PART A

GENERAL PROVISIONS

Sec. A.1 Scope. Except as otherwise specifically provided, the regulations apply to all persons who receive, possess, use, transfer, own, or acquire any source of radiation; provided, however, that nothing in the regulations except for registration of radiation machine facilities/sources as specified in Section B.5.a. shall apply to any person to the extent such person is subject to regulation by the Nuclear Regulatory Commission.[1]

Sec. A.2 Definitions. As used in the regulations, these terms have the definitions set forth below.

"A_1" means the maximum activity of special form radioactive material permitted in a Type A package.

"A_2" means the maximum activity of radioactive material, other than special form radioactive material, permitted in a Type A package.

"Absorbed dose (D)" means the energy deposited by ionizing radiation per unit mass (of any material). The conventional unit of absorbed dose is the rad. One rad is equal to 0.01 J/kg. The International Standard (SI) unit of absorbed dose is the gray (Gy) (1 Gy = 100 rad).

"Absorbed dose rate" means absorbed dose per unit time, for machines with timers, or dose monitor unit per unit time for linear accelerators.

"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. For purposes of this definition, "particle accelerator" is an equivalent term.

"Accelerator-produced material" means any material made radioactive by a particle accelerator.

"Accessible surface diagnostic" means the external surface of the enclosure or housing of the radiation producing machine as provided by the manufacturer.

"Accessible surface therapy" means surface of equipment or of an equipment part that can be easily or accidentally touched by persons without the use of a tool.

"Act" means Del. Code Title 16, Chapter 74, Radiation Control.

"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 diagnostic" means any filtration which is in addition to the inherent filtration.

---

1 Attention is directed to the fact that except for registration, the Nuclear Regulatory Commission is the regulator of source material, byproduct material, and special nuclear material in Delaware.

“Added filtration therapy” means any filtration placed in the path of the useful beam in addition to the inherent filtration.

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

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

"Agency" means the Administrative Agent for the Authority on Radiation Protection, i.e., the Office of Radiation Control, Division of Public Health, Delaware Health and Social Services.

"Agreement State" means any State with which the U.S. Nuclear Regulatory Commission or the Atomic Energy Commission has entered into an effective agreement under subsection 274b. of the Atomic Energy Act of 1954, as amended (73 Statute 689). Delaware is not an agreement state.

“Air Kerma” means the kinetic energy released by ionizing radiation per unit mass of air. This unit is the gray. The air kerma in gray (mGy) is equivalent to exposure in roentgen (R) multiplied by 8.37 E+2.

"Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, particulates, 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 the 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.

"ALARA or As low as is reasonably achievable" means making every reasonable effort to maintain exposures to radiation as far below the dose limits in the 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.

"ALI or Annual limit on intake" 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 equivalent dose (H) of 0.05 Sv (5 rem) or a committed equivalent dose (H) 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 of Part D.

"Aluminum equivalent" means the thickness of type 1100 aluminum alloy[2] affording the same attenuation, under specified conditions, as the material in question.

2 The nominal chemical composition of type 100 aluminum is 99.00 percent minimum aluminum, 0.12 percent copper.

"Analytical x-ray equipment" means equipment used for x-ray diffraction or fluorescence analysis.

"Analytical x-ray system" means a group of components utilizing x- or gamma-rays to determine the elemental composition or to examine the microstructure of materials.

"Area of use" means a portion of a physical structure that has been set aside for the purpose of producing, preparing, receiving, using, or storing radioactive material.

“Applicant” means a person seeking a certificate, license or registration issued under the provisions of the ACT and the requirements of the regulations.

"Assembler" means any person engaged in the business of assembling, replacing, or installing one or more components into an x-ray system or subsystem. The term includes the owner of an x-ray system or his or her employee or agent who assembles components into an x-ray system that is subsequently used to provide professional or commercial services.

"Attenuation block" means a block or stack, having dimensions 20 centimeters by 20 centimeters by 3.8 centimeters, of type 1100 aluminum alloy[3] or other materials having equivalent attenuation.

“Authority” means the Authority on Radiation Protection created by Del. Code Title 16 § 7404.

"Authorized user" means a practitioner of the healing arts who is identified as an authorized user on an Agency, Agreement State, Licensing State or the Nuclear Regulatory Commission license that authorizes the medical use of radioactive material.

"AEC or Automatic exposure control" means a device which automatically controls one or more technique factors in order to obtain at a preselected location(s) a required quantity of radiation (Includes devices such as phototimers and ion chambers).

"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. “Background radiation” does not include sources of radiation from radioactive materials regulated by the Agency.

"Barrier" (See "Protective barrier").

"Beam axis diagnostic" means a line from the source through the centers of the x-ray fields.

"Beam axis therapy" means the axis of rotation of the beam limiting device.

"Beam-limiting device (collimator)" means a device to restrict the dimensions of the x- ray field.

"Beam-limiting device therapeutic" 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.

3 See Footnote #2.

"Beam scattering foil" means a thin piece of material (usually metallic) placed in the beam to scatter a beam of electrons in order to provide a more uniform electron distribution in the useful beam.

"Becquerel" (Bq) means the SI unit of activity. One becquerel is equal to 1 disintegration or transformation per second (dps or tps).

"Bent beam linear accelerator" means a linear accelerator geometry in which the accelerated electron beam must change direction by passing through a bending magnet.

"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 the regulations, "radiobioassay" 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" means:

(1) 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

(2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium or thorium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute "byproduct material" within this definition.

"C-arm x-ray system" means an x-ray system in which the image receptor and x-ray tube housing assembly are connected by a common mechanical support system in order to maintain a desired spatial relationship. This system is designed to allow a change in the projection of the beam through the patient without a change in the position of the patient.

"Cabinet radiography" means industrial radiography conducted in an enclosure or cabinet shielded so that radiation levels at every location on the exterior meet the limitations specified in Section D.301 of the regulations.

"Cabinet x-ray system" means an x-ray system with the x-ray tube installed in an enclosure independent of existing architectural structures except the floor on which it may be placed. The cabinet x-ray system is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude personnel from its interior during generation of radiation. Included are all x-ray systems designed primarily for the inspection of carry-on baggage at airline, railroad, and bus terminals, and in similar facilities. An x-ray tube used within a shielded part of a building, or x-ray equipment which may temporarily or occasionally incorporate portable shielding, is not considered a cabinet x-ray system.

"Calendar quarter" means not less than 12 consecutive weeks nor 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. The method observed by the licensee or registrant for determining calendar quarters shall only be changed at the beginning of a year.

"Calibration" means the determination of (1) the response or reading of an instrument relative to a series of known radiation values over the range of the instrument, or (2) the strength of a source of radiation relative to a standard.

"Cephalometric device" means a device intended for the radiographic visualization and measurement of the dimensions of the human head.

“Certificate” is an official document issued by the Agency which authorizes a person to perform a specified radiation activity.

"Certified cabinet x-ray system" means an x-ray system which has been certified in accordance with 21 CFR 1010.2 as being manufactured and assembled pursuant to the provisions of 21 CFR 1020.40.

"Certified components" means components of x-ray systems which are subject to regulations promulgated under Public Law 90-602, the Radiation Control for Health and Safety Act of 1968, the Food and Drug Administration.

"Certified system" means any x-ray system which has one or more certified component(s).

"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 an organic compound which is capable of complexing either metal ions and/or metal atoms.

"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 less 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 the regulations, "lung class" and "inhalation class" are equivalent terms.

“C or Coulumb” means
the SI unit of electric charge.

"C_v or Coefficient of variation " means the ratio of the standard deviation to the mean value of a set of observations. It is estimated using the following equation:

$$Cv = \frac{s}{\bar{x}} = \frac{1}{\bar{x}} \left[\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1} \right]^{1/2}$$

where:

s = Standard deviation of the observed values;

$\bar{x}$ = Mean value of observations in sample;

x_i = i_{th} observation in sample;

n = Number of observations in sample.

"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.

"Collimator" means a device used to limit the radiation field. Beam-limiting devices are specific types of collimators.

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

"Computed tomography dose index" means the integral from -7T to +7T of the dose profile along a line perpendicular to the tomographic plane divided by the product of the nominal tomographic section thickness and the number of tomograms produced in a single scan, that is:

$$\overline{\text{CTDI}} = \frac{1}{n\ T} \int_{-7T}^{+7T} D(z)\ dz$$

where:

z = Position along a line perpendicular to the tomographic plane;

D(z) = Dose at position z;

T = Nominal tomographic section thickness;

n = Number of tomograms produced in a single scan.

This definition assumes that the dose profile is centered around z=0 and that, for a multiple tomogram system, the scan increment between adjacent scans is nT.

"Contact therapy system" means a therapeutic radiation machine with a short target to skin distance (TSD), usually less than 5 centimeters.

"Control panel" means that part of the x-ray control upon which are mounted the switches, knobs, pushbuttons, and other hardware necessary for manually setting the technique factors.

"Cooling curve" means the graphical relationship between heat units stored and cooling time.

"CT conditions of operation" means all selectable parameters governing the operation of a CT x-ray system including, but not limited to, nominal tomographic section thickness, filtration, and the technique factors as defined in F.2.

"CTDI" (See "Computed tomography dose index").

“CT or Computed tomography" means the production of a cross-sectional image through the acquisition and computer processing of a tomogram.

"CT gantry" means the tube housing assemblies, beam-limiting devices, detectors, and the supporting structures and frames which hold these components.

"CTN" (See "CT number").

"CT Number" means the number used to represent the x-ray attenuation associated with each elemental area of the CT image.

$$\overline{\text{CTN}} = \frac{\text{k}\ (\mu_x - \mu_w)}{\mu_w}$$

where:

k k = A constant, a normal value of 1,000 when the Houndsfield scale of CTN is used;

μ_x = Linear attenuation coefficient of the material of interest;

μ_w = Linear attenuation coefficient of water.

"Curie" means a unit of quantity of activity. One curie (Ci) is that quantity of radioactive material which decays at the rate of 3.7E+10 disintegrations or transformations per second (dps or tps).

"Dead-man switch" means a switch so constructed that a circuit closing contact can be maintained only by continuous pressure on the switch by the operator.

"Declared pregnant woman" means a woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

"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. This source may also be used for other purposes.

"Deep equivalent dose" (H_d), which applies to external whole body exposure, means the equivalent dose (H) at a tissue depth of 1 centimeter (1000 mg/cm^2).

"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 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.)

"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.

"DAC or Derived air concentration" 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 the 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 of Part D.

"DAC hour or Derived air concentration-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 equivalent dose (H) of 0.05 Sv (5 rem).

"Detector" (See "Radiation detector").

"Diagnostic clinical procedures manual" means a collection of written procedures that describes each method (and other instructions and precautions) by which the licensee performs diagnostic clinical procedures; where each diagnostic clinical procedure has been approved by the authorized user and includes the radiopharmaceutical, dosage, and route of administration.

"Diagnostic source assembly" means the tube housing assembly with a beam-limiting device attached.

"Diagnostic x-ray system" means an x-ray system designed for irradiation of any part of the human or animal body for the purpose of diagnosis or visualization.

"Diagnostic x-ray imaging system" means an assemblage of components for the generation, emission and reception of x-rays and the transformation, storage and visual display of the resultant x-ray image.

"Direct scattered radiation" means that scattered radiation which has been deviated in direction only by materials irradiated by the useful beam (See "Scattered radiation").

“Direct Supervision” means the physical presence of the supervisor and is used for purposes of instruction.

"Dose" is a generic term that means absorbed dose, equivalent dose (H_T), effective equivalent dose (H_E), committed equivalent dose ($H_{T,50}$), committed effective equivalent dose ($H_{E,50}$), total organ equivalent dose (TOED), or total effective equivalent dose (TEED). For purposes of the regulations, "radiation dose" is an equivalent term.

“Dose equivalent” see Equivalent dose (H_T).

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

"Dose monitor unit (DMU)" means a unit response from the beam monitoring system from which the absorbed dose can be calculated.

“Dose profile diagnostic" means dose as a function of position in any direction perpendicular to the beam axis.

"Dose profile CT" means the dose as a function of position along a line.

"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 equivalent dose (H_E)" means the sum of the products of the equivalent dose (H) for each organ or tissue and the tissue weighting factor (w_T): $H_E = \sum_T W_T x H(Sv)$. The unit of effective dose equivalent is the Sievert. See Appendix C of Part F for a table of tissue weighting factors.

"Elemental area" means the smallest area within a tomogram for which the x-ray attenuation properties of a body are depicted. (See also "Picture element").

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

"Entrance exposure rate" means the exposure free in air per unit time at the point where the center of the useful beam enters the patient.

“Entrance Skin Exposure (ESE)” means the calculated amount of exposure at the skin of the patient for a selected x-ray projection or x-ray exam.

"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.

"Equipment" (See "X-ray equipment").

“Equivalent Dose (H_T)” means the product of the absorbed dose (D) and the radiation weighting factor (W_R), formerly called the quality factor (Q): $H_T = W_R \cdot D$. The unit of equivalent dose is the Sievert (Sv). See Appendix C of Part F for a table of radiation weighting factors (W_R).

“Exemption” means an exclusion may be granted from a regulatory requirement by the Agency or the Authority. When the exclusion is based on a national standard or similar documented and publicly available information, the Agency may grant it. Otherwise, the exemption shall be referred to the Authority for consideration.

“E” or “Exponential” means 10 raised (E + x) or lowered (E – x) to the specified order of magnitude (x); e.g., where x = 4: $E + 4 = 10^4$ or 10,000; whereas $E - 4 = 10^{-4}$ or 0.0001.

"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 the amount of charge (i.e., the concentration of ions of one sign) produced by ionizing radiation per unit mass of air. The SI unit of exposure is coulombs per kilogram (C/kg). The traditional unit is the Roentgen (R), which corresponds to an exposure of $2.58 \cdot 10^{-4}$ c/kg of air. More

recently, exposure has also been expressed in terms Air Kerma (K) given by the absorbed dose in air in units of Sieverts (Sv): $K(mGy) = 0.0873 \cdot X(R)$.

“Exposure rate” means exposure per unit time (R/s) as measured at the center of the useful beam.

"External beam radiation therapy" means therapeutic irradiation in which the source of radiation is at a distance from the body.

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

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

"Eye equivalent dose" means the equivalent dose (H_T) received by the eye at a tissue depth of 0.3 cm.

"Facility" means the location, building, vehicle, or complex under one administrative control, at which one or more radiation sources are installed, located and/or used.

"Fail-safe characteristics" mean a design feature which causes beam port shutters to close, or otherwise prevents emergence of the primary beam, upon the failure of a safety or warning device.

"Field emission equipment" means equipment which uses an x-ray tube in which electron emission from the cathode is due solely to the action of an electric field.

"Field-flattening filter" means a filter used to homogenize the absorbed dose rate over the radiation field.

"Filter diagnostic" means material placed in the useful beam to preferentially absorb selected radiations.

"Filter therapy" means material placed in the useful beam to change beam quality in therapeutic radiation machines subject to Subpart X.6.

"Fluoroscopic imaging assembly" means a subsystem by means of which a radiographic image is produced in real time. The assembly includes an image receptor, such as an image intensifier and an image display such as a CRT and/or a spot film device.

"Focal spot (actual)" means the area projected on the anode of the x-ray tube bombarded by the electrons accelerated from the cathode and from which the useful beam originates. The actual dimensions of the focal spot can be measured by means of a pinhole camera.

"Former Atomic Energy Commission or Nuclear Regulatory Commission licensed facilities" means nuclear reactors, nuclear fuel reprocessing plants, uranium enrichment plants, or critical mass experimental facilities where Atomic Energy Commission or Nuclear Regulatory Commission licenses have been terminated.

"Gantry" means that part of a radiation therapy system supporting and allowing movements of the radiation head about a center of rotation.

"General purpose radiographic x-ray system" means any radiographic x-ray system which, by design, is not limited to radiographic examination of specific anatomical regions.

"Generally applicable environmental radiation standards" means standards issued by the Environmental Protection Agency 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.

"Gonad shield" means a protective barrier for the testes or ovaries.

"Gray (Gy)" means the SI unit of absorbed dose, kerma, and specific energy imparted equal to 1 joule per kilogram. The previous unit of absorbed dose (rad) is being replaced by the gray (1 Gy=100 rad).

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

"Healing arts" means but is not limited to the practice of medicine, surgery, dentistry, registered pharmacy, podiatry, osteopathy, chiropractic, veterinary medicine or nursing.

"Healing arts screening" means the testing of human beings using x-ray machines for the detection or evaluation of health indications when such tests are not specifically and individually ordered by a licensed practitioner of the healing arts legally authorized to prescribe such x-ray tests for the purpose of diagnosis or treatment.

“Hearing” means a proceeding to examine an application or other matter before the Authority in order to adjudicate rights, duties or privileges.

"Heat unit" means a unit of energy equal to the product of the peak kilovoltage, milliamperes, and seconds, i.e., kVp x mA x second.

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

“Houndsfield” see CT number.

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

"HVL diagnostic or Half-value layer diagnostic" means the thickness of specified material which attenuates the beam of radiation to an extent such that the exposure rate is reduced by one-half. In this definition, the contribution of all scattered radiation, other than any which might be present initially in the beam concerned, is deemed to be excluded.

"HVL therapy or Half-value layer therapy" 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.

"Image intensifier" means a device which converts the image information carried by an x-ray beam (the x-ray attenuation pattern) into a visible light image which can be observed in real time; i.e., during the course of the exposure.

"Image receptor" means any device, such as a fluorescent screen or radiographic film, which transforms incident x-ray photons either into a visible image or into another form which can be made into a visible image by further transformations.

"Image receptor support" means, for mammographic systems, that part of the system designed to support the image receptor during mammography.

“Imminent Radiation Hazard(s)” means an imminent hazard exists when the radiation levels that exist are in excess of three times the regulatory limit.

"Individual" means any human being.

"Individual monitoring" means the assessment of:

(1) Equivalent dose (H) (a) by the use of individual monitoring devices or (b) by the use of survey data; or

(2) Committed effective equivalent dose (H) (a) by bioassay or (b) 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 equivalent dose (H). For purposes of the regulations, "personnel dosimeter" and "dosimeter" are equivalent terms. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters (TLDs), pocket ionization chambers, and personal air sampling devices.

"Industrial radiography" means the examination of the macroscopic structure of materials by nondestructive methods using sources of ionizing radiation to produce radiographic images.

“Industrial Technician” means any individual recognized by the Radiation Safety Officer who uses a source of radiation, tools or radiation survey instruments in industry.

"Inhalation class" (see "Class").

"Inherent filtration" means the filtration of the useful beam provided by the permanently installed components of the x-ray tube and the tube housing.

"Inspection" means an official examination or observation including, but not limited to, tests, surveys, and monitoring to determine compliance with the regulations.

"Instrument traceability" (for ionizing radiation measurements) means the ability to show that an instrument has been calibrated at specified time intervals using a national standard or a transfer standard. If a transfer standard is used, the calibration must be at a laboratory accredited by a program which requires continuing participation in measurement quality assurance with the National Institute of Standards and Technology or other equivalent national or international program.

"Interlock" means a device preventing the start or continued operation of equipment unless certain predetermined conditions prevail.

"Internal dose" means that portion of the equivalent dose (H) received from radioactive material taken into the body.

"Interruption of irradiation" means the stopping of irradiation with the possibility of continuing irradiation without resetting of operating conditions at the control panel.

“Interventional fluoroscopy x-ray system” means an x-ray system in which the beam axis of the x-ray beam is not constrained to be perpendicular to the plane of the x-ray tube.

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

"Isocenter" means the center of the sphere through which the useful beam axis passes while the gantry moves through its full range of motions.

"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.]

"Kilovolts peak (kVp)" (See "Peak tube potential").

"kV" means kilovolts.

"kVp" (See "Peak tube potential").

"kWs" means kilowatt second.

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

"Leakage radiation diagnostic" means radiation emanating from the diagnostic source assembly except for:

(1) the useful beam; and

(2) radiation produced when the exposure switch or timer is not activated.

"Leakage radiation accelerator" means radiation emanating from the accelerator except for the useful beam.

"Leakage technique factors" means the technique factors associated with the diagnostic source assembly which are used in measuring leakage radiation. They are defined as follows:

(1) For diagnostic source assemblies intended for capacitor energy storage equipment, the maximum-rated peak tube potential and the maximum-rated number of exposures in an hour for operation at the maximum-rated peak tube potential with the quantity of charge per exposure being 10 millicoulombs, i.e., 10 milliampere seconds, or the minimum obtainable from the unit, whichever is larger;

(2) For diagnostic source assemblies intended for field emission equipment rated for pulsed operation, the maximum-rated peak tube potential and the maximum-rated number of x-ray pulses in an hour for operation at the maximum-rated peak tube potential;

(3) For all other diagnostic source assemblies, the maximum-rated peak tube potential and the maximum-rated continuous tube current for the maximum-rated peak tube potential.

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

"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 in accordance with the regulations adopted by the Authority on Radiation Protection.

"Licensee" means any person who is licensed by the Agency in accordance with the Regulations and the Act.

“Licensee’s Representative” means a person who has been authorized by the licensee to represent them during activities or proceedings governed by the regulations.

"Licensing State" means any State with regulations equivalent to the Suggested State Regulations for Control of Radiation relating to, and an effective program for, the regulatory control of NARM and which has been granted final designation by the Conference of Radiation Control Program Directors, Inc.

"Light field" means that area of the intersection of the light beam from the beam-limiting device and one of the set of planes parallel to and including the plane of the image receptor, whose perimeter is the locus of points at which the illumination is one-fourth of the maximum in the intersection.

"Limits" [See "Dose limits"].

"Line-voltage regulation" means the difference between the no-load and the load line potentials expressed as a percent of the load line potential. It is calculated using the following equation:

Percent line-voltage regulation = $100\ (V_n-V_l)/V_l$

where:

V_n = No-load line potential; and
V_l = Load line potential.

"Lixiscope" means a portable light-intensified imaging device using a sealed source.

"Local components" mean part of an analytical x-ray system and include areas that are struck by x-rays such as radiation source housings, port and shutter assemblies, collimators, sample holders, cameras, goniometers, detectors, and shielding, but do not include power supplies, transformers, amplifiers, readout devices, and control panels.

"Lost or missing source of radiation" means licensed or registered source of radiation whose location is unknown. This definition includes, but is not limited to, radioactive 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"].

“Lux” means a characteristic of a radiation receptor.

"mA" means milliampere.

“Manager” means the individual working at the facility who is authorized by the owner to sign the application form as the applicant.

"Management" means the chief executive officer or that individual's designee.

"mAs" means milliampere second.

"Maximum line current" means the root-mean-square current in the supply line of an x-ray machine operating at its maximum rating.

"Medical institution" means an organization in which several medical disciplines are practiced.

"Medical use" means the intentional internal or external administration of radioactive material, or the radiation therefrom, to humans in the practice of the healing arts.

"Megavolt (MV) [mega electron volt (MeV)]" means the energy equal to that acquired by a particle with one electron charge in passing through a potential difference of one million volts in a vacuum. [Note: current convention is to use MV for photons and MeV for electrons.]

"Member of the public" means an individual except when that individual is receiving an occupational or patient dose.

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

"Misadministration" means the administration of:

(1) A radiopharmaceutical dosage greater than 1.11 megabecquerels (30 μCi) of either sodium iodide I-125 or I-131:

(a) Involving the wrong patient or wrong pharmaceutical; or

(b) When both the administered dosage differs from the prescribed dosage by more than 20 percent of the prescribed dosage and the difference between the administered dosage and prescribed dosage exceeds 1.11 megabecquerels (30 μCi);

(2) A therapeutic radiopharmaceutical dosage, other than sodium iodide I-125 or I-131;

(a) Involving the wrong patient, wrong radiopharmaceutical, or wrong route of administration; or

(b) When the administered dosage differs from the prescribed dosage by more than 20 percent of the prescribed dosage;

(3) A gamma stereotactic radiosurgery radiation dose:

(a) Involving the wrong patient or wrong treatment site; or

(b) When the calculated total administered dose differs from the total prescribed dose by more than 10 percent of the total prescribed dose;

(4) A teletherapy radiation dose:

(a) Involving the wrong patient, wrong mode of treatment, or wrong treatment site; or

(b) When the treatment consists of 3 or fewer fractions and the calculated total administered dose differs from the total prescribed dose by more than 10 percent of the total prescribed dose; or

(c) When the calculated weekly administered dose exceeds the weekly prescribed dose by 30 percent or more of the weekly prescribed dose; or

(d) When the calculated total administered dose differs from the total prescribed dose by more than 20 percent of the total prescribed dose;

(5) A brachytherapy radiation dose:

(a) Involving the wrong patient, wrong radionuclide, or wrong treatment site (excluding, for permanent implants, seeds that were implanted in the correct site but migrated outside the treatment site); or

(b) Involving a sealed source that is leaking; or

(c) When, for a temporary implant, one or more sealed sources are not removed upon completion of the procedure; or

(d) When the calculated administered dose differs from the prescribed dose by more than 20 percent of the prescribed dose;

(6) A diagnostic radiopharmaceutical dosage, other than quantities greater than 1.11 megabecquerels (30 μCi) of either sodium iodide I-125 or I-131, both:

(a) Involving the wrong patient, wrong radiopharmaceutical, wrong route of administration, or when the administered dosage differs from the prescribed dosage; and

(b) When the dose to the patient exceeds 50 millisieverts (5 rem) effective equivalent dose (H) or 500 millisieverts (50 rem) equivalent dose (H) to any individual organ.

"Mobile nuclear medicine service" means the transportation and medical use of radioactive material.

"Mobile x-ray equipment" (See "X-ray equipment").

“Modification” means a change in the specification of a machine or radiation facility.

"Monitor unit (MU)" (See "Dose monitor unit").

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

"Moving beam radiation therapy" means radiation therapy with any planned displacement of radiation field or patient relative to each other, or with any planned change of absorbed dose distribution. It includes arc, skip, conformal, intensity modulation and rotational therapy.

"Multiple tomogram system" means a computed tomography x-ray system which obtains x-ray transmission data simultaneously during a single scan to produce more than one tomogram.

"NARM" means any naturally occurring or accelerator-produced radioactive material. It does not include byproduct, source, or special nuclear material.[4]

"Natural radioactivity" means radioactivity of naturally occurring nuclides.[5]

"Noise" means the standard deviation of the fluctuations in CTN expressed as a percentage of the attenuation coefficient of water. Its estimate (S_n) is calculated using the following expression:

$$S_n = \frac{100 \bullet \mu_x \bullet s}{\mu_w}$$

Where:

μ_x = Linear attenuation coefficient of the material of interest.

μ_w = Linear attenuation coefficient of water.

s = Standard deviation of the CTN of picture elements in a specified area of the CT image.

"Nominal tomographic section thickness" means the full width at half-maximum of the sensitivity profile taken at the center of the cross-sectional volume over which x-ray transmission data are collected.

"Nominal treatment distance" means:

a. For electron irradiation, the distance from the scattering foil, virtual source, or exit window of the electron beam to the entrance surface of the irradiated object along the central axis of the useful beam.

b. For X-ray irradiation, the virtual source or target to isocenter distance along the central axis of the useful beam. For non-isocentric equipment, this distance shall be that specified by the manufacturer.

4 For purposes of meeting the definition of a Licensing State, NARM refers only to discrete sources of NARM. Diffuse sources of NARM are excluded.

5 See Footnote #5.

"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 the regulations, "deterministic effect" is an equivalent term.

"Normal operating procedures" mean step-by-step instructions necessary to accomplish the analysis. These procedures shall include sample insertion and manipulation, equipment alignment, routine maintenance by the registrant or licensee, and data recording procedures, which are related to radiation safety.

“Notice of Violation” means a written statement of one or more alleged infringements of a legally binding requirement. The notice normally requires the licensee, registrant or other permit holder to provide a written statement describing the following:

(1) corrective steps taken by the licensee, registrant or other permit holder and the results achieved;

(2) corrective steps to be taken to prevent recurrence; and

(3) the projected date for achieving full compliance. The Authority may require responses to notices of violation to be under oath.

"Nuclear Regulatory Commission" means the 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 assigned duties for the licensee or registrant involve exposure to sources of radiation, whether or not the sources of radiation are in the possession of the licensee, registrant, or other person. Occupational dose does not include dose received from background radiation, or as a patient from medical practices, or from voluntary participation in medical research programs, or as a member of the public.

"Open-beam configuration" means an analytical x-ray system in which an individual could accidentally place some part of his body in the primary beam path during normal operation.

“Owner” means the person/individual who owns/leases the radiation source. An out-of-state owner shall authorize a manager to sign the application form.

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

"Particle accelerator" (See "Accelerator").

"Patient diagnostic" means an individual or animal subjected to healing arts examination, diagnosis, or treatment.

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

"Peak tube potential" means the maximum value of the potential difference across the x-ray tube during an exposure.

"Periodic quality assurance check" means a procedure which is performed to ensure that a previous calibration continues to be valid.

"Permanent radiographic installation" means an installation or structure designed or intended for radiography and in which radiography is regularly performed.

"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 shall not include federal government agencies.

"Personal supervision" means guidance and instruction provided to a radiographer trainee by a radiographer instructor who is present at the site, in visual contact with the trainee while the trainee is using sources of radiation, and in such proximity that immediate assistance can be given if required.

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

"Phantom diagnostic" means a volume of material behaving in a manner similar to tissue with respect to the attenuation and scattering of radiation. This requires that both the atomic number (Z) and the density of the material be similar to that of tissue.

"Phantom therapy" 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 in the State of Delaware to compound and dispense drugs, prescriptions, and poisons.

"Physician" means an individual licensed to practice medicine in the State of Delaware.

"Picture element (pixel)" means a two-dimensional element of a projection image, usually represented by a single numerical value called the pixel value.

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

"Portable x-ray equipment" (See "X-ray equipment").

"PID or Position indicating device" means a device on dental x-ray equipment used to indicate the beam position and to establish a definite source-surface (skin) distance. It may or may not incorporate or serve as a beam-limiting device.

"PBL or Positive beam limitation" means the automatic or semi-automatic adjustment of an x-ray beam to the size of the selected image receptor, whereby exposures cannot be made without such adjustment.

"Practical range of electrons" corresponds to classical electron range where the only remaining contribution to dose is from bremsstrahlung X-rays. A further explanation may be found in "Clinical Electron Beam Dosimetry: Report of AAPM Radiation Therapy Committee Task Group 25" [Medical Physics 18(1): 73-109, Jan/Feb. 1991] and ICRU Report 35, "Radiation Dosimetry: Electron Beams with Energies Between 1 and 50 MeV", International Commission on Radiation Units and Measurements, September 15, 1984.

"Prescribed dosage" means the quantity of radiopharmaceutical activity as documented:

(1) In a written directive; or

(2) Either in the diagnostic clinical procedures manual or in any appropriate record in accordance with the directions of the authorized user for diagnostic procedures.

"Prescribed dose" means:

(1) For gamma stereotactic radiosurgery, the total dose as documented in the written directive; or

(2) For teletherapy, the total dose and dose per fraction as documented in the written directive; or

(3) For brachytherapy, either the total source strength and exposure time, or the total dose, as documented in the written directive.

"Primary beam" means radiation which passes through an aperture of the source housing by a direct path from the x-ray tube or a radioactive source located in the radiation source housing.

"Primary dose monitoring system" means a system which will monitor the useful beam during irradiation and which will terminate irradiation when a pre-selected number of dose monitor units have been delivered.

"Primary protective barrier" (See "Protective barrier").

"Protective apron" means an apron made of radiation absorbing materials used to reduce radiation exposure.

"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 which attenuates stray radiation.

"Protective glove" means a glove made of radiation absorbing materials used to reduce radiation exposure.

"Public dose" means the dose received by a member of the public from sources of radiation from licensed or registered operations. Public dose does not include occupational dose, or dose received from background radiation, or dose received as a patient from medical practices, or dose received from voluntary participation in medical research programs.

"Pyrophoric material" means any liquid that ignites spontaneously in dry or moist air at or below 130 °F (54.4 °C) or 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 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 to advise regarding radiation protection needs, for example, individuals certified in the appropriate field by the American Board of Radiology, or the American Board of Health Physics, or the American Board of Medical Physics, or those having equivalent qualifications. 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, for example, individuals certified in Therapeutic Radiological Physics or X-Ray and Radium Physics by the American Board of Radiology, or those having equivalent qualifications.

"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" means the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg per gram or 0.01 joule per kilogram (0.01 gray).

"Radiation" means alpha particles, beta particles, gamma rays, x rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. For purposes of the regulations, ionizing radiation is an equivalent term. Radiation, as used in the regulations, does not include non-ionizing radiation, such as radiowaves or microwaves, visible, infrared, or ultraviolet light.

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

"Radiation detector" means a device which in the presence of radiation provides a signal or other indication suitable for use in measuring one or more quantities of incident radiation.

"Radiation dose" [See "Dose"].

"Radiation field" (See "Useful beam")

"Radiation head" means the structure from which the useful beam emerges.

"Radiation machine" means any device capable of producing radiation except, those devices with radioactive material as the only source of radiation.

"Radiation safety officer" means an individual who has the knowledge and responsibility to apply appropriate radiation protection regulations.

“Radiation source” see source of radiation.

"Radiation Therapy Physicist" means an individual qualified in accordance with X.3d.

"Radiation therapy simulation system" means a radiographic or fluoroscopic x-ray system intended for localizing the volume to be exposed during radiation therapy and confirming the position and size of the therapeutic irradiation field.

“Radiation weighting factor (W_R)” means a weighting factor used in calculating equivalent dose, which takes account of the relative effectiveness of the particular kind of ionizing radiation in producing

biological damage. The radiation weighting factor (W_R) was formerly called the quality factor (Q). See Appendix C of Part F for a table of radiation weighting factors.

"Radioactive material" means any solid, liquid, or gas which emits radiation spontaneously.

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

"Radiobioassay" (See "Bioassay").

"Radiograph" means a displayed image of an x-ray attenuation pattern, e.g., on photographic film or on a CRT display.

"Radiographer" means any individual who performs or personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for assuring compliance with the requirements of the regulations and all license and/or certificate of registration conditions.

"Radiographer instructor" means any radiographer who has been authorized by the Agency to provide on-the-job training to radiographer trainees in accordance with Subparagraph E.201b.ii.

"Radiographer trainee" means any individual who, under the personal supervision of a radiographer instructor, uses sources of radiation, related handling tools, or radiation survey instruments during the course of his instruction.

"Radiographic exposure device" means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.

"Radiographic imaging system" any system which permanently or semi-permanently records a radiographic image on an image receptor and displays the recorded image as a radiograph.

"Radiographic personnel" means any radiographer, radiographer instructor, or radiographer trainee.

"Rating" means the operating limits as specified by the component manufacturer.

"Recordable event" means the administration of:

(1) A radiopharmaceutical or radiation without a written directive where a written directive is required;

(2) A radiopharmaceutical or radiation where a written directive is required without daily recording of each administered radiopharmaceutical dosage or radiation dose in the appropriate record;

(3) A radiopharmaceutical dosage greater than 1.11 megabecquerels (30 μCi) of sodium iodide I-125 or I-131 when both the administered dosage differs from the prescribed dosage by more than 10 percent of the prescribed dosage, and the difference between the administered dosage and the prescribed dosage exceeds 555 kilobecquerels (15 μCi);

(4) A therapeutic radiopharmaceutical dosage, other than sodium iodide I-125 or I-131, when the administered dosage differs from the prescribed dosage by more than 10 percent of the prescribed dosage

(5) A teletherapy radiation dose when the calculated weekly administered dose exceeds the weekly prescribed dose by 15 percent or more of the weekly prescribed dose; or

(6) A brachytherapy radiation dose when the calculated administered dose differs from the prescribed dose by more than 10 percent of the prescribed dose.

"Recording" means creation of a retrievable, permanent or semi-permanent record of a radiographic image.

"Redundant beam monitoring system" means a combination of two dose monitoring systems in which each system is designed to terminate irradiation in accordance with a pre-selected number of dose monitor units.

"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 employees to standardize results of experiments and to relate biological insult to a common base. A description of the reference man is contained in the International Commission on Radiological Protection report, ICRP Publication 23, "Report of the Task Group on Reference Man."

"Reference plane" means a plane which is displaced from and parallel to the tomographic plane.

"Registrant" means any person who is registered with the Agency and is legally obligated to register/enroll with the Agency pursuant to the regulations and the Act.

“Registrant’s Agent” means an individual whose training and experience is acceptable to the Agency.

"Registration" means to enroll or register with the Agency in accordance with the regulations.

"Regulations" mean all parts of the Delaware Radiation Control Regulations (DRCR) and all parts of the Delaware Radiation Technologist Certification Regulations (RTCR).

"Regulations of the U.S. Department of Transportation" means the regulations in 49 CFR Parts 100-189 and the Parts 390-397.

“Regulations of the US Nuclear Regulatory Commission” means the regulations in 10 CFR Parts 0-199.

"Rem" means the special unit of any of the quantities expressed as ~~dose~~ equivalent dose (H). The equivalent dose (H) in rem is equal to the absorbed dose in rad multiplied by the radiation weighting factor (1 rem = 0.01 Sv).

"Research and development" means (1) theoretical analysis, exploration, or experimentation; or (2) 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.

"Respiratory protective equipment" means an apparatus, such as a respirator, used to reduce an individual's intake of airborne radioactive materials.

"Restricted area" means an area, access to which is limited by the licensee or registrant for the purposes of protecting individuals against undue risks from exposure to sources of radiation. 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" means the special unit of exposure. One roentgen (R) equals 2.58E-4 coulombs/per kilogram of air (see "Exposure" and A.13).

"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.

"Scan" means the complete process of collecting x-ray transmission data for the production of a tomogram. Data can be collected simultaneously during a single scan for the production of one or more tomograms.

"Scan increment" means the amount of relative displacement of the patient with respect to the CT x-ray system between successive scans measured along the direction of such displacement.

"Scan sequence" means a pre-selected set of two or more scans performed consecutively under pre-selected CT conditions of operation.

"Scan time" means the period of time between the beginning and end of x-ray transmission data accumulation for a single scan.

"Scattered radiation" means radiation emitted by interaction with matter, the interaction being accompanied by a change in direction of the radiation. (See "Direct scattered radiation").

"Sealed source" means any container of radioactive material which has been constructed in such a manner as to prevent the escape of any radioactive material.

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

"Secondary protective barrier" (See "Protective barrier").

"Sensitometer" means a device for exposing photographic x-ray film to visible light of varying intensity.

"Sensitometric test" means determination of the response curve of a photographic film. The response curve shows the dependence of film optical density (OD) plotted on the ordinate (y-axis) to exposure, plotted as the logarithm of exposure (log E) on the abscissa (x-axis). The exposure scale may be relative or absolute. This test may be performed by exposing the film to visible light from a calibrated sensitometer or by exposing the film/intensifying screen system to x-rays.

“Severity Level” means a classification of violations based on relative seriousness of each violation and the significance of the effect of the violation on the occupational or public health or safety.

"Shadow tray" means a device attached to the radiation head to support auxiliary beam blocking material.

"Shallow equivalent dose" (H_s), which applies to the external exposure of the skin or an extremity, means the equivalent dose at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of 1 square centimeter.

"Shielded position" means the location within the radiographic exposure device or storage container which, by manufacturer's design, is the proper location for storage of the sealed source.

"Shielded-room radiography" means industrial radiography conducted in a room shielded so that radiation levels at every location on the exterior meet the limitations specified in Section D.201, 207, 208 and 301 of the regulations.

"Shutter" means a device attached to the tube housing assembly which can intercept the entire cross sectional area of 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.

"SID or Source-image receptor distance" means the distance from the source to the center of the input surface of the image receptor.

"Sievert" means the SI unit of any of the quantities expressed as equivalent dose (H). The equivalent dose (H) in sievert is equal to the absorbed dose in gray multiplied by the radiation weighting factor (1 Sv = 100 rem).

"Simulator (radiation therapy simulation system)" means any X-ray system intended for localizing the volume to be exposed during radiation therapy and reproducing the position and size of the therapeutic irradiation field.

"Single tomogram system" means a CT x-ray system which obtains x-ray transmission data during a scan to produce a single tomogram.

"Source diagnostic" means the focal spot of the x-ray tube.

"Source therapy" means the region and/or material from which the radiation emanates.

"Source changer" means a device designed and used for replacement of sealed sources in radiographic exposure devices, including those source changers also used for transporting and storage of sealed sources.

"Source material" means:

(1) Uranium or thorium, or any combination thereof, in any physical or chemical form; or

(2) Ores that contain by weight one-twentieth of 1 percent (0.05 percent) or more of uranium, thorium or any combination of uranium and thorium. 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 (2) of byproduct material.

"Source of radiation" means any radioactive material or any device or equipment emitting, or capable of producing, radiation.

"Source traceability" means the ability to show that a radioactive source has been calibrated either by the national standards laboratory of the National Institute of Standards and Technology, or by a laboratory which participates in a continuing measurement quality assurance program with National Institute of Standards and Technology or other equivalent national or international program.

"Special form radioactive material" means radioactive material that 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 Nuclear Regulatory Commission. A special form encapsulation designed in accordance with the Nuclear Regulatory Commission 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 the 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.

"Spot check" means an abbreviated calibration procedure which is performed to assure that a previous calibration continues to be valid.

"Spot film" means a radiograph which is made during a fluoroscopic examination to permanently record conditions which exist during that fluoroscopic procedure.

"Spot-film device" means a device intended to transport and/or position a radiographic image receptor between the x-ray source and fluoroscopic image receptor. It includes a device intended to hold a cassette over the input end of an image intensifier for the purpose of making a radiograph.

"SSD diagnostic or Source-skin distance diagnostic" means the distance between the source and the skin entrance plane of the patient.

"SSD therapy or Source-skin distance therapy" (See "TSD Target-skin distance")]

“SSRCR” means the ionizing category of the suggested State Regulations for Control of Radiation.

"Stationary beam radiation therapy" means radiation therapy without displacement of one or more mechanical axes relative to the patient during irradiation.

"Stationary x-ray equipment" (See "X-ray equipment").

"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 the regulations, "probabilistic effect" is an equivalent term.

"Storage" means a condition in which a device or source is not being used for an extended period of time, has been made inoperable, and shall be tagged by the Agency.

"Storage area" means any location, facility, or vehicle which is used to store, to transport, or to secure a 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 device, container, or source.

"Storage container" means a shielded device in which sealed sources are secured and stored.

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

"Survey" means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of sources of radiation. When appropriate, such evaluation includes, but is not limited to, tests, physical examinations, and measurements of levels of radiation or concentrations of radioactive material present.

"Target" means that part of an X-ray tube or accelerator onto which a beam of accelerated particles is directed to produce ionizing radiation or other particles.

"Technique factors" means the following conditions of operation:

(1) For capacitor energy storage equipment, peak tube potential in kV and quantity of charge in mAs;

(2) For field emission equipment rated for pulsed operation, peak tube potential in kV, and number of x-ray pulses;

(3) For CT x-ray systems designed for pulsed operation, peak tube potential in kV, scan time in seconds, and either tube current in mA, x-ray pulse width in seconds, and the number of x-ray pulses per scan, or the product of tube current, x-ray pulse width, and the number of x-ray pulses in mAs;

(4) For CT x-ray systems not designed for pulsed operation, peak tube potential in kV, and either tube current in mA and scan time in seconds, or the product of tube current and exposure time in mAs and the scan time when the scan time and exposure time are equivalent; and

(5) For all other equipment, peak tube potential in kV, and either tube current in mA and exposure time in seconds, or the product of tube current and exposure time in mAs.

"Teletherapy" means therapeutic irradiation in which the source of radiation is at a distance from the body.

"Teletherapy physicist" means an individual identified as the qualified teletherapy physicist on an Agency license.

"Temporary job site" means any location where industrial radiography is performed other than the location(s) listed in a specific license or registration.

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

"Test" means the process of verifying compliance with an applicable regulation.

"Therapeutic radiation machine" means X-ray or electron-producing equipment designed and used for external beam radiation therapy. A therapeutic radiation machine is a radiation source.

"Tissue Weighting Factor W_T" means a weighting factor used in calculating effective dose intended to assign the proportion of risk of stochastic effects resulting from irradiation of a particular tissue compared to uniform whole body irradiation.

Tissue Weighting Factors (W_T) Assigned by the International Commission on Radiological Protection*

Tissue/Organ	w_T
Gonads	0.20
Stomach	0.12
Colon	0.12
Lung	0.12 (0.08) I
Red bone marrow	0.12
Breast	0.05
Esophagus	0.05
Bladder	0.05
Liver	0.05
Thyroid	0.05
Bone surfaces	0.01
Skin	0.01H
Remainder	0.05

*Adapted from 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication No. 60, Oxford: Pergammon 1991.
H Applied to the mean equivalent dose over the entire skin.
I Bronchial epithelium

"Tomogram" means the depiction of the x-ray attenuation properties of a section through the body.

"Tomographic plane" means that geometric plane which is identified as corresponding to the output tomogram.

"Tomographic section" means the volume of an object whose x-ray attenuation properties are imaged in a tomogram.

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

"Total organ equivalent dose (H)" (TOED) means the sum of the deep equivalent dose and the committed equivalent dose ($H_{T,50}$) to the organ receiving the highest dose as described in D.1107a.vi. of the regulations.

"Traceable to a National Standard" (See "Instrument traceability" or "Source traceability").

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

“Transport group” means any of one of seven groups into which radionuclides in normal form are classified, according to their toxicity and their relative potential hazard in transport.

"TSD or Target-skin distance" means the distance measured along the beam axis from the center of the front surface of the X-ray target and/or electron virtual source to the surface of the irradiated object or patient.

"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.

"Tube rating chart" means the set of curves which specify the rated limits of operation of the tube in terms of the technique factors.

"TVL or Tenth-value layer" 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-tenth of the value measured without the material at the same point.

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

"Unrestricted area" means an area, access to which is neither limited nor controlled by the licensee or registrant. For purposes of the 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 system to produce radiation.

"Variable-aperture beam-limiting device" means a beam-limiting device which has capacity for stepless adjustment of the x-ray field size at a given SID.

"Very high radiation area" means an area, accessible to individuals, in which radiation levels could result in an individual receiving an absorbed dose in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a source of radiation or from any surface that the radiation penetrates.[6]

“Violation” means an infringement of any rule, certificate, license, or registration condition, order of the Agency, or provisions of the Act.

"Visual field" means the area illuminated by light, simulating the radiation field.

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

"Visible area" means that portion of the input surface of the image receptor over which an incident x-ray photons are producing a visible image.

"Visiting authorized user" means an authorized user who is not identified on the license of the licensee being visited.

"Waste" means those low-level radioactive wastes that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level waste has the same meaning as in the Low-Level Radioactive Waste Policy Act, P.L. 96-573, as amended by P.L. 99-240, effective January 15, 1986; that is, radioactive waste (a) not classified as high-level radioactive waste, spent nuclear fuel, or byproduct material as defined in Section 11e.(2) of the Atomic Energy Act (uranium or thorium tailings and waste) and (b) classified as low-level radioactive waste consistent with existing law and in accordance with (a) by the Nuclear Regulatory Commission.

"Waste handling licensees" mean 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 effects continuous change in transmission over all or a part of the useful beam.

"Week" means 7 consecutive days starting on Sunday.

"Weighting factor" see Radiation Weighting Factor.

"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 with radiation source 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 1.3E+5 MeV of potential alpha particle energy. The short-lived radon daughters of radon-222 are polonium-218, lead-214, bismuth-214, and polonium-214; and those of radon-220 are polonium-216, lead-212, bismuth-212, and polonium-212.

---

6 At very high doses received at high dose rates, units of absorbed dose, gray and rad, are appropriate, rather than units of equivalent dose, sievert and rem.

"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.

"Written directive" means an order in writing for a specific patient, dated and signed by an authorized user prior to the administration of a radiopharmaceutical or radiation, except as specified in (6), containing the following information:

(1) For any administration of quantities greater than 1.11 megabecquerels (30 μCi) of sodium iodide I-125 or I-131: the radionuclide, and dosage; and route of administration to end; or

(2) For a therapeutic administration of a radiopharmaceutical [other than sodium iodide I-125 or I-131: the radiopharmaceutical, dosage, and route of administration; or

(3) For gamma stereotactic radiosurgery: target coordinates, collimator size, plug pattern, and total dose; or

(4) For teletherapy: the total dose, dose per fraction, treatment site, and overall treatment period; or

(5) For high-dose-rate remote afterloading brachytherapy: the radionuclide, treatment site, and total dose; or

(6) For all other brachytherapy,

(a) Prior to implantation: the radionuclide, number of sources, and source strengths; and

(b) After implantation but prior to completion of the procedure: the radionuclide, treatment site, and total source strength and exposure time (or, equivalently, the total dose).

"X-ray exposure control" means a device, switch, button or other similar means by which an operator initiates and/or terminates the radiation exposure. The x-ray exposure control may include such associated equipment as timers and back-up timers.

"X-ray equipment" means an x-ray system, subsystem, or component thereof. Types of x-ray equipment are as follows:

(1) "Mobile x-ray equipment" means x-ray equipment mounted on a permanent base with wheels and/or casters for moving while completely assembled.

(2) "Portable x-ray equipment" means x-ray equipment designed to be hand-carried.

(3) "Stationary x-ray equipment" means x-ray equipment which is installed in a fixed location.

"X-ray field" means that area of the intersection of the useful beam and any one of the set of planes parallel to and including the plane of the image receptor, whose perimeter is the locus of points at which the exposure rate is one-fourth of the maximum in the intersection.

"X-ray high-voltage generator" means a device which transforms electrical energy from the potential supplied by the x-ray control to the tube operating potential. The device may also include means for transforming alternating current to direct current, filament transformers for the x-ray tube(s), high-voltage switches, electrical protective devices, and other appropriate elements.

"X-ray system" means an assemblage of components for the controlled production of x-rays. It includes minimally an x-ray high-voltage generator, an x-ray control, a tube housing assembly, a beam-limiting device, and the necessary supporting structures. Additional components which function with the system are considered integral parts of the system.

"X-ray table" means a patient support device with its patient support structure (tabletop) interposed between the patient and the image receptor during radiography and/or fluoroscopy. This includes, but is not limited to, any stretcher equipped with a radiolucent panel and any table equipped with a cassette tray (or bucky), cassette tunnel, image intensifier, or spot-film device beneath the tabletop.

"X-ray tube diagnostic" means any electron tube which is designed for the conversion of electrical energy into X-ray energy.

"X-ray tube therapy" means any electron tube which is designed to be used primarily for the production of X-rays.

"Year" means the period of time beginning in January used to determine compliance with the provisions of the-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.

Exemptions from the Regulatory Requirements

Sec. A.3 Exemptions. An exemption may be granted by the Agency if, based on documented and publicly available information, the Agency has verified that the proposed exempted practice or equipment does not pose any danger to the applicant, his employees or any others coming into contact with the exempted practice or equipment. An exemption request that deviates from accepted standards as specified in the regulations, such that the safe use of said practice or equipment cannot be supported by extraneous documented and publicly available information must be referred to the Authority on Radiation Protection for consideration.

a. General Provision. The Agency as the agent for the Authority on Radiation Protection may, upon application or upon its own initiative, grant such exemptions or exceptions from the requirements of the regulations as it determines are authorized by law and will not result in undue hazard to public health and safety or property.

b. Department of Energy Contractors and Nuclear Regulatory Commission Contractors. Any Department of Energy contractor or subcontractor and any Nuclear Regulatory Commission contractor or subcontractor of the following categories operating within this State is exempt from the regulations to the extent that such contractor or subcontractor under his contract receives, possesses, uses, transfers, or acquires sources of radiation:

    i. Prime contractors performing work for the 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;

    ii. Prime contractors of the Department of Energy performing research in, or development, manufacture, storage, testing, or transportation of, atomic weapons or components thereof;

iii. prime contractors of the Department of Energy using or operating nuclear reactors or other nuclear devices in a United States Government-owned vehicle or vessel; and

iv. any other prime contractor or subcontractor of the Department of Energy or of the Nuclear Regulatory Commission when the State and the Nuclear Regulatory Commission jointly determine:

(1) That the exemption of the prime contractor or subcontractor is authorized by law; and

(2) That, under the terms of the contract or subcontract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety.

General Regulatory Requirements

Sec. A.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 the regulations.

Sec. A.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 the regulations.

Sec. A.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. Sources 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.

Additional Regulatory Requirements

Sec. A.7 Additional Requirements. The Authority through the A~~a~~gency may, by rule, regulation, or order, impose upon any licensee or registrant such requirements in addition to those established in the regulations as it deems appropriate or necessary to minimize danger to public health and safety or property.

Enforcement Requirements

Sec. A.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 felony, misdemeanor or crime and, upon conviction, may be punished by fine or imprisonment or both, as provided by law.

Sec. A.9 Impounding. Sources of radiation shall be subject to impoundment pursuant to Section 7415 of the Act.

Sec. A.10 Prohibited Uses

a. A hand-held fluoroscopic screen shall not be used with x-ray equipment unless it has been listed in the Registry of Sealed Source and Devices or accepted for certification by the Food and Drug Administration, Center for Devices and Radiological Health.

b. A shoe-fitting fluoroscopic device shall not be used.

c. A closed end PID (conical position indicating device) shall not be used.

d. A source of radiation shall not be abandoned.

Interpretations

Sec. A.11 Interpretations. Except as specifically authorized by the Agency in writing, no interpretation of the regulations by an officer or employee of the Agency other than a written interpretation by the Authority on Radiation Protection will be recognized to be binding upon the Agency.

Communications

Sec. A.12 Communications. All communications and reports concerning the regulations, and applications filed thereunder, should be addressed to the Agency at its Office of Radiation Control, Division of Public Health, Jesse Cooper Building, PO Box 637, Dover, DE 19903.

Sec. A.13 Units of Exposure and Dose

a. As used in the regulations, the unit of exposure is the coulomb per kilogram (C/kg) of air. One roentgen is equal to 2.58E-4 coulomb per kilogram of air.

b. As used in the regulations, the units of dose are:

   i. Gray (Gy) is the SI unit of absorbed dose. One gray is equal to an absorbed dose of 1 joule per kilogram (100 rad).

   ii. Rad is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 erg per gram or 0.01 joule per kilogram (0.01 Gy).

   iii. Rem is the special unit of any of the quantities expressed as equivalent dose (H). The equivalent dose (H) in rem is equal to the absorbed dose in rad multiplied by the radiation weighting factor (1 rem = 0.01 Sv).

iv. Sievert is the SI unit of any of the quantities expressed as equivalent dose (H). The equivalent dose (H) in sievert is equal to the absorbed dose in gray multiplied by the radiation weighting factor (1 Sv = 100 rem).

c. As used in the regulations, the radiation weighting factors for converting absorbed dose to equivalent dose (H) are shown in Table I.

d. If it is more convenient to measure the neutron fluence rate than to determine the neutron equivalent dose (H) rate in sievert per hour or rem per hour, as provided in A.13c., 0.01 Sv (1 rem) of neutron radiation of unknown energies may, for purposes of the regulations, be assumed to result from a total fluence 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 equivalent dose (H) or the appropriate Q value from Table II to convert a measured tissue dose in gray or rad to equivalent dose (H) in sievert or rem.

Sec. A.14 Units of Activity. For purposes of the 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.

a. One becquerel (Bq) = 1 disintegration or transformation per second (dps or tps).

b. One curie (Ci) = 3.7E+10 disintegrations or transformations per second (dps or tps) = 3.7E+10 becquerel (Bq) = 2.22E+12 disintegrations or transformations per minute (dpm or tpm).

TABLE I

RADIATION WEIGHTING FACTORS AND ABSORBED DOSE EQUIVALENCIES

Type of Radiation	Radiation Weighting Factor (Q)	Absorbed Dose Equal to a Unit Equivalent dose (H)[a/]
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 (energy dependent)	5-20	0.1
High energy protons > 2 MeV	5	0.1

[a/] Absorbed dose in gray equal to 1 Sv or the absorbed dose in rad equal to 1 rem.

Note: For radiations principally used in medical imaging (x-rays, gamma rays, beta particles) $W_T = 1$, thus the absorbed dose and the equivalent dose are equal (i.e., 1Gy = 1 Sv). Adapted from the 1990 recommendations of the International Commission on Radiological Protection, ICRP Publication No. 60, Oxford: Pergammon 1991.

TABLE II

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

Neutron Energy (MeV)	Radiation Weighting Factor [a/]	Fluence per Unit equivalent dose (H)[b/] (Neutrons cm^{-2} rem^{-1})	Fluence per Unit equivalent dose (H)[b/] (Neutrons cm^{-2} Sv^{-1})
(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

[a/] *Value of radiation weighting factor at the point where the equivalent dose (H) is maximum in a 30-centimeter diameter cylinder tissue-equivalent phantom.*

[b/] *Monoenergetic neutrons incident normally on a 30-centimeter diameter cylinder tissue-equivalent phantom.*