

## Subchapter I — General Provisions

### HFS 157.01 Authority and purpose.

- (1) This chapter is promulgated under the authority of ss. 254.31 to 254.45, Stats. to regulate the receipt, use, transfer, possession, ownership or acquisition of any source of radiation. The standards in this chapter generally conform to nationally accepted standards for protection against the harmful effects of ionizing radiation. The publications referenced in this chapter are available for inspection at the department, the secretary of state's office, the office of the revisor of statutes and at the respective federal agency or organization website.
  - (2) Subchapter I establishes the definitions used in this chapter, prohibitions and general regulatory requirements.
  - (3) Subchapter II establishes requirements for the licensing of radioactive material, license fee schedules, registration requirements for certain types of devices purchased under a general license and reciprocity requirements.
  - (4) Subchapter III establishes standards for protection against ionizing radiation resulting from activities conducted under a license or registration issued by the department. The requirements of subch. III are designed to control the receipt, possession, use, transfer and disposal of sources of radiation by any licensee or registrant so that the total dose to an individual, including doses resulting from all sources of radiation other than background radiation, does not exceed the standards for protection against radiation prescribed in subch. III. However, nothing in subch. III limits actions the department may take to protect health and safety in an emergency.
  - (5) Subchapter IV establishes radiation safety requirements for persons using sources of radiation in industrial radiography.
  - (6) Subchapter V establishes radiation safety requirements for using sources of radiation for well logging including mineral-logging, radioactive markers and subsurface tracer studies. The requirements of subch. V are in addition to the requirements of subchs. I, II, III, VIII and X.
  - (7) Subchapter VI establishes requirements for the medical use of radioactive material. The requirements provide for the radiation safety of workers, the general public and human research subjects.
  - (8) Subchapter VII establishes radiation safety requirements for operating irradiators that use sealed sources containing radioactive material to irradiate objects or materials using gamma radiation.
  - (9) Subchapter VIII establishes requirements for the use of diagnostic or therapeutic x-ray equipment, including accelerators, by or under the supervision of an individual authorized and licensed by state statutes to engage in the healing arts or veterinary medicine; and to establish registration requirements for radiation machines.
  - (10) Subchapter IX establishes radiation safety requirements for the use of cabinet and analytical x-ray systems.
  - (11) Subchapter X establishes requirements for persons licensed or registered under this chapter to provide workers with notices, instructions and reports relating to activities under a license or registration.
  - (12) Subchapter XI establishes options available to facilities and individuals in connection with department inspections to determine compliance with the provisions of this chapter and radiological working conditions or other requirements specified in a license.
  - (13) Subchapter XII establishes classification and fiscal penalty criteria for violations of license conditions, emergency orders or the requirements of this chapter; and criteria for requesting and scheduling hearings to contest department assessments of forfeiture, licensing actions or emergency orders.
  - (14) Subchapter XIII establishes requirements for the packaging, preparation for shipment and transportation of radioactive material.
  - (15) Subchapter XIV establishes radioactivity requirements for community water systems.
- History:** CR 01-108: cr. Register July 2002 No. 559, eff. 8-1-02; corrections in (16) made under s. 13.93 (2m) (b) 7., Stats., Register July 2002 No. 559; CR 06-021: am. (6), r. (16) Register October 2006 No. 610, eff. 11-1-06.

### HFS 157.02 Applicability.

- (1) Except as specified, this chapter applies to all persons who receive, possess, use, transfer, own or acquire any source of radiation, except that nothing in this chapter shall apply to any person subject to regulation by the U.S. nuclear regulatory commission.
- (2) A licensee subject to the requirements of subch. II is also subject to the requirements of subchs. I, III, X and XIII.
- (3) Subchapter III applies to all persons licensed or registered by the department to receive, possess, use, transfer or dispose of sources of radiation. The limits in subch. III do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of medical diagnosis or therapy, or to voluntary participation in medical research programs.
- (4) The requirements of subch. IV are for industrial radiography operations and are in addition to the requirements of subchs. I, II, III, VIII, X, XI, XII, and XIII.
- (5) Subchapter V applies to all licensees or registrants who use sources of radiation for well logging including mineral-logging, radioactive markers and subsurface tracer studies. The requirements of subch. V are in addition to the requirements of subchs. I, II, III, VIII, X, XI, XII and XIII.
- (6) Subchapter VI applies to all persons using radioactive material in the healing arts. The requirements of subch. VI are in addition to the requirements of subchs. I, II, III, X, XI, XII and XIII.
- (7) Subchapter VII applies to panoramic irradiators having either dry or wet storage of the radioactive sealed sources and to underwater irradiators in which both the source and the product being irradiated are submerged. Irradiators

whose dose rates exceed 5 grays (500 rads) per hour at one meter from the radioactive sealed sources in air or in water, as applicable for the irradiator type, are covered by subch. VII. Nothing in subch. VII relieves a licensee from complying with other federal, state and local regulations governing the siting, zoning, land use and building code requirements for industrial facilities. Subchapter VII does not apply to self-contained dry-source-storage irradiators in which both the source and the area subject to irradiation are contained within a device and are not accessible by personnel, medical radiology or teletherapy, radiography for the irradiation of materials for nondestructive testing purposes, gauging or open-field, agricultural irradiations. The requirements of subch. VII are in addition to the requirements of subchs. I, II, III, X, XI, XII and XIII.

**(8)** Subchapter VIII applies to all persons registered to use x-ray devices. The requirements of subch. VIII are in addition to the requirements of subchs. I, III, X, XI and XII.

**(9)** Subchapter IX applies to all persons registered to use cabinet and analytical x-ray devices. The requirements of subch. IX are in addition to the requirements of subchs. I, III, VIII, X, XI and XII.

**(10)** The requirements of subch. X apply to all persons who receive, possess, use, own or transfer sources of radiation registered with or licensed by the department under subchs. II and VIII of this chapter.

**(11)** Subchapter XI applies to all persons who receive, possess, use, own or transfer radioactive materials or radiation producing machines licensed by or registered with the department.

**(12)** Subchapter XII applies to all persons who possess, use, store, transfer or receive radioactive materials, or who possess radiation machines.

**(13)** Subchapter XIII applies to any person who transports radioactive material or delivers radioactive material to a carrier for transport.

**(14)** The radioactivity requirements in subch. XIV apply to all community water systems, except those meeting all of the conditions of s. HFS 157.95.

**History:** CR 01-108: cr. Register July 2002 No. 559, eff. 8-1-02; CR 06-021:am. (4) to (7) and (10), r. (15) Register October 2006 No. 610, eff. 11-1-06.

**HFS 157.03 Definitions.** In this chapter:

**(1)** "A1" means the maximum activity of special form radioactive material permitted in a Type A package. This value is either listed in Table VI and Table VIII in Appendix O or may be derived under the procedures prescribed in Appendix O.

**(2)** "A2" means the maximum activity of radioactive material, other than special form material, LSA and SCO material, permitted in a Type A package. This value is either listed in Table VI and Table VIII in Appendix O or may be derived under the procedures prescribed in Appendix O.

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

**(4)** "Absorbed dose rate" means absorbed dose per unit time, for machines with timers, or dose monitor unit per unit time for accelerators.

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

**(6)** "Accelerator-produced material" means any material made radioactive by an accelerator.

**(7)** "Accessible surface" means surface of equipment or of an equipment part, housing or enclosure of the radiation producing machine that may be easily or accidentally touched by persons without the use of a tool.

**(8)** "Act" means ss. 254.31 to 254.45, Stats.

**(9)** "Activity" means the rate of disintegration or transformation or decay of radioactive material. The units of activity are the becquerel and the curie.

**(10)** "Added filtration" means any filtration which is in addition to the inherent filtration.

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

**(12)** "Adult" means an individual 18 or more years of age.

**(13)** "Agreement state" means any state with which the U.S. nuclear regulatory commission or the U.S. atomic energy commission has entered into an effective agreement under subsection 274b of the atomic energy act of 1954, as amended.

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

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

**(16)** "Airborne radioactivity area" means a room, enclosure or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations that meet either of the following criteria:

(a) In excess of the derived air concentrations specified in Appendix E, table I.

(b) 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% of the annual limit on intake or 12 DAC-hours.

**(17)** “Air kerma” or “K” means the sum of the initial kinetic energies of all the charged ionizing particles liberated by uncharged ionizing particles per unit mass of air. Kerma is determined as the quotient of dE divided by dM, where dE is the sum of the initial kinetic energies of all the charged ionizing particles liberated by uncharged ionizing particles in air of mass dM. The SI unit of air kerma is joule per kilogram and the special name for the unit of kerma is the gray.

**(17m)** “Air kerma rate” means the air kerma per unit time.

**(18)** “Alarming ratemeter” means a radiation measurement device that may be set to alarm at a pre-set dose rate.

**(19)** “Alert” means an event may occur, is in progress, or has occurred that could lead to a release of radioactive material but that the release is not expected to require a response by offsite response organizations to protect people offsite.

**(20)** “Alignment helmet” means a guide placed on the head that directs radiation to a specific site during stereotactic surgery.

**(21)** “Aluminum equivalent” means the thickness of type 1100 aluminum alloy affording the same attenuation, under specified conditions, as the material in question.

**Note:** The nominal chemical composition of type 1100 aluminum is 99.00 percent minimum aluminum and 0.12% copper.

**(22)** “Analytical x-ray system” means x-ray equipment designed to analyze the composition of materials.

**(23)** “Annual refresher safety training” means a review conducted or provided by the licensee or registrant for its employees on radiation safety aspects of industrial radiography.

**(24)** “Annual limit on intake” or “ALI” means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. Annual limit on intake is the smaller value of intake of a given radionuclide in a year by the reference person that would result in a committed effective dose equivalent of 0.05 Sv (5 rem) or a committed dose equivalent of 0.5 Sv (50 rem) to any individual organ or tissue.

**Note:** Annual limit on intake values for intake by ingestion and by inhalation of selected radionuclides are given in table I, columns 1 and 2, of Appendix E.

**(25)** “ANSI” means the American National Standards Institute.

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

**(27)** “As low as is reasonably achievable” or “ALARA” means making every reasonable effort to maintain exposures to radiation as far below the dose limits in this chapter 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.

**(28)** “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.

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

**(30)** “Associated equipment” means equipment that is used in conjunction with a radiographic exposure device to make radiographic exposures that drives, guides or comes in contact with the source.

**Note:** Examples of associated equipment include a guide tube, control tube, control cable, removable source stop, “J” tube and collimator when used as an exposure head.

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

**(32)** “Attenuation block” means a block or stack of type 1100 aluminum alloy, or aluminum alloy having equivalent attenuation, with dimensions 20 centimeters by 20 centimeters or larger by 3.8 centimeters that is large enough to intercept the entire x-ray beam.

**(32m)** “Authorized medical physicist” means an individual who has any of the following qualifications:

(a) Meets the training requirements in s. HFS 157.61 (8) and (11).

(b) Is identified as an authorized medical physicist on a specific medical use license or equivalent permit issued by the department, NRC or another agreement state.

(c) Is identified as an authorized medical physicist on a permit issued by the department, NRC or another agreement state specific medical use licensee of broad scope that is authorized to permit the use of radioactive material.

**(33)** “Authorized nuclear pharmacist” means a pharmacist licensed by the state under ch. 450, Stats., and who fulfills at least one of the following:

(a) Meets the requirements in s. HFS 157.61 (9) and (11).

(b) Is identified as an authorized nuclear pharmacist on a nuclear regulatory commission or agreement state license or other equivalent permit or license recognized by the NRC that authorizes the medical use of radioactive material or the practice of nuclear pharmacy.

(c) Is identified as an authorized nuclear pharmacist on a permit issued by an NRC or agreement state specific licensee of broad scope that is authorized to permit the medical use of radioactive material or the practice of nuclear pharmacy.

(d) Is approved as an authorized nuclear pharmacist by a nuclear pharmacy authorized by the NRC or an agreement state to approve authorized nuclear pharmacists.

**(34)** “Authorized user” means a state licensed person engaged in the healing arts who fulfills at least one of the following:

(a) Meets the recentness of training requirements in s. HFS 157.61 (11) and the certification requirement, depending upon the desired use of the radioactive material, found in any of the following:

1. Section HFS 157.63 (4) (a).
2. Section HFS 157.63 (5) (a).
3. Section HFS 157.64 (4) (a).
4. Section HFS 157.64 (5) (a).
5. Section HFS 157.64 (6) (a).
6. Section HFS 157.65 (8) (a).
7. Section HFS 157.66 (2) (a).
8. Section HFS 157.67 (17) (a).

(b) Is identified as an authorized user on a nuclear regulatory commission or agreement state license or other equivalent permit or license recognized by the NRC that authorizes the medical use of radioactive material.

(c) Is identified as an authorized user on a permit issued by a nuclear regulatory commission or agreement state specific licensee of broad scope that is authorized to permit the medical use of radioactive material.

**(35)** “Automatic exposure control” or “AEC” means a device that automatically controls one or more technique factors to obtain at a preselected location a required quantity of radiation.

**Note:** Examples of an automatic exposure control includes devices such as phototimers and ion chambers.

**(36)** “Autoradiograph” means a radiographic image created by placing a sealed source on radiographic film to directly expose the film.

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

**(38)** “Barrier” means a device or material used to restrict access to an area.

**(39)** “Beam axis” means a line from the source through the centers of the radiation fields.

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

**(41)** “Beam scattering foil” means a thin piece of material, usually metallic, placed in the beam to scatter a beam of electrons to provide a more uniform electron distribution in the useful beam.

**(42)** “Beam-limiting device” means a field defining collimator that provides a means to restrict the dimensions of the useful beam to the desired dimensions.

**(43)** “Becquerel” or “Bq” means the SI unit of activity. One becquerel equals one disintegration or transformation per second. The special unit of decay is the curie and is being replaced by the becquerel.

**(44)** “Bent beam linear accelerator” means a linear accelerator geometry in which the accelerated electron beam must change direction by passing through a bending magnet.

**(45)** “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.

**(46)** “Brachytherapy” means a method of radiation therapy in which sources are used to deliver a radiation dose at a distance of up to a few centimeters by surface, intracavitary or interstitial application.

**(47)** “Brachytherapy source” means a radioactive material or a manufacturer-assembled material train or a combination of these materials.

**(48)** “Broad scope license” means a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of up to multi-curie quantities of radioactive material, including the establishment of administrative procedures that assure control of procurement and safe use of radioactive materials.

**Note:** Section HFS 157.13 (3) (b) describes the different types of broad scope licenses.

**(49)** “Buffer zone” means a portion of a disposal site that is controlled by the licensee that lies under the disposal units and is between the disposal units and the site boundary.

**(50)** “Byproduct material” means either of the following:

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

(b) 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.

**(51)** “Cabinet radiography” means industrial radiography conducted in an enclosure or cabinet so shielded that every location on the exterior meets the dose limits for individual members of the public as specified in s. HFS 157.23 (1).

**(52)** “Cabinet x-ray system” means an x-ray system, manufactured under the requirements of 21 CFR 1020.40, with an x-ray tube installed in an enclosure that is independent of existing architectural structures except the floor. 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. “Cabinet x-ray system” includes 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 that may temporarily or occasionally incorporate portable shielding is not considered a cabinet x-ray system.

**(53)** “Calendar quarter” means a period of time equal to one-fourth of the year observed by the licensee or registrant, 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.

*Note:* A calendar quarter is approximately 13 consecutive weeks.

**(54)** “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 to maintain a desired spatial relationship. The system allows the operator to change the projection of the beam through the patient without changing the position of the patient.

**(55)** “Calibration” means determining either of the following:

(a) The response or reading of an instrument relative to a series of known radiation values over the range of the instrument.

(b) The strength of a source of radiation relative to a standard.

**(56)** “Carrier” means a person engaged in the transportation of passengers or property by land or water as a common, contract or private carrier or by civil aircraft.

**(57)** “Cephalometric device” means a device intended for the radiographic visualization and measurement of the dimensions of the human head.

**(57g)** “Certificate holder” means a person who has been issued a certificate of compliance or other package approval by the U.S. nuclear regulatory commission.

**(57r)** “Certificate of Compliance” or “CoC” means the certificate issued by the U.S. nuclear regulatory commission under subpart D of 10 CFR 71 which approves the design of a package for the transportation of radioactive material.

**(58)** “Certified components” means components of x-ray systems subject to 21 CFR 1010.2.

**(59)** “Certified system” means any x-ray system that has one or more components certified under 21 CFR 1010.2.

**(60)** “Certifying entity” means an independent certifying organization meeting the requirements in 10 CFR 34, Appendix A or an agreement state meeting the requirements in 10 CFR 34, Appendix A, Parts II and III.

**(61)** “Changeable filters” means any filter, exclusive of inherent filtration, that may be removed from the useful beam through any electronic, mechanical or physical process.

**(62)** “Chelating agent” means a chemical compound used to remove radioactive material from other substances.

*Note:* Examples of chelating agents are amine polycarboxylic acids, hydroxycarboxylic acids, glucinic acid and polycarboxylic acids.

**(63)** “Chiropractor” means an individual licensed under ch.446, Stats., to practice chiropractic.

**(64)** “Class” means a classification scheme for inhaled material according to the material’s rate of clearance from the pulmonary region of the lung. Materials are classified as D, W or Y, depending on the amount of time half of the material clears from human lungs. Half of class D material clears from lungs in less than 10 days; half of class W material clears from lungs in from 10 to 100 days; and half of class Y material clears from lungs in greater than 100 days.

**(65)** “Cinefluorography” means the continuous recording of a fluoroscopy image using movie film.

**(66)** “Client’s address” means the area of use or a temporary jobsite for the purpose of providing mobile medical service.

**(67)** “Closed transport vehicle” means a transport vehicle equipped with a securely attached exterior enclosure that during normal transportation restricts the access of unauthorized persons to the cargo space containing a radioactive material. The enclosure may be either temporary or permanent but shall limit access from top, sides and ends. In the case of packaged materials, the vehicle may be of the “see-through” type that allows observation of the packages while prohibiting access.

**(68)** “Coefficient of variation” means the ratio of the standard deviation to the mean value of a population of observations. It is estimated using the following equation:

$$C = \frac{s}{\bar{X}} = \frac{1}{\bar{X}} \left[ \frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1} \right]^{1/2}$$

where:

S = standard deviation of the observed values;

X = mean value of observations in sample;

X<sub>i</sub> = ith observation in sample; and

n = number of observations in sample.

**(69)** “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.

**(70)** “Collimator” means one of the following:

- (a) A radiation shield that is placed on the end of the guide tube or directly onto a radiographic exposure device to restrict the size of the radiation beam when the sealed source is moved into position to make a radiographic exposure.
- (b) A device attached to an x-ray tube that limits the radiation area.

**(71)** “Commission” means the United States nuclear regulatory commission.

**(72)** “Committed dose equivalent” or “CDE” means the dose equivalent to organs or tissues of reference that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

**(73)** “Committed effective dose equivalent” or “CEDE” is the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to each of these organs or tissues.

**Note:** Committed effective dose equivalent ( $HE_{50}$ ) equals the sum of the weighting factor ( $w_T$ ) times the committed dose equivalent ( $HT_{50}$ ).

**(74)** “Computed tomography” or “CT” means the production of a tomogram by the acquisition and computer processing of x-ray transmission data.

**(75)** (a) “Computed tomography dose index” or “CTDI” means the integral from  $-10T$  to  $+10T$  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:

$$CTDI = \frac{1}{nT} \int_{-10T}^{+10T} D(z) dz$$

where:

$z$  = position along a line perpendicular to the tomographic plane;

$D(z)$  = dose at position  $z$ ;

$T$  = nominal tomographic section thickness in millimeters;

$n$  = number of tomograms produced in a single scan.

(b) The definition of “computed tomography dose index” assumes that the dose profile is centered around  $z=0$  and that, for a multiple tomogram system, the scan increment between adjacent scans is  $nT$ .

**(75m)** “Consignment” means each shipment of a package or groups of packages or load of radioactive material offered by a shipper for transport.

**(76)** “Constraint” means a value above which specified licensee or registrant actions are required.

**(77)** “Contact therapy system” means a therapeutic radiation machine with a short target to skin distance, usually less than 5 centimeters.

**(78)** “Control cable” means the cable that is connected to the source assembly and used to drive the source to and from the exposure location.

**(79)** “Control drive mechanism” means a device that enables the source assembly to be moved into and out of the exposure device.

**(80)** “Control panel” means that part of an x-ray control upon which are mounted the switches, knobs, pushbuttons and other hardware necessary for manually setting the technique factors.

**(81)** “Control tube” means a protective sheath for guiding the control cable. The control tube connects the control drive mechanism to the radiographic exposure device.

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

**(82m)** “Conveyance” means any one of the following:

(a) For transport by public highway or rail, any transport vehicle or large freight container.

(b) For transport by water, any vessel, or any hold, compartment or defined deck area of a vessel, including any transport vehicle on board the vessel.

(c) For transport by aircraft, any aircraft.

**(83)** “Cooling curve” means the graphical relationship between heat units stored and cooling time.

**(84)** “Critical group” means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

**(84m)** “Criticality safety index” or “CSI” means the dimensionless number, rounded up to the next tenth, assigned to and placed on the label of a fissile material package, to designate the degree of control of accumulation of packages containing fissile material during transportation.

**Note:** Determination of the criticality safety index is described in s. HFS 157.93 (7) and (8).

**(85)** “CT conditions of operation” means all selectable parameters governing the operation of a CT x-ray system including nominal tomographic section thickness, filtration and the technique factors as defined in s. HFS 157.84.

**(86)** “CT gantry” means the tube housing assemblies, beam-limiting devices, detectors and the supporting structures and frames that hold these components.

**(87)** “CT number” or “CTN” means the number used to represent the x-ray attenuation associated with each elemental area of the CT image as expressed in the following equation:

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

where:

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

$\mu_x$  = linear attenuation coefficient of the material of interest;

$\mu_w$  = linear attenuation coefficient of water.

**(87m)** “Cumulative air kerma” means the total air kerma accrued from the beginning of an examination or procedure and includes all contributions from fluoroscopic and radiographic irradiation.

**(88)** “Curie” or “Ci” means  $3.7 \times 10^{10}$  disintegrations per second =  $3.7 \times 10^{10}$  becquerels =  $2.22 \times 10^{12}$  disintegrations per minute.

**(89)** “Dead-man switch” means a switch so constructed that a circuit closing contact may be maintained only by continuous pressure on the switch by the operator.

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

**(91)** “Decommission” means to remove a facility or site safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license; or release of the property under restricted conditions and termination of the license.

**(92)** “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.

**(93)** “Deep dose equivalent” or “Hd” means the dose equivalent at a tissue depth of one centimeter ( $1000 \text{ mg/cm}^2$ ) and applies to external whole body exposure.

**(94)** “Deliberate misconduct” means an intentional act or omission that the person knows would cause any of the following:

(a) A licensee, registrant or applicant to be in violation of any requirement under this chapter, any order of the department, or any term, condition or limitation of any license or registration issued by the department under this chapter.

(b) A violation of a requirement, procedure, instruction, contract, purchase order or policy of a licensee, registrant, applicant, or contractor or subcontractor of a licensee, registrant or applicant.

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

**(96)** “Dentist” means an individual licensed under ch. 447, Stats., to practice dentistry.

**(97)** “Department” means the department of health and family services.

**(98)** “Depleted uranium” means uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

**(99)** “Derived air concentration” or “DAC” means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work, results in an intake of one ALI.

**Note:** For purposes of this chapter, 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 E.

**(100)** “Derived air concentration-hour” or “DAC-hour” means the product of the concentration of radioactive material in air, expressed as a fraction or multiple of the derived air concentration for each radionuclide, and the time of exposure to that radionuclide, in hours. A licensee or registrant may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 0.05 Sv (5 rem).

**(101)** “Detector” means a device which in the presence of radiation provides, by either direct or indirect means, a signal or other indication suitable for use in measuring one or more quantities of incident radiation.

**(101m)** “Deuterium” means deuterium and any deuterium compounds, including heavy water, in which the ratio of deuterium atoms to hydrogen atoms exceeds 1:5000.

**(102)** “Diagnostic source assembly” means the tube housing assembly with a beam-limiting device attached.

**(103)** “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.

**(103m)** “DICOM” means digital imaging and communications in medicine.

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

**Note:** Sorbent exhaustion refers to the inability of an absorbent material to absorb any more of the material for which it was designed.

**(105)** “Disposal” means the isolation of radioactive wastes from the environment inhabited by man and containing his food-chains by emplacement in a land disposal facility.

**(106)** “Disposal site” means that portion of a land disposal facility which is used for the disposal of waste. It consists of disposal units and a buffer zone.

**(107)** “Disposal unit” means a discrete portion of a disposal site into which waste is placed for disposal.

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

- (109)** “Dose equivalent” or “H<sub>T</sub>” means the product of the absorbed dose in tissue, quality factor and all other necessary modifying factors at the location of interest. The units of dose equivalent are the sievert and rem.
- (110)** “Dose limits” means the permissible upper bounds of radiation doses established under this chapter.
- (111)** “Dose monitor unit” means a unit response from the beam monitoring system from which the absorbed dose may be calculated.
- (112)** “Dose profile” means the dose as a function of position along a line.
- (113)** “Dosimeter” means a recording device used to measure exposure to ionizing radiation.
- (114)** “Dosimetry processor” means an individual or an organization that processes and evaluates individual monitoring devices to determine the radiation dose delivered to the monitoring devices.
- (115)** “Doubly encapsulated sealed source” means a sealed source in which the radioactive material is sealed within an inner capsule and that capsule is sealed within an outer capsule.
- (116)** “Effective dose equivalent” or “EDE” means the sum of the products of the dose equivalent to each organ or tissue and the weighting factor applicable to each of the body organs or tissues that are irradiated ( $HE = \sum w_T H_T$ ).  
**Note:** Effective dose equivalent (HE) equals the sum of the weighting factor (w<sub>T</sub>) times the dose equivalent to each organ or tissue (H<sub>T</sub>).
- (117)** “Electron microscope” means a microscope utilizing electrons to provide high magnification examination of materials.
- (118)** “Elemental area” means the smallest area within a tomogram for which the x-ray attenuation properties of a body are depicted.
- (119)** “Embryo or fetus” means the developing human organism from conception until the time of birth.
- (120)** “Emergency” means an event requiring prompt action to mitigate a threat to the health and safety of workers and the public or a threat of damage to the environment.
- (121)** “Energy compensation source” or “ECS” means a small sealed source, with an activity not exceeding 3.7 MBq (100 microcuries), used within a well logging tool, or other tool components, to provide a reference standard to maintain the well logging tool’s calibration when in use.
- (122)** “Enriched uranium” means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.
- (123)** “Entrance air kerma rate” means the air kerma free in air per unit time at the point where the center of the useful beam enters the patient.
- (124)** “Entrance or access point” means any location through which 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.
- (124m)** “Exclusive use” means the sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for the safe handling of the consignment. The consignor shall issue specific instructions, in writing, for maintenance of exclusive use shipment controls, and include them with the shipping paper information provided to the carrier by the consignor.
- (125)** “Explosive material” means any chemical compound, mixture or device that produces a substantial instantaneous release of gas and heat spontaneously or by contact with sparks or flame.
- (126)** “Exposure” means the quotient of dQ divided by dm where “dQ” is the absolute value of the total charge of the ions of one sign produced in air when all the electrons liberated by photons in a volume element of air having mass “dm” are completely stopped in air. The SI unit of exposure is the coulomb per kilogram. The standard unit of exposure is the roentgen.
- (127)** “Exposure head” means a device that locates the gamma radiography sealed source in the selected working position.
- (128)** “Exposure rate” means the exposure per unit of time, such as roentgen per minute and milliroentgen per hour.
- (129)** “External beam radiation therapy” means therapeutic irradiation in which the source of radiation is at a distance from the body.
- (130)** “External dose” means that portion of the dose equivalent received from any source of radiation outside the body.
- (131)** “External sinking fund” means an account, segregated from licensee assets and outside the licensee’s administrative control, into which monies are periodically deposited that are sufficient to pay decommissioning costs expected at the time licensee operations are terminated.
- (132)** “Extremity” means hand, elbow, arm below the elbow, foot, knee and leg below the knee.
- (133)** “Extremity bone densitometer” means a device that tests the mineral content of the bone of the fore arm, hand or foot.
- (134)** “FDA” means the U.S. food and drug administration.
- (135)** “Field emission equipment” means equipment that uses an x-ray tube in which electron emission from the cathode is due solely to the action of an electric field.
- (136)** “Field station” means a facility where radioactive sources may be stored or used and from which equipment is dispatched to temporary job sites.

**(137)** “Film badge” means a dosimeter containing radiation sensitive photographic film for measuring radiation dose plus various filters that characterize the type of radiation encountered. When developed, the darkness of the film is directly proportional to the amount of radiation received.

**(138)** “Filter” means material placed in the useful beam to preferentially absorb selected radiation energies.

**(139)** “Filtering facepiece” means a negative pressure respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps.

**Note:** Elastomeric refers to material that is elastic and form fitting to provide a tight seal against the face.

**(140)** “Fissile material” means the radionuclides uranium–233, uranium–235, plutonium–239 and plutonium–241, or any combination of these radionuclides. Fissile material means the fissile nuclides themselves, not material containing fissile nuclides. Unirradiated natural uranium and depleted uranium, and natural uranium or depleted uranium that has been irradiated in thermal reactors only are not included in this definition.

**Note:** Certain exclusions from fissile material controls are provided in 10 CFR 71.15.

**(141)** “Fissile material package” or Type AF package, Type BF package, Type B(U)F package, or Type B(M)F package means a fissile material packaging together with its fissile material contents.

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

**(143)** “Fit test” means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

**(143m)** “Fluoroscopic air kerma display device” means a device, or subsystem, or component that provided the display of the air kerma rate and cumulative air kerma required by 21 CFR 1020.32 (k). It includes radiation detectors, if any, electronic and computer components, associated software, and display units.

**(144)** “Fluoroscopic imaging assembly” means a subsystem in which x–ray photons produce a visible image. It includes the image receptor such as the image intensifier and spot–film device, electrical interlocks, if any, and structural material providing linkage between the image receptor and diagnostic source assembly.

**(145)** “Fresh water aquifer” means, for the purposes of this chapter, a geologic formation that is capable of yielding fresh water to a well or spring.

**(146)** “Gantry” means that part of a radiation therapy system supporting and allowing movements of the radiation head about a center of rotation.

**(147)** “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.

**(148)** “Gamma stereotactic radiosurgery” means the use of a device containing a radioactive material providing multiple point radiation therapy treatment to a specific tumor site.

**(149)** “Generally applicable environmental radiation standards” means standards issued by the U.S. environmental protection agency under the authority of 42 USC 23, 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.

**(150)** “Gonad shield” means a protective barrier for the testes or ovaries.

**(150m)** “Graphite” means, for the purposes of 10 CFR 71.15 and 10 CFR 71.22, graphite with a boron equivalent content less than 5 parts per million and density greater than 1.5 grams per cubic centimeter.

**(151)** “Gray” or “Gy” means the SI unit of absorbed dose, air kerma and specific energy imparted equal to one joule per kilogram.

**Note:** The special unit of absorbed dose is being replaced by the gray. 1 Gy equals 100 rad.

**(152)** “Guide tube” means a flexible or rigid tube, for guiding the source assembly and the attached control cable from the exposure device to the exposure head. The guide tube may also include the connections necessary for attachment to the exposure device and to the exposure head.

**(153)** “Half–value layer” or “HVL” means the thickness of specified material which attenuates an x–ray or gamma radiation beam such that the air kerma rate at a point within the radiation beam is reduced to one–half of the air kerma rate at the same point without the material present. In this definition, the contribution of all scattered radiation, other than any that might be present initially in the radiation beam concerned, is excluded.

**(154)** “Hands–on experience” means experience in all of those areas considered to be directly involved in the radiography process.

**Note:** “Hands–on experience” includes taking radiographs, calibration of survey instruments, operational and performance testing of survey instruments and devices, film development, posting of warning signs in radiation areas, transportation of radiography equipment, posting on a bulletin board of records and radiation area surveillance, as applicable.

**(155)** “Healing arts” means a profession concerned with diagnosis and treatment of human maladies, including the practice of medicine, dentistry, osteopathy chiropractic and podiatry.

**(156)** “Healing arts screening” means the exposure of a human being to x–rays without prior examination disclosing a need for an x–ray procedure and prescription for such a study by a practitioner of the healing arts.

**(157)** “Heat unit” means a unit of energy equal to 0.75 joule. It is approximately equal to the energy given by the product of the peak kilovoltage, milliamperere and seconds, which is kVp x mA x time in seconds.

- (158)** “Helmet” means a rigid respiratory inlet covering that also provides head protection against impact and penetration.
- (159)** “High dose–rate remote afterloader” or “HDR” means a device that delivers a dose rate in excess of 12 gray (1200 rads) per hour.
- (160)** “High radiation area” means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving a dose equivalent in excess of one mSv (0.1 rem) in one hour at 30 centimeters from any source of radiation or 30 centimeters from any surface that the radiation penetrates.
- (161)** “Hood” means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.
- (162)** “Human use” means the internal or external administration of radiation or radioactive material to human beings.
- (163)** “Image intensifier” means a device, installed in its housing, which instantaneously converts an x–ray pattern into a corresponding light image of higher intensity.
- (164)** “Image receptor support” means, for mammographic systems, that part of the system designed to support the image receptor during mammography.
- (165)** “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 that may be made into a visible image by further transformations.
- (166)** “Independent certifying organization” means an independent organization that meets all of the criteria specified in 10 CFR 34, Appendix A.
- (167)** “Individual” means any human being.
- (168)** “Individual monitoring” means the assessment of any of the following:
- Dose equivalent by the use of individual monitoring devices or by the use of survey data.
  - Committed effective dose equivalent by bioassay or by determination of the time–weighted air concentrations to which an individual has been exposed.
- (169)** “Individual monitoring devices,” mean devices designed to be worn by a single individual for the assessment of dose equivalent. Examples of individual monitoring devices are film badges, thermoluminescent dosimeters, optically stimulated luminescent dosimeters, pocket dosimeters, direct reading dosimeters and personal air sampling devices.
- (170)** “Industrial radiography” means an examination of the structure of materials by the nondestructive method of utilizing ionizing radiation to make radiographic images.
- (171)** “Inherent filtration” means the filtration of the useful beam provided by the permanently installed components of the tube housing assembly.
- (172)** “Injection tool” means a device used for controlled subsurface injection of radioactive tracer material.
- (173)** “Inspection” means an official examination or observation by the department including tests, surveys and monitoring to determine compliance with rules, regulations, orders, requirements and conditions of the department.
- (174)** “Interlock” means a device preventing the start or continued operation of equipment unless certain predetermined conditions prevail.
- (175)** “Internal dose” means that portion of the dose equivalent received from radioactive material taken into the body.
- (176)** “Ionizing radiation” means alpha particles, beta particles, gamma rays, x rays, neutrons, high–speed electrons, high–speed protons and other particles capable of producing ions. “Ionizing radiation” does not include radiowaves or microwaves, visible, infrared or ultraviolet light.
- (177)** “Irradiation” means the exposure of a living being or matter to ionizing radiation.
- (178)** “Irradiator” means a facility that uses radioactive sealed sources for the irradiation of objects or materials and in which radiation dose rates exceeding 5 grays (500 rads) per hour exist at one meter from the sealed radioactive sources in air or water, as applicable for the irradiator type, but does not include irradiators in which both the sealed source and the area subject to irradiation are contained within a device and are not accessible to personnel.
- (179)** “Irradiator operator” means an individual who has successfully completed the training and testing described in s. HFS 157.73 (12) and is authorized by the terms of the license to operate the irradiator without a supervisor present.
- (180)** “Irradiator operator supervisor” means an individual who meets the requirements for an irradiator operator and who physically oversees operation of the irradiator by an individual who is currently receiving training and testing described in s. HFS 157.73 (12).
- (181)** “Isocenter” means the center of the sphere through which the useful beam axis passes while the gantry moves through its full range of motions.
- (182)** “Kilovolt” or “kV” means the energy equal to that acquired by a photon with one electron charge in passing through a potential difference of 1,000 volts in a vacuum.
- Note:** Current convention uses kV to designate photons and keV to designate electrons.
- (183)** “Kilovolts peak” or “kVp” means the maximum value of the potential difference across an x–ray tube during an exposure.
- (184)** “kWs” means kilowatt second.
- (185)** “Land disposal facility” means the land, buildings and structures, and equipment used for the disposal of radioactive wastes.
- (185m)** “Last–image hold” or “LIH” means an image obtained either by retaining one or more fluoroscopic images,

which may be temporally integrated, at the end of a fluoroscopic exposure or by initiating a separate and distinct radiographic exposure automatically and immediately in conjunction with termination of the fluoroscopic exposure.

**(185r)** “Lateral fluoroscope” means the x-ray tube and image receptor combination in a biplane system dedicated to the lateral projection. It consists of the lateral x-ray tube housing assembly and the lateral image receptor that are fixed in position relative to the table with the x-ray beam axis parallel to the plane of the table.

**(186)** “Lay-barge radiography” means industrial radiography performed on any water vessel used for laying pipe.

**(187)** “Lead equivalent” means the thickness of the material in question affording the same attenuation as lead.

**(188)** “Leakage radiation” means radiation emanating from the diagnostic source assembly except for any of the following:

- (a) The useful beam.
- (b) Radiation produced when the exposure switch or timer is not activated.

**(189)** “Lens dose equivalent” or “LDE” means the external dose equivalent to the lens of the eye at a tissue depth of 0.3 centimeter (300 mg/cm<sup>2</sup>).

**(190)** “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 department.

**(191)** “Licensed practitioner” means a chiropractor, dentist, physician or podiatrist licensed in the state of Wisconsin.

**(192)** “Licensing state” means any state approved by the Conference of Radiation Control Program Directors, Inc., as having regulations equivalent to the Suggested State Regulations for Control of Radiation relating to NARM and an effective program for the regulatory control of NARM.

**(193)** “Light field” means the 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.

**(194)** “Logging tool” means a device used subsurface to perform well logging.

**(195)** “Loose-fitting facepiece” means a respiratory inlet covering that is designed to form a partial seal with the face.

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

**(197)** “Low dose-rate remote afterloader” or “LDR” means a device that delivers a dose rate of less than or equal to 2 gray (200 rads) per hour.

**(197m)** “Low specific activity” means radioactive material with limited specific activity which is nonfissile or is excepted under s. HFS 157.92 (2) (c), and which satisfies the descriptions and limits set forth in ss. HFS 157.03 (198), (199) or (200). Shielding materials surrounding the low specific activity material may not be considered in determining the estimated average specific activity of the package contents.

**(198)** “Low specific activity – I” or “LSA-I material” means any of the following:

- (a) Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radioactive radionuclides which are not intended to be processed for the use of radionuclides.
- (b) Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures.
- (c) Radioactive material for which the A<sub>2</sub> value is unlimited.
- (d) Other radioactive material in which the radioactive material is distributed throughout and the estimated average specific activity does not exceed 30 times the value for exempt material activity concentration determined under Appendix A.

**(199)** “Low specific activity – II” or “LSA-II material” means either of the following:

- (a) Water with tritium concentration up to 0.8 terabecquerel per liter (20.0 Ci/L).
- (b) Other material in which the radioactive material is distributed throughout, and the average specific activity does not exceed 10<sup>-4</sup> A<sub>2</sub>/g for solids and gases and 10<sup>-5</sup> A<sub>2</sub>/g for liquids.

**(200)** “Low specific activity – III” or “LSA-III material” means solids, such as consolidated wastes or activated materials, excluding powders, for which all of the following apply:

- (a) The radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent, for example, concrete, bitumen or ceramic.
- (b) The radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that, even under loss of packaging, the loss of radioactive material per package by leaching, when placed in water for 7 days, would not exceed 0.1 A<sub>2</sub>.
- (c) The estimated average specific activity of the solid does not exceed 2 x 10<sup>-3</sup> A<sub>2</sub>/g.

**(201)** “Low toxicity alpha emitters” means natural uranium, depleted uranium, natural thorium; uranium-235, uranium-238, thorium-232, thorium-228 or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or alpha emitters with a half-life of less than 10 days.

**(202)** “mA” means milliamperere.

**(203)** “Mammography” means radiography of the breast, but does not include radiography of the breast performed during invasive interventions for localization or biopsy procedures.

**(204)** “Management” means the chief executive officer or other individual having the authority to manage, direct or administer the licensee’s activities, or those persons’ delegate or delegates.

**(205)** “Manual brachytherapy” means a type of brachytherapy in which the radioactive sources are manually inserted either into the body cavities that are in close proximity to a tumor or directly into the tumor volume.

**Note:** Examples of radioactive sources are seeds and ribbons.

**(206)** “mAs” means milliamperere second.

**(207)** “Maximum line current” means the root-mean-square current in the supply line of an x-ray machine operating at its maximum rating.

**(208)** “Medical event” means an improper administration of radiation or radioactive material to a patient or human research subject that requires reporting to the department.

**(209)** “Medical institution” means an organization in which medical disciplines are practiced.

**(210)** “Medical physicist” means an individual with any of the following qualifications:

(a) Certified by the American board of radiology or the American board of health physics in one or more of the following:

1. Therapeutic radiological physics.
2. Roentgen-ray and gamma-ray physics.
3. X-ray and radium physics.
4. Radiological physics.
5. Comprehensive health physics.

(b) Certified by the American board of medical physics in radiation oncology physics.

(c) Certified by the Canadian college of medical physics.

**(211)** “Medical use” means the intentional internal or external administration of radioactive material or the radiation from radioactive material to patients or human research subjects under the supervision of an authorized user.

**(212)** “Medium dose-rate remote afterloader” or “MDR” means a device that delivers a dose rate of greater than 2 gray (200 rads) but less than 12 gray (1200 rads) per hour at the point or surface where the dose is prescribed.

**(213)** “Megavolt” or “MV” 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:** The current convention is to use MV to designate photons and MeV to designate electrons.

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

**(215)** “Minor” means an individual less than 18 years of age.

**(216)** “Mobile medical service supplier” means a mobile service that carries or receives radioactive materials for medical use at a client’s address.

**(217)** “Mobile x-ray equipment” means x-ray equipment mounted on a permanent base with wheels or casters for moving while completely assembled.

**(218)** “Moderator” means a material that decreases the energy of neutrons.

**(219)** “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.

**(220)** “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.

**(221)** “Multiple tomogram system” means a computed tomography x-ray system that obtains x-ray transmission data simultaneously during a single scan to produce more than one tomogram image.

**(222)** “NARM” means any naturally occurring or accelerator-produced radioactive material. It does not include byproduct, source or special nuclear material.

**(223)** “Natural radioactivity” means radioactivity of naturally occurring nuclides.

**(224)** “Natural thorium” means thorium with the naturally occurring distribution of thorium isotopes, which is essentially 100 weight percent thorium-232.

**(225)** “Natural uranium” means uranium with the naturally occurring distribution of uranium isotopes, which is approximately 0.711 weight percent uranium-235, and the remainder by weight essentially uranium-238.

**(226)** “Negative pressure respirator – tight fitting” means a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

**(227)** “Neutron absorber” means a material that absorbs neutrons emitted from radioactive material.

**(228)** “Noble gas” means a chemically inert gas that does not combine with other elements.

**(229)** “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.

**(230)** “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. health effects, 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.

**(232)** “Normal form radioactive material” means radioactive material that has not been demonstrated to qualify as special form radioactive material.

**(233)** “Notice of violation” means a written notice provided in response to an alleged infraction of ss. 254.31 to 254.45, Stats., this chapter, the conditions of a license or an order issued by the department.

**(234)** “NRC” means the U.S. nuclear regulatory commission.

**(235)** “Nuclear waste” means a quantity of source, byproduct or special nuclear material required to be in NRC-approved specification packaging while transported to, through or across a state boundary to a disposal site, or to a collection point for transport to a disposal site.

**(236)** “Optically stimulated luminescent dosimeter” or “OSL” means a dosimeter containing a crystalline solid for measuring radiation dose plus filters to help characterize the type of radiation encountered.

**Note:** When exposed to the appropriate energy of light, exposed optically stimulated luminescent crystals give off light proportional to the energy received from the radiation.

**(237)** “Occupational dose” means the dose received by an individual in the course of employment in which the individual’s assigned duties involve exposure to radiation, or to radioactive material from licensed and unlicensed sources of radiation, whether in the possession of the licensee, registrant or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under s. HFS 157.62 (8), from voluntary participation in medical research programs or as a member of the public.

**(238)** “Offshore platform radiography” means industrial radiography conducted from a platform over a body of water.

**(239)** “Offsite response organization” means the non-licensee offsite organizations that may be needed to respond to an emergency, including local fire, police, ambulance and hospital services.

**(240)** “Output” means the exposure rate, dose rate or a quantity related in a known manner to these rates from a brachytherapy source or a teletherapy, remote afterloader or gamma stereotactic radiosurgery unit for a specified set of exposure conditions.

**(241)** “Package” means the packaging together with its radioactive contents as presented for transport.

**(242)** “Packaging” means the assembly of components necessary to ensure compliance with the packaging requirements of 49 CFR Part 173, Subpart I. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system and auxiliary equipment may be designated as part of the packaging.

**(243)** “Panoramic dry-source-storage irradiator” means a device in which the irradiations occur in air in areas potentially accessible to personnel and in which the sources are stored in shields made of solid materials. The term includes beam-type dry-source-storage devices in which only a narrow beam of radiation is produced.

**(244)** “Panoramic irradiator” means a device in which the irradiations are performed in air in areas potentially accessible to personnel. The term includes beam-type devices.

**(245)** “Panoramic wet-source-storage irradiator” means a device in which the irradiations occur in air in areas potentially accessible to personnel and in which the sources are stored under water in a storage pool.

**(246)** “Pass box” means a box with openings on each side that is placed in a wall between an x-ray room and a darkroom allowing transfer of film holders between the 2 rooms.

**(247)** “Patient” means an individual or animal subjected to healing arts examination, diagnosis or treatment.

**(247m)** “PACS” means picture archiving and communication system.

**(248)** “Periodic quality control check” means a procedure that is performed to ensure that a previous calibration continues to be valid.

**(249)** “Permanent radiographic installation” means an enclosed shielded room, cell or vault, not located at a temporary jobsite, in which radiography is performed.

**(250)** “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 does not include federal government agencies or Indian tribes or bands.

**(251)** “Person in control” means the individual directly responsible for safe operation of the radiation installation.

**(251m)** “Personnel dosimeter” means a dosimeter, assigned to an individual, that is processed and evaluated by an accredited national voluntary laboratory accreditation program (NVLAP) processor.

**(252)** “Personal supervision” means guidance and instruction by the supervisor who is physically present at the jobsite and watching the performance of the operation in such proximity that contact may be maintained and immediate assistance given as required.

**(253)** “Phantom” means a volume of material behaving in a manner similar to tissue with respect to the attenuation and scattering of radiation.

**Note:** This requires that both the atomic number (Z) and the density of the material be similar to that of tissue.

**(254)** “Pharmacist” means an individual licensed under ch.450, Stats., to practice pharmacy.

**(255)** “Physician” means a medical doctor or doctor of osteopathy licensed under ch. 448, Stats., to prescribe drugs in the practice of medicine.

**(256)** “Picture element” means an elemental area of a tomogram.

**(257)** “Planned special exposure” means an infrequent exposure to radiation, separate from and in addition to the annual occupational dose limits, that requires a licensee or registrant to calculate the dose to be received by individuals prior to initiation of the planned task, as required under s. HFS 157.22 (6).

**(258)** “Pocket dosimeter” means a type of individual monitoring device that allows the user to view the accumulated radiation exposure received as recorded by the device.

**(259)** “Podiatrist” means an individual licensed under ch.448, Stats., to practice podiatry.

**(260)** “Pool irradiator” means any irradiator where the sources are stored or used in a pool of water including panoramic wet-source-storage irradiators and underwater irradiators.

**(261)** “Portable x-ray equipment” means x-ray equipment designed to be hand-carried.

**(262)** “Position indicating device” or “PID” means a device on dental x-ray equipment used to indicate the beam position and to establish a definite source-surface distance from the skin.

**Note:** A position indicating device may or may not incorporate or serve as a beam-limiting device.

**(263)** “Positive beam limitation” or “PBL” 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.

**(264)** “Positive pressure respirator” means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

**(264m)** “Positron emission tomography/computed tomography” or “PET/CT” means a dual modality imaging assembly comprised of two distinct components, one using radioactive material for imaging and the other using an x-ray source.

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

**(266)** “Practical examination” means a demonstration through application of the safety rules and principles in industrial radiography including use of all procedures and equipment to be used by radiographic personnel.

**(267)** “Preceptor” means an individual who provides, directs or verifies training and experience required for an individual to become an authorized user, an authorized medical physicist, an authorized nuclear pharmacist, or a Radiation Safety Officer for medical use.

**(268)** “Prescribed dosage” means the specified activity or a range of activities of a drug containing radioactive material as documented by any of the following means:

(a) In a written directive or prescription.

(b) Under directions of the authorized user for procedures not requiring a written directive.

**(269)** “Prescribed dose” means any of the following:

(a) For gamma stereotactic radiosurgery, the total dose as documented in the written directive.

(b) For teletherapy, the total dose and dose per fraction as documented in the written directive.

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

(d) For remote afterloaders, the total dose and dose per fraction as documented in the written directive.

**(270)** “Pressure demand respirator” means a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

**(271)** “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.

**(272)** “Primary protective barrier” means the material, excluding filters, placed in the useful beam.

**(273)** “Principal activities” means activities authorized by the license that are essential to achieving the purpose for which the license was issued or amended. “Principal activities” do not include storage during which no licensed material is accessed for use or disposal and activities incidental to decontamination or decommissioning.

**(274)** “Product conveyor system” means a system for moving the product to be irradiated to, from and within the area where irradiation takes place.

**(275)** “Protective apron” means an apron made of radiation absorbing materials used to reduce radiation exposure to the wearer.

**(276)** “Protective barrier” means a primary or secondary protective barrier of radiation absorbing material or materials used to reduce radiation exposure.

**(277)** “Protective glove” means a glove made of radiation absorbing materials used to reduce radiation exposure and that surrounds the hand and fingers.

**(278)** “Public dose” means the dose received by a member of the public from exposure to sources of radiation released by a licensee or registrant or to any other source of radiation under the control of a licensee or registrant. It does not include occupational dose, dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released under s. HFS 157.62 (8) or from voluntary participation in medical research programs.

**(279)** “Pulsed dose-rate remote afterloader” or “PDR” means a device that uses a single source capable of delivering dose rates in the high dose-rate range, but has both of the following characteristics:

(a) Is approximately one-tenth of the activity of typical high dose-rate remote afterloader sources.

(b) Is used to simulate the radiobiology of a low dose rate treatment by inserting the source for a given fraction of each hour.

**(279m)** “Pulsed mode” means operation of the x-ray system such that the x-ray tube current is pulsed by the x-ray control to produce one or more exposure intervals of duration less than one-half second.

**(280)** “Pyrophoric liquid” means any liquid that ignites spontaneously in dry or moist air at or below 54.4\_ C (130\_ F). This includes spontaneously combustible and water-reactive materials.

**(281)** “Pyrophoric solid” means any solid material, other than an explosive material, which under normal conditions is liable to cause fires through friction, retained heat from manufacturing or processing, or which may be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious transportation, handling or disposal hazard.

**(282)** “Qualitative fit test” or “QLFT” means a pass or fail fit test to assess the adequacy of respirator fit that relies on the individual’s response to the test agent.

**(283)** “Quality control” means an ongoing program to ensure continued reliable performance of the equipment designed to detect changes which may result in a clinically significant degradation in image quality or a significant increase in radiation exposure.

**(284)** “Quality factor” or “Q” means the modifying factor listed in tables 157.06A and 157.06B of s. HFS 157.06 (4) that is used to derive dose equivalent from absorbed dose.

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

**(286)** “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).

**(287)** “Radiation” means alpha particles, beta particles, gamma rays, x rays, neutrons, high-speed electrons, high-speed protons and other particles capable of producing ions. “Radiation” does not include non-ionizing radiation, such as radiowaves or microwaves, visible, infrared or ultraviolet light.

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

**(289)** “Radiation head” means the structure from which the useful beam emerges.

**(290)** “Radiation incident” means the loss of control of a radioactive source or materials or the unintended exposure of an individual to radiation that exceeds the limits in this chapter.

**(291)** “Radiation installation” means any location or facility where radiation machines are used or where radioactive material is produced, transported, stored, disposed of or used for any purpose.

**(292)** “Radiation machine” means any device capable of producing radiation, except those devices with radioactive material as the only source of radiation.

**(293)** “Radiation room” means a shielded room in which irradiations take place. Underwater irradiators do not have radiation rooms.

**(294)** “Radiation safety officer” or “RSO” means an individual who has the knowledge and training to apply appropriate radiation regulations and has been assigned the responsibility for the overall radiation safety program by the registrant or licensee and is identified on a registration or a specific license.

**(295)** “Radiation safety officer for industrial radiography” means an individual with the responsibility for the overall radiation safety program for a licensee or registrant and who meets the requirements of s. HFS 157.44 (2).

**(295m)** “Radiation safety officer for medical use” means an individual that meets the requirements of ss. HFS 157.61 (7) (a) or (c) 1. and 157.61 (11), or who is identified as a radiation safety officer on a department, NRC or another agreement state medical use license or other equivalent license or permit recognized by the department for similar types and uses of radioactive material.

**(296)** “Radiation therapy simulation system” means a radiographic, CT 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.

**(297)** “Radioactive drug” means any chemical compound containing radioactive material that may be used on or administered to patients or human research subjects as an aid in the diagnosis, treatment or prevention of disease or other abnormal condition.

**(298)** “Radioactive marker” means radioactive material placed in the well-bore or on a structure intended for subsurface use for the purpose of depth determination or direction orientation.

**(299)** “Radioactive material” means any solid, liquid or gas that emits radiation spontaneously.

**(300)** “Radioactivity” means the transformation of unstable atomic nuclei by the emission of radiation.

**(301)** “Radiograph” means an image which is created directly or indirectly by radiation and results in a permanent record, either film or electronically stored image.

**(302)** “Radiographer” means any individual who performs or who, in attendance at the site where the sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for assuring compliance with the requirements of this chapter and the conditions of the license or registration.

**(303)** “Radiographer certification” means written approval received from a certifying entity stating that an individual has satisfactorily met the equivalent radiation safety, testing and experience criteria in s. HFS 157.44 (3) (a).

**(304)** “Radiographer’s assistant” means any individual who under the direct supervision of a radiographer, uses radiographic exposure devices, sources of radiation, related handling tools or radiation survey instruments in industrial radiography.

**(305)** “Radiographic exposure device” means any instrument containing a sealed source fastened or contained within the instrument, 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.

**(306)** “Radiographic imaging system” means any system whereby a permanent or semi-permanent image is recorded on an image receptor by the action of ionizing radiation.

**(307)** “Radiographic operations” means all activities performed with a radiographic exposure device or with a radiation machine. Activities include using, transporting, except by common or contract carriers or storing at a temporary job site, performing surveys to confirm the adequacy of boundaries, setting up equipment and any activity inside restricted area boundaries. Transporting a radiation machine is not considered a radiographic operation.

**(308)** “Radionuclide” means a radioactive form of an element.

**(309)** “Rating” means the operating limits as specified by the component manufacturer.

**(310)** “Redundant beam monitoring system” means a combination of 2 dose monitoring systems in which each system is designed to terminate irradiation under a pre-selected number of dose monitor units.

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

**(312)** “Reference plane” means a plane that is displaced from and parallel to the tomographic plane.

**(313)** “Regulations of the U.S. Department of Transportation” means the regulations in 49 CFR 100 to 189 and 390 to 397.

**(314)** “Rem” means the special unit of any of the quantities expressed as dose equivalent.

Note: The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor. One rem equals 0.01 sievert.

**(315)** “Research and development” means either of the following:

(a) Theoretical analysis, exploration or experimentation.

(b) The practical application of investigative findings and theories of a scientific or technical nature 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.

**(316)** “Residual radioactivity” means radioactivity in structures, materials, soils, groundwater and other media at a site resulting from activities under the licensee’s or registrant’s control. “Residual radioactivity” includes radioactivity from all sources used by the licensee or registrant, but excludes background radiation. “Residual radioactivity” also includes radioactive materials remaining at the site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made in accordance with the provisions of this chapter.

**(317)** “Respiratory protective equipment” means an apparatus, such as a respirator, used to reduce an individual’s intake of airborne radioactive materials.

**(318)** “Restricted area” means an area, access to which is limited by the licensee or registrant for the purpose of protecting individuals against undue risks from exposure to 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.

**(319)** “Roentgen” or “R” means the special unit of exposure. One roentgen equals  $2.58E-4$  coulombs per kilogram of air.

Note: See the definition of the term “exposure” and also s. HFS 157.06 (4) for a further explanation of units of exposure.

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

**(321)** “Scan” means the complete process of collecting x-ray transmission data for the production of a tomogram. Data may be collected simultaneously during a single scan for the production of one or more tomograms.

**(322)** “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.

**(323)** “Scan sequence” means a pre-selected set of 2 or more scans performed consecutively under pre-selected CT conditions of operation.

**(324)** “Scan time” means the period of time between the beginning and end of x-ray transmission data accumulation for a single scan.

**(325)** “Scattered radiation” means ionizing radiation emitted by interaction of ionizing radiation with matter, the interaction being accompanied by a change in direction of the radiation.

**(326)** “SCO-I” means a surface contaminated object (SCO) for which all of the following apply:

(a) The non-fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 4 Bq/cm<sup>2</sup> ( $10^{-4}$  microcurie/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 0.4 Bq/cm<sup>2</sup> ( $10^{-5}$  microcurie/cm<sup>2</sup>) for all other alpha emitters.

(b) The fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 4x10<sup>4</sup> Bq/cm<sup>2</sup> (1.0 microcurie/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 4x10<sup>3</sup> Bq/cm<sup>2</sup> (0.1 microcurie/cm<sup>2</sup>) for all other alpha emitters.

(c) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 4x10<sup>4</sup> Bq/cm<sup>2</sup> (1.0 microcurie/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 4x10<sup>3</sup> Bq/cm<sup>2</sup> (0.1 microcurie/cm<sup>2</sup>) for all other alpha emitters.

**(327)** “SCO-II” means a surface contaminated object (SCO) for which the limits for SCO-1 are exceeded and on which all of the following apply:

(a) The non-fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 400 Bq/cm<sup>2</sup> (10<sup>-2</sup> microcurie/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 40 Bq/cm<sup>2</sup> (10<sup>-3</sup> microcurie/cm<sup>2</sup>) for all other alpha emitters.

(b) The fixed contamination on the accessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 8x10<sup>5</sup> Bq/cm<sup>2</sup> (20 microcurie/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 8x10<sup>4</sup> Bq/cm<sup>2</sup> (2 microcurie/cm<sup>2</sup>) for all other alpha emitters.

(c) The non-fixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm<sup>2</sup> (or the area of the surface if less than 300 cm<sup>2</sup>) does not exceed 8x10<sup>5</sup> Bq/cm<sup>2</sup> (20 microcurie/cm<sup>2</sup>) for beta and gamma and low toxicity alpha emitters, or 8x10<sup>4</sup> Bq/cm<sup>2</sup> (2 microcurie/cm<sup>2</sup>) for all other alpha emitters.

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

**(329)** “Sealed Source and Device Registry” or “SSDR” means the national registry that contains all the registration certificates, maintained by the NRC that summarize the radiation safety information for the sealed sources and devices and describe the licensing and use conditions approved for the product.

**(330)** “Secondary dose monitoring system” means a system that will terminate irradiation in the event of failure of the primary dose monitoring system.

**(331)** “Secondary protective barrier” means the material that attenuates stray radiation.

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

**(333)** “Shadow tray” means a device attached to the radiation head to support auxiliary beam blocking material.

**(334)** “Shallow dose equivalent” or “H<sub>s</sub>” means the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm<sup>2</sup>). “Shallow dose equivalent” applies to the external exposure of the skin of the whole body or the skin of an extremity.

**(335)** “SI” means the abbreviation for the International System of Units.

**(336)** “Shielded position” means the location within the radiographic exposure device, source changer or storage container that, by manufacturer’s design, is the proper location for storage of the sealed source.

**(337)** “Shutter” means a device attached to the tube housing assembly which may totally intercept the useful beam and which has a lead equivalency not less than that of the tube housing assembly.

**(338)** “Sievert” or “Sv” means the SI unit of dose equivalent. The unit of dose equivalent is the joule per kilogram. The special unit of dose equivalent (rem) is being replaced by the sievert. 1 Sv=100 rem.

**(339)** “Single tomogram system” means a CT x-ray system which obtains x-ray transmission data during a scan to produce a single tomogram.

**(340)** “Site area emergency” means an event may occur, is in progress, or has occurred that could lead to a significant release of radioactive material and require a response by offsite response organizations to protect people offsite.

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

**(342)** “Source” means the region and material from which the radiation emanates.

**(343)** “Source applicator” means a device used to place a radioactive source in a precise anatomical location within the body.

**(344)** “Source assembly” means an assembly that consists of the sealed source and a connector that attaches the source to the control cable. The source assembly may include a ballstop to secure the source in the shielded position.

**(345)** “Source changer” means a device designed and used for replacement of sealed sources in radiographic exposure devices and which may also be used for transporting and storing sealed sources.

**(346)** “Source holder” means a housing or assembly into which a radioactive source is placed to facilitate the handling and use of the source in well logging operations.

**(347)** “Source-image receptor distance” or “SID” means the distance from the source of radiation to the center of the input surface of the image receptor.

**(348)** “Source material” means either of the following:

(a) Uranium or thorium, or any combination thereof, in any physical or chemical form.

(b) Ores that contain by weight one-twentieth of one percent or more of uranium, thorium or any combination of uranium and thorium. Source material does not include special nuclear material.

**(349)** “Special form radioactive material” means radioactive material that satisfies all the following conditions:

(a) It is either a single solid piece or is contained in a sealed capsule that may be opened only by destroying the capsule.

(b) The piece or capsule has at least one dimension not less than 5 millimeters (0.2 in.).

(c) It satisfies the test requirements specified by the NRC in 10 CFR 71.75 at the time of its design or construction.

**(350)** “Special nuclear material” means plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the nuclear regulatory commission determines to be special nuclear material; or any material artificially enriched by any of the foregoing. Special nuclear material does not include source material.

**(351)** “Special nuclear material in quantities not sufficient to form a critical mass” means uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; uranium-233 in quantities not exceeding 200 grams; plutonium in quantities not exceeding 200 grams; or any combination of them under the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all of the kinds of special nuclear material in combination may not exceed one.

**Note:** For example, the following quantities in combination would not exceed the limitation and are within the formula:

$$\frac{175 \text{ (grams contained U-235)}}{350} + \frac{10 \text{ (grams U-233)}}{200} + \frac{50 \text{ (grams Pu)}}{200} = 1$$

**(352)** “Special unit” means the alternative system of units for quantifying absorbed dose in rad, dose equivalent in rem and radioactivity in curie.

**(353)** “Specific activity” of a radionuclide means the radioactivity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

**(354)** “Specific license” means a license, under requirements prescribed by the department by rule, to possess, use, manufacture, produce, transfer or acquire radioactive material or devices or equipment utilizing radioactive material.

**(355)** “Spot film” means a radiograph, which is made during a fluoroscopic examination to permanently record conditions that exist during that fluoroscopic procedure.

**(356)** “Spot-film device” means a device intended to transport and position a radiographic image receptor between an 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.

**(357)** “Stationary beam radiation therapy” means radiation therapy without displacement of one or more mechanical axes relative to the patient during irradiation.

**(358)** “Stationary x-ray equipment” means x-ray equipment that is installed in a fixed location.

**(359)** “Stereotactic radiosurgery” means the use of external radiation in conjunction with a stereotactic guidance device to deliver a dose to a tissue volume from multiple sources of radiation simultaneously.

**(360)** “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.

**(361)** “Storage area” means any secure location, facility or vehicle that is used to store and secure a radiographic exposure device, a radiation machine, a storage container or a sealed source, when it is not in use.

**(362)** “Storage container” means a device in which sealed sources or radiation machines are secured and stored.

**(363)** “Stray radiation” means the sum of leakage and scattered radiation.

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

**(365)** “S-tube” means a tube through which the radioactive source travels when inside a radiographic exposure device.

**(366)** “Subsurface” means below the surface of the earth.

**(367)** “Subsurface tracer study” means the release of a substance tagged with radioactive material to trace the movement or position of the tagged substance in the well-bore or adjacent formation.

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

**(369)** “Surface casing for protecting fresh water aquifers” means a pipe or tube used as a lining in a well to isolate fresh water aquifers from the well.

**(370)** “Surface contaminated object” or “SCO” means a solid object that is not itself classed as radioactive material, but which has radioactive material distributed on any of its surfaces.

**(371)** “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, an evaluation includes tests, physical examinations and measurements of levels of radiation or concentrations of radioactive material present.

**(371m)** “Tailing” means the residual material resulting from the extraction of minerals from the earth.

**(372)** “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.

**(373)** “Target-skin distance” or “TSD” means the distance measured along the beam axis from the center of the front surface of the x-ray target or electron virtual source to the surface of the irradiated object or patient.

**(374)** “Technique factors” means the following conditions of operation:

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

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

(c) 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 milliseconds, 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 per scan expressed as mAs.

(d) 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.

(e) 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.

**(375)** “Teletherapy” means a method of radiation therapy in which collimated gamma rays are delivered from a source at a distance from the patient or human research subject.

**(376)** “Temporary job site” means a location where any of the following occur:

(a) Radiographic operations are performed and sources of radiation may be stored other than at the location or locations of use authorized on the license or registration.

(b) Radioactive materials are present for the purpose of performing well logging or subsurface tracer studies.

**(377)** “Tenth-value layer” or “TVL” means the thickness of a specified material that attenuates x-radiation or gamma radiation to an extent 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.

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

**(379)** “Test” means the process of verifying compliance with an applicable regulation.

**(380)** “Therapeutic dosage” means a dosage of an unsealed radioactive material that is intended to deliver a radiation dose to a patient or human research subject for palliative or curative treatment.

**(381)** “Therapeutic dose” means a radiation dose delivered from a sealed source containing radioactive material to a patient or human research subject for palliative or curative treatment.

**(382)** “Therapeutic radiation machine” means x-ray, gamma ray or electron-producing equipment designed and used for external beam radiation therapy.

**(383)** “Thermoluminescent dosimeter” or “TLD” means a dosimeter containing a crystalline solid for measuring radiation dose, plus filters to help characterize the types of radiation encountered. When heated, TLD crystals that have been exposed to ionizing radiation give off light proportional to the energy they received from the radiation.

**(384)** “Tight-fitting facepiece” means a respiratory inlet covering that forms a complete seal with the face.

**(385)** “Tomogram” means the depiction of the x-ray attenuation properties of a section through the body.

**(386)** “Tomographic plane” means that geometric plane which is identified as corresponding to the output tomogram.

**(387)** “Tomographic section” means the volume of an object whose x-ray attenuation properties are imaged in a tomogram.

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

**(389)** “Total organ dose equivalent” or “TODE” means the sum of the deep dose equivalent and the committed dose equivalent to the organ receiving the highest dose.

**(390)** “Transport index” or “TI” means the dimensionless number, rounded up to the next tenth, placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is the number is determined by multiplying the maximum radiation level in millisievert (mSv) per hour at one meter (3.3 feet) from the external surface of the package by 100, which is equivalent to the maximum radiation level in millirem per hour at one meter (3.3 ft).

**(391)** “Transuranic waste” means waste containing elements having an atomic number greater than 92, a half-life greater than 5 years and in quantities greater than 3.7 kBq/gm (100 nCi/gm).

**(392)** “Treatment site” means the anatomical description of the tissue intended to receive a radiation dose, as described in a written directive.

**(393)** “Tritium neutron generator target source” means a tritium target source used within a neutron generator tube to produce neutrons for use in well logging applications.

**(394)** “Tube housing assembly” means the tube housing with tube installed. It includes high-voltage, filament transformers and other appropriate elements which are contained within the tube housing.

**(395)** “Tube” means an x-ray tube, unless otherwise specified.

**(396)** “Type A package” means a packaging that, together with its radioactive contents limited to A1 or A2 as appropriate, meets the requirements of 49 CFR 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required under normal conditions of transport as demonstrated by the tests set forth in 49 CFR 173.465 or 173.466, as appropriate.

**(397)** “Type A quantity” means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A1 for special form radioactive material or A2 for normal form radioactive material, where A1 and A2 are given in Appendix O or may be determined by procedures described in Appendix O.

**(398)** “Type B package” means a packaging that, together with its radioactive contents, is designed to retain the integrity of containment and shielding required by 49 CFR 173 when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR 71.

**Note:** A Type B package design is designated as B(U) or B(M). B(U) refers to the need for unilateral approval of international shipments; B(M) refers to the need for multilateral approval. No distinction is made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, refer to 49 CFR Part 173. A Type B package approved prior to September 6, 1983 was designated only as Type B.

- (399)** “Type B quantity” means a quantity of radioactive material greater than a type A quantity.
- (400)** “Type of use” means use of radioactive material as specified in s. HFS 157.63 (1) or (2), 157.64 (1), 157.65 (1), 157.66 (1) or 157.67 (1).
- (401)** “Underwater irradiator” means an irradiator in which the sources always remain shielded under water and humans do not have access to the sealed sources or the space subject to irradiation without entering the pool.
- (402)** “Underwater radiography” means industrial radiography performed when the radiographic exposure device and related equipment are beneath the surface of the water.
- (402m)** “Unirradiated uranium” means uranium containing not more than  $2 \times 10^3$  Bq of plutonium per gram of uranium-235, not more than  $9 \times 10^6$  Bq of fission products per gram of uranium-235, and not more than  $5 \times 10^{-3}$  g of uranium-236 per gram of uranium-235.
- (403)** “Unit dosage” means a quantity of radioactive material that meets all the following criteria:
- Is obtained or prepared under the requirements in s. HFS 157.63 (1) or (2) or 157.64 (1).
  - Is to be administered as a single dosage to a patient or human research subject without any further manipulation of the dosage after it is initially prepared, except to adjust the dosage to patient needs.
- (404)** “Unrefined and unprocessed ore” means ore in its natural form prior to any processing, such as grinding, roasting, refining or altering the ore from its natural state.
- (405)** “Unrestricted area” or “uncontrolled area” means an area, access to which is neither limited nor controlled by the licensee or registrant.
- (406)** “Uranium sinker bar” means a weight containing depleted uranium used to pull a logging tool down toward the bottom of a well.
- (407)** “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.
- (408)** “User seal check” means an action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.
- (409)** “Variable-aperture beam-limiting device” means a beam-limiting device that has capacity for stepless adjustment of the x-ray field size at a given SID.
- (410)** “Very high radiation area” means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 5 Gy (500 rad) in one hour at one meter from a source of radiation or one meter from any surface that the radiation penetrates.
- (411)** “Virtual source” means a point from which radiation appears to originate.
- (412)** “Visible area” means that portion of the input surface of the image receptor over which incident x-ray photons are producing a visible image.
- (413)** “Waste” means those materials having a low level of radioactivity that are acceptable for disposal in a land disposal facility and are not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in 42 USC 2011.
- (414)** “Waste handling licensee” mean a person licensed to receive and store radioactive residue prior to disposal and a person licensed to dispose of radioactive residue.
- (415)** “Wedge filter” means a filter which effects continuous change in transmission over all or a part of the useful beam.
- (416)** “Week” means 7 consecutive days starting on Sunday.
- (417)** “Weighting factor” or “wT” for an organ or tissue means the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of wT are:
- Organ Dose Weighting Factors
- Organ or Tissue wT
- Gonads 0.25
- Breast 0.15
- Red bone marrow 0.12
- Lung 0.12
- Thyroid 0.03
- Bone surfaces 0.03
- Remainder 0.30a/  
Whole Body 1.00b/
- a/ 0.30 results from 0.06 for each of 5 “remainder” organs, excluding the skin and the lens of the eye, that receive the highest doses.
- b/ For the purpose of weighting the external whole body dose, for adding it to the internal dose, a single weighting factor, wT = 1.0, has been specified. The department shall approve the use of other weighting factors for external exposure on a case-by-case basis until such time as specific guidance is issued.
- (418)** “Well” means a drilled hole in which well logging may be performed.

**(419)** “Well logging” means all operations involving the lowering and raising of measuring devices or tools which may contain sources of radiation into wells or cavities for the purpose of obtaining information about the well or adjacent formations which may be used in oil, gas, mineral, groundwater or geological exploration.

**(419m)** “Well–logging assistant” means any individual who, under the personal supervision of a well logging supervisor, handles sources of radiation that are not in logging tools or shipping containers or who performs surveys required by s. HFS 157.55.

**(420)** “Well logging supervisor” means any individual who uses sources of radiation or provides personal supervision of the use of sources of radiation at the well site and who is responsible for assuring compliance with the requirements of this chapter.

**(421)** “Well logging tool” means a device used subsurface to perform well logging.

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

**(423)** “Wipe sample” means a piece of material used to wipe over the area of a surface or device to collect radioactive contamination.

**(426)** “Worker” means an individual engaged in work under a license or registration issued by the department and controlled by a licensee or registrant, but does not include the licensee or registrant.

**(427)** “Working level” or “WL” means any combination of short–lived radon daughters in one 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 are for radon–222: polonium–218, lead–214, bismuth–214 and polonium–214; and for radon–220: polonium–216, lead–212, bismuth–212, and polonium–212.

**(428)** “Working level month” or “WLM” means an exposure to one working level for 170 hours. Two thousand working hours per year divided by 12 months per year is approximately equal to 170 hours per month.

**(429)** “Written directive” means an authorized user’s written order for the administration of radioactive material or radiation from radioactive material or a radiation machine to a specific patient or human research subject.

**(430)** “X–ray equipment” means an x–ray system, subsystem or component thereof that is one of the following:

(a) Mobile x–ray equipment.

(b) Portable x–ray equipment.

(c) Stationary x–ray equipment.

**(431)** “X–ray exposure control” means a device, switch, button or other similar means by which an operator initiates or terminates the radiation exposure. An x–ray exposure control may include such associated equipment as timers and back–up timers.

**(432)** “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.

**(433)** “X–ray high–voltage generator” means a device that transforms electrical energy from the potential supplied by an x–ray control to the tube operating potential. The device may also include means for transforming alternating current to direct current, filament transformers for an x–ray tube or tubes, high–voltage switches, electrical protective devices and other appropriate elements.

**(434)** “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.

**(435)** “X–ray table” means a patient support device with its patient support structure (tabletop) interposed between the patient and the image receptor during radiography or fluoroscopy. An x–ray table includes any stretcher equipped with a radiolucent panel and any table equipped with a cassette tray, cassette tunnel, image intensifier or spot–film device beneath the tabletop.

**(436)** “X–ray tube” means any electron tube designed to be used primarily for the production of x–rays.

**(437)** “Year” means the period beginning on January 1<sup>st</sup> used to determine compliance with the provisions of this chapter. 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.

**History:** CR 01–108: cr. Register July 2002 No. 559, eff. 8–1–02; CR 06–021: am. (1), (2), (13), (46), (98), (140), (141), (198) (a), (c), (199) (b), (200) (intro.), (c), (201), (210) (a) (intro.), (224), (225), (296), (326), (327), (334), (353), (376) (b), (390), (398), (418), (419) and (428); cr. (17m), (32m), (57g), (57r), (75m), (82m), (84m), (87m), (101m), (103m), (124m), (143m), (150m), (185m), (185r), (197m), (210) (a) 5., (247m), (251m), (264m), (279m), (295m), (371m), (402m) and (419m); r. and recr. (32), (68), (198) (d) and (267); r. (210) (d), (e), (424) and (425) Register October 2006 No. 610, eff. 11–1–06.

#### **HFS 157.04 Exemptions from the regulatory requirements.**

**(1) GENERAL.** The department may, upon application or upon its own initiative, grant such exemptions or exceptions from the requirements of this chapter as it determines are authorized by law and will not result in undue hazard to public health and safety or property or endanger the common defense and security.

**(2) U.S. DOE AND NRC CONTRACTORS.** U.S. department of energy contractors or subcontractors and any NRC contractor or subcontractor in any of the following categories operating within this state are exempt from this chapter to the extent

that the contractor or subcontractor under their contract receives, possesses, uses, transfers or acquires sources of radiation:

(a) Prime contractors performing work for the U.S. department of energy at U.S. government owned or controlled sites, including the transportation of byproduct material to or from such sites and the performance of contract services during temporary interruptions of such transportation.

(b) Prime contractors of the U.S. department of energy performing research in, or development, manufacture, storage, testing or transportation of atomic weapons or components of atomic weapons.

(c) Prime contractors of the U.S. department of energy using or operating nuclear reactors or other nuclear devices in a United States government owned vehicle or vessel.

(d) Any other prime contractor or subcontractor of the U.S. department of energy or of the NRC when the state and the NRC jointly determine all the following:

1. The exemption of the prime contractor or subcontractor is authorized by law.

2. Under the terms of the contract or subcontract, there is adequate assurance that the work may be accomplished without undue risk to the public health and safety.

**History:** CR 01-108: cr. Register July 2002 No. 559, eff. 8-1-02.

### **HFS 157.05 Prohibitions.**

**(1) DEVICES.** The following devices may not be used in Wisconsin:

(a) A hand-held fluoroscopic screen unless it has been listed in the Registry of Sealed Source and Devices.

(b) A shoe-fitting fluoroscopic device.

**(2) DELIBERATE MISCONDUCT.** No person may do any of the following:

(a) Engage in deliberate misconduct that causes or would have caused, if not detected, a licensee, registrant or applicant under this chapter to be in violation of any rule or order of the department; or any term, condition or limitation of any license or registration issued by the department under this chapter.

(b) Deliberately submit to the department; a licensee, registrant or applicant under this chapter; or a contractor or subcontractor of a licensee, registrant or applicant under this chapter; any information that the person knows to be incomplete or inaccurate.

**(3) RADIATION SURVEY INSTRUMENTATION.** No person may operate a portable device containing radioactive material designed to measure moisture content or density of materials unless calibrated and operable radiation survey instrumentation that meets the requirements of s. HFS 157.52 (4) (a), (b) and (c) is available for use at each site where the portable devices are used.

**(4) TRAINING.** (a) No person may use a portable device containing radioactive material used to measure moisture content or density of materials or determine lead content of paint unless the person has completed 8 hours of manufacturer's training or equivalent training that meets the requirements of Appendix S.

(b) A person providing equivalent training under par. (a) for certified lead inspectors or risk assessors shall meet the qualification requirements of s. HFS 163.24 (3) (a) 1. and 3. and shall complete an additional 8 hours of radiation safety training.

**(5)** No person may use a portable device containing radioactive material designed to measure moisture content or density of materials unless there is a minimum of 2 independent physical controls that form tangible barriers to secure the device from unauthorized removal, whenever the device is not under the control and constant surveillance of the licensee.

**History:** CR 01-108: cr. Register July 2002 No. 559, eff. 8-1-02; CR 06-021:am. (1) (a) and (3), cr. (5) Register October 2006 No. 610, eff. 11-1-06.

### **HFS 157.06 General regulatory requirements.**

**(1) RECORDS.** A licensee or registrant shall maintain records showing the receipt, transfer and disposal of all sources of radiation until the department terminates the license or registration authorizing possession of the device or material, and for 3 years following transfer or disposal of the device or material.

**Note:** Additional record requirements are specified elsewhere in this chapter.

**(2) INSPECTIONS.** (a) A licensee or registrant shall afford the department at all reasonable times opportunity to inspect sources of radiation, packaging and the premises and facilities on which the sources of radiation are used or stored and consult with workers.

(b) Each licensee and registrant shall make available to the department for inspection, upon reasonable notice, records maintained under this chapter.

(c) The department shall provide official notification in writing of the inspection findings, including any notice of violation, to the licensee or registrant.

**(3) TESTS.** A licensee or registrant shall perform upon instructions from the department, or shall permit the department to perform, such reasonable tests as the department deems appropriate or necessary including tests of any of the following:

(a) Sources of radiation.

(b) Facilities wherein sources of radiation are used or stored.

(c) Radiation detection and monitoring instruments.

(d) Other equipment and devices used with utilization or storage of licensed or registered sources of radiation.

**(4) UNITS OF EXPOSURE AND DOSE.** (a) The unit of exposure is the coulomb per kilogram of air. One roentgen is equal to  $2.58E-4$  coulomb per kilogram of air.

(b) The units of dose are any of the following:

1. Gray is the SI unit of absorbed dose. One gray is equal to an absorbed dose of one joule per kilogram (100 rad).
2. 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.
3. Rem is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rem is equal to the absorbed dose in rad multiplied by the quality factor.

**Note:** 0.01 sievert equals one rem.

4. Sievert is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sievert is equal to the absorbed dose in gray multiplied by the quality factor.

**Note:** One sievert equals 100 rem.

(c) The quality factors for converting absorbed dose to dose equivalent are shown in Table HFS 157.06A.

TABLE HFS 157.06A

Quality Factors and Absorbed Dose Equivalencies

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

**Note:** Absorbed dose in gray equal to one Sv or the absorbed dose in rad equal to one rem.

(d) If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in sievert per hour or rem per hour, as provided in par. (c), 0.01 Sv (1 rem) of neutron radiation of unknown energies may 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, a licensee or registrant may use the fluence rate per unit dose equivalent or the appropriate Q value from Table HFS 157.06B to convert a measured tissue dose in gray or rad to dose equivalent in sievert or rem.

TABLE HFS 157.06B  
 Mean Quality Factors, Q, and Fluence Per Unit Dose  
 Equivalent For Monoenergetic Neutrons

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

a Value of quality factor at the point where the dose equivalent 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.

**(5) UNITS OF ACTIVITY.** For purposes of this chapter, activity is expressed in the SI unit of becquerel or in the special unit of curie, or their multiples, or disintegrations or transformations per unit of time. One becquerel = one disintegration or transformation per second. One curie = 3.7E+10 disintegrations or transformations per second = 3.7E+10 becquerel = 2.22E+12 disintegrations or transformations per minute.

**History:** CR 01-108: cr. Register July 2002 No. 559, eff. 8-1-02.