

## § 835.2

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documented to comply with the criteria for release set forth in a DOE authorized limit which has been approved by a Secretarial Officer in consultation with the Chief Health, Safety and Security Officer.

(7) Radioactive material transportation not performed by DOE or a DOE contractor.

(c) Occupational doses received as a result of excluded activities and radioactive material transportation listed in paragraphs (b)(1) through (b)(4) and (b)(7) of this section, shall be included to the extent practicable 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.

(d) The requirements in subparts F and G of this part do not apply to radioactive material transportation by DOE or a DOE contractor conducted:

(1) Under the continuous observation and control of an individual who is knowledgeable of and implements required exposure control measures, or

(2) In accordance with Department of Transportation regulations or DOE orders that govern such movements.

[58 FR 65485, Dec. 14, 1993, as amended at 63 FR 59679, Nov. 4, 1998; 71 FR 68733, Nov. 28, 2006; 72 FR 31922, June 8, 2007]

### § 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.

*Activity Median Aerodynamic Diameter (AMAD)* means a particle size in an aerosol where fifty percent of the activity in the aerosol is associated with particles of aerodynamic diameter greater than the AMAD.

*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 of 5 rems (0.05 sieverts (Sv)) (1 rem = 0.01 Sv) or a committed equivalent dose of 50 rems (0.5 Sv) to any individual organ or tissue. ALI values for intake by ingestion and inhalation of selected radionuclides are based on International Commission on Radiological Protection Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*, published July, 1994 (ISBN 0 08 042651 4). This document is available from Elsevier Science Inc., Tarrytown, NY.

*Authorized limit* means a limit on the concentration of residual radioactive material on the surfaces or within the property that has been derived consistent with DOE directives including the as low as is reasonably achievable (ALARA) process requirements, given the anticipated use of the property and has been authorized by DOE to permit the release of the property from DOE radiological control.

*Background* means radiation from:

(1) Naturally occurring radioactive materials which have not been technologically enhanced;

(2) Cosmic sources;

(3) Global fallout as it exists in the environment (such as from the testing of nuclear explosive devices);

(4) 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

(5) 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:

(1) 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

(2) 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.

*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 in § 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 cloud of radioactive material. Except as noted in the footnotes to appendix A of this part, the values are based on dose coefficients from International Commission on Radiological Protection Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*, published July, 1994 (ISBN 0 08 042651 4) and the associated ICRP computer program, *The ICRP Database of Dose Coefficients: Workers and Members of the Public*, (ISBN 0 08 043 8768). These materials are available from Elsevier Science Inc., Tarrytown, NY.

*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.

*Deterministic 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).

*DOE* means the United States Department of Energy.

*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 purpose 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 an equivalent dose to the whole body in excess of 0.1 rems (0.001 Sv) 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.

*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 DOE 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 waves or microwaves, or visible, infrared, or ultraviolet light.

*Radiation area* means any area, accessible to individuals, in which radiation levels could result in an individual receiving an equivalent dose to the whole body in excess of 0.005 rem (0.05 mSv) 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. Radioactive material transportation does not include preparation of material or packagings for transportation, 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 Sv) per year total effective dose.

*Real property* means land and anything permanently affixed to the land such as buildings, fences and those things attached to the buildings, such as light fixtures, plumbing and heating fixtures.

*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.

*Special tritium compound (STC)* means any compound, except for H<sub>2</sub>O, that contains tritium, either intentionally (e.g., by synthesis) or inadvertently (e.g., by contamination mechanisms).

*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 average energy imparted by ionizing radiation to the matter in a volume element per unit mass of irradiated material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

*Committed effective dose (E<sub>50</sub>)* means the sum of the committed equivalent doses to various tissues or organs in the body (H<sub>T,50</sub>), each multiplied by the appropriate tissue weighting factor (w<sub>T</sub>)—that is,  $E_{50} = \sum w_T H_{T,50} + W_{\text{Remainder}} H_{\text{Remainder},50}$ . Where  $W_{\text{Remainder}}$  is the tissue weighting factor assigned to the remainder organs and tissues and  $H_{\text{Remainder},50}$  is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rem (or Sv).

*Committed equivalent dose (H<sub>T,50</sub>)* means the equivalent dose 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 equivalent dose is expressed in units of rem (or Sv).

*Cumulative total effective dose* means the sum of all total effective dose values recorded for an individual plus, for occupational exposures received before the implementation date of this amendment, the cumulative total effective dose equivalent (as defined in the November 4, 1998 amendment to this rule) values recorded for an individual, where available, for each year occupational dose was received, beginning January 1, 1989.

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

*Effective dose (E)* means the summation of the products of the equivalent dose received by specified tissues or organs of the body (H<sub>T</sub>) and the appropriate tissue weighting factor (w<sub>T</sub>)—that is,  $E = \sum w_T H_T$ . It includes the dose from radiation sources internal and/or external to the body. For purposes of compliance with this part, equivalent dose to the whole body may be used as

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effective dose for external exposures. The effective dose is expressed in units of rem (or Sv).

*Equivalent dose* ( $H_T$ ) means the product of average absorbed dose ( $D_{T,R}$ ) in rad (or gray) in a tissue or organ (T) and a radiation (R) weighting factor ( $w_R$ ). For external dose, the equivalent dose to the whole body is assessed at a depth of 1 cm in tissue; the equivalent dose to the lens of the eye is assessed at a depth of 0.3 cm in tissue, and the equivalent dose to the extremity and skin is assessed at a depth of 0.007 cm in tissue. Equivalent dose is expressed in units of rem (or Sv).

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

*Radiation weighting factor* ( $w_R$ ) means the modifying factor used to calculate the equivalent dose from the average tissue or organ absorbed dose; the absorbed dose (expressed in rad or gray) is multiplied by the appropriate radiation weighting factor. The radiation weighting factors to be used for determining equivalent dose in rem are as follows:

RADIATION WEIGHTING FACTORS<sup>1</sup>,  $w_R$

Type and energy range	Radiation weighting factor
Photons, electrons and muons, all energies .....	1
Neutrons, energy < 10 keV <sup>2,3</sup> .....	5
Neutrons, energy 10 keV to 100 keV <sup>2,3</sup> .....	10
Neutrons, energy > 100 keV to 2 MeV <sup>2,3</sup> .....	20
Neutrons, energy > 2 MeV to 20 MeV <sup>2,3</sup> .....	10
Neutrons, energy > 20 MeV <sup>2,3</sup> .....	5
Protons, other than recoil protons, energy > 2 MeV .....	5
Alpha particles, fission fragments, heavy nuclei .....	20

<sup>1</sup> All values relate to the radiation incident on the body or, for internal sources, emitted from the source.  
<sup>2</sup> When spectral data are insufficient to identify the energy of the neutrons, a radiation weighting factor of 20 shall be used.  
<sup>3</sup> When spectral data are sufficient to identify the energy of the neutrons, the following equation may be used to determine a neutron radiation weighting factor value:

$$w_R = 5 + 17 \exp \left[ \frac{-(\ln(2E_n))^2}{6} \right] \text{ Where } E_n \text{ is the neutron energy in MeV.}$$

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

TISSUE WEIGHTING FACTORS FOR VARIOUS ORGANS AND TISSUES

Organs or tissues, T	Tissue weighting factor, $w_T$
Gonads .....	0.20
Red bone marrow .....	0.12

TISSUE WEIGHTING FACTORS FOR VARIOUS ORGANS AND TISSUES—Continued

Organs or tissues, T	Tissue weighting factor, $w_T$
Colon .....	0.12
Lungs .....	0.12
Stomach .....	0.12
Bladder .....	0.05
Breast .....	0.05
Liver .....	0.05
Esophagus .....	0.05
Thyroid .....	0.05
Skin .....	0.01
Bone surfaces .....	0.01
Remainder <sup>1</sup> .....	0.05

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

Organs or tissues, T	Tissue weighting factor, $w_T$
Whole body <sup>2</sup> .....	1.00

<sup>1</sup>“Remainder” means the following additional tissues and organs and their masses, in grams, following parenthetically: adrenals (14), brain (1400), extrathoracic airways (15), small intestine (640), kidneys (310), muscle (28,000), pancreas (100), spleen (180), thymus (20), and uterus (80). The equivalent dose to the remainder tissues ( $H_{\text{remainder}}$ ), is normally calculated as the mass-weighted mean dose to the preceding ten organs and tissues. In those cases in which the most highly irradiated remainder tissue or organ receives the highest equivalent dose of all the organs, a weighting factor of 0.025 (half of remainder) is applied to that tissue or organ and 0.025 (half of remainder) to the mass-weighted equivalent dose in the rest of the remainder tissues and organs to give the remainder equivalent dose.

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

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

*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 of 1954 or in 10 CFR part 820 and not defined in this part are used consistent with their meanings given in the Atomic Energy Act of 1954 or in 10 CFR part 820.

[72 FR 31922, June 8, 2007, as amended at 74 FR 18116, Apr. 21, 2009]

**§ 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 ex-

tended 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, or other conventional units, such as, dpm, dpm/100 cm<sup>2</sup> or mass units. The SI units, becquerel (Bq), gray (Gy), and sievert (Sv), may be provided parenthetically for reference with scientific standards.

[72 FR 31925, June 8, 2007]

**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 the amendments to this part published on June 8, 2007 shall be achieved no later than July 9, 2010.

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