

# PART A

## GENERAL PROVISIONS

1. **Scope.** Except as otherwise specifically provided, these regulations apply to all persons who receive, possess, use, transfer, own or acquire any source of radiation; provided, however that nothing in these regulations shall apply to any person to the extent such person is subject to regulation by the U.S. Nuclear Regulatory Commission.<sup>1/</sup>
2. **Definitions.** As used in these regulations, these terms have the definitions set forth below. Additional definitions used only in a certain part will be found in that part.

**Absorbed dose** means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the Gray (Gy) and the rad.

**Accelerator** means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of 1 MeV.

**Accelerator-produced material** means any material made radioactive by a particle accelerator. See Appendix B of Part C.

**Act** means 22 MRSA c. 160.

**Activity** means the rate of disintegration or transformation or decay of radioactive material. The units of activity are the Becquerel (Bq) and the curie (Ci).

**Added filtration** means any filtration, which is in addition to the inherent filtration.

**Additional authorized use/storage site** – see Field Station

**Address of use** means the building or buildings that are identified on the license and where radioactive material may be received, prepared, used, or stored.

**Adult** means an individual 18 or more years of age.

**Agency** means Department of Human Services.

**Agreement state** means any State with which the U.S. Nuclear Regulatory Commission (NRC) or the U.S. Atomic Energy Commission has entered into effective agreement under subsection 274b. of the Atomic Energy Act of 1954, as amended.

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

**Airborne radioactivity area** means a room, enclosure, or area in which airborne radioactive materials exist in concentrations:

- (1) In excess of the derived air concentrations (DACs) specified in Appendix B, Table I of Part D of these regulations, or
- (2) To such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

**Air-purifying respirator** means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

---

<sup>1/</sup> Attention is directed to the fact that regulation by the State of source material, byproduct material, and special nuclear material in quantities not sufficient to form a critical mass is subject to the provisions of the agreement between the State and the U.S. Nuclear Regulatory Commission and to 10 CFR Part 150 of the Commission's regulations.

## A.2

**Alert** means events may occur, are in progress, or have occurred that could lead to a release of radioactive material but that the release is not expected to require a response by offsite response organizations to protect persons offsite.

**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 that would result in a committed effective dose equivalent of 0.05 Sv (5 rem) or a committed dose equivalent of 0.5 Sv (50 rem) to any individual organ or tissue. ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table I, Columns 1 and 2, of Appendix B.

**ANSI** means American National Standards Institute.

**Area of use** means a portion of an address of use that has been set aside for the purpose of receiving, preparing, using, or storing radioactive material.

**As low as is reasonably achievable (ALARA)** means making every reasonable effort to maintain exposures to radiation as far below the dose limits in these regulations as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed or registered sources of radiation in the public interest.

**Assigned Protection Factor (APF)** means the expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly trained and fitted users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF.

**Atmosphere-supplying respirator** means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SAR's) and self-contained breathing apparatus (SCBA) units.

**Atomic energy** means all forms of energy released in the course of nuclear fission or nuclear transformation.

**Background radiation** means radiation from cosmic sources; naturally occurring radioactive materials, including radon, except as a decay product of source or special nuclear material, and including global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under control of the licensee. "Background radiation" does not include sources of radiation from radioactive materials regulated by the Agency.

**Barrier** (See "Protective barrier")

**Beam axis** means the axis of rotation of the beam-limiting device.

**Beam limiting device** means a field defining collimator, integral to the therapeutic radiation machine, which provides a means to restrict the dimensions of the useful beam.

**Beam monitoring system** means a system designed and installed in the radiation head to detect and measure the radiation present in the useful beam.

**Becquerel** (See "Units of radioactivity")

**Bioassay** means the determination of kinds, quantities or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement, in vivo counting, or by analysis and evaluation of materials excreted or removed from the human body. For purposes of these regulations, "radio-bioassay" is an equivalent term.

**Brachytherapy** means a method of radiation therapy in which sealed sources are utilized to deliver a radiation dose at a distance of up to a few centimeters, by surface, intracavitary, or interstitial application.

**Byproduct Material** "By-product material" means:

- A. 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; and
- B. The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

**Calendar quarter** means not less than 12 consecutive weeks or more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be so arranged such that no day is included in more than one calendar quarter and no day in any one year is omitted from inclusion within a calendar quarter. No licensee or registrant shall change the method observed by him of determining calendar quarters for purposes of these regulations except at the beginning of a year.

**Calibration** means the determination of (a) the response or reading of an instrument relative to a series of known radiation values over the range of the instrument, or (b) the strength of a source of radiation relative to a standard.

**CFR** means Code of Federal Regulations.

**Changeable filters** means any filter, exclusive of inherent filtration, which can be removed from the useful beam through any electronic, mechanical, or physical process.

**Chelating agent** means amine polycarboxylic acids, hydroxy-carboxylic acids, gluconic acid, and polycarboxylic acids.

**Class** means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D, Days, of fewer than 10 days, for Class W, Weeks, from 10 to 100 days, and for Class Y, Years, of greater than 100 days. For purposes of these regulations, "lung class" and "inhalation class" are equivalent terms.

**Collective dose** means the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

**Commencement of construction** means any clearing of land, excavation, or other substantial action that would adversely affect the natural environment of a site but does not include changes desirable for the temporary use of the land for public recreational uses, necessary borings to determine site characteristics or other pre-construction monitoring to establish background information related to the suitability of a site or to the protection of environmental values.

**Committed dose equivalent** ( $H_{T50}$ ) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

**Committed effective dose equivalent** (CEDE) ( $H_{E,50}$ ) is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to each of these organs or tissues ( $H_{E,50} = \sum w_T H_{T,50}$ ).

**Consortium** means an association of medical use licensees and a PET radionuclide production facility in the same geographical area that jointly own or share in the operation and maintenance cost of the PET radionuclide production facility that produces PET radionuclides for use in producing radioactive drugs within the consortium for noncommercial distributions among its associated members for medical use. The PET radionuclide production facility within the consortium must be located at an educational institution or Federal facility or a medical facility.

**Constraint** (*dose constraint*) means a value above which specified licensee actions are required.

**Controlled area** means an area, outside of a restricted area but inside the site boundary, access to which can be limited by the licensee or registrant for any reason.

## A.2

**Critical Group** means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

**Curie** (See "Units of radioactivity")

**Cyclotron** means a type of particle accelerator that is used for the production of radioactive material.

**Cyclotron / PET Facility** means a facility comprised of a cyclotron and a nuclear pharmacy that specializes in the preparation of Positron Emission Tomography (PET) radiopharmaceuticals.

**Declared pregnant woman** means a woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

**Decommission** means to remove (as a facility) safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license.

**Dedicated check source** means a radioactive source that is used to assure the constant operation of a radiation detection or measurement device over several months or years.

**Deep-dose equivalent** ( $H_d$ ), which applies to external whole body exposure, means the dose equivalent at a tissue depth of 1 centimeter ( $1000 \text{ mg/cm}^2$ ).

**Demand respirator** means an atmosphere-supplying respirator that admits breathing air to the face piece only when a negative pressure is created inside the face piece by inhalation.

**Dentist** means an individual duly registered and licensed to practice dentistry or dental surgery or any branch thereof under 32 MRSA §1084.

**Depleted uranium** means the source material uranium in which the isotope uranium-235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

**Derived air concentration** (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI. For purposes of these regulations, the condition of light work is an inhalation rate of 1.2 cubic meters of air per hour for 2,000 hours in a year. DAC values are given in Table I, Column 3, of Appendix B.

**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 derived air concentration for each radionuclide, and the time of exposure to that radionuclide, in hours. A licensee or registrant may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 0.05 Sv (5 rem).

**Detector** (See "Radiation detector")

**Discrete source** means a radionuclide that has been processed so that its concentration within a material has been purposely increased for use for commercial, medical, or research activities.

**Disposable respirator** means a respirator for which maintenance is not intended and that is designed to be discarded after excessive breathing resistance, sorbent exhaustion, physical damage, or end-of-service-life renders it unsuitable for use. Examples of this type of respirator are a disposable half-mask respirator or a disposable escape-only self-contained breathing apparatus (SCBA).

**Distinguishable from background** means that the detectable concentration of a radionuclide is statistically different from the background concentration of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

**Dose** is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent as defined in other definitions in this part. For purposes of these regulations, "radiation dose" is an equivalent term.

**Dose commitment** means the total radiation dose to a part of the body that will result from retention in the body of radioactive material. For the purposes of estimating the dose commitment, it is assumed that from the time of intake the period of exposure to retained material will not exceed 50 years.

**Dose equivalent ( $H_T$ )** means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the Sievert (Sv) and the rem .

**Dose limits** means the permissible upper bounds of radiation doses established in accordance with these regulations. For purposes of these regulations, "limits" is an equivalent term.

**Dosimetry processor** means an individual or an organization that processes and evaluates individual monitoring devices in order to determine the radiation dose delivered to the monitoring devices.

**Effective dose equivalent ( $H_E$ )** means the sum of the products of the dose equivalent to each organ or tissue ( $H_T$ ) and the weighting factor ( $w_T$ ) applicable to each of the body organs or tissues that are irradiated ( $H_E = \sum w_T H_T$ ).

**Effective kilogram** means

- (1) for the source material uranium in which the uranium isotope uranium - 235 is greater than 0.005 (0.5 weight percent) of the total uranium present: 10,000 kilograms, and
- (2) for any other source material: 20,000 kilograms.

**Effective kilograms of special nuclear material** means:

- (1) for plutonium and uranium-233 their weight in kilograms;
- (2) for uranium with an enrichment in the isotope U-235 of 0.01 (1%) and above, its element weight in kilograms multiplied by the square of its enrichment expressed as a decimal weight fraction; and
- (3) for uranium with an enrichment in the isotope U-235 below 0.01 (1%), by its element weight in kilograms multiplied by 0.0001.

**Embryo / fetus** means the developing human organism from conception until the time of birth.

**Entrance or access point** means any opening through which an individual or extremity of an individual could gain access to radiation areas or to licensed or registered radioactive materials. This includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

**Explosive material** means any chemical compound, mixture, or device, which produces a substantial instantaneous release of gas and heat spontaneously or by contact with, sparks or flame.

**Exposure** means being exposed to ionizing radiation or to radioactive material.

**Exposure rate** means the exposure per unit of time, such as roentgen per minute and milliroentgen per hour.

**External dose** means that portion of the dose equivalent received from any source of radiation outside the body.

**Extremity** means hand, elbow, and arm below the elbow, foot, knee, and leg below the knee.

**Facility** means the location at which one or more devices are installed and/or located within one building, vehicle, or under one roof and are under the same administrative control.

**Field station** or site means a facility where licensed or registered material may be stored or used and from which equipment is dispatched. This includes an additional authorized use/storage site. The term authorized use/storage site refers to those authorized use/storage locations specifically named on a license or certificate of registration other than (1) the main site specified on a license or certificate of registration or (2) or other temporary job sites.

**Filtering face piece (dust mask)** means a negative pressure particulate respirator with a filter as an integral part of the face piece or with the entire face piece composed of the filtering medium.

**Fit factor** means a quantitative estimate of the fit of a particular respirator to a specific individual and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

## A.2

**Fit Test** means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

**Former U.S. Atomic Energy Commission (AEC) or U.S. Nuclear Regulatory Commission (NRC) licensed facilities** means nuclear reactors, nuclear fuel reprocessing plants, uranium enrichment plants, or critical mass experimental facilities where AEC or NRC licenses have been terminated.

**Formula quantity** means strategic special nuclear material in any combination in a quantity of 5000 grams or more computed by the formula,  $\text{grams} = (\text{grams contained U - 235}) + 2.5 (\text{grams U - 233} + \text{grams plutonium})$ . This class of material is sometimes referred to as a Category I quantity of material.

**GED** means General Educational Development.

**Generally applicable environmental radiation standards** means standards issued by the U.S. Environmental Protection Agency (EPA) under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material.

**Gray** (See "Units of dose")

**Half value layer (HVL)** means the thickness of a specified material which attenuates X-radiation or gamma radiation to an extent such that the air kerma rate, exposure rate or absorbed dose rate is reduced to one half of the value measured without the material at the same point.

**Hazardous waste** means those wastes designated as hazardous by the U.S. Environmental Protection Agency regulations in 40 CFR Part 261.

**Healing arts** means any discipline which involves the diagnosis or treatment of individuals by a practitioner who is licensed for that purpose by the State of Maine, and which discipline, prior to the effective date of these regulations, included the intentional exposure of individuals to sources of radiation for diagnosis or treatment

**Helmet** means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

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

**Hood** means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

**Human use** means the internal or external administration of radiation or radioactive material to human beings.

**HVL** (See "Half-value layer")

**Individual** means any human being.

**Individual monitoring** means the assessment of:

- (1) Dose equivalent
  - (a) by the use of individual monitoring devices or
  - (b) by the use of survey data; or
- (2) Committed effective dose equivalent (1) by bioassay or (2) by determination of the time-weighted air concentrations to which an individual has been exposed, that is, DAC-hours. [See the definition of DAC-hours in Part D].

**Individual monitoring devices** means devices designed to be worn by a single individual for the assessment of dose equivalent. For purposes of these regulations, "personnel dosimeter" and "dosimeter" are equivalent terms. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, personal air sampling devices, and optically stimulated luminescence (OSL) devices.

**Inhalation class** (see "Class")

**Inspection** means an official examination or observation including but not limited to, tests, surveys, and monitoring to determine compliance with rules, regulations, orders, requirements and conditions of the Agency.

**Interlock** means a device arranged or connected such that the occurrence of an event or condition is required before a second event or condition can occur or continue to occur.

**Internal dose** means that portion of the dose equivalent received from radioactive material taken into the body.

**Irradiation** means the exposure of a living being or matter to ionizing radiation.

**Kilovolt (kV) [kilo electron volt (keV)]** means the energy equal to that acquired by a particle with one electron charge in passing through a potential difference of one thousand volts in a vacuum. [Note: current convention is to use kV for photons and keV for electrons.]

**Lead equivalent** means the thickness of the material in question affording the same attenuation, under specified conditions, as lead.

**Lens dose equivalent (LDE)** applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm<sup>2</sup>).

**License** means a license issued by the Agency in accordance with the regulations adopted by the Agency.

**Licensed [or registered] material** means radioactive material received, possessed, used, transferred or disposed of under a general or specific license [or registration] issued by the Agency.

**Licensee** means any person who is licensed by the Agency in accordance with these regulations and the Act.

**Limits** (See "Dose limits")

**Loose-fitting face piece** means a respiratory inlet covering that is designed to form a partial seal with the face.

**Lost or missing licensed [or registered] source of radiation** means licensed [or registered] source of radiation whose location is unknown. This definition includes licensed [or registered] material that has been shipped but has not reached its planned destination and whose location cannot be readily traced in the transportation system.

**Lung class** (See "Class")

**mA** means milliamperere.

**Major processor** means a user processing, handling, or manufacturing radioactive material exceeding Type A quantities as unsealed sources or material, or exceeding 4 times Type B quantities as sealed sources, but does not include nuclear medicine programs, universities, industrial radiographers or small industrial programs. Type A and B quantities are defined in Section 71.4 of 10 CFR Part 71.

**Management** means the chief executive officer or other individual having the authority to manage, direct, or administer the licensee's activities, or that person's delegate or delegates.

**Member of the public** means an individual in a controlled or unrestricted area. However, an individual is not a member of the public during any period in which the individual receives an occupational dose.

**Microcurie (μCi)** means that amount of radioactive material which disintegrates at the rate of 37 thousand atoms per second.

## A.2

**Millicurie (mCi)** means that amount of radioactive material which disintegrates at the rate of 37 million atoms per second.

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

**Monitoring** means the measurement of radiation levels, radioactive material concentrations, surface area concentrations or quantities of radioactive material and the use of the results of these measurements to evaluate potential exposures and doses. For purposes of these regulations, "radiation monitoring" and "radiation protection monitoring" are equivalent terms.

**NARM** means any naturally occurring or accelerator-produced radioactive material. It does not include byproduct, source, or special nuclear material. See Appendix B of Part C.

**Nationally tracked source** means a sealed source containing a quantity equal to or greater than Category 1 or 2 levels of any radioactive material listed in Appendix E of Part D. In this context a sealed source is defined as radioactive material that is sealed in a capsule or closely bonded, in a solid form and which is not exempt from regulatory control. It does not mean material encapsulated solely for disposal, or nuclear material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet. Category 1 nationally tracked sources are those containing radioactive material at a quantity equal to or greater than the Category 1 threshold. Category 2 nationally tracked sources are those containing radioactive material at a quantity equal to or greater than the Category 2 threshold but less than the Category 1 threshold.

**Natural radioactivity** means radioactivity of naturally occurring nuclides.

**Negative pressure respirator (tight fitting)** means a respirator in which the air pressure inside the face piece is negative during inhalation with respect to the ambient air pressure outside the respirator.

**Nonstochastic effect** means a health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect. For purposes of these regulations, "deterministic effect" is an equivalent term.

**Nuclear Regulatory Commission (NRC)** means the U.S. Nuclear Regulatory Commission or its duly authorized representatives.

**Occupational dose** means the dose received by an individual in the course of employment in which the individual's duties involve exposure to radiation or to radioactive material from licensed, or registered, and unlicensed, or unregistered, sources of radiation, whether in the possession of the licensee, registrant, or other person. Occupational dose does not include dose received: from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with Part G, from voluntary participation in medical research programs, or as a member of the public.

**Offshore waters** means that land and water, within the Agreement States' Submerged Lands Act jurisdiction, on or above the U.S. Outer Continental Shelf. The territorial waters of Maine extend to a line three geographical miles distant from the coastline.

**Package** means the packaging together with its radioactive contents as presented for transport.

**Particle accelerator** (See "Accelerator")

**Patient** means an individual subjected to machine produced external beam radiation for the purposes of medical therapy.

**Permanent storage site** means any location that is specifically named on a license or certificate of registration and that is used only for storage of sources of radiation.

**Person** means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, political subdivision of this State, any other State or political subdivision or agency thereof, and any legal successor, representative, agent or agency of the foregoing but not including Federal Government agencies.

**Personnel monitoring equipment** (See "Individual monitoring devices")

**Phantom** means an object behaving in essentially the same manner as tissue, with respect to absorption or scattering of the ionizing radiation in question.

**Pharmacist** means an individual licensed by this State to compound and dispense drugs, prescriptions, and poisons.

**Physician** means a medical doctor or doctor of osteopathy duly registered and licensed to practice medicine or surgery or any branch thereof under 32 MRSA §3270.

**Planned special exposure** means an infrequent exposure to radiation, separate from and in addition to the annual occupational dose limits.

**Podiatrist** means an individual duly registered and licensed to practice podiatry or any branch thereof under 32 MRSA §3552.

**Positive pressure respirator** means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

**Positron Emission Tomography (PET) radionuclide production facility** means as a facility operating a cyclotron or accelerator for the purpose of producing PET radionuclides.

**Powered air-purifying respirator (PAPR)** means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

**Pressure demand respirator** means a positive pressure atmosphere-supplying respirator that admits breathing air to the face piece when the positive pressure is reduced inside the face piece by inhalation.

**Primary protective barrier:** (See "Protective barrier")

**Protective barrier** means a barrier of radiation absorbing material(s) used to reduce radiation exposure. The types of protective barriers are as follows:

- (1) "Primary protective barrier" means the material, excluding filters, placed in the useful beam.
- (2) "Secondary protective barrier" means the material that attenuates stray radiation.

**Principal activities**, as used in this part, means activities authorized by the license, which are essential to achieving the purpose(s) for which the license was issued or amended. Storage during which no licensed material is accessed for use or disposal and activities incidental to decontamination or decommissioning are not principal activities.

**Production facility** means production facility as defined in the regulations contained in Part C of these regulations.

**Public dose** means the dose received by a member of the public from exposure to radiation or to radioactive material released by a licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released, under Part G, from voluntary participation in medical research programs.

**Pyrophoric liquid** means any liquid that ignites spontaneously in dry or moist air at or below 130 °F (54.4 °C). A pyrophoric solid is any solid material, other than one classed as an explosive, which under normal conditions is liable to cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard. Included are spontaneously combustible and water-reactive materials.

**Qualified expert** means an individual who is either a Radiological Physicist, or an X-ray Survey Technician (see Part F.4.) and has demonstrated to the satisfaction of the Agency that such individual possesses the knowledge and training to measure ionizing radiation, to evaluate safety techniques, and advise regarding radiation protection needs. With reference to the calibration of radiation therapy equipment, an individual having, in addition to the above qualifications, training and experience in the clinical applications of radiation physics to radiation therapy.

**Qualitative fit test (QLFT)** means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

## A.2

**Quality factor (Q)** means the modifying factor, listed in Tables I and II of A.13 that is used to derive dose equivalent from absorbed dose.

**Quantitative fit test (QNFT)** means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

**Quarter** means a period of time equal to one-fourth of the year observed by the licensee, approximately 13 consecutive weeks, providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

**Rad** (See "Units of dose")

**Radiation** "Radiation" means ionizing radiation and non-ionizing radiation.

- (1). "Ionizing radiation" means gamma rays and x rays, alpha and beta particles, high-speed electrons, neutrons, protons and other nuclear particles; but not sound or radio waves, or visible, infrared or ultraviolet light.
- (2). "Non-ionizing radiation" means any electromagnetic radiation, other than ionizing electromagnetic radiation, and any sonic, ultrasonic or infrasonic wave.

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

**Radiation detector** means a device, which, in the presence of radiation provides, by either direct or indirect means, a signal or other indication suitable for use in measuring one or more quantities of incident radiation.

**Radiation dose** (See "Dose")

**Radiation machine** means any device capable of producing radiation except those, which produce radiation only from radioactive material.

**Radiation safety officer** is an individual named by the licensee or registrant who has knowledge of, responsibility for, and authority to enforce appropriate radiation protection rules, standards, and practices on behalf of the licensee or registrant.

**Radiation therapy physicist** means an individual qualified in accordance with Part G §961 of these Rules.

**Radioactive material** means any material which emits ionizing radiation spontaneously. It includes accelerator-produced, by-product, naturally occurring, source and special nuclear materials.

**Radioactivity** means the transformation of unstable atomic nuclei by the emission of radiation.

**Radio-bioassay** (See "Bioassay")

**Radiological physicist** means an individual who:

- (1) is certified by the American Board of Radiology in therapeutic radiological physics, diagnostic radiological physics, or medical nuclear physics; or
- (2) has a bachelor's degree in one of the physical sciences or engineering and three years full-time experience working in therapeutic radiological physics under the direction of a physicist certified by the American Board of Radiology. The work duties must include duties involving the calibration and spot checks of a medical accelerator or sealed source teletherapy unit; or
- (3) has a Master's degree or Doctorate in physics, biophysics, radiological physics, health physics, or engineering; has had 1 year's full-time training in therapeutic radiological physics; and has had 1 year's full-time work experience in a radiotherapy facility where the individual's duties involve calibration and spot checks of a medical accelerator or a sealed source teletherapy unit.

**Reference man** means a hypothetical aggregation of human physical and physiological characteristics determined by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

**Registrant** means any person who is registered with the Agency and is legally obligated to register with the Agency pursuant to these regulations and the Act.

**Registration** means registration with the Agency in accordance with the regulations adopted by the Agency.

**Regulations of the U.S. Department of Transportation** means the regulations in 49 CFR Parts 100-189.

**REM** (See "Units of dose")

**Research and development** means (a) theoretical analysis, exploration, or experimentation; or (b) the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials, and processes. Research and development does not include the internal or external administration of radiation or radioactive material to human beings.

**Residential location** means any area where structures in which people lodge or live are located, and the grounds on which such structures are located including, but not limited to, houses, apartments, condominiums, and garages.

**Residual radioactivity** means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under the licensee's control. This includes all radioactivity from all licensed, or registered, and unlicensed sources used by the licensee, but excludes background radiation. It also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive materials at the site and previous burials at the site, even if those burials were made in accordance with the provisions of Part D.

**Respiratory protection device** means an apparatus, such as a respirator, used to reduce the individual's intake of airborne radioactive materials.

**Restricted area** means an area, access to which is limited by the licensee or registrant for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive material. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

**Roentgen** (See "Units of dose")

**Sanitary sewerage** means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee or registrant.

**Scattered radiation** means ionizing radiation emitted by interaction of ionizing radiation with matter, the interaction being accompanied by a change in direction of the radiation. Scattered primary radiation means scattered radiation that has been deviated in direction only by materials irradiated by the useful beam.

**Sealed source** means any radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.

**Secondary dose monitoring system** means a system that will terminate irradiation in the event of failure of the primary dose monitoring system.

**Self-contained breathing apparatus (SCBA)** means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

**Shallow dose equivalent ( $H_s$ )**, which applies to the external exposure of the skin of the whole body or the skin of an extremity, means the dose equivalent at a tissue depth of 0.007 centimeter ( $7 \text{ mg/cm}^2$ ).

**Shutter** means a device attached to the tube housing assembly which can totally intercept the useful beam and which has a lead equivalency not less than that of the tube housing assembly.

**SI** means the abbreviation for the International System of Units.

**Sievert** (See "Units of dose")

## A.2

**Site area emergency** means events may occur, are in progress, or have occurred that could lead to a significant release of radioactive material and that could require a response by offsite response organizations to protect persons offsite.

**Site boundary** means that line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee or registrant.

**Source material** means

- (1) uranium or thorium, or any combination thereof, in any physical or chemical form; or
- (2) ores, which contain by weight one-twentieth of one percent (0.05 percent) or more of
  - a. uranium,
  - b. thorium, or
  - c. any combination thereof.

Source material does not include special nuclear material.

**Source material milling** means any activity that results in the production of byproduct material as defined by definition of byproduct material.

**Sources of radiation** means collectively, radioactive material and radiation generating equipment.

**Special form** means radioactive material, which satisfies the following conditions:

- (1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;
- (2) The piece or capsule has at least one dimension not less than 5 millimeters (0.2 inch); and
- (3) It satisfies the test requirements specified by the U.S. NRC. A special form encapsulation designed in accordance with the NRC requirements in effect on June 30, 1983, and constructed prior to July 1, 1985 may continue to be used. A special form encapsulation either designed or constructed after June 30, 1985 must meet requirements of this definition applicable at the time of its design or construction.

**Special nuclear material** means:

- (1) Plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material that the Agency declares by order to be special nuclear material after <sup>2/</sup> the U.S. Nuclear Regulatory Commission, pursuant to the provisions of section 51 of the Atomic Energy Act of 1954, as amended, determines to be special nuclear material, but does not include source material; or
- (2) Any material artificially enriched by any of the foregoing but does not include source material.

**Special nuclear material in quantities not sufficient to form a critical mass** means uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; uranium-233 in quantities not exceeding 200 grams; plutonium in quantities not exceeding 200 grams; or any combination of them in accordance with the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all of the kinds of special nuclear material in combination shall not exceed "1" (i.e., unity). For example, the following quantities in combination would not exceed the limitation and are within the formula:

$$\frac{175(\text{grams containing U-235})}{350} + \frac{50(\text{gms U-233})}{200} + \frac{50(\text{gms Pu})}{200} = 1$$

---

<sup>2/</sup> This wording is provided for states that cannot automatically adopt changes made by the Nuclear Regulatory Commission.

**Stochastic effect** means a health effect that occurs randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects. For purposes of these regulations, "probabilistic effect" is an equivalent term.

**Storage area** means any location, facility, or vehicle which is used to store and secure a radiation machine, radiographic exposure device, a storage container, or a sealed source when it is not in use and which is locked or has a physical barrier to prevent accidental exposure, tampering with, or unauthorized removal of the machine, device, container, or source.

**Storage container** is a device in which a sealed source is secured and stored.

**Storage facility** is a structure designed to house one or more sources of radiation to provide security and shielding at a permanent storage site. A storage facility is also known as a vault.

**Stray radiation** means the sum of leakage and scattered radiation.

**Structured educational program** means an educational program designed to impart particular knowledge and practical education through interrelated studies and supervised training.

**Supplied-air respirator (SAR) or airline respirator** means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

**Survey** means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, and/or presence of radiological material or other sources of radiation. When appropriate, such an evaluation includes, but is not limited to, a physical survey of the location of radioactive material and measurements or calculations of levels of radiation, or concentration or quantities of radioactive material present.

**Temporary job site** means a location where radiographic operations are conducted and where sources of radiation may be stored other than those location(s) of use authorized on the license or a certificate of registration.

**Termination of irradiation** means the stopping of irradiation in a fashion that will not permit continuance of irradiation without the resetting of operating conditions at the control panel.

**Test** means the process of verifying compliance with applicable regulation.

**These regulations** means all parts of Maine Rules Relating to Radiation Protection 10-144A CMR 220.

**Tight-fitting face piece** means a respiratory inlet covering that forms a complete seal with the face.

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

**Total organ dose equivalent (TODE)** means the sum of the effective dose equivalent and the committed effective dose equivalent to the organ receiving the highest dose as described in D.2106.A(6) of these regulations.

**Transport container** means a package that is designed to provide radiation safety and security when sealed sources are transported and that meets all applicable requirements of the U.S. Department of Transportation.

**Tube** means an X-ray tube, unless otherwise specified.

**Tube housing assembly** means the tube housing with tube installed. It includes high voltage and/or filament transformers and other appropriate elements when such are contained within the tube housing.

## A.2

**U.S. Department of Energy** means the Department of Energy established by Public Law 95-91, August 4, 1977, 91 Stat. 565, 42 U.S.C. 7101 et seq., to the extent that the Department exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers and components and transferred to the Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104(b), (c) and (d) of the Energy Reorganization Act of 1974 (Public Law 93-438, October 11, 1974, 88 Stat. 1233 at 1237, 42 U.S.C. 5814, effective January 19, 1975) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Public Law 95-91, August 4, 1977, 91 Stat. 565 at 577-578, 42 U.S.C. 7151, effective October 1, 1977.)

**Units of Dose:** The units of radiation dose are:

- (1) **Gray** (Gy) is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule/kilogram (100 rads).
- (2) **Roentgen** (r) is the special unit of exposure. One roentgen equals  $2.58 \times 10^{-4}$  coulombs/kilogram of air.
- (3) **Rad** (rad) is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg/gram or 0.01 joule/kilogram (0.01 Gray).
- (4) **Rem** (rem) is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 Sievert).
- (5) **Sievert** (Sv) is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

**Units of radioactivity:** The units of activity are:

- (1) **Becquerel** (Bq) is the SI unit for the expression of activity. One becquerel is equal to 1 disintegration per second (dps). One becquerel =  $2.7 \times 10^{-11}$  curie.
- (2) **Curie** (Ci) is a unit of quantity of radioactivity. One curie (Ci) is that quantity of radioactive material which decays at the rate of  $3.7 \times 10^{10}$  disintegration per second (dps). Commonly used submultiples of the curie are the millicurie and the microcurie. One millicurie (mCi) = 0.0001 curie =  $3.7 \times 10^7$  dps. One microcurie ( $\mu$ Ci) = 0.000001 curie =  $3.7 \times 10^4$  dps.

**Unrefined and unprocessed ore** means ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

**Unrestricted area** means any area access to, which is neither limited nor controlled by the licensee or registrant. For purposes of these regulations, "uncontrolled area" is an equivalent term.

**Useful beam** means the radiation emanating from the tube housing port or the radiation head and passing through the aperture of the beam-limiting device when the exposure controls are in a mode to cause the therapeutic radiation machine to produce radiation.

**User seal check (fit check)** means an action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.

**Very high radiation area** means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 5 Gy (500 rads) in 1 hour at 1 meter from a source of radiation or 1 meter from any surface that the radiation penetrates.<sup>2/</sup>

**Virtual source** means a point from which radiation appears to originate.

---

<sup>2/</sup> At very high doses received at high dose rates, units of absorbed dose, gray and rad, are appropriate, rather than units of dose equivalent, sievert and rem.

**Waste** means those low-level radioactive wastes containing source, special nuclear, or radioactive material, that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level radioactive waste can not also be classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or radioactive material as defined in the definition of radioactive material set forth in this section.

**Waste handling licensees** means persons licensed to receive and store radioactive wastes prior to disposal and/or persons licensed to dispose of radioactive waste.

**Wedge filter** means a filter which causes continuous change in transmission over all or a part of the useful beam.

**Week** means 7 consecutive days starting on Sunday.

**Weighting factor** ( $w_T$ ) for an organ or tissue (T) means the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of  $w_T$  are:

ORGAN DOSE WEIGHTING FACTORS

<u>Organ/Tissue</u>	<u><math>w_T</math></u>
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30 <sup>a</sup>
<b>Whole Body</b>	<b>1.00<sup>b</sup></b>

- a 0.30 results from 0.06 for each of 5 "remainder" organs, excluding the skin and the lens of the eye, that receive the highest doses.
- b For the purpose of weighting the external whole body dose, for adding it to the internal dose, a single weighting factor,  $w_T = 1.0$ , has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

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

**Worker** means an individual engaged in work under a license or registration issued by the Agency and controlled by a licensee or registrant, but does not include the licensee or registrant.

**Working level** (WL) means any combination of short-lived radon daughters in 1 liter of air that will result in the ultimate emission of  $1.3 \times 10^5$  MeV of potential alpha particle energy. The short-lived radon daughters are for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214; and for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212.

**Working level month** (WLM) means an exposure to 1 working level for 170 hours. 2,000 working hours per year divided by 12 months per year is approximately equal to 170 hours per month.

**X-Ray Survey Technician** shall possess a high school diploma; and

- (1) A BS/BA degree in Health Physics or Radiological Health and have one year's experience in the field of diagnostic x-ray as outlined in Appendix E of Part F; or
- (2) A BS/BA Degree in a Natural Science and have 2 years experience in the field of diagnostic x-ray as outlined in Appendix E of Part F; or
- (3) Be licensed in the State of Maine as a Radiologic Technologist with three years experience in the field of diagnostic x-ray as outlined in Appendix E of Part F; or
- (4) Have educational training equivalent to one of the above criteria; as determined by the Agency; and have five years experience in the field of diagnostic x-ray as outlined in Appendix E of Part F.

**X ray tube** means any electron tube that is designed to be used primarily for the production of X-rays.

## A.3

**Year** means the period of time beginning in January used to determine compliance with the provisions of these regulations. The licensee or registrant may change the starting date of the year used to determine compliance by the licensee or registrant provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

### 3. Exemptions.

- A. General Provision. The Agency may, upon application therefore or upon its own initiative, grant such exemptions or exceptions from the requirements of these regulations as it determines are authorized by law and will not result in undue hazard to public health and safety or property.
- B. U.S. Department of Energy Contractors and U.S. Nuclear Regulatory Commission Contractors. Any U.S. Department of Energy contractor or subcontractor and any U.S. Nuclear Regulatory Commission contractor or subcontractor of the following categories operating within this State is exempt from these regulations to the extent that such contractor or subcontractor under his contract receives, possesses, uses, transfers or acquires sources of radiation:
  - (1) prime contractors performing work for the U.S. Department of Energy at U.S. Government-owned or controlled sites, including the transportation of sources of radiation to or from such sites and the performance of contract services during temporary interruptions of such transportation;
  - (2) prime contractors of the U.S. Department of Energy performing research in, or development, manufacture, storage, testing or transportation of, atomic weapons or components thereof;
  - (3) prime contractors of the U.S. Department of Energy using or operating nuclear reactors or other nuclear devices in a United States Government-owned vehicle or vessel; and
  - (4) any other prime contractor or subcontractor of the U.S. Department of Energy or of the U.S. Nuclear Regulatory Commission when the State and the Nuclear Regulatory Commission jointly determine:
    - a. that the exemption of the prime contractor or subcontractor is authorized by law; and
    - b. that under the terms of the contract or subcontract, there is adequate assurance that the work there under can be accomplished without undue risk to the public health and safety.
- C. Common and contract carriers, freight forwarders, and warehousemen are exempt from the requirements for a license to the extent that they transport or store radioactive material in the regular course of carriage for another.

**4. Records.** Each licensee and registrant shall maintain records showing the receipt, transfer, and disposal of all sources of radiation. Additional record requirements are specified elsewhere in these regulations.

### 5. Inspections.

- A. Each licensee and registrant shall afford the Agency at all reasonable times opportunity to inspect sources of radiation and the premises and facilities wherein such sources of radiation are used or stored.
- B. Each licensee and registrant shall make available to the Agency for inspection, upon reasonable notice, records maintained pursuant to these regulations.
- C. Inspection frequencies are indicated in Appendix A to Part C, and Part F.3.C for radiation material and x-ray machines respectively.

**6. Tests.** Each licensee and registrant shall perform upon instructions from the Agency, or shall permit the Agency to perform, such reasonable tests as the Agency deems appropriate or necessary including, but not limited to, tests of:

- A. source of radiation;
- B. facilities wherein sources of radiation are used or stored;
- C. radiation detection and monitoring instruments; and

D. other equipment and devices used in connection with utilization or storage of licensed or registered sources of radiation.

**7. Additional Requirements.** The Agency may, by rule, regulation, or order, impose upon any licensee or registrant such requirements in addition to those established in these regulations as it deems appropriate or necessary to minimize danger to public health and safety or property.

**8. Violations.** An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or any regulation or order issued thereunder. Any person who willfully violates any provision of the Act or any regulation or order issued thereunder may be guilty of a crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

**9. Impounding.** Sources of radiation shall be subject to impounding pursuant to Section 688 (2) of the Act.

**10. Prohibited Uses.**

A. Hand-held fluoroscopic screens shall not be used.

B. Shoe-fitting fluoroscopic devices shall not be used.

**11. Interpretations.** Except as specifically authorized by the Agency in writing, no interpretation of these regulations by an officer or employee of the Agency other than a written interpretation by the legal counsel will be recognized to be binding upon the Agency.

**12. Communications.** All communications and reports concerning these regulations, and applications filed thereunder, should be addressed to the Radiation Control Program, 11 State House Station, Augusta, Maine 04333-0011.

**13. The International System of Units (SI).** The Metric Conversion Act of 1975 (PL 94-168) urged the increasing awareness and use of the International System of Units (SI). The generally accepted regulatory values in the narrative portions of this document are followed by the SI equivalents in parentheses. Where appropriate schedules and appendices are provided with notes concerning conversion factors. The inclusion of the SI equivalent is for informational purposes only unless otherwise specified.

A. Units of Exposure and Dose

(1) **ABSORBED DOSE.** The unit of absorbed dose is the gray (Gy) which is equal to 1 joule per kilogram. One rad is equal to  $1 \times 10^{-2}$  gray. Sub-multiples included in this document are the milligray (mGy) and the microgray ( $\mu$ Gy).

(2) **DOSE EQUIVALENT.** The unit of dose equivalent is the sievert (Sv) which is equal to 1 joule per kilogram. The dose equivalent in sievert is equal to the absorbed dose in Gray multiplied by the quality factor. One Rem is equal to  $1 \times 10^{-2}$  Sievert. Submultiples included in this document are the millisievert (mSv) and the microsievert ( $\mu$ Sv).

(3) **EXPOSURE.** The unit of exposure is the Coulomb per kilogram (C/kg). One roentgen is equal to  $2.58 \times 10^{-4}$  coulomb per kilogram of air. Submultiples of this unit are the millicoulomb per kilogram (mC/kg) and the microcoulomb per kilogram ( $\mu$ C/kg).

(4) **QUALITY FACTORS.** As used in these regulations, the quality factors for converting absorbed dose to dose equivalent are shown in Table I. (next page)

**A.13.A(4)**

**TABLE I**  
**QUALITY FACTORS AND ABSORBED DOSE EQUIVALENCIES**

TYPE OF RADIATION	Quality Factor (Q)	Absorbed Dose Equal to a Unit Dose Equivalent <sup>a</sup>
X, gamma, or beta radiation and high-speed electrons	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

<sup>a</sup> Absorbed dose in gray equal to 1 Sv or the absorbed dose in rad equal to 1 rem.

- (5) If it is more convenient to measure the neutron influence rate than to determine the neutron dose equivalent rate in sievert per hour or rem per hour, as provided in A.13.A.(4), 0.01 Sv (1 rem) of neutron radiation of unknown energies may, for purposes of these regulations, be assumed to result from a total influence of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, the licensee or registrant may use the fluence rate per unit dose equivalent or the appropriate Q value from Table II to convert a measured tissue dose in gray or rad to dose equivalent in sievert or rem.

**TABLE II**  
**MEAN QUALITY FACTORS, Q, AND FLUENCE PER UNIT DOSE EQUIVALENT FOR MONOENERGETIC NEUTRONS**

Neutron Energy (MeV)	Quality Factor <sup>a</sup> (Q)	Fluence per Unit Dose Equivalent <sup>b</sup> (neutrons cm <sup>-2</sup> rem <sup>-1</sup> )	Fluence/Unit Dose Equivalent <sup>b</sup> (neutrons cm <sup>-2</sup> Sv <sup>-1</sup> )
(thermal)			
2.5E-8	2	980E+6	980E+8
1E-7	2	980E+6	980E+8
1E-6	2	810E+6	810E+8
1E-5	2	810E+6	810E+8
1E-4	2	840E+6	840E+8
1E-3	2	980E+6	980E+8
1E-2	2.5	1010E+6	1010E+8
1E-1	7.5	170E+6	170E+8
5E-1	11	39E+6	39E+8
1	11	27E+6	27E+8
2.5	9	29E+6	29E+8
5	8	23E+6	23E+8
7	7	24E+6	24E+8
10	6.5	24E+6	24E+8
14	7.5	17E+6	17E+8
20	8	16E+6	16E+8
40	7	14E+6	14E+8
60	5.5	16E+6	16E+8
1E+2	4	20E+6	20E+8
2E+2	3.5	19E+6	19E+8
3E+2	3.5	16E+6	16E+8
4E+2	3.5	14E+6	14E+8

<sup>a</sup>Value of quality factor (Q) at the point where the dose equivalent is maximum in a 30-centimeter diameter cylinder tissue-equivalent phantom.

<sup>b</sup>Monoenergetic neutrons incident normally on a 30-centimeter diameter cylinder tissue-equivalent phantom.

- B. Units of Activity. For purposes of these regulations, activity is expressed in the SI unit of becquerel (Bq) or in the special unit of curie (Ci), or their multiples, or disintegrations or transformations per unit of time.
- (1) The unit of measurement of radioactivity is the becquerel (Bq) and it is equal to one transformation per second.
  - (2) One curie is equal to  $3.7 \times 10^{10}$  disintegrations or transformations per second (dps or tps) =  $3.7\text{E}+10$  becquerel (Bq) =  $2.22\text{E}+12$  disintegrations or transformations per minute (dpm or tpm). Multiples included in this document are kilobecquerel (kBq), megabecquerel (MBq), gigabecquerel (GBq), and petabecquerel (PBq).