10^2$ .....	3.5	11
$4 \times 10^2$ .....	3.5	10

*Shallow dose equivalent* means the dose equivalent deriving from external radiation at a depth of 0.007 cm in tissue.

*Total effective dose equivalent* (TEDE) means the sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

*Weighting factor* ( $w_T$ ) means the fraction of the overall health risk, resulting from uniform, whole body irradiation, attributable to specific tissue (T). The dose equivalent to tissue ( $H_T$ ) is multiplied by the appropriate weighting factor to obtain the effective dose equivalent contribution from that tissue. The weighting factors are as follows:

**WEIGHTING FACTORS FOR VARIOUS ORGANS AND TISSUES**

Organs or tissues, T	Weighting factor, $w_T$
Gonads .....	0.25
Breasts .....	0.15
Red bone marrow .....	0.12
Lungs .....	0.12
Thyroid .....	0.03

**§ 835.3**

**WEIGHTING FACTORS FOR VARIOUS ORGANS AND TISSUES—Continued**

Organs or tissues, T	Weighting factor, w <sub>T</sub>
Bone surfaces .....	0.03
Remainder <sup>1</sup> .....	0.30
Whole body <sup>2</sup> .....	1.00

<sup>1</sup>“Remainder” means the five other organs or tissues, excluding the skin and lens of the eye, with the highest dose (e.g., liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, and upper large intestine). The weighting factor for each remaining organ or tissue is 0.06.

<sup>2</sup>For the case of uniform external irradiation of the whole body, a weighting factor (w<sub>T</sub>) equal to 1 may be used in determination of the effective dose equivalent.

*Whole body* means, for the purposes of external exposure, head, trunk (including male gonads), arms above and including the elbow, or legs above and including the knee.

(c) Terms defined in the Atomic Energy Act and not defined in this part are used consistent with the meanings given in the Act.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59680, Nov. 4, 1998]

**§ 835.3 General rule.**

(a) No person or DOE personnel shall take or cause to be taken any action inconsistent with the requirements of:

(1) This part; or

(2) Any program, plan, schedule, or other process established by this part.

(b) With respect to a particular DOE activity, contractor management shall be responsible for compliance with the requirements of this part.

(c) Where there is no contractor for a DOE activity, DOE shall ensure implementation of and compliance with the requirements of this part.

(d) Nothing in this part shall be construed as limiting actions that may be necessary to protect health and safety.

(e) For those activities that are required by §§ 835.102, 835.901(e), 835.1202 (a), and 835.1202(b), the time interval to conduct these activities may be extended by a period not to exceed 30 days to accommodate scheduling needs.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59682, Nov. 4, 1998]

**§ 835.4 Radiological units.**

Unless otherwise specified, the quantities used in the records required by this part shall be clearly indicated in special units of curie, rad, roentgen, or

rem, including multiples and subdivisions of these units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv), are only provided parenthetically in this part for reference with scientific standards.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59682, Nov. 4, 1998]

**Subpart B—Management and Administrative Requirements**

**§ 835.101 Radiation protection programs.**

(a) A DOE activity shall be conducted in compliance with a documented radiation protection program (RPP) as approved by the DOE.

(b) The DOE may direct or make modifications to a RPP.

(c) The content of each RPP shall be commensurate with the nature of the activities performed and shall include formal plans and measures for applying the as low as reasonably achievable (ALARA) process to occupational exposure.

(d) The RPP shall specify the existing and/or anticipated operational tasks that are intended to be within the scope of the RPP. Except as provided in § 835.101(h), any task outside the scope of a RPP shall not be initiated until an update of the RPP is approved by DOE.

(e) The content of the RPP shall address, but shall not necessarily be limited to, each requirement in this part.

(f) The RPP shall include plans, schedules, and other measures for achieving compliance with regulations of this part. Unless otherwise specified in this part, compliance with amendments to this part shall be achieved no later than 180 days following approval of the revised RPP by DOE. Compliance with the requirements of § 835.402(d) for radiobioassay program accreditation shall be achieved no later than January 1, 2002.

(g) An update of the RPP shall be submitted to DOE:

(1) Whenever a change or an addition to the RPP is made;

(2) Prior to the initiation of a task not within the scope of the RPP; or

(3) Within 180 days of the effective date of any modifications to this part.