



New Jersey (State)  
Department of Health,  
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Trenton, New Jersey 08625

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NEW JERSEY  
**RADIATION PROTECTION CODE**  
(Amended 1969)



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**Promulgated by**  
**COMMISSION ON RADIATION PROTECTION**  
**New Jersey State Department of Health**

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## NEW JERSEY RADIATION PROTECTION CODE

The following provisions of the New Jersey Radiation Protection Code as revised and which became effective March 1, 1968 were promulgated by the Commission on Radiation Protection under authority of the Radiation Protection Act (N.J.S.A. 26: 2D-1 et seq).

(Signed)

Frank G. Dunnington, Chairman

## NEW JERSEY RADIATION PROTECTION CODE

### CHAPTER I—GENERAL REQUIREMENTS

#### SECTION I—PURPOSE AND RESPONSIBILITY

##### 1.1 Purpose

The Purpose of this Code is to Prohibit and prevent unnecessary radiation as defined in the Radiation Protection Act (Chapter 116, P.L. 1958). This Code is therefore designed to limit exposure to ionizing radiation to levels consistent with good public health and industrial practice.

##### 1.2 Responsibility

Owners and all persons installing, using, handling, transporting or storing sources of radiation shall be responsible for compliance with the provisions of this Code, excepting that in the case of sources of radiation for which licenses or registrations have been issued by the Department, the licensee or registrant as the case may be shall be responsible for compliance with the provisions of the Code.

#### SECTION 2—DEFINITIONS

The following terms as used in this Code shall mean and include:

**2.1 Agreement State**—Any state with which the United States Atomic Energy Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, as amended.

**2.2 Airborne-Radioactivity Area**—An area accessible to individuals, in which airborne radioactive materials are present in concentrations such that the: (a) values at any time are in excess of the respective values stated in Section 7.5, Column B, or prorated values if more than one isotope is present; or (b) values averaged over the hours of occupancy in any week are in excess of 25% of the respective foregoing values.

**2.3 Area**—A bounded space such as a room, floor, building, plant or any designated geographical entity having physical or imaginary boundaries.

**2.4 Average Dose Rate**—An integrated or accumulated dose of radiation divided by the time over which the integration or accumulation took place or by a specified length of time.

**2.5 Beam-Monitoring Device**—A device placed in the useful beam to indicate the relative output of a radiation-producing machine.

**2.6 Byproduct Material**—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.

**2.7 Calendar Quarter**—Not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be so arranged that no day in any year is omitted from inclusion within a calendar quarter. For purpose of this Code, no licensee or registrant shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.

**2.8 Commission**—The New Jersey Commission on Radiation Protection.

**2.9 Contamination**—Means radioactive contamination.

**2.10 Contamination Hazard**—A condition or situation which might result in an exposure of an individual to radioactive materials substantially in excess of the maximum permissible concentrations.

**2.11 Controlled Area**—Any area to which the access, occupancy and activity of those within are subject to control and supervision for the purpose of radiation protection.

**2.12 Curie**—That amount of a specific radionuclide which disintegrates at the rate of 37 billion atoms per second.

**2.13 Dead-man Switch**—A switch which can be kept closed only when the operator applies continuous pressure.

**2.14 Department**—The New Jersey State Department of Health.

**2.15 Diagnostic-type Protective Tube Housing**—X-ray tube housing so constructed that the leakage radiation at a distance of 1 meter from the target cannot exceed 100 mr in 1 hour when the tube is operated at any of its specified ratings.

**2.16 Dose**—The quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. The units used are rad and rem.

**2.17 Dose Rate**—Dose per unit time.

**2.18 Emergency Exposure**—An exposure to radiation of an emergency worker during rescue or other emergency operations.

**2.19 Emergency Worker**—A member of the owner's staff or of a public voluntary or governmental agency engaged in safety or other emergency operations.

**2.20 Hazard**—See Sections 2.10 and 2.39.

**2.21 High-Radiation Area**—An area which is accessible to individuals and in which there exists

radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

**2.22 Human Use**—The internal or external administration of radiation or radioactive materials to human beings.

**2.23 Installation**—A radiation source, with its associated equipment, and the area in which it is housed.

**2.24 Instructed Individual**—An individual who has received appropriate instructions as to the safe means and methods of performing work with or near radiation sources.

**2.25 Leakage Radiation**—All radiation coming from within the tube housing except the useful beam.

**2.26 License**—Except where otherwise specified, means a license issued by the United States Atomic Energy Commission or any other state for possession and use of radioactive materials. (See also 2.60 State License.)

**2.27 Maximum Permissible Dose**—The maximum dose to which the body or a particular part of the body of a person shall be permitted to be exposed continuously or intermittently in a stated period of time.

**2.28 Monitoring**—A periodic or continuous determination of radiation levels or of radioactive contamination.

**2.29 Occupational Dose**—Includes exposure of an individual to radiation (1) in a controlled area; or (2) in the course of employment in which the individual's duties involve exposure to radiation, provided that "occupational dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

**2.30 Owner**—A person who has title to a radiation source or who possesses a radiation source as a lessee, bailee or pursuant to the terms of a license issued by the Department, by a Federal agency, or by any other state.

**2.31 Person**—Means:— (1) an individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, municipality, any state, or other legal entity; (2) any legal successor, representative, agent, or agency of the foregoing.

**2.32 Personnel-Monitoring Equipment**—Means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.).

**2.33 Pharmacist**—An individual licensed by the State to practice pharmacy.

**2.34 Primary Protective Barrier**—Barrier intended to attenuate the useful beam to the required degree.

**2.35 Qualified Individual**—An individual suited by training and experience to perform dependable radiation surveys and to determine the degree of radiation hazard.

**2.36 Rad**—The dose corresponding to the absorption of 100 ergs per gram; a measure of the dose of any radiation to body tissues in terms of the energy absorbed per unit mass of the tissue.

**2.37 Radiation**—Means any or all of the following: alpha rays, beta rays, gamma rays, xrays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light.

**2.38 Radiation Area**—An area which is accessible to individuals and in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any workweek a dose in excess of 100 millirems.

**2.39 Radiation Hazard**—A condition or situation which might result in an exposure of individuals to radiation substantially in excess of the maximum permissible dose.

**2.40 Radiation Incident**—Any unexpected event, occurrence or circumstance involving substantial radiation exposure or radioactive contamination.

**2.41 Radiation-Producing Machine**—A machine or device capable of generating radiation, such as x-ray producing machines, particle accelerators, high-voltage rectifiers, high-voltage projection equipment, electron microscopes and other types of high-voltage machines.

**2.42 Radiation Source**—Same as Source of Radiation.

**2.43 Radioactive Material**—A natural or artificially produced substance (solid, liquid or gas) which emits radiation spontaneously.

**2.44 Radiographer**—Any individual who performs or who, in attendance at the site where the radiation sources are being used, personally supervises radiographic operations and who is responsible to the owner for assuring compliance with the requirements of this Code.

**2.45 Radiographer's Assistant**—Any individual who, under the personal supervision of a radiographer, uses sources of radiation including radiation-producing machines, radiographic-exposure devices, sealed sources or related handling tools, or survey instruments in radiography.

**2.46 Radiographic-Exposure Device**—Any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure.

**2.47 Radiography**—The examination of humans or animals, or of the structure of materials by non-destructive methods, utilizing sealed sources or

radiation-producing machines. This term is not intended to apply to techniques such as electron-microscopy or x-ray diffraction.

**2.48 Rem**—A measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one rad of xrays. For the purpose of the Code, any of the following are considered to be equivalent to a dose of one rem:

- (1) An exposure of 1 r due to x or gamma radiation;
- (2) A dose of 1 rad due to x, gamma, or beta radiation;
- (3) A dose of 0.1 rad due to neutrons or high-energy protons;
- (4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye.

If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in subparagraph (3) of this paragraph, one rem of neutron radiation may, for purposes of this Code, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

| Neutron energy<br>(Mev) | Number of neutrons<br>per square centimeter<br>equivalent to<br>a dose of 1 rem<br>(neutrons/cm <sup>2</sup> ) | Average flux to<br>deliver 100 milli-<br>rem in 40 hours<br>(neutrons/cm <sup>2</sup> per<br>sec.) |
|-------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| Thermal                 | 970x10 <sup>6</sup>                                                                                            | 670                                                                                                |
| 0.0001                  | 720x10 <sup>6</sup>                                                                                            | 500                                                                                                |
| 0.005                   | 820x10 <sup>6</sup>                                                                                            | 570                                                                                                |
| 0.02                    | 400x10 <sup>6</sup>                                                                                            | 280                                                                                                |
| 0.1                     | 120x10 <sup>6</sup>                                                                                            | 80                                                                                                 |
| 0.5                     | 43x10 <sup>6</sup>                                                                                             | 30                                                                                                 |
| 1.0                     | 26x10 <sup>6</sup>                                                                                             | 18                                                                                                 |
| 2.5                     | 29x10 <sup>6</sup>                                                                                             | 20                                                                                                 |
| 5.0                     | 26x10 <sup>6</sup>                                                                                             | 18                                                                                                 |
| 7.5                     | 24x10 <sup>6</sup>                                                                                             | 17                                                                                                 |
| 10                      | 24x10 <sup>6</sup>                                                                                             | 17                                                                                                 |
| 10 to 30                | 14x10 <sup>6</sup>                                                                                             | 10                                                                                                 |

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

**2.50 Roentgen**—The quantity of x or gamma radiation such that the associated corpuscular emission per .001293 grams of air produces, in air, ions carrying

one (1) electrostatic unit of quantity of electricity of either sign.

**2.51 Sealed Source**—A radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

**2.52 Secondary Protective Barrier**—Barrier intended to attenuate radiation other than the useful beam to the required degree.

**2.53 Shall**—Indicates a mandatory requirement.

**2.54 Shielding**—Any material introduced into the path of radiation to reduce the radiation level.

**2.55 Source Material**—(a) Uranium or thorium, or any combination thereof, in any physical or chemical form or (b) ores which contain by weight one-twentieth of one percent (0.05 percent) or more of (1) uranium, (2) thorium or (3) any combination thereof. Source material does not include special nuclear material.

**2.56 Source of Radiation**—A material, equipment or machine emitting or capable of emitting radiation.

**2.57 Special Nuclear Material**—Means plutonium, uranium 233, uranium enriched in the isotope 233, or in isotope 235, or any material artificially enriched by any of the foregoing but does not include source material.

**2.58 Special Nuclear Material in Quantities Not Sufficient to Form a Critical Mass**—Uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; uranium 233 in quantities not exceeding 200 grams; plutonium in quantities not exceeding 200 grams; or any combination of them in accordance with the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all the kinds of special nuclear material in combination shall not exceed "1" (i.e., unity). For example, the following quantities in combination would not exceed the limitation and is within the formula, as follows:

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

**2.59 State**—The State of New Jersey.

**2.60 State License**—Means a license for radioactive materials issued by the Department. (See also 2.26 License.)

**2.61 Storage Container**—A device in which radioactive materials or sources are transported or stored.

**2.62 Survey**—Evaluation for a specific set of conditions of actual or potential radiation or

contamination levels by or under the supervision of a qualified individual.

**2.63 Therapeutic-type Protective Tube Housing**—X-ray tube housing so constructed that when the tube is operated at any of its specified ratings the leakage radiation at a distance of 1 meter from the target cannot exceed 1 r in 1 hour and, at a distance of 5 cm from any point on the surface of the housing, cannot exceed 30 r in 1 hour.

**2.64 Total Filtration**—The filtration produced by all materials inserted in the useful beam including (1) the materials comprising the tube and its housing, (2) any measuring devices in the beam which act as a filter, and (3) any material purposely placed in the beam as filters.

**2.65 Unnecessary Radiation**—The use of gamma rays, x-rays, alpha and beta particles, high-speed electrons, neutrons, protons, and other atomic or nuclear particles in such a manner as to be injurious or dangerous to the health of the people or the industrial or agricultural potentials of the State. (As defined in the Radiation Protection Act, Chapter 116, P.L. 1958).

**2.66 Unrefined and Unprocessed Ore**—Ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

**2.67 Useful Beam**—That part of the radiation beam which passes through the window, aperture, cone, or other collimating device of the tube housing.

**2.68 User**—Any individual who personally utilizes or manipulates a source of radiation.

### **SECTION 3—USE OF SOURCES OF RADIATION AND SPECIAL EXEMPTIONS**

#### **3.1 Supervision**

All radiation installations except those generally licensed (Section 5.17) shall be under the supervision of an individual who by training and experience is competent to assume the responsibilities for compliance with this Code. The owner shall designate this individual on the registration or license application forms provided by the Department.

#### **3.2 Instruction**

**3.2.1** All persons working in or frequenting the vicinity of radiation-producing machines or radioactive materials shall be properly and adequately instructed in the use of necessary safeguards and procedures and be supplied with such safety devices as may be required. All visitors to controlled areas shall be adequately instructed or escorted to prevent unnecessary exposure.

**3.2.2** Each owner shall make readily available for inspection by employees a copy of this Code, a copy of the license or registration and a copy of the applicable operating procedures.

**3.2.3** Each owner of an installation where employee(s) are working in or frequenting any portion of a controlled area shall conspicuously post RH-D14, a

Notice to Employees, in a sufficient number of places to permit observation of a copy by employees on their way to or from their place of employment.

#### **3.3 Authorized Use of Radiation Sources**

The owner shall take all reasonable measures to prevent radiation-producing machines and radioactive materials from being used or possessed by individuals other than those specifically authorized by the owner; if operation is under a license, such authorization must be in conformity with the conditions of that license.

#### **3.4 Unattended Radiation Sources**

When radiation-producing machines or radioactive materials are left unattended, all reasonable measures shall be taken to prevent their use or possession by any unauthorized individual.

#### **3.5 Faulty Radiation Installations**

Whenever any shielding is found to be defective or insufficient, or any protective device is found to be insufficient or operating improperly, the owner shall insure that the operation of the installation is either (a) discontinued and is not resumed until such shielding or device shall have been properly changed, augmented or repaired, or (b) is operated with sufficient additional precautions during the period of repair.

#### **3.6 Intentional Human Irradiation**

Only persons licensed or otherwise permitted by law shall arrange for irradiation of or apply radiation to a human being or integral part thereof.

#### **3.7 Exemptions for Prevention or Control of Diseases**

Regulations contained in Sections 7, 8 or 16.2 shall not apply insofar as they relate to the intentional exposure of patients to radiation for the purpose of diagnosis, treatment or investigation for the prevention or control of disease.

#### **3.8 Special Exemptions**

The Department, upon request by an owner or on its own initiative with the approval of the Commission, may grant a specific exemption from any requirement of this Code should it determine that such exemption is not likely to result in unnecessary radiation.

### **SECTION 4—REGISTRATION**

#### **4.1 Responsibility for Registering**

Except as exempted by Section 4.3 or otherwise specifically exempted by the New Jersey State Department of Health, the owner of every radiation-producing machine and of all radioactive materials shall register same or cause same to be registered with the **New Jersey State Department of Health, Box 1540, Trenton, New Jersey, 08625** on forms available from the Department.

#### **4.2 Date Registration is Due**

Every radiation-producing machine and each radioactive source must be registered within 15 days of the date it is acquired. The registration shall be effective until further notice.

#### 4.6 Table of Exempt Quantities

| Radioactive Material                           | Column A<br>Not as a<br>sealed<br>source<br>(micro-<br>curies) | Column B<br>As a<br>sealed<br>source<br>(micro-<br>curies) |
|------------------------------------------------|----------------------------------------------------------------|------------------------------------------------------------|
| Antimony (Sb 124)                              | 1                                                              | 10                                                         |
| Arsenic 76 (As 76)                             | 10                                                             | 10                                                         |
| Arsenic 77 (As 77)                             | 10                                                             | 10                                                         |
| Barium 140+Lanthanum 140<br>(Ba 140+La 140)    | 1                                                              | 10                                                         |
| Beryllium (Be 7)                               | 50                                                             | 50                                                         |
| Cadmium 109+Silver 109<br>(Cd 109+Ag 109)      | 10                                                             | 10                                                         |
| Calcium 45 (Ca 45)                             | 10                                                             | 10                                                         |
| Carbon 14 (C 14)                               | 50                                                             | 50                                                         |
| Cerium 144+Praseodymium 144<br>(Ce 144+Pr 144) | 1                                                              | 10                                                         |
| Cesium 137+Barium 137<br>(Ce 137+Ba 137)       | 1                                                              | 10                                                         |
| Chlorine 36 (Cl 36)                            | 1                                                              | 10                                                         |
| Chromium 51 (Cr 51)                            | 50                                                             | 50                                                         |
| Cobalt 60 (Co 60)                              | 1                                                              | 10                                                         |
| Copper 64 (Cu 64)                              | 50                                                             | 50                                                         |
| Europium 154 (Eu 154)                          | 1                                                              | 10                                                         |
| Fluorine 18 (F 18)                             | 50                                                             | 50                                                         |
| Gallium 72 (Ga 72)                             | 10                                                             | 10                                                         |
| Germanium 71 (Ge 71)                           | 50                                                             | 50                                                         |
| Gold 198 (Au 198)                              | 10                                                             | 10                                                         |
| Gold 199 (Au 199)                              | 10                                                             | 10                                                         |
| Hydrogen 3 (Tritium) H 3)                      | 250                                                            | 250                                                        |
| Indium 114 (In 114)                            | 1                                                              | 10                                                         |
| Iodine 131 (I 131)                             | 10                                                             | 10                                                         |
| Iridium 192 (Ir 192)                           | 10                                                             | 10                                                         |
| Iron 55 (Fe 55)                                | 50                                                             | 50                                                         |
| Iron 59 (Fe 59)                                | 1                                                              | 10                                                         |
| Lanthanum 140 (La 140)                         | 10                                                             | 10                                                         |
| Manganese 52 (Mn 52)                           | 1                                                              | 10                                                         |
| Manganese 56 (Mn 56)                           | 50                                                             | 50                                                         |
| Molybdenum 99 (Mo 99)                          | 10                                                             | 10                                                         |
| Nickel 59 (Ni 59)                              | 1                                                              | 10                                                         |
| Nickel 63 (Ni 63)                              | 1                                                              | 10                                                         |
| Niobium 95 (Nb 95)                             | 10                                                             | 10                                                         |
| Palladium 109 (Pd 109)                         | 10                                                             | 10                                                         |
| Palladium 103+Rhodium 103<br>(Pd 103+Rh 103)   | 50                                                             | 50                                                         |
| Phosphorus 32 (P 32)                           | 10                                                             | 10                                                         |
| Polonium 210 (Po 210)                          | 0.1                                                            | 1                                                          |
| Potassium 42 (K 42)                            | 10                                                             | 10                                                         |
| Praseodymium 143 (Pr 143)                      | 10                                                             | 10                                                         |
| Promethium 147 (Pm 147)                        | 10                                                             | 10                                                         |
| Radium + daughters                             | 0.1                                                            | 1                                                          |
| Rhenium 186 (Re 186)                           | 10                                                             | 10                                                         |
| Rhodium 105 (Rh 105)                           | 10                                                             | 10                                                         |
| Rubidium 86 (Rb 86)                            | 10                                                             | 10                                                         |
| Ruthenium 106+Rhodium 106<br>(Ru 106+Rh 106)   | 1                                                              | 10                                                         |
| Samarium 153 (Sm 153)                          | 10                                                             | 10                                                         |
| Scandium 46 (Sc 46)                            | 1                                                              | 10                                                         |
| Silver 105 (Ag 105)                            | 1                                                              | 10                                                         |
| Silver 111 (Ag 111)                            | 10                                                             | 10                                                         |
| Sodium 22 (Na 22)                              | 10                                                             | 10                                                         |
| Sodium 24 (Na 24)                              | 10                                                             | 10                                                         |

| Radioactive Material                                                   | Column A<br>Not as a<br>sealed<br>source<br>(micro-<br>curies) | Column B<br>As a<br>sealed<br>source<br>(micro-<br>curies) |
|------------------------------------------------------------------------|----------------------------------------------------------------|------------------------------------------------------------|
| Strontium 89 (Sr 89)                                                   | 1                                                              | 10                                                         |
| Strontium 90+Yttrium 90<br>(Sr 90+Y 90)                                | 0.1                                                            | 1                                                          |
| Sulfur 35 (S 35)                                                       | 50                                                             | 50                                                         |
| Tantalum 182 (Ta 182)                                                  | 10                                                             | 10                                                         |
| Technetium 96 (Tc 96)                                                  | 1                                                              | 10                                                         |
| Technetium 99 (Tc 99)                                                  | 1                                                              | 10                                                         |
| Tellurium 127 (Te 127)                                                 | 10                                                             | 10                                                         |
| Tellurium 129 (Te 129)                                                 | 1                                                              | 10                                                         |
| Thallium 204 (Tl 204)                                                  | 50                                                             | 50                                                         |
| Tin 113 (Sn 113)                                                       | 10                                                             | 10                                                         |
| Tungsten 185 (W 185)                                                   | 10                                                             | 10                                                         |
| Vanadium 48 (V 48)                                                     | 1                                                              | 10                                                         |
| Yttrium 90 (Y 90)                                                      | 1                                                              | 10                                                         |
| Yttrium 91 (Y 91)                                                      | 1                                                              | 10                                                         |
| Zinc 65 (Zn 65)                                                        | 10                                                             | 10                                                         |
| Beta and/or Gamma emitting<br>radioactive material not listed<br>above | 1                                                              | 10                                                         |

#### 4.3 Exemptions from Registration

4.3.1 The following machines are exempt from registration and from the requirements of Sections 8, 9 and 11:

a. Radiation machines not being used in such a manner as to produce radiation, such as equipment in storage or on display. This does not apply to machines which are operated while on display.

b. Electrical equipment that is not primarily intended to produce radiation and that does not produce radiation greater than 0.5 millirem per hour at any readily accessible point 5 cm from the surface. Production-testing facilities for such equipment shall not be exempt if any individual might receive a radiation dose exceeding the limits established in Section 7.2.

4.3.2 Those radioactive materials covered in specific and general state licenses issued by the Department in accordance with Section 5 are exempt from registration requirements.

4.3.3 Quantities of radioactive material equal to or less than those listed in Section 4.6 are exempt from registration requirements provided that no individual user of radioactive material shall have more than 10 such quantities at any one time.

#### 4.4 Amendments to Registration

Any change in the information contained in a registration shall require an amendment to the registration by the owner within 15 days after such change.

#### **4.5 Sale, Transfer of Title, or Disposal of Radiation-Producing Machines**

##### **4.5.1 Sale or Transfer of Title of New Radiation-Producing Machines**

Whenever a manufacturer, his agent or a dealer sells or transfers title to a radiation-producing machine, said manufacturer, his agent or the dealer shall give written notification thereof to the Department. Written notification shall be given within 15 days of such sale or transfer of title and shall include the name and address of the new owner or owners.

##### **4.5.2 Sale, Transfer of Title, or Disposal of Used Radiation-Producing Machines**

Whenever an owner sells, transfers title to or disposes of a radiation-producing machine, said owner shall give written notification thereof to the Department. This written notification shall be given within 15 days of such sale, transfer of title or disposal and shall include the name and address of the owner(s) or details of the final disposal of the machine.

### **SECTION 5 — LICENSING**

#### **5.0 Application**

New Jersey licenses issued in accordance with this Section 5 are for the possession and use of radioactive substances obtained from naturally occurring materials or produced by an accelerator.

#### **5.1 License Requirements**

No person shall produce, transfer, receive, acquire, own, possess or use any radioactive substance obtained from naturally occurring materials or produced by an accelerator unless authorized by a specific State license issued by the Department, a general State license as provided in Section 5.5 hereof, or an exemption as provided in Section 5.3 hereof. Excepted from the above are source materials and special nuclear materials.

#### **5.2 Recognition of Licenses Under Other Jurisdictions**

**5.2.1** Subject to these regulations, any person who possesses a specific license or equivalent licensing document issued by a Federal agency or any other state may, pursuant to such document, transport, receive, possess, and/or use the radioactive materials specified in such licensing document within this State for a period not in excess of 20 days in any period of 12 consecutive months without obtaining a specific license from the Department provided that:

(a) The licensing document does not limit the activity authorized by such document to specified installations or locations; and

(b) The user notifies the Department in writing at least 2 days prior to the time that such radioactive material is brought into this State. Such notification

shall indicate the location, period, and type of proposed possession and use within this State, and shall be accompanied by a copy of the pertinent licensing document. If in a specific case the 2-day period would impose an undue hardship on the user, he may, upon application to the Department, obtain permission to proceed sooner; and

(c) The user complies with all applicable regulations of the Department and with all the terms and conditions of his licensing document, except any such terms and conditions which may be inconsistent with applicable regulations of the Department; and

(d) Provided further that the Department may require the user to supply such other information as the Department may reasonably request.

**5.2.2** The Department may withdraw, limit, or qualify its acceptance of such licenses issued by another agency, or any product distributed pursuant to such licensing documents, upon determining that such action is necessary in order to prevent undue hazard to public health and safety or property.

#### **5.3 Exemptions**

##### **5.3.1 Federal Operations**

Plants or laboratories owned by or operated on behalf of a Federal agency, are exempt from the provisions of this Chapter.

##### **5.3.2 Carriers**

Common and contract carriers are exempt from the licensing requirements of this Code while transporting or storing radioactive materials covered by Section 5.1 in the regular course of carriage for another, or storage incident thereto.

##### **5.3.3 Exempt Concentrations and Quantities of Radioactive Material**

**5.3.3.1** Any person is exempt from the licensing requirements of this Code to the extent that such person receives, possesses, uses, transfers, owns or acquires products or materials containing radioactive substances specified in Section 5.1 in concentrations not in excess of those listed in Section 5.19.

##### **5.3.3.2 Certain luminous timepieces**

(a) Any person is exempt from the requirements for a State license set forth in the Radiation Protection Act and from the regulations of this Code to the extent that such person receives, possesses, uses, transfers, owns or acquires luminous timepieces or hands or dials containing radium.

(b) Any person who desires to apply radium to luminous timepieces or hands or dials shall apply for a specific State license.

##### **5.3.4 Other Exemptions**

Naturally occurring radioactive materials of an equivalent specific radioactivity not exceeding that of natural potassium ( $10^{-9}$  curies per gram of potassium) are exempt from this Code.

### 5.3.5 Special Exemptions

The Department, upon request by an owner or on its own initiative with the approval of the Commission, may grant a specific exemption from any requirement of Section 5 should it determine that such exemption is not likely to result in unnecessary radiation.

### 5.4 Types of Licenses

State licenses for radioactive materials are of two types: general and specific. The general State licenses described in Section 5.5 are effective without the filing of an application with the Department or the issuance of licensing documents to particular persons. Specific State licenses are issued to named persons upon application filed pursuant to the requirements of Section 5.

### 5.5 General Licenses

#### 5.5.1 General Licensing of Radioactive Material

**5.5.1.1** Authorization is hereby given under general State license for radioactive materials to use, transfer, receive, acquire, own and possess radioactive materials specified in Section 5.1, as follows:

**5.5.1.1.1** Radioactive material incorporated in a device or equipment which is listed in Section 5.17 and has been manufactured pursuant to a specific State license issued by the Department, or a specific license of a Federal agency or other state.

**5.5.1.1.2** The quantities of radioactive materials listed in Section 5.18, provided that no person shall at any one time possess or use, pursuant to the general licensing provisions of this paragraph, more than a total of ten such listed quantities.

**5.5.1.2** The general State licenses provided in Section 5.5.1.1 are subject to the provisions of the Radiation Protection Act, and to Chapter I of this Code. In addition, persons who transfer, receive, acquire, own, possess or use items and quantities of radioactive materials listed in Sections 5.17 and 5.18 pursuant to the general State licenses provided in Section 5.5.1.1:

(a) Shall not effect an increase in the radioactivity of said scheduled items or quantities by adding other radioactive material thereto, by combining radioactive material from two or more such items or quantities, or by altering them in any other manner so as to increase thereby the rate of radiation therefrom:

(b) Shall not administer externally or internally, or direct the administration of, said scheduled items or quantities or any part thereof to a human being for any purpose, including, but not limited to, diagnostic, therapeutic, and research purposes;

(c) Shall not add, or direct the addition of, said scheduled items or quantities or any part thereof to any food, beverage, cosmetic, drug, or other product designed for ingestion or inhalation by, or application to, a human being;

(d) Shall not include said scheduled items or

quantities or any part thereof in any device, instrument, apparatus (including component parts and accessories thereto) intended for use in diagnosis, treatment or prevention of disease in human beings or animals or otherwise intended to affect the structure or any function of the body of human beings or animals.

**5.5.1.3** Authorization is hereby given under general State license to own, receive, acquire, possess and use radioactive material when contained in devices designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition or for producing light or an ionized atmosphere, when such devices are manufactured in accordance with the specifications contained in a specific license authorizing distribution under a general license issued to the supplier by the Department, a Federal agency, or any other state; provided that:

(a) Such devices are labeled in accordance with the provisions of the specific license which authorizes the distribution of the devices; and

(b) Such devices bear a label containing the following or substantially similar statement:

"This device has been manufactured for distribution as a generally licensed device pursuant to

---

(identify appropriate section of the regulations)

---

(name of licensing agency and state)

License No. \_\_\_\_\_ by \_\_\_\_\_  
(name of supplier)

Removal of this label is prohibited."

(c) Such devices shall be installed on the premises of the general licensee by a person authorized to install such devices under a specific license issued to the installer by the Department, a Federal agency, or any other state.

**5.5.1.4** Persons who receive, acquire, possess or use a device pursuant to a general license specified in Section 5.5.1.3:

(a) Shall not transfer, abandon or dispose of the device except by transfer to a person duly authorized to receive such device by a specific license issued by the Department, a Federal agency, or any other state;

(b) Shall assure that all labels affixed to the device at the time of receipt and bearing the statement, "Removal of this label is prohibited," are maintained thereon and shall comply with the instructions contained in such labels;

(c) Shall have the device tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than 6-month intervals; provided that, devices containing only

tritium need not be tested for any purpose and that devices containing only krypton need not be tested for leakage;

(d) Shall have the tests required by paragraph (c) of this subsection and all other services involving the radioactive material, its shielding and containment, performed by the supplier or other person duly authorized by a specific license issued by the Department, a Federal agency, or any other state to manufacture, install or service such devices;

(e) Shall maintain records of all tests performed on the devices as required under this section, including the dates and results of the tests and the names and addresses of the persons conducting the tests;

(f) Upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the shielding or containment of the radioactive material or the on-off mechanism or indicator, shall immediately suspend operation of the device until it has been either (1) repaired by a person (supplier, manufacturer, or other) holding a specific license issued by the Department, a Federal agency, or any other state to manufacture, install or service such devices, or (2) disposed of by transfer to a person holding a specific license issued by the Department, a Federal agency, or any other state to receive the radioactive material contained in the device; and

(g) Shall be exempt from the requirements of this Code, except the provisions of Sections 5.9, 5.14, 5.15, 5.16, 5.17, 9.2, 9.4 and Section 16 of this Code.

## **5.6 Application for Specific State Licenses and Renewals**

### **5.6.1 Application Forms**

5.6.1.1 Application for specific State Licenses and renewals shall be filed with the **New Jersey State Department of Health, Box 1540, Trenton, New Jersey, 08625, Attention: Radiological Health Program**, on Form RH-25, "Application for Radioactive Material License." Applications may also be filed in person at the Department's offices in Trenton, New Jersey.

5.6.1.2 An application for a license may include a request for a State license authorizing one or more activities.

5.6.1.3 In his application, the applicant may incorporate by reference information contained in previous applications, statements, or reports filed with the Department.

5.6.1.4 Except as provided in Section 5.6.1.5, applications and documents submitted to the Department will be made available for public inspection.

5.6.1.5 A person who proposes that a document or a part be withheld in whole or in part from public disclosure shall at the time of filing submit an application for withholding or make timely application thereafter identifying the document or part, and stating reasons why it should be withheld. He shall, as far as

possible, incorporate in a separate paper any part sought to be withheld. The Department may withhold any document or part thereof from public inspection if disclosure of its contents is not required in the public interest and would adversely affect the interest of a person concerned.

### **5.6.2 Additional Information**

The Department may at any time after the filing of the original or renewal application, and before the expiration of the license, require further statements in order to enable the Department to determine whether the application should be granted or denied or whether a license should be modified or revoked. All applications and statements shall be signed by the applicant or licensee or a person duly authorized to act for and on his behalf.

## **5.7 General Requirements for Approval of Specific State License Applications**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license will be issued, provided:

5.7.1 The applicant is qualified by reason of training and experience to use the radioactive material for the purpose requested in such manner as to protect health, minimize danger to life or property and prevent unnecessary radiation; and

5.7.2 The applicant's proposed equipment, facilities and procedures are adequate to protect health, minimize danger to life or property and prevent unnecessary radiation; and

5.7.3 The applicant satisfies special requirements as may be applicable in Section 5.8 hereof.

## **5.8 Special Requirements for Approval of Specific State License Applications**

### **5.8.1 Human Use by Institutions**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license for human use by an institution of radioactive materials specified in Section 5.1 will be issued, provided:

5.8.1.1 The applicant satisfies the general requirements specified in Section 5.7; and

5.8.1.2 The applicant has appointed a medical isotopes committee of at least three members to evaluate all proposals for research, diagnosis, and therapeutic use of radioactive material within that institution. Membership of the committee should include physicians expert in internal medicine, hematology, therapeutic radiology, and a person experienced in assay of radioactive material and protection against ionizing radiation; and

5.8.1.3 The applicant possesses adequate facilities for the clinical care of patients; and

5.8.1.4 The physician(s) designated on the application as the individual user(s) has substantial pertinent experience in the use, the handling and administration of radioactive material and, where applicable, the clinical management of radioactive patients; and

5.8.1.5 If the application is for a State license to use unspecified quantities or multiple types of radioactive materials, the applicant's staff has had substantial pertinent experience in using a variety of radioactive materials for various human uses.

#### **5.8.2 Human Use by a Physician or Dentist**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license for human use by a physician or dentist of radioactive materials specified in Section 5.1 will be issued, provided:

5.8.2.1 The applicant satisfies the general requirements specified in Section 5.7; and

5.8.2.2 The applicant has access to a hospital possessing adequate facilities to hospitalize and monitor the applicant's radioactive patients whenever it is advisable; and

5.8.2.3 The applicant has had extensive training and supervised experience in the proposed use, the handling and administration of radioisotopes, and where applicable, the clinical management of radioactive patients. The applicant shall furnish suitable evidence of such experience with his application. A statement from the institution where he acquired his training and experience, indicating its amount and nature, may be submitted as evidence of such experience.

#### **5.8.3 "Human Use" of Sealed Sources**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license for human use of a sealed source of radioactive materials specified in Section 5.1 will be issued, provided:

5.8.3.1 The applicant satisfies the general requirements specified in Section 5.7; and

5.8.3.2 The applicant, or if the application is made by an institution, the individual user has specialized training in the therapeutic use of the radioactive device considered or has experience equivalent to such training, and

5.8.3.3 The individual user is a physician or dentist.

#### **5.8.4 Multiple Quantities or Types of Radioactive Material for Use in Research and Development**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license for multiple quantities or types of radioactive material specified in Section 5.1 for use in research and development will be issued, provided:

5.8.4.1 The applicant satisfies the general requirements specified in Section 5.7; and

5.8.4.2 The applicant's staff has had substantial training and experience with a variety of radioisotopes for various research and development uses; and

5.8.4.3 The applicant has established an isotope committee (composed of such persons as a radiological safety officer, a representative of the business office, and one or more persons trained or experienced in the safe use of radioactive materials) which will review and approve or disapprove proposals for use of radioactive materials in advance of purchase of such materials; and

5.8.4.4 The applicant has appointed a radiological safety officer who shall be responsible for rendering advice and assistance on radiological safety.

#### **5.8.5 Multiple Quantities or Types of Radioactive Material for Use in Processing**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license for multiple quantities or types of radioactive material specified in Section 5.1 for use in processing for distribution to other authorized persons will be issued, provided:

5.8.5.1 The applicant satisfies the general requirements specified in Section 5.7; and

5.8.5.2 The applicant's staff has had training and experience in the processing and distribution of a variety of radioisotopes; and

5.8.5.3 The applicant has appointed a radiological safety officer who shall be responsible for rendering advice and assistance on radiological safety.

#### **5.8.6 Distribution of Devices to Persons Generally Licensed Under Sections 5.5.1.3, 5.5.1.4**

Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license to distribute certain devices to persons generally licensed under Sections 5.5.1.3 and 5.5.1.4 will be issued, provided:

5.8.6.1 The applicant satisfies the general requirements specified in Section 5.7; and

5.8.6.2 The applicant submits sufficient information relating to the design, manufacturer, prototype testing, quality control procedures, labeling, proposed uses and potential hazards of the device to provide reasonable assurance that:

(a) The radioactive material contained in the device will not be lost;

(b) That no person will receive a radiation dose to a major portion of his body in excess of 0.5 rem in any one year under ordinary circumstances of use;

(c) The device can be safely operated by persons not having training in radiological protection; and

(d) The radioactive material within the device would not be accessible to unauthorized persons.

**5.8.6.3** In describing the label or labels and contents thereon to be affixed to the device, the applicant shall separately indicate those instructions and precautions which are necessary to assure safe operation of the device. Such instructions and precautions shall be contained on labels bearing the statement, "Removal of this label is prohibited."

#### **5.8.7 Sealed Sources for Use in Industrial and Non-Medical Radiography**

Upon determination by the Department that an applicant meets the requirements of this Code and the New Jersey Radiation Protection Act, a specific State license for use in industrial and non-medical radiography of a sealed source or sources of radioactive materials specified in Section 5.1 will be issued, provided:

**5.8.7.1** The applicant satisfies the general requirements specified in Section 5.7; and

**5.8.7.2** The applicant will have an adequate program for training radiographers and radiographers' assistants and submits to the Department a schedule or description of such program which specifies the:

- (a) Initial training;
- (b) Periodic training;
- (c) On-the-job training;

(d) Means to be used by the licensee to determine the radiographer's knowledge and understanding of and ability to comply with the requirements of this Code, the specific licensing requirements, and the operating and emergency instructions of the applicant; and

(e) Means to be used by the licensee to determine the radiographer's assistant's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant.

**5.8.7.3** The applicant has established and submitted to the Department satisfactory written operating and emergency instructions as prescribed by Section 22 of this Code and/or other regulation of the Commission; and

**5.8.7.4** The applicant will have an adequate internal inspection system, or other management control, providing assurance that the requirements of this Code, the specific State license provisions, and the applicant's operating and emergency instructions are followed by radiographers and radiographers' assistants; and

**5.8.7.5** The applicant submits a description of its over-all organizational structure pertaining to the radiography program, including specified delegations of authority and responsibility for operation of the program; and

**5.8.7.6** The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources for possible leakage and contamination and submits to the

Department a description of such procedures, including:

- (a) Instrumentation to be used;
- (b) Method of performing test; e.g., points on equipment to be smeared and method of taking smear; and
- (c) Pertinent experience of the person who will perform the test.

#### **5.8.8 Transfer of Products Containing Exempt Concentrations of Radioactive Material**

**5.8.8.1** Upon determination by the Department that an applicant meets the requirements of this Code and the Radiation Protection Act, a specific State license to transfer possession or control of products or materials containing exempt concentrations of radioactive material specified in Section 5.1 which the transferor has introduced into the product or material will be issued, provided:

(a) The applicant satisfies the general requirements specified in Section 5.7;

(b) The applicant submits a description of the product or material into which the radioactive material will be introduced, intended use of the radioactive material and the product into which it is introduced, method of introduction, initial concentration of the radioactive material in the product or material, control methods to assure that no more than the specified concentration is introduced into the product or material, estimated time interval between introduction and transfer of the product or material, and estimated concentration of the radioisotope in the product or material at the time of proposed transfer by the applicant; and

(c) The applicant provides reasonable assurance that the concentrations of the radioactive material at the time of transfer will not exceed the concentrations in Section 5.19, that reconcentration of the radioactive material in concentrations exceeding those in Section 5.19 is not likely, that the product or material is not likely to be inhaled or ingested, and that the use of lower concentrations is not feasible.

**5.8.8.2** Each licensee licensed under the provisions of Section 5.8.8.1 shall file an annual report with the Department describing the kinds and quantities of products transferred, the concentration of radioactive material contained and the quantity of radioactive material transferred during the reporting period. Each report shall cover the 12-month period ending June 30 and shall be filed within 30 days thereafter.

#### **5.9 Terms and Conditions of State Licenses**

##### **5.9.1 Applicability of Radiation Protection Act and Department Regulations**

Each State license issued pursuant to Section 5 of this Code shall be subject to all the provisions of the Radiation Protection Act (Chapter 116, P. L. 1958), now

or hereafter in effect, and to all rules, regulations of the Commission and orders of the Department.

#### **5.9.2 Transfer of State Licenses and Privileges**

State licenses and privileges thereunder shall not be assigned or otherwise transferred except as specifically authorized by the Department in writing.

#### **5.9.3 Responsibilities**

Each person licensed by the Department pursuant to Section 5 of this Code shall confine his possession and use of radioactive material to the locations and purposes authorized by such license, and shall not use or permit the use of radioactive materials contrary to the applicable requirements of these regulations. Persons licensed under the provisions of Section 5 of this Code may transfer radioactive material within the State only to other persons authorized to receive such material or as otherwise authorized by the Department in writing.

#### **5.9.4 Specific Requirements**

The Department may incorporate in any State license at the time of issuance, or thereafter, all such additional requirements and conditions with respect to the licensee's receipt, possession, use or transfer of radioactive material as it deems appropriate or necessary in order to assure compliance with this Code.

#### **5.9.5 Reports by Suppliers of Generally Licensed Devices**

Each licensee authorized under Section 5.8.6 to distribute certain devices to generally licensed persons:

**5.9.5.1** Shall report to the **New Jersey State Department of Health, Box 1540, Trenton, New Jersey 08625 Attention: Radiological Health Program**, all transfers of such devices to persons in New Jersey generally licensed under Sections 5.5.1.3 and 5.5.1.4. Such report shall identify each general licensee by name and address, the type and number of device transferred, and the quantity and kind of radioactive material contained in the device. The report shall be submitted within 30 days after the end of each calendar quarter in which such a device is transferred to generally licensed persons; and

**5.9.5.2** Shall furnish to each general licensee to whom he transfers such device a copy of Sections 5.5.1.3 and 5.5.1.4.

#### **5.10 Expiration of State License**

Except as provided in Section 5.11, each specific State license shall expire at midnight of the day, in the month and year stated therein.

#### **5.11 Status of State Licenses Pending Renewal**

In any case in which a licensee, not less than 30 days prior to expiration of his existing State license, has filed an application in proper form for renewal, such existing license shall not expire until the Department has acted upon the application.

#### **5.12 Amendment of State Licenses at Request of Licensee**

Applications for amendment of a State license shall

be filed in accordance with Section 5.6 and shall specify the amendment desired and the grounds for such amendment.

#### **5.13 Records**

All licensees under the provisions of Section 5 of this Code shall keep records in accordance with Section 9.

#### **5.14 Inspections**

##### **5.14.1 Inspection of Material, Premises and Facilities**

All licensees shall afford to the Department an opportunity to inspect radioactive material and the facilities and premises wherein radioactive material is used or stored.

##### **5.14.2 Inspection of Records**

Upon request of the Department, licensees shall make available for inspection by the Department records kept pursuant to the regulations in this Code.

#### **5.15 Tests**

Each licensee shall perform at the request of the Department, or permit the Department to perform if it so desires, such tests as the Department deems appropriate or necessary for the administration of this Code, including tests of:

- (a) Radioactive material;
- (b) Facilities wherein radioactive material is utilized or stored;
- (c) Radiation detection and monitoring instruments; and
- (d) Other equipment and devices used in connection with the utilization or storage of radioactive material.

#### **5.16 Modification, Revocation and Termination of State Licenses**

##### **5.16.1 Modification and Revocation of State Licenses**

**5.16.1.1** The terms and conditions of each State license shall be subject to amendment, revision or modification, or the license may be suspended or revoked by reason of amendments to the Radiation Protection Act, or by reason of rules, regulations, codes and orders issued pursuant to authority of said Act.

**5.16.1.2** Any State license may be revoked, suspended or modified, in whole or in part, for any material false statement in the application, or because of conditions revealed by such application or statement of fact or any report, records or inspection or other means which would warrant the Department to refuse to grant a State license on an original application, or for violation of, or failure to observe any of the terms and provisions of the Act or the license, or of any rule or regulation of the Commission or order of the Department.

**5.16.1.3** Except in cases of emergency as defined by New Jersey Statutes Annotated 26:2D-12, no State license shall be modified, suspended or revoked prior to

a hearing conducted by the Department on the basis of a complaint filed by it indicating facts or conduct warranting suspension, modification or revocation of a license. This complaint and a notice of hearing shall be served at least two weeks prior to the date scheduled for the hearing.

#### 5.16.2 Termination at Licensee's Request

The Department may terminate a specific State license upon request submitted by the licensee to the Department in writing.

#### 5.17 Generally Licensed Devices

The following devices and equipment incorporating radioactive material, when manufactured, tested and labeled by the manufacturer in accordance with the specifications contained in a specific State license issued by the Department, or a specific license of a Federal agency or any other state, are placed under a general State license pursuant to Section 5.5.1.1.1:

(a) **Static Elimination Device.** Devices designed for use as static eliminators which contain, as a sealed source or sources, radioactive material consisting of a total of not more than 500 microcuries of Polonium 210 per device.

(b) **Spark Gap and Electronic Tubes.** Spark gap tubes and electronic tubes which contain radioactive material consisting of not more than 1 microcurie of Radium per tube.

(c) **Ion Generating Tube.** Devices designed for ionizing of air which contain, as a sealed source or sources, radioactive material consisting of a total of not more than 500 microcuries of Polonium 210 or 50 microcuries of Radium per device.

(d) **Other Devices.** Such other devices as the Commission may authorize.

#### 5.18 Generally Licensed Quantities

The following quantities of radioactive substances when obtained from naturally occurring materials or when produced by an accelerator are generally licensed pursuant to Section 5.5.1.1.2.

| Radioactive Material                                             | Column A<br>Not as a Sealed Source<br>(microcuries) | Column B<br>As a Sealed Source<br>(microcuries) |
|------------------------------------------------------------------|-----------------------------------------------------|-------------------------------------------------|
| Beryllium (Be 7)                                                 | 50                                                  | 50                                              |
| Bismuth 207 (Bi 207)                                             | 1                                                   | 10                                              |
| Cadmium 109 + Silver 109 (Cd 109 + Ag 109)                       | 10                                                  | 10                                              |
| Cerium 141 (Ce 141)                                              | 1                                                   | 10                                              |
| Chromium 51 (Cr 51)                                              | 50                                                  | 50                                              |
| Cobalt 57 (Co 57)                                                | 20                                                  | 20                                              |
| Germanium 68 (Ge 68)                                             | 1                                                   | 10                                              |
| Iron 55 (Fe 55)                                                  | 50                                                  | 50                                              |
| Manganese 52 (Mn 52)                                             | 1                                                   | 10                                              |
| Polonium 210 (Po 210)                                            | 0.1                                                 | 1                                               |
| Radium and daughters                                             | 0.1                                                 | 1                                               |
| Sodium 22 (Na 22)                                                | 10                                                  | 10                                              |
| Vanadium 48 (V 48)                                               | 1                                                   | 10                                              |
| Zinc 65 (Zn 65)                                                  | 10                                                  | 10                                              |
| Beta and/or gamma emitting radioactive material not listed above | 1                                                   | 10                                              |

There are no generally licensed quantities for **alpha emitting** materials other than those listed above.

#### 5.19 Exempt Concentrations

(See Sections 5.3.3.1 and 5.8.8.1)

The following concentrations of radioactive substances when obtained from naturally occurring materials or when produced by an accelerator are exempt concentrations:

| Element<br>(Atomic Number)                                                                        | Isotope | Column I<br>Gas<br>Concentrations<br>uc/cc* | Column II<br>Liquid & Solid<br>Concentrations<br>uc/cc** |
|---------------------------------------------------------------------------------------------------|---------|---------------------------------------------|----------------------------------------------------------|
| Beryllium (4)                                                                                     | Be 7    | —                                           | $2 \times 10^{-2}$                                       |
| Cadmium (48)                                                                                      | Cd 109  | —                                           | $2 \times 10^{-3}$                                       |
| Carbon (6)                                                                                        | C 14    | $1 \times 10^{-6}$                          | $8 \times 10^{-3}$                                       |
| Chromium (24)                                                                                     | Cr 51   | —                                           | $2 \times 10^{-2}$                                       |
| Cobalt (27)                                                                                       | Co 57   | —                                           | $5 \times 10^{-3}$                                       |
| Hydrogen (1)                                                                                      | H 3     | $5 \times 10^{-6}$                          | $3 \times 10^{-2}$                                       |
| Iron (26)                                                                                         | Fe 55   | —                                           | $8 \times 10^{-3}$                                       |
| Manganese (25)                                                                                    | Mn 52   | —                                           | $3 \times 10^{-4}$                                       |
| Manganese (25)                                                                                    | Mn 54   | —                                           | $1 \times 10^{-3}$                                       |
| Tungsten (74)                                                                                     | W 181   | —                                           | $4 \times 10^{-3}$                                       |
| Vanadium (23)                                                                                     | V 48    | —                                           | $3 \times 10^{-4}$                                       |
| Zinc (30)                                                                                         | Zn 65   | —                                           | $1 \times 10^{-3}$                                       |
| Beta and/or gamma emitting radioactive material not listed above with half life less than 3 years | —       | $1 \times 10^{-10}$                         | $1 \times 10^{-6}$                                       |

NOTE 1: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the concentrations in Section 5.19, the value given is that of the parent isotope and takes into account the radioactivity of the daughters.

NOTE 2: For purposes of Section 5.3.3 where a combination of isotopes is involved, the limit for the combination shall be computed as follows:

Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in Section 5.19 for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (i.e., unity).

EXAMPLE:

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt Concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt Concentration of Isotope B}} \leq 1$$

\* Values are given only for those materials normally used as gases.

\*\* uc/gm for solids.

### SECTION 6—CONTROLLED AREAS

#### 6.1 Areas Which Must be Controlled

6.1.1 Every area in which there is any reasonable possibility of an occupant receiving more than the radiation doses specified in Section 7.2 shall be set apart as a controlled area.

6.1.2 The limitations of this section shall not be applicable to outgoing or incoming shipments of

radioactive material while being transported in conformance with the regulations of Section 14.

## 6.2 Limitations on Controlled Areas

No area within a controlled area shall be used for residential quarters, although a room or rooms in residential buildings may be set apart as a controlled area.

## SECTION 7 — PERMISSIBLE DOSE RATES, RADIATION LEVELS AND CONCENTRATIONS

### 7.1 Exposure of Individuals in Controlled Areas

7.1.1 Except as provided in Section 7.1.2, no individual in a controlled area shall receive in any period of one calendar quarter a dose in excess of the limits specified in the following table:

#### Rems per Calendar Quarter

- |                                                                                     |      |
|-------------------------------------------------------------------------------------|------|
| 1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads | 1 ¼. |
| 2. Hands and forearms; feet and ankles                                              | 18¾. |
| 3. Skin of whole body                                                               | 7½.  |

Doses received by human patients from intentional exposure to radiation for the purpose of diagnosis or therapy shall be excluded.

7.1.2 An individual in a controlled area may receive a dose to the whole body greater than that permitted under Section 7.1.1, provided:

(a) During any calendar quarter the dose to the whole body shall not exceed 3 rem; and

(b) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rem where "N" equals the individual's age in years at his last birthday; and

(c) The owner has determined the individual's accumulated occupational dose to the whole body on Form RH-27, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of Section 7.1.3. As used in Section 7.1.2, "dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

(d) Doses received by human patients from intentional exposure to radiation for the purpose of diagnosis or therapy shall be excluded, in the computations of parts (a) and (b).

7.1.3 This section contains requirements which must be satisfied by owners who propose, pursuant to Section 7.1.2, to permit individuals in a controlled area to receive exposure to radiation in excess of the limits specified in Section 7.1.1.

7.1.3.1 Before permitting any individual in a controlled area to receive exposure to radiation in excess of the limits specified in Section 7.1.1, each owner shall:

(a) Obtain a certificate on Form RH-27, or on a clear and legible record containing all the information required in that form, signed by the individual showing each period of time after the individual attained the age of 18 in which the individual received, or may have received, an occupational dose of radiation; and

(b) Calculate on Form RH-27, in accordance with the instructions appearing therein, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under Section 7.1.2.

7.1.3.2 In the preparation of Form RH-27, or a clear and legible record containing all information required in that form, the owner shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. In any case where an owner is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

| Parts of body                                                                | Column 1                                                            | Column 2                                                                         |
|------------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------------------------------------------------------------|
|                                                                              | Assumed exposure in rem for calendar quarters prior to Jan. 1, 1961 | Assumed exposure in rem for calendar quarters beginning on or after Jan. 1, 1961 |
| Whole body, gonads, active blood-forming organs, head and trunk, lens of eye | 3¾                                                                  | 1¼                                                                               |

7.1.3.3. If calculation of the individual's accumulated occupational dose for all periods prior to January 1, 1961, yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in Section 7.1.2., the excess may be disregarded. The owner shall retain and preserve records used in preparing Form RH-27, or its equivalent, as specified in Section 7.1.2(c).

7.1.4 For individuals within a controlled area, the radiation dose to tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which such materials are taken into the body. Where this intake results from the occurrence of radioactive materials in the air, the concentration of the radioisotopes in the air, averaged over any seven consecutive days, shall not be permitted to exceed the concentrations listed in Section 7.5, Column B, or prorated values if more than one isotope is present. The limits given in Section 7.5, Column B, are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be

increased proportionately. In any such period, where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

**7.1.5** Except as authorized by the Department in writing, no allowance shall be made in Section 7.1.4 for the use of protective clothing or equipment, or particle size.

**7.1.5.1** The Department may authorize an owner to expose an individual in a controlled area to airborne concentrations in excess of the limits specified in Section 7.5, Column B, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable and that the individual will not inhale concentrations in excess of the limits established in Section 7.5, Column B. Each application under this subsection shall include an analysis of particle size in the concentrations and a description of the methods used in determining the particle size.

**7.1.5.2** The Department may authorize an owner to expose an individual in a controlled area to airborne concentrations in excess of the limits specified in Section 7.5, Column B, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest, or absorb quantities of radioactive material in excess of those which might otherwise be permitted under this Code for individuals in controlled areas during a 40-hour week. Each application under this subsection shall contain the following information:

(a) A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;

(b) Procedures for the fitting, maintenance, and cleaning of the protective equipment;

(c) Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each workweek. The proposed periods for use of the equipment by any individual shall not be of such duration as would discourage observance by the individual of the proposed procedures; and

(d) The average concentrations present in the areas occupied by the individuals.

**7.1.6** The dose received by any individual under 18 years of age shall not exceed 10% of the limits established in Section 7.1.1 nor shall such an individual be exposed to concentrations of radioactive material greater than those listed in Section 7.5, Column D. For purposes of this section, concentrations may be averaged over periods not greater than one week.

## **7.2 Radiation Levels Outside Controlled Areas**

**7.2.1** The radiation level at any point outside the

confines of the controlled area shall be limited to a value such that there is no reasonable possibility that any individual outside the controlled area will receive a radiation dose to the whole body, head and trunk, active blood-forming organs, gonads, or lens of the eyes, in excess of 0.5 rem in any one year.

**7.2.2** The radiation level at any point outside the confines of a controlled area shall not exceed:

(a) A radiation level which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour, or

(b) A radiation level which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

**7.2.3** Any person may apply to the Department for proposed limits upon levels of radiation outside of controlled areas in excess of those specified in Section 7.2.2 resulting from the applicant's possession or use of sources of radiation. Such applications shall include information as to anticipated average radiation levels and anticipated occupancy times for each area involved. The Department will approve the proposed limits if the applicant demonstrates to the satisfaction of the Department that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

**7.2.4** The limitations of this section shall not be applicable to outgoing or incoming shipments of radioactive materials while being transported in conformance with the regulations of Section 14.

## **7.3 Concentrations in Effluents from Controlled Areas**

Concentrations of radioactive materials in effluents from controlled areas shall meet the requirements of Sections 13.2 and 13.3 of this Code.

## **7.4 Exposures in the Event of Radiation Incidents or Emergencies**

In the event of a radiation incident in which an employee or emergency worker receives more than the limits specified in Section 7.1, or in the event of emergency conditions in which immediate action required to minimize danger to life results in an employee or emergency worker receiving doses beyond the limits specified in Section 7.1, each employer shall take measures to limit additional exposure of his employees to an extent and for a period, which shall be subject to approval by the Department. All such doses shall be reported as required by Section 16 and shall be included in the records required by Section 9.

## 7.5 Maximum Permissible Average Concentrations of Radioactive Materials In Air and Water

| Radionuclide   |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|----------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|                |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column         |          | A                           | B                   | C                  | D                   |
| Actinium 227   | (sol.)   | $6 \times 10^{-5}$          | $2 \times 10^{-12}$ | $2 \times 10^{-6}$ | $8 \times 10^{-14}$ |
|                | (insol.) | $9 \times 10^{-3}$          | $3 \times 10^{-11}$ | $3 \times 10^{-4}$ | $9 \times 10^{-18}$ |
| Actinium 228   | (sol.)   | $3 \times 10^{-3}$          | $8 \times 10^{-8}$  | $9 \times 10^{-5}$ | $3 \times 10^{-9}$  |
|                | (insol.) | $3 \times 10^{-3}$          | $2 \times 10^{-8}$  | $9 \times 10^{-5}$ | $6 \times 10^{-10}$ |
| Americium 241  | (sol.)   | $10^{-4}$                   | $6 \times 10^{-12}$ | $4 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                | (insol.) | $8 \times 10^{-4}$          | $10^{-10}$          | $2 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Americium 242m | (sol.)   | $1 \times 10^{-4}$          | $6 \times 10^{-12}$ | $4 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                | (insol.) | $3 \times 10^{-3}$          | $3 \times 10^{-10}$ | $9 \times 10^{-5}$ | $9 \times 10^{-12}$ |
| Americium 242  | (sol.)   | $4 \times 10^{-3}$          | $4 \times 10^{-8}$  | $1 \times 10^{-4}$ | $1 \times 10^{-9}$  |
|                | (insol.) | $4 \times 10^{-3}$          | $5 \times 10^{-8}$  | $1 \times 10^{-4}$ | $2 \times 10^{-9}$  |
| Americium 243  | (sol.)   | $10^{-4}$                   | $6 \times 10^{-12}$ | $4 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                | (insol.) | $8 \times 10^{-4}$          | $10^{-10}$          | $3 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Americium 244  | (sol.)   | $1 \times 10^{-1}$          | $4 \times 10^{-6}$  | $5 \times 10^{-3}$ | $1 \times 10^{-7}$  |
|                | (insol.) | $1 \times 10^{-1}$          | $2 \times 10^{-5}$  | $5 \times 10^{-3}$ | $8 \times 10^{-7}$  |
| Antimony 122   | (sol.)   | $8 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|                | (insol.) | $8 \times 10^{-4}$          | $10^{-7}$           | $3 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Antimony 124   | (sol.)   | $7 \times 10^{-4}$          | $2 \times 10^{-7}$  | $2 \times 10^{-5}$ | $5 \times 10^{-9}$  |
|                | (insol.) | $7 \times 10^{-4}$          | $2 \times 10^{-8}$  | $2 \times 10^{-5}$ | $7 \times 10^{-10}$ |
| Antimony 125   | (sol.)   | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|                | (insol.) | $3 \times 10^{-3}$          | $3 \times 10^{-8}$  | $10^{-4}$          | $9 \times 10^{-10}$ |
| Argon 37       | (imm.)   | ....                        | $6 \times 10^{-3}$  | ....               | $10^{-4}$           |
| Argon 41       | (imm.)   | ....                        | $2 \times 10^{-6}$  | ....               | $4 \times 10^{-8}$  |
| Arsenic 73     | (sol.)   | 0.01                        | $2 \times 10^{-6}$  | $5 \times 10^{-4}$ | $7 \times 10^{-8}$  |
|                | (insol.) | 0.01                        | $4 \times 10^{-7}$  | $5 \times 10^{-4}$ | $10^{-8}$           |
| Arsenic 74     | (sol.)   | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $5 \times 10^{-5}$ | $10^{-8}$           |
|                | (insol.) | $2 \times 10^{-3}$          | $10^{-7}$           | $5 \times 10^{-5}$ | $4 \times 10^{-9}$  |
| Arsenic 76     | (sol.)   | $6 \times 10^{-4}$          | $10^{-7}$           | $2 \times 10^{-5}$ | $4 \times 10^{-9}$  |
|                | (insol.) | $6 \times 10^{-4}$          | $10^{-7}$           | $2 \times 10^{-5}$ | $3 \times 10^{-9}$  |
| Arsenic 77     | (sol.)   | $2 \times 10^{-3}$          | $5 \times 10^{-7}$  | $8 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|                | (insol.) | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $8 \times 10^{-5}$ | $10^{-8}$           |
| Astatine 211   | (sol.)   | $5 \times 10^{-5}$          | $7 \times 10^{-9}$  | $2 \times 10^{-6}$ | $2 \times 10^{-10}$ |
|                | (insol.) | $2 \times 10^{-3}$          | $3 \times 10^{-8}$  | $7 \times 10^{-5}$ | $10^{-9}$           |
| Barium 131     | (sol.)   | $5 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|                | (insol.) | $5 \times 10^{-3}$          | $4 \times 10^{-7}$  | $2 \times 10^{-4}$ | $10^{-8}$           |
| Barium 140     | (sol.)   | $8 \times 10^{-4}$          | $10^{-7}$           | $3 \times 10^{-5}$ | $4 \times 10^{-9}$  |
|                | (insol.) | $7 \times 10^{-4}$          | $4 \times 10^{-8}$  | $2 \times 10^{-5}$ | $10^{-9}$           |
| Berkelium 249  | (sol.)   | 0.02                        | $9 \times 10^{-10}$ | $6 \times 10^{-4}$ | $3 \times 10^{-11}$ |
|                | (insol.) | 0.02                        | $10^{-7}$           | $6 \times 10^{-4}$ | $4 \times 10^{-9}$  |
| Berkelium 250  | (sol.)   | $6 \times 10^{-3}$          | $1 \times 10^{-7}$  | $2 \times 10^{-4}$ | $5 \times 10^{-9}$  |
|                | (insol.) | $6 \times 10^{-3}$          | $1 \times 10^{-6}$  | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
| Beryllium 7    | (sol.)   | 0.05                        | $6 \times 10^{-8}$  | 0.002              | $2 \times 10^{-7}$  |
|                | (insol.) | 0.05                        | $10^{-6}$           | 0.002              | $4 \times 10^{-8}$  |
| Bismuth 206    | (sol.)   | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|                | (insol.) | $10^{-3}$                   | $10^{-7}$           | $4 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Bismuth 207    | (sol.)   | $2 \times 10^{-3}$          | $2 \times 10^{-7}$  | $6 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|                | (insol.) | $2 \times 10^{-3}$          | $10^{-8}$           | $6 \times 10^{-5}$ | $5 \times 10^{-10}$ |
| Bismuth 210    | (sol.)   | $10^{-3}$                   | $6 \times 10^{-9}$  | $4 \times 10^{-5}$ | $2 \times 10^{-10}$ |
|                | (insol.) | $10^{-3}$                   | $6 \times 10^{-9}$  | $4 \times 10^{-5}$ | $2 \times 10^{-10}$ |
| Bismuth 212    | (sol.)   | 0.01                        | $10^{-7}$           | $4 \times 10^{-4}$ | $3 \times 10^{-9}$  |
|                | (insol.) | 0.01                        | $2 \times 10^{-7}$  | $4 \times 10^{-4}$ | $7 \times 10^{-9}$  |
| Bromine 82     | (sol.)   | $8 \times 10^{-3}$          | $10^{-6}$           | $3 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|                | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Cadmium 109    | (sol.)   | $5 \times 10^{-3}$          | $5 \times 10^{-8}$  | $2 \times 10^{-4}$ | $2 \times 10^{-9}$  |
|                | (insol.) | $5 \times 10^{-3}$          | $7 \times 10^{-8}$  | $2 \times 10^{-4}$ | $3 \times 10^{-9}$  |
| Cadmium 115m   | (sol.)   | $7 \times 10^{-4}$          | $4 \times 10^{-8}$  | $3 \times 10^{-5}$ | $10^{-9}$           |
|                | (insol.) | $7 \times 10^{-4}$          | $4 \times 10^{-8}$  | $3 \times 10^{-5}$ | $10^{-9}$           |

| Radionuclide    |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|-----------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|                 |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column          |          | A                           | B                   | C                  | D                   |
| Cadmium 115     | (sol.)   | $10^{-3}$                   | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $8 \times 10^{-9}$  |
|                 | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Calcium 45      | (sol.)   | $3 \times 10^{-4}$          | $3 \times 10^{-8}$  | $9 \times 10^{-6}$ | $10^{-9}$           |
|                 | (insol.) | $5 \times 10^{-3}$          | $10^{-7}$           | $2 \times 10^{-4}$ | $4 \times 10^{-9}$  |
| Calcium 47      | (sol.)   | $10^{-3}$                   | $2 \times 10^{-7}$  | $5 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|                 | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Californium 249 | (sol.)   | $10^{-4}$                   | $2 \times 10^{-12}$ | $4 \times 10^{-6}$ | $5 \times 10^{-14}$ |
|                 | (insol.) | $7 \times 10^{-4}$          | $10^{-10}$          | $2 \times 10^{-5}$ | $3 \times 10^{-12}$ |
| Californium 250 | (sol.)   | $4 \times 10^{-4}$          | $5 \times 10^{-12}$ | $10^{-5}$          | $2 \times 10^{-13}$ |
|                 | (insol.) | $7 \times 10^{-4}$          | $10^{-10}$          | $3 \times 10^{-5}$ | $3 \times 10^{-12}$ |
| Californium 251 | (sol.)   | $1 \times 10^{-4}$          | $2 \times 10^{-12}$ | $4 \times 10^{-6}$ | $6 \times 10^{-14}$ |
|                 | (insol.) | $8 \times 10^{-4}$          | $1 \times 10^{-10}$ | $3 \times 10^{-5}$ | $3 \times 10^{-12}$ |
| Californium 252 | (sol.)   | $7 \times 10^{-4}$          | $2 \times 10^{-11}$ | $2 \times 10^{-5}$ | $7 \times 10^{-13}$ |
|                 | (insol.) | $7 \times 10^{-4}$          | $10^{-10}$          | $2 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Californium 253 | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-10}$ | $1 \times 10^{-4}$ | $3 \times 10^{-11}$ |
|                 | (insol.) | $4 \times 10^{-3}$          | $8 \times 10^{-10}$ | $1 \times 10^{-4}$ | $3 \times 10^{-11}$ |
| Californium 254 | (sol.)   | $4 \times 10^{-6}$          | $5 \times 10^{-12}$ | $10^{-7}$          | $2 \times 10^{-13}$ |
|                 | (insol.) | $4 \times 10^{-6}$          | $5 \times 10^{-12}$ | $10^{-7}$          | $2 \times 10^{-13}$ |
| Carbon 14       | (sol.)   | 0.02                        | $4 \times 10^{-6}$  | $8 \times 10^{-4}$ | $10^{-7}$           |
|                 | (insol.) | ....                        | $5 \times 10^{-5}$  | ....               | $10^{-6}$           |
| Cerium 141      | (sol.)   | $3 \times 10^{-3}$          | $4 \times 10^{-7}$  | $9 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|                 | (insol.) | $3 \times 10^{-3}$          | $2 \times 10^{-7}$  | $9 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Cerium 143      | (sol.)   | $10^{-3}$                   | $3 \times 10^{-7}$  | $4 \times 10^{-5}$ | $9 \times 10^{-9}$  |
|                 | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $7 \times 10^{-9}$  |
| Cerium 144      | (sol.)   | $3 \times 10^{-4}$          | $10^{-8}$           | $10^{-5}$          | $3 \times 10^{-10}$ |
|                 | (insol.) | $3 \times 10^{-4}$          | $6 \times 10^{-9}$  | $10^{-5}$          | $2 \times 10^{-10}$ |
| Cesium 131      | (sol.)   | 0.07                        | $10^{-5}$           | 0.002              | $4 \times 10^{-7}$  |
|                 | (insol.) | 0.03                        | $3 \times 10^{-6}$  | $9 \times 10^{-4}$ | $10^{-7}$           |
| Cesium 134m     | (sol.)   | 0.2                         | $4 \times 10^{-5}$  | 0.006              | $10^{-6}$           |
|                 | (insol.) | 0.03                        | $6 \times 10^{-6}$  | 0.001              | $2 \times 10^{-7}$  |
| Cesium 134      | (sol.)   | $3 \times 10^{-4}$          | $4 \times 10^{-8}$  | $9 \times 10^{-6}$ | $10^{-9}$           |
|                 | (insol.) | $10^{-3}$                   | $10^{-8}$           | $4 \times 10^{-5}$ | $4 \times 10^{-10}$ |
| Cesium 135      | (sol.)   | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|                 | (insol.) | $7 \times 10^{-3}$          | $9 \times 10^{-8}$  | $2 \times 10^{-4}$ | $3 \times 10^{-9}$  |
| Cesium 136      | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $9 \times 10^{-5}$ | $10^{-8}$           |
|                 | (insol.) | $2 \times 10^{-3}$          | $2 \times 10^{-7}$  | $6 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Cesium 137      | (sol.)   | $4 \times 10^{-4}$          | $6 \times 10^{-8}$  | $2 \times 10^{-5}$ | $2 \times 10^{-9}$  |
|                 | (insol.) | $10^{-3}$                   | $10^{-8}$           | $4 \times 10^{-5}$ | $5 \times 10^{-10}$ |
| Chlorine 36     | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $8 \times 10^{-5}$ | $10^{-8}$           |
|                 | (insol.) | $2 \times 10^{-3}$          | $2 \times 10^{-8}$  | $6 \times 10^{-5}$ | $8 \times 10^{-10}$ |
| Chlorine 38     | (sol.)   | 0.01                        | $3 \times 10^{-6}$  | $4 \times 10^{-4}$ | $9 \times 10^{-8}$  |
|                 | (insol.) | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $7 \times 10^{-8}$  |
| Chromium 51     | (sol.)   | 0.05                        | $10^{-5}$           | 0.002              | $4 \times 10^{-7}$  |
|                 | (insol.) | 0.05                        | $2 \times 10^{-6}$  | 0.002              | $8 \times 10^{-8}$  |
| Cobalt 57       | (sol.)   | 0.02                        | $3 \times 10^{-6}$  | $5 \times 10^{-4}$ | $10^{-7}$           |
|                 | (insol.) | 0.01                        | $2 \times 10^{-7}$  | $4 \times 10^{-4}$ | $6 \times 10^{-9}$  |
| Cobalt 58m      | (sol.)   | 0.08                        | $2 \times 10^{-5}$  | 0.003              | $6 \times 10^{-7}$  |
|                 | (insol.) | 0.06                        | $9 \times 10^{-6}$  | 0.002              | $3 \times 10^{-7}$  |
| Cobalt 58       | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|                 | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-8}$  | $9 \times 10^{-5}$ | $2 \times 10^{-9}$  |
| Cobalt 60       | (sol.)   | $10^{-3}$                   | $3 \times 10^{-7}$  | $5 \times 10^{-5}$ | $10^{-8}$           |
|                 | (insol.) | $10^{-3}$                   | $9 \times 10^{-8}$  | $3 \times 10^{-5}$ | $3 \times 10^{-10}$ |
| Copper 64       | (sol.)   | 0.01                        | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $7 \times 10^{-8}$  |
|                 | (insol.) | $6 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
| Curium 242      | (sol.)   | $7 \times 10^{-4}$          | $10^{-10}$          | $2 \times 10^{-5}$ | $4 \times 10^{-12}$ |
|                 | (insol.) | $7 \times 10^{-4}$          | $2 \times 10^{-10}$ | $3 \times 10^{-5}$ | $6 \times 10^{-12}$ |

| Radionuclide     |           | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|------------------|-----------|-----------------------------|---------------------|--------------------|---------------------|
|                  |           | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column           |           | A                           | B                   | C                  | D                   |
| Curium 243       | (sol.)    | $10^{-4}$                   | $6 \times 10^{-12}$ | $5 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                  | (insol.)  | $7 \times 10^{-4}$          | $10^{-10}$          | $2 \times 10^{-5}$ | $3 \times 10^{-12}$ |
| Curium 244       | (sol.)    | $2 \times 10^{-4}$          | $9 \times 10^{-12}$ | $7 \times 10^{-6}$ | $3 \times 10^{-13}$ |
|                  | (insol.)  | $8 \times 10^{-4}$          | $10^{-10}$          | $3 \times 10^{-5}$ | $3 \times 10^{-12}$ |
| Curium 245       | (sol.)    | $10^{-4}$                   | $5 \times 10^{-12}$ | $4 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                  | (insol.)  | $8 \times 10^{-4}$          | $10^{-10}$          | $3 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Curium 246       | (sol.)    | $10^{-4}$                   | $5 \times 10^{-12}$ | $4 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                  | (insol.)  | $8 \times 10^{-4}$          | $10^{-10}$          | $3 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Curium 247       | (sol.)    | $1 \times 10^{-4}$          | $5 \times 10^{-12}$ | $4 \times 10^{-6}$ | $2 \times 10^{-13}$ |
|                  | (insol.)  | $6 \times 10^{-4}$          | $1 \times 10^{-10}$ | $2 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Curium 248       | (sol.)    | $1 \times 10^{-5}$          | $6 \times 10^{-13}$ | $4 \times 10^{-7}$ | $2 \times 10^{-14}$ |
|                  | (insol.)  | $4 \times 10^{-5}$          | $1 \times 10^{-11}$ | $1 \times 10^{-6}$ | $4 \times 10^{-13}$ |
| Curium 249       | (sol.)    | $6 \times 10^{-2}$          | $1 \times 10^{-5}$  | $2 \times 10^{-3}$ | $4 \times 10^{-7}$  |
|                  | (insol.)  | $6 \times 10^{-2}$          | $1 \times 10^{-5}$  | $2 \times 10^{-3}$ | $4 \times 10^{-7}$  |
| Dysprosium 165   | (sol.)    | 0.01                        | $3 \times 10^{-6}$  | $4 \times 10^{-4}$ | $9 \times 10^{-8}$  |
|                  | (insol.)  | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $7 \times 10^{-8}$  |
| Dysprosium 166   | (sol.)    | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $8 \times 10^{-9}$  |
|                  | (insol.)  | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $7 \times 10^{-9}$  |
| Einsteinium 253  | (sol.)    | $7 \times 10^{-4}$          | $8 \times 10^{-10}$ | $2 \times 10^{-5}$ | $3 \times 10^{-11}$ |
|                  | (insol.)  | $7 \times 10^{-4}$          | $6 \times 10^{-10}$ | $2 \times 10^{-5}$ | $2 \times 10^{-11}$ |
| Einsteinium 254m | (sol.)    | $5 \times 10^{-4}$          | $5 \times 10^{-9}$  | $2 \times 10^{-5}$ | $2 \times 10^{-10}$ |
|                  | (insol.)  | $5 \times 10^{-4}$          | $6 \times 10^{-9}$  | $2 \times 10^{-5}$ | $2 \times 10^{-10}$ |
| Einsteinium 254  | (sol.)    | $4 \times 10^{-4}$          | $2 \times 10^{-11}$ | $1 \times 10^{-5}$ | $6 \times 10^{-13}$ |
|                  | (insol.)  | $4 \times 10^{-4}$          | $1 \times 10^{-10}$ | $1 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Einsteinium 255  | (sol.)    | $8 \times 10^{-4}$          | $5 \times 10^{-10}$ | $3 \times 10^{-5}$ | $2 \times 10^{-11}$ |
|                  | (insol.)  | $8 \times 10^{-4}$          | $4 \times 10^{-10}$ | $3 \times 10^{-5}$ | $1 \times 10^{-11}$ |
| Erbium 169       | (sol.)    | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $9 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|                  | (insol.)  | $3 \times 10^{-3}$          | $4 \times 10^{-7}$  | $9 \times 10^{-5}$ | $10^{-8}$           |
| Erbium 171       | (sol.)    | $3 \times 10^{-3}$          | $7 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|                  | (insol.)  | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Europium 152     | (9.2 hr.) |                             |                     |                    |                     |
|                  | (sol.)    | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
|                  | (insol.)  | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
| Europium 152     | (13 yr.)  |                             |                     |                    |                     |
|                  | (sol.)    | $2 \times 10^{-3}$          | $10^{-8}$           | $8 \times 10^{-5}$ | $4 \times 10^{-10}$ |
|                  | (insol.)  | $2 \times 10^{-3}$          | $2 \times 10^{-8}$  | $8 \times 10^{-5}$ | $6 \times 10^{-10}$ |
| Europium 154     | (sol.)    | $6 \times 10^{-4}$          | $4 \times 10^{-9}$  | $2 \times 10^{-5}$ | $10^{-10}$          |
|                  | (insol.)  | $6 \times 10^{-4}$          | $7 \times 10^{-9}$  | $2 \times 10^{-5}$ | $2 \times 10^{-10}$ |
| Europium 155     | (sol.)    | $6 \times 10^{-3}$          | $9 \times 10^{-8}$  | $2 \times 10^{-4}$ | $3 \times 10^{-9}$  |
|                  | (insol.)  | $6 \times 10^{-3}$          | $7 \times 10^{-8}$  | $2 \times 10^{-4}$ | $3 \times 10^{-9}$  |
| Fermium 254      | (sol.)    | $4 \times 10^{-3}$          | $6 \times 10^{-8}$  | $1 \times 10^{-4}$ | $2 \times 10^{-9}$  |
|                  | (insol.)  | $4 \times 10^{-3}$          | $7 \times 10^{-8}$  | $1 \times 10^{-4}$ | $2 \times 10^{-9}$  |
| Fermium 255      | (sol.)    | $1 \times 10^{-3}$          | $2 \times 10^{-8}$  | $3 \times 10^{-5}$ | $6 \times 10^{-10}$ |
|                  | (insol.)  | $1 \times 10^{-3}$          | $1 \times 10^{-8}$  | $3 \times 10^{-5}$ | $4 \times 10^{-10}$ |
| Fermium 256      | (sol.)    | $3 \times 10^{-5}$          | $3 \times 10^{-9}$  | $9 \times 10^{-7}$ | $1 \times 10^{-10}$ |
|                  | (insol.)  | $3 \times 10^{-5}$          | $2 \times 10^{-9}$  | $9 \times 10^{-7}$ | $6 \times 10^{-11}$ |
| Fluorine 18      | (sol.)    | 0.02                        | $5 \times 10^{-6}$  | $8 \times 10^{-4}$ | $2 \times 10^{-7}$  |
|                  | (insol.)  | 0.01                        | $3 \times 10^{-6}$  | $5 \times 10^{-4}$ | $9 \times 10^{-8}$  |
| Gadolinium 153   | (sol.)    | $6 \times 10^{-3}$          | $2 \times 10^{-7}$  | $2 \times 10^{-4}$ | $8 \times 10^{-9}$  |
|                  | (insol.)  | $6 \times 10^{-3}$          | $9 \times 10^{-8}$  | $2 \times 10^{-4}$ | $3 \times 10^{-9}$  |
| Gadolinium 159   | (sol.)    | $2 \times 10^{-3}$          | $5 \times 10^{-7}$  | $8 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|                  | (insol.)  | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $8 \times 10^{-5}$ | $10^{-8}$           |
| Gallium 72       | (sol.)    | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $8 \times 10^{-9}$  |
|                  | (insol.)  | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Germanium 71     | (sol.)    | 0.05                        | $10^{-5}$           | 0.002              | $4 \times 10^{-7}$  |
|                  | (insol.)  | 0.05                        | $6 \times 10^{-6}$  | 0.002              | $2 \times 10^{-7}$  |

| Radionuclide  |                | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|---------------|----------------|-----------------------------|---------------------|--------------------|---------------------|
|               |                | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column        |                | A                           | B                   | C                  | D                   |
| Gold 196      | (sol.)         | $5 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.)       | $4 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Gold 198      | (sol.)         | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $5 \times 10^{-5}$ | $10^{-8}$           |
|               | (insol.)       | $10^{-3}$                   | $2 \times 10^{-7}$  | $5 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Gold 199      | (sol.)         | $5 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.)       | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Hafnium 181   | (sol.)         | $2 \times 10^{-3}$          | $4 \times 10^{-8}$  | $7 \times 10^{-5}$ | $10^{-9}$           |
|               | (insol.)       | $2 \times 10^{-3}$          | $7 \times 10^{-8}$  | $7 \times 10^{-5}$ | $3 \times 10^{-9}$  |
| Holmium 166   | (sol.)         | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $7 \times 10^{-9}$  |
|               | (insol.)       | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Hydrogen 3    | (sol., insol.) | 0.1                         | $5 \times 10^{-6}$  | 0.003              | $2 \times 10^{-7}$  |
|               | (imm.)         | ....                        | $2 \times 10^{-3}$  | ....               | $4 \times 10^{-5}$  |
| Indium 113m   | (sol.)         | 0.04                        | $8 \times 10^{-6}$  | 0.001              | $3 \times 10^{-7}$  |
|               | (insol.)       | 0.04                        | $7 \times 10^{-6}$  | 0.001              | $2 \times 10^{-7}$  |
| Indium 114m   | (sol.)         | $5 \times 10^{-4}$          | $10^{-7}$           | $2 \times 10^{-5}$ | $4 \times 10^{-9}$  |
|               | (insol.)       | $5 \times 10^{-4}$          | $2 \times 10^{-8}$  | $2 \times 10^{-5}$ | $7 \times 10^{-10}$ |
| Indium 115m   | (sol.)         | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $8 \times 10^{-8}$  |
|               | (insol.)       | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $6 \times 10^{-8}$  |
| Indium 115    | (sol.)         | $3 \times 10^{-3}$          | $2 \times 10^{-7}$  | $9 \times 10^{-5}$ | $9 \times 10^{-9}$  |
|               | (insol.)       | $3 \times 10^{-3}$          | $3 \times 10^{-8}$  | $9 \times 10^{-5}$ | $10^{-9}$           |
| Iodine 125    | (sol.)         | $4 \times 10^{-5}$          | $5 \times 10^{-9}$  | $2 \times 10^{-7}$ | $8 \times 10^{-11}$ |
|               | (insol.)       | $6 \times 10^{-3}$          | $2 \times 10^{-7}$  | $2 \times 10^{-4}$ | $6 \times 10^{-9}$  |
| Iodine 126    | (sol.)         | $5 \times 10^{-5}$          | $8 \times 10^{-9}$  | $3 \times 10^{-7}$ | $9 \times 10^{-11}$ |
|               | (insol.)       | $3 \times 10^{-3}$          | $3 \times 10^{-7}$  | $9 \times 10^{-5}$ | $10^{-8}$           |
| Iodine 129    | (sol.)         | $10^{-5}$                   | $2 \times 10^{-9}$  | $6 \times 10^{-8}$ | $2 \times 10^{-11}$ |
|               | (insol.)       | $6 \times 10^{-3}$          | $7 \times 10^{-8}$  | $2 \times 10^{-4}$ | $2 \times 10^{-9}$  |
| Iodine 131    | (sol.)         | $6 \times 10^{-5}$          | $9 \times 10^{-9}$  | $3 \times 10^{-7}$ | $1 \times 10^{-10}$ |
|               | (insol.)       | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
| Iodine 132    | (sol.)         | $2 \times 10^{-3}$          | $2 \times 10^{-7}$  | $8 \times 10^{-6}$ | $3 \times 10^{-9}$  |
|               | (insol.)       | $5 \times 10^{-3}$          | $9 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Iodine 133    | (sol.)         | $2 \times 10^{-4}$          | $3 \times 10^{-8}$  | $1 \times 10^{-6}$ | $4 \times 10^{-10}$ |
|               | (insol.)       | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $7 \times 10^{-9}$  |
| Iodine 134    | (sol.)         | $4 \times 10^{-3}$          | $5 \times 10^{-7}$  | $2 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|               | (insol.)       | 0.02                        | $3 \times 10^{-6}$  | $6 \times 10^{-4}$ | $10^{-7}$           |
| Iodine 135    | (sol.)         | $7 \times 10^{-4}$          | $10^{-7}$           | $4 \times 10^{-6}$ | $1 \times 10^{-9}$  |
|               | (insol.)       | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $7 \times 10^{-5}$ | $10^{-8}$           |
| Iridium 190   | (sol.)         | $6 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.)       | $5 \times 10^{-3}$          | $4 \times 10^{-7}$  | $2 \times 10^{-4}$ | $10^{-8}$           |
| Iridium 192   | (sol.)         | $10^{-3}$                   | $10^{-7}$           | $4 \times 10^{-5}$ | $4 \times 10^{-9}$  |
|               | (insol.)       | $10^{-3}$                   | $3 \times 10^{-8}$  | $4 \times 10^{-5}$ | $9 \times 10^{-10}$ |
| Iridium 194   | (sol.)         | $10^{-3}$                   | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $8 \times 10^{-9}$  |
|               | (insol.)       | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Iron 55       | (sol.)         | 0.02                        | $9 \times 10^{-7}$  | $8 \times 10^{-4}$ | $3 \times 10^{-8}$  |
|               | (insol.)       | 0.07                        | $10^{-6}$           | 0.002              | $3 \times 10^{-8}$  |
| Iron 59       | (sol.)         | $2 \times 10^{-3}$          | $10^{-7}$           | $6 \times 10^{-5}$ | $5 \times 10^{-9}$  |
|               | (insol.)       | $2 \times 10^{-3}$          | $5 \times 10^{-8}$  | $5 \times 10^{-5}$ | $2 \times 10^{-9}$  |
| Krypton 85m   | (imm.)         | ....                        | $6 \times 10^{-6}$  | ....               | $10^{-7}$           |
| Krypton 85    | (imm.)         | ....                        | $10^{-5}$           | ....               | $3 \times 10^{-7}$  |
| Krypton 87    | (imm.)         | ....                        | $10^{-6}$           | ....               | $2 \times 10^{-8}$  |
| Lanthanum 140 | (sol.)         | $7 \times 10^{-4}$          | $2 \times 10^{-7}$  | $2 \times 10^{-5}$ | $5 \times 10^{-9}$  |
|               | (insol.)       | $7 \times 10^{-4}$          | $10^{-7}$           | $2 \times 10^{-5}$ | $4 \times 10^{-9}$  |
| Lead 203      | (sol.)         | 0.01                        | $3 \times 10^{-6}$  | $4 \times 10^{-4}$ | $9 \times 10^{-8}$  |
|               | (insol.)       | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $6 \times 10^{-8}$  |
| Lead 210      | (sol.)         | $4 \times 10^{-6}$          | $10^{-10}$          | $10^{-7}$          | $4 \times 10^{-12}$ |
|               | (insol.)       | $5 \times 10^{-3}$          | $2 \times 10^{-10}$ | $2 \times 10^{-4}$ | $8 \times 10^{-12}$ |

| Radionuclide  |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|---------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|               |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column        |          | A                           | B                   | C                  | D                   |
| Lead 212      | (sol.)   | $6 \times 10^{-4}$          | $2 \times 10^{-8}$  | $2 \times 10^{-5}$ | $6 \times 10^{-10}$ |
|               | (insol.) | $5 \times 10^{-4}$          | $2 \times 10^{-8}$  | $2 \times 10^{-5}$ | $7 \times 10^{-10}$ |
| Lutecium 177  | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Manganese 52  | (sol.)   | $10^{-3}$                   | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $7 \times 10^{-9}$  |
|               | (insol.) | $9 \times 10^{-4}$          | $10^{-7}$           | $3 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Manganese 54  | (sol.)   | $4 \times 10^{-3}$          | $4 \times 10^{-7}$  | $10^{-4}$          | $10^{-8}$           |
|               | (insol.) | $3 \times 10^{-3}$          | $4 \times 10^{-8}$  | $10^{-4}$          | $10^{-9}$           |
| Manganese 56  | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Mercury 197m  | (sol.)   | $6 \times 10^{-3}$          | $7 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
|               | (insol.) | $5 \times 10^{-3}$          | $8 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Mercury 197   | (sol.)   | $9 \times 10^{-3}$          | $10^{-6}$           | $3 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.) | 0.01                        | $3 \times 10^{-6}$  | $5 \times 10^{-4}$ | $9 \times 10^{-8}$  |
| Mercury 203   | (sol.)   | $5 \times 10^{-4}$          | $7 \times 10^{-8}$  | $2 \times 10^{-5}$ | $2 \times 10^{-9}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $10^{-7}$           | $10^{-4}$          | $4 \times 10^{-9}$  |
| Molybdenum 99 | (sol.)   | $5 \times 10^{-3}$          | $7 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
|               | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $7 \times 10^{-9}$  |
| Neodymium 144 | (sol.)   | $2 \times 10^{-3}$          | $8 \times 10^{-11}$ | $7 \times 10^{-5}$ | $3 \times 10^{-12}$ |
|               | (insol.) | $2 \times 10^{-3}$          | $3 \times 10^{-10}$ | $8 \times 10^{-5}$ | $10^{-11}$          |
| Neodymium 147 | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
|               | (insol.) | $2 \times 10^{-3}$          | $2 \times 10^{-7}$  | $6 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Neodymium 149 | (sol.)   | $8 \times 10^{-3}$          | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $6 \times 10^{-8}$  |
|               | (insol.) | $8 \times 10^{-3}$          | $10^{-6}$           | $3 \times 10^{-4}$ | $5 \times 10^{-8}$  |
| Neptunium 237 | (sol.)   | $9 \times 10^{-5}$          | $4 \times 10^{-12}$ | $3 \times 10^{-6}$ | $10^{-13}$          |
|               | (insol.) | $9 \times 10^{-4}$          | $10^{-10}$          | $3 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Neptunium 239 | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|               | (insol.) | $4 \times 10^{-3}$          | $7 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Nickel 59     | (sol.)   | $6 \times 10^{-3}$          | $5 \times 10^{-7}$  | $2 \times 10^{-4}$ | $2 \times 10^{-8}$  |
|               | (insol.) | 0.06                        | $8 \times 10^{-7}$  | 0.002              | $3 \times 10^{-8}$  |
| Nickel 63     | (sol.)   | $8 \times 10^{-4}$          | $6 \times 10^{-8}$  | $3 \times 10^{-5}$ | $2 \times 10^{-9}$  |
|               | (insol.) | 0.02                        | $3 \times 10^{-7}$  | $7 \times 10^{-4}$ | $10^{-8}$           |
| Nickel 65     | (sol.)   | $4 \times 10^{-3}$          | $9 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Niobium 93m   | (sol.)   | 0.01                        | $10^{-7}$           | $4 \times 10^{-4}$ | $4 \times 10^{-9}$  |
|               | (insol.) | 0.01                        | $2 \times 10^{-7}$  | $4 \times 10^{-4}$ | $5 \times 10^{-9}$  |
| Niobium 95    | (sol.)   | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $10^{-7}$           | $10^{-4}$          | $3 \times 10^{-9}$  |
| Niobium 97    | (sol.)   | 0.03                        | $6 \times 10^{-6}$  | $9 \times 10^{-4}$ | $2 \times 10^{-7}$  |
|               | (insol.) | 0.03                        | $5 \times 10^{-6}$  | $9 \times 10^{-4}$ | $2 \times 10^{-7}$  |
| Osmium 185    | (sol.)   | $2 \times 10^{-3}$          | $5 \times 10^{-7}$  | $7 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $2 \times 10^{-3}$          | $5 \times 10^{-8}$  | $7 \times 10^{-5}$ | $2 \times 10^{-9}$  |
| Osmium 191m   | (sol.)   | 0.07                        | $2 \times 10^{-5}$  | 0.003              | $6 \times 10^{-7}$  |
|               | (insol.) | 0.07                        | $9 \times 10^{-6}$  | 0.002              | $3 \times 10^{-7}$  |
| Osmium 191    | (sol.)   | $5 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.) | $5 \times 10^{-3}$          | $4 \times 10^{-7}$  | $2 \times 10^{-4}$ | $10^{-8}$           |
| Osmium 193    | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
|               | (insol.) | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $5 \times 10^{-5}$ | $9 \times 10^{-9}$  |
| Palladium 103 | (sol.)   | 0.01                        | $10^{-6}$           | $3 \times 10^{-4}$ | $5 \times 10^{-8}$  |
|               | (insol.) | $8 \times 10^{-3}$          | $7 \times 10^{-7}$  | $3 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Palladium 109 | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $9 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $7 \times 10^{-5}$ | $10^{-8}$           |
| Phosphorus 32 | (sol.)   | $5 \times 10^{-4}$          | $7 \times 10^{-8}$  | $2 \times 10^{-5}$ | $2 \times 10^{-9}$  |
|               | (insol.) | $7 \times 10^{-4}$          | $8 \times 10^{-8}$  | $2 \times 10^{-5}$ | $3 \times 10^{-9}$  |
| Platinum 191  | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |

| Radionuclide     |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|------------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|                  |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column           |          | A                           | B                   | C                  | D                   |
| Platinum 193m    | (sol.)   | 0.03                        | $7 \times 10^{-6}$  | 0.001              | $2 \times 10^{-7}$  |
|                  | (insol.) | 0.03                        | $5 \times 10^{-6}$  | 0.001              | $2 \times 10^{-7}$  |
| Platinum 193     | (sol.)   | 0.03                        | $10^{-6}$           | $9 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|                  | (insol.) | 0.05                        | $3 \times 10^{-7}$  | 0.002              | $10^{-8}$           |
| Platinum 197m    | (sol.)   | 0.03                        | $6 \times 10^{-6}$  | 0.001              | $2 \times 10^{-7}$  |
|                  | (insol.) | 0.03                        | $5 \times 10^{-6}$  | $9 \times 10^{-4}$ | $2 \times 10^{-7}$  |
| Platinum 197     | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|                  | (insol.) | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Plutonium 238    | (sol.)   | $10^{-4}$                   | $2 \times 10^{-12}$ | $5 \times 10^{-6}$ | $7 \times 10^{-14}$ |
|                  | (insol.) | $8 \times 10^{-4}$          | $3 \times 10^{-11}$ | $3 \times 10^{-5}$ | $10^{-12}$          |
| Plutonium 239    | (sol.)   | $10^{-4}$                   | $2 \times 10^{-12}$ | $5 \times 10^{-6}$ | $6 \times 10^{-14}$ |
|                  | (insol.) | $8 \times 10^{-4}$          | $3 \times 10^{-11}$ | $3 \times 10^{-5}$ | $10^{-12}$          |
| Plutonium 240    | (sol.)   | $10^{-4}$                   | $2 \times 10^{-12}$ | $5 \times 10^{-6}$ | $6 \times 10^{-14}$ |
|                  | (insol.) | $8 \times 10^{-4}$          | $4 \times 10^{-11}$ | $3 \times 10^{-5}$ | $10^{-12}$          |
| Plutonium 241    | (sol.)   | $7 \times 10^{-3}$          | $9 \times 10^{-11}$ | $2 \times 10^{-4}$ | $3 \times 10^{-12}$ |
|                  | (insol.) | 0.04                        | $4 \times 10^{-8}$  | 0.001              | $10^{-9}$           |
| Plutonium 242    | (sol.)   | $10^{-4}$                   | $2 \times 10^{-12}$ | $5 \times 10^{-6}$ | $6 \times 10^{-14}$ |
|                  | (insol.) | $9 \times 10^{-4}$          | $4 \times 10^{-11}$ | $3 \times 10^{-5}$ | $10^{-12}$          |
| Plutonium 243    | (sol.)   | $1 \times 10^{-2}$          | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $6 \times 10^{-8}$  |
|                  | (insol.) | $1 \times 10^{-2}$          | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $8 \times 10^{-8}$  |
| Plutonium 244    | (sol.)   | $1 \times 10^{-4}$          | $2 \times 10^{-12}$ | $4 \times 10^{-6}$ | $6 \times 10^{-14}$ |
|                  | (insol.) | $3 \times 10^{-4}$          | $3 \times 10^{-11}$ | $1 \times 10^{-5}$ | $1 \times 10^{-12}$ |
| Polonium 210     | (sol.)   | $2 \times 10^{-5}$          | $5 \times 10^{-10}$ | $7 \times 10^{-7}$ | $2 \times 10^{-11}$ |
|                  | (insol.) | $8 \times 10^{-4}$          | $2 \times 10^{-10}$ | $3 \times 10^{-5}$ | $7 \times 10^{-12}$ |
| Potassium 42     | (sol.)   | $9 \times 10^{-3}$          | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $7 \times 10^{-8}$  |
|                  | (insol.) | $6 \times 10^{-4}$          | $10^{-7}$           | $2 \times 10^{-5}$ | $4 \times 10^{-9}$  |
| Praseodymium 142 | (sol.)   | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $7 \times 10^{-9}$  |
|                  | (insol.) | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Praseodymium 143 | (sol.)   | $10^{-3}$                   | $3 \times 10^{-7}$  | $5 \times 10^{-5}$ | $10^{-8}$           |
|                  | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $5 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Promethium 147   | (sol.)   | $6 \times 10^{-3}$          | $6 \times 10^{-8}$  | $2 \times 10^{-4}$ | $2 \times 10^{-9}$  |
|                  | (insol.) | $6 \times 10^{-3}$          | $10^{-7}$           | $2 \times 10^{-4}$ | $3 \times 10^{-9}$  |
| Promethium 149   | (sol.)   | $10^{-3}$                   | $3 \times 10^{-7}$  | $4 \times 10^{-5}$ | $10^{-8}$           |
|                  | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Protactinium 230 | (sol.)   | $7 \times 10^{-3}$          | $2 \times 10^{-9}$  | $2 \times 10^{-4}$ | $6 \times 10^{-11}$ |
|                  | (insol.) | $7 \times 10^{-3}$          | $8 \times 10^{-10}$ | $2 \times 10^{-4}$ | $3 \times 10^{-11}$ |
| Protactinium 231 | (sol.)   | $3 \times 10^{-5}$          | $10^{-12}$          | $9 \times 10^{-7}$ | $4 \times 10^{-14}$ |
|                  | (insol.) | $8 \times 10^{-4}$          | $10^{-10}$          | $2 \times 10^{-5}$ | $4 \times 10^{-12}$ |
| Protactinium 233 | (sol.)   | $4 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|                  | (insol.) | $3 \times 10^{-3}$          | $2 \times 10^{-7}$  | $10^{-4}$          | $6 \times 10^{-9}$  |
| Radium 223       | (sol.)   | $2 \times 10^{-5}$          | $2 \times 10^{-9}$  | $7 \times 10^{-7}$ | $6 \times 10^{-11}$ |
|                  | (insol.) | $10^{-4}$                   | $2 \times 10^{-10}$ | $4 \times 10^{-6}$ | $8 \times 10^{-12}$ |
| Radium 224       | (sol.)   | $7 \times 10^{-5}$          | $5 \times 10^{-9}$  | $2 \times 10^{-6}$ | $2 \times 10^{-10}$ |
|                  | (insol.) | $2 \times 10^{-4}$          | $7 \times 10^{-10}$ | $5 \times 10^{-6}$ | $2 \times 10^{-11}$ |
| Radium 226       | (sol.)   | $4 \times 10^{-7}$          | $3 \times 10^{-11}$ | $3 \times 10^{-8}$ | $3 \times 10^{-12}$ |
|                  | (insol.) | $9 \times 10^{-4}$          | $5 \times 10^{-11}$ | $3 \times 10^{-5}$ | $2 \times 10^{-12}$ |
| Radium 228       | (sol.)   | $8 \times 10^{-7}$          | $7 \times 10^{-11}$ | $3 \times 10^{-8}$ | $2 \times 10^{-12}$ |
|                  | (insol.) | $7 \times 10^{-4}$          | $4 \times 10^{-11}$ | $3 \times 10^{-5}$ | $10^{-12}$          |
| Radon 220        |          | ....                        | $3 \times 10^{-7}$  | ....               | $10^{-8}$           |
| Radon 222        |          | ....                        | $3 \times 10^{-8}$  | ....               | $1 \times 10^{-9}$  |
| Rhenium 183      | (sol.)   | 0.02                        | $3 \times 10^{-6}$  | $6 \times 10^{-4}$ | $9 \times 10^{-8}$  |
|                  | (insol.) | $8 \times 10^{-3}$          | $2 \times 10^{-7}$  | $3 \times 10^{-4}$ | $5 \times 10^{-9}$  |
| Rhenium 186      | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $9 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|                  | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $5 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Rhenium 187      | (sol.)   | 0.07                        | $9 \times 10^{-6}$  | 0.003              | $3 \times 10^{-7}$  |
|                  | (insol.) | 0.04                        | $5 \times 10^{-7}$  | 0.002              | $2 \times 10^{-8}$  |

| Radionuclide  |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|---------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|               |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column        |          | A                           | B                   | C                  | D                   |
| Rhenium 188   | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
|               | (insol.) | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Rhodium 103m  | (sol.)   | 0.4                         | $8 \times 10^{-5}$  | 0.01               | $3 \times 10^{-6}$  |
|               | (insol.) | 0.3                         | $6 \times 10^{-5}$  | 0.01               | $2 \times 10^{-6}$  |
| Rhodium 105   | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Rubidium 86   | (sol.)   | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $7 \times 10^{-5}$ | $10^{-8}$           |
|               | (insol.) | $7 \times 10^{-4}$          | $7 \times 10^{-8}$  | $2 \times 10^{-5}$ | $2 \times 10^{-9}$  |
| Rubidium 87   | (sol.)   | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|               | (insol.) | $5 \times 10^{-3}$          | $7 \times 10^{-8}$  | $2 \times 10^{-4}$ | $2 \times 10^{-9}$  |
| Ruthenium 97  | (sol.)   | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $8 \times 10^{-8}$  |
|               | (insol.) | 0.01                        | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $6 \times 10^{-8}$  |
| Ruthenium 103 | (sol.)   | $2 \times 10^{-3}$          | $5 \times 10^{-7}$  | $8 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $2 \times 10^{-3}$          | $8 \times 10^{-8}$  | $8 \times 10^{-5}$ | $3 \times 10^{-9}$  |
| Ruthenium 105 | (sol.)   | $3 \times 10^{-3}$          | $7 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
| Ruthenium 106 | (sol.)   | $4 \times 10^{-4}$          | $8 \times 10^{-8}$  | $10^{-5}$          | $3 \times 10^{-9}$  |
|               | (insol.) | $3 \times 10^{-4}$          | $6 \times 10^{-9}$  | $10^{-5}$          | $2 \times 10^{-10}$ |
| Samarium 147  | (sol.)   | $2 \times 10^{-3}$          | $7 \times 10^{-11}$ | $6 \times 10^{-5}$ | $2 \times 10^{-12}$ |
|               | (insol.) | $2 \times 10^{-3}$          | $3 \times 10^{-10}$ | $7 \times 10^{-5}$ | $9 \times 10^{-12}$ |
| Samarium 151  | (sol.)   | 0.01                        | $6 \times 10^{-8}$  | $4 \times 10^{-4}$ | $2 \times 10^{-9}$  |
|               | (insol.) | 0.01                        | $10^{-7}$           | $4 \times 10^{-4}$ | $5 \times 10^{-9}$  |
| Samarium 153  | (sol.)   | $2 \times 10^{-3}$          | $5 \times 10^{-7}$  | $8 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $8 \times 10^{-5}$ | $10^{-8}$           |
| Scandium 46   | (sol.)   | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $8 \times 10^{-9}$  |
|               | (insol.) | $10^{-3}$                   | $2 \times 10^{-8}$  | $4 \times 10^{-5}$ | $8 \times 10^{-10}$ |
| Scandium 47   | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $9 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $5 \times 10^{-7}$  | $9 \times 10^{-5}$ | $2 \times 10^{-8}$  |
| Scandium 48   | (sol.)   | $8 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|               | (insol.) | $8 \times 10^{-4}$          | $10^{-7}$           | $3 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Selenium 75   | (sol.)   | $9 \times 10^{-3}$          | $10^{-6}$           | $3 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.) | $8 \times 10^{-3}$          | $10^{-7}$           | $3 \times 10^{-4}$ | $4 \times 10^{-9}$  |
| Silicon 31    | (sol.)   | 0.03                        | $6 \times 10^{-6}$  | $9 \times 10^{-4}$ | $2 \times 10^{-7}$  |
|               | (insol.) | $6 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Silver 105    | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|               | (insol.) | $3 \times 10^{-3}$          | $8 \times 10^{-8}$  | $10^{-4}$          | $3 \times 10^{-9}$  |
| Silver 110m   | (sol.)   | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $7 \times 10^{-9}$  |
|               | (insol.) | $9 \times 10^{-4}$          | $10^{-8}$           | $3 \times 10^{-5}$ | $3 \times 10^{-10}$ |
| Silver 111    | (sol.)   | $10^{-3}$                   | $3 \times 10^{-7}$  | $4 \times 10^{-5}$ | $10^{-8}$           |
|               | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Sodium 22     | (sol.)   | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $6 \times 10^{-9}$  |
|               | (insol.) | $9 \times 10^{-4}$          | $9 \times 10^{-9}$  | $3 \times 10^{-5}$ | $3 \times 10^{-10}$ |
| Sodium 24     | (sol.)   | $6 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
|               | (insol.) | $8 \times 10^{-4}$          | $10^{-7}$           | $3 \times 10^{-5}$ | $5 \times 10^{-9}$  |
| Strontium 85m | (sol.)   | 0.2                         | $4 \times 10^{-5}$  | 0.007              | $10^{-6}$           |
|               | (insol.) | 0.2                         | $3 \times 10^{-5}$  | 0.007              | $10^{-6}$           |
| Strontium 85  | (sol.)   | $3 \times 10^{-3}$          | $2 \times 10^{-7}$  | $10^{-4}$          | $8 \times 10^{-9}$  |
|               | (insol.) | $5 \times 10^{-3}$          | $10^{-7}$           | $2 \times 10^{-4}$ | $4 \times 10^{-9}$  |
| Strontium 89  | (sol.)   | $3 \times 10^{-4}$          | $3 \times 10^{-8}$  | $3 \times 10^{-6}$ | $3 \times 10^{-10}$ |
|               | (insol.) | $8 \times 10^{-4}$          | $4 \times 10^{-8}$  | $3 \times 10^{-5}$ | $10^{-9}$           |
| Strontium 90  | (sol.)   | $1 \times 10^{-5}$          | $1 \times 10^{-9}$  | $4 \times 10^{-7}$ | $4 \times 10^{-11}$ |
|               | (insol.) | $10^{-3}$                   | $5 \times 10^{-9}$  | $4 \times 10^{-5}$ | $2 \times 10^{-10}$ |
| Strontium 91  | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $7 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $10^{-3}$                   | $3 \times 10^{-7}$  | $5 \times 10^{-5}$ | $9 \times 10^{-9}$  |
| Strontium 92  | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $7 \times 10^{-5}$ | $2 \times 10^{-8}$  |
|               | (insol.) | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |

| Radionuclide   |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|----------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|                |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column         |          | A                           | B                   | C                  | D                   |
| Sulfur 35      | (sol.)   | $2 \times 10^{-3}$          | $3 \times 10^{-7}$  | $6 \times 10^{-5}$ | $9 \times 10^{-9}$  |
|                | (insol.) | $8 \times 10^{-3}$          | $3 \times 10^{-7}$  | $3 \times 10^{-4}$ | $9 \times 10^{-9}$  |
| Tantalum 182   | (sol.)   | $10^{-3}$                   | $4 \times 10^{-8}$  | $4 \times 10^{-5}$ | $10^{-9}$           |
|                | (insol.) | $10^{-3}$                   | $2 \times 10^{-8}$  | $4 \times 10^{-5}$ | $7 \times 10^{-10}$ |
| Technetium 96m | (sol.)   | 0.4                         | $8 \times 10^{-5}$  | 0.01               | $3 \times 10^{-6}$  |
|                | (insol.) | 0.3                         | $3 \times 10^{-5}$  | 0.01               | $10^{-6}$           |
| Technetium 96  | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|                | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $5 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Technetium 97m | (sol.)   | 0.01                        | $2 \times 10^{-6}$  | $4 \times 10^{-4}$ | $8 \times 10^{-9}$  |
|                | (insol.) | $5 \times 10^{-3}$          | $2 \times 10^{-7}$  | $2 \times 10^{-4}$ | $5 \times 10^{-9}$  |
| Technetium 97  | (sol.)   | 0.05                        | $10^{-5}$           | 0.002              | $4 \times 10^{-7}$  |
|                | (insol.) | 0.02                        | $3 \times 10^{-7}$  | $8 \times 10^{-4}$ | $10^{-8}$           |
| Technetium 99m | (sol.)   | 0.2                         | $4 \times 10^{-5}$  | 0.006              | $10^{-6}$           |
|                | (insol.) | 0.08                        | $10^{-5}$           | 0.003              | $5 \times 10^{-7}$  |
| Technetium 99  | (sol.)   | 0.01                        | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $7 \times 10^{-8}$  |
|                | (insol.) | $5 \times 10^{-3}$          | $6 \times 10^{-8}$  | $2 \times 10^{-4}$ | $2 \times 10^{-9}$  |
| Tellurium 125  | (sol.)   | $5 \times 10^{-3}$          | $4 \times 10^{-7}$  | $2 \times 10^{-4}$ | $10^{-8}$           |
|                | (insol.) | $3 \times 10^{-3}$          | $10^{-7}$           | $10^{-4}$          | $4 \times 10^{-9}$  |
| Tellurium 127m | (sol.)   | $2 \times 10^{-3}$          | $10^{-7}$           | $6 \times 10^{-5}$ | $5 \times 10^{-9}$  |
|                | (insol.) | $2 \times 10^{-3}$          | $4 \times 10^{-8}$  | $5 \times 10^{-5}$ | $10^{-9}$           |
| Tellurium 127  | (sol.)   | $8 \times 10^{-3}$          | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $6 \times 10^{-8}$  |
|                | (insol.) | $5 \times 10^{-3}$          | $9 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Tellurium 129m | (sol.)   | $10^{-3}$                   | $8 \times 10^{-8}$  | $3 \times 10^{-5}$ | $3 \times 10^{-9}$  |
|                | (insol.) | $6 \times 10^{-4}$          | $3 \times 10^{-8}$  | $2 \times 10^{-5}$ | $10^{-9}$           |
| Tellurium 129  | (sol.)   | 0.02                        | $5 \times 10^{-6}$  | $8 \times 10^{-4}$ | $2 \times 10^{-7}$  |
|                | (insol.) | 0.02                        | $4 \times 10^{-6}$  | $8 \times 10^{-4}$ | $10^{-7}$           |
| Tellurium 131m | (sol.)   | $2 \times 10^{-3}$          | $4 \times 10^{-7}$  | $6 \times 10^{-5}$ | $10^{-8}$           |
|                | (insol.) | $10^{-3}$                   | $2 \times 10^{-7}$  | $4 \times 10^{-5}$ | $6 \times 10^{-9}$  |
| Tellurium 132  | (sol.)   | $9 \times 10^{-4}$          | $2 \times 10^{-7}$  | $3 \times 10^{-5}$ | $7 \times 10^{-9}$  |
|                | (insol.) | $6 \times 10^{-4}$          | $10^{-7}$           | $2 \times 10^{-5}$ | $4 \times 10^{-9}$  |
| Terbium 160    | (sol.)   | $10^{-3}$                   | $10^{-7}$           | $4 \times 10^{-5}$ | $3 \times 10^{-9}$  |
|                | (insol.) | $10^{-3}$                   | $3 \times 10^{-8}$  | $4 \times 10^{-5}$ | $10^{-9}$           |
| Thallium 200   | (sol.)   | 0.01                        | $3 \times 10^{-6}$  | $4 \times 10^{-4}$ | $9 \times 10^{-8}$  |
|                | (insol.) | $7 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
| Thallium 201   | (sol.)   | $9 \times 10^{-3}$          | $2 \times 10^{-6}$  | $3 \times 10^{-4}$ | $7 \times 10^{-8}$  |
|                | (insol.) | $5 \times 10^{-3}$          | $9 \times 10^{-7}$  | $2 \times 10^{-4}$ | $3 \times 10^{-8}$  |
| Thallium 202   | (sol.)   | $4 \times 10^{-3}$          | $8 \times 10^{-7}$  | $10^{-4}$          | $3 \times 10^{-8}$  |
|                | (insol.) | $2 \times 10^{-3}$          | $2 \times 10^{-7}$  | $7 \times 10^{-5}$ | $8 \times 10^{-9}$  |
| Thallium 204   | (sol.)   | $3 \times 10^{-3}$          | $6 \times 10^{-7}$  | $10^{-4}$          | $2 \times 10^{-8}$  |
|                | (insol.) | $2 \times 10^{-3}$          | $3 \times 10^{-8}$  | $6 \times 10^{-5}$ | $9 \times 10^{-10}$ |
| Thorium 227    | (sol.)   | $5 \times 10^{-4}$          | $3 \times 10^{-10}$ | $2 \times 10^{-5}$ | $10^{-11}$          |
|                | (insol.) | $5 \times 10^{-4}$          | $2 \times 10^{-10}$ | $2 \times 10^{-5}$ | $6 \times 10^{-12}$ |
| Thorium 228    | (sol.)   | $2 \times 10^{-4}$          | $9 \times 10^{-12}$ | $7 \times 10^{-6}$ | $3 \times 10^{-13}$ |
|                | (insol.) | $4 \times 10^{-4}$          | $6 \times 10^{-12}$ | $10^{-5}$          | $2 \times 10^{-13}$ |
| Thorium 230    | (sol.)   | $5 \times 10^{-5}$          | $2 \times 10^{-12}$ | $2 \times 10^{-6}$ | $8 \times 10^{-14}$ |
|                | (insol.) | $9 \times 10^{-4}$          | $10^{-11}$          | $3 \times 10^{-5}$ | $3 \times 10^{-13}$ |
| Thorium 231    | (sol.)   | $7 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $5 \times 10^{-8}$  |
|                | (insol.) | $7 \times 10^{-3}$          | $10^{-6}$           | $2 \times 10^{-4}$ | $4 \times 10^{-8}$  |
| Thorium 232    | (sol.)   | $5 \times 10^{-5}$          | $3 \times 10^{-11}$ | $2 \times 10^{-6}$ | $10^{-12}$          |
|                | (insol.) | $10^{-3}$                   | $3 \times 10^{-11}$ | $4 \times 10^{-5}$ | $10^{-12}$          |
| Thorium 234    | (sol.)   | $5 \times 10^{-4}$          | $6 \times 10^{-8}$  | $2 \times 10^{-5}$ | $2 \times 10^{-9}$  |
|                | (insol.) | $5 \times 10^{-4}$          | $3 \times 10^{-8}$  | $2 \times 10^{-5}$ | $10^{-9}$           |
| Thorium Nat.   | (sol.)   | $3 \times 10^{-5}$          | $3 \times 10^{-11}$ | $10^{-6}$          | $10^{-12}$          |
|                | (insol.) | $3 \times 10^{-4}$          | $3 \times 10^{-11}$ | $10^{-5}$          | $10^{-12}$          |
| Thulium 170    | (sol.)   | $10^{-3}$                   | $4 \times 10^{-8}$  | $5 \times 10^{-5}$ | $10^{-9}$           |
|                | (insol.) | $10^{-3}$                   | $3 \times 10^{-8}$  | $5 \times 10^{-5}$ | $10^{-9}$           |

#### 4.6 Table of Exempt Quantities

| Radionuclide    |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|-----------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|                 |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column          |          | A                           | B                   | C                  | D                   |
| Thulium 171     | (sol.)   | 0.01                        | 10 <sup>-7</sup>    | 5x10 <sup>-4</sup> | 4x10 <sup>-9</sup>  |
|                 | (insol.) | 0.01                        | 2x10 <sup>-7</sup>  | 5x10 <sup>-4</sup> | 8x10 <sup>-9</sup>  |
| Tin 113         | (sol.)   | 2x10 <sup>-3</sup>          | 4x10 <sup>-7</sup>  | 9x10 <sup>-5</sup> | 10 <sup>-8</sup>    |
|                 | (insol.) | 2x10 <sup>-3</sup>          | 5x10 <sup>-8</sup>  | 8x10 <sup>-5</sup> | 2x10 <sup>-9</sup>  |
| Tin 125         | (sol.)   | 5x10 <sup>-4</sup>          | 10 <sup>-7</sup>    | 2x10 <sup>-5</sup> | 4x10 <sup>-9</sup>  |
|                 | (insol.) | 5x10 <sup>-4</sup>          | 8x10 <sup>-8</sup>  | 2x10 <sup>-5</sup> | 3x10 <sup>-9</sup>  |
| Tungsten 181    | (sol.)   | 0.01                        | 2x10 <sup>-6</sup>  | 4x10 <sup>-4</sup> | 8x10 <sup>-8</sup>  |
|                 | (insol.) | 0.01                        | 10 <sup>-7</sup>    | 3x10 <sup>-4</sup> | 4x10 <sup>-9</sup>  |
| Tungsten 185    | (sol.)   | 4x10 <sup>-3</sup>          | 8x10 <sup>-7</sup>  | 10 <sup>-4</sup>   | 3x10 <sup>-8</sup>  |
|                 | (insol.) | 3x10 <sup>-3</sup>          | 10 <sup>-7</sup>    | 10 <sup>-4</sup>   | 4x10 <sup>-9</sup>  |
| Tungsten 187    | (sol.)   | 2x10 <sup>-3</sup>          | 4x10 <sup>-7</sup>  | 7x10 <sup>-5</sup> | 2x10 <sup>-8</sup>  |
|                 | (insol.) | 2x10 <sup>-3</sup>          | 3x10 <sup>-7</sup>  | 6x10 <sup>-5</sup> | 10 <sup>-8</sup>    |
| Uranium 230     | (sol.)   | 7x10 <sup>-5</sup>          | 3x10 <sup>-10</sup> | 2x10 <sup>-6</sup> | 10 <sup>-11</sup>   |
|                 | (insol.) | 10 <sup>-4</sup>            | 10 <sup>-10</sup>   | 5x10 <sup>-6</sup> | 4x10 <sup>-12</sup> |
| Uranium 232     | (sol.)   | 2x10 <sup>-5</sup>          | 10 <sup>-10</sup>   | 8x10 <sup>-7</sup> | 3x10 <sup>-12</sup> |
|                 | (insol.) | 8x10 <sup>-4</sup>          | 3x10 <sup>-11</sup> | 3x10 <sup>-5</sup> | 9x10 <sup>-13</sup> |
| Uranium 233     | (sol.)   | 10 <sup>-4</sup>            | 5x10 <sup>-10</sup> | 4x10 <sup>-6</sup> | 2x10 <sup>-11</sup> |
|                 | (insol.) | 9x10 <sup>-4</sup>          | 10 <sup>-10</sup>   | 3x10 <sup>-5</sup> | 4x10 <sup>-12</sup> |
| Uranium 234     | (sol.)   | 10 <sup>-4</sup>            | 6x10 <sup>-10</sup> | 4x10 <sup>-6</sup> | 2x10 <sup>-11</sup> |
|                 | (insol.) | 9x10 <sup>-4</sup>          | 10 <sup>-10</sup>   | 3x10 <sup>-5</sup> | 4x10 <sup>-12</sup> |
| Uranium 235     | (sol.)   | 10 <sup>-4</sup>            | 5x10 <sup>-10</sup> | 4x10 <sup>-6</sup> | 2x10 <sup>-11</sup> |
|                 | (insol.) | 8x10 <sup>-4</sup>          | 10 <sup>-10</sup>   | 3x10 <sup>-5</sup> | 4x10 <sup>-12</sup> |
| Uranium 236     | (sol.)   | 10 <sup>-4</sup>            | 6x10 <sup>-10</sup> | 5x10 <sup>-6</sup> | 2x10 <sup>-11</sup> |
|                 | (insol.) | 10 <sup>-3</sup>            | 10 <sup>-10</sup>   | 3x10 <sup>-5</sup> | 4x10 <sup>-12</sup> |
| Uranium 238     | (sol.)   | 2x10 <sup>-5</sup>          | 7x10 <sup>-11</sup> | 6x10 <sup>-7</sup> | 3x10 <sup>-12</sup> |
|                 | (insol.) | 10 <sup>-3</sup>            | 10 <sup>-10</sup>   | 4x10 <sup>-5</sup> | 5x10 <sup>-12</sup> |
| Uranium 240     | (sol.)   | 1x10 <sup>-3</sup>          | 2x10 <sup>-7</sup>  | 3x10 <sup>-5</sup> | 8x10 <sup>-9</sup>  |
| & Neptunium 240 | (insol.) | 1x10 <sup>-3</sup>          | 2x10 <sup>-7</sup>  | 3x10 <sup>-5</sup> | 6x10 <sup>-9</sup>  |
| Uranium-Nat.    | (sol.)   | 2x10 <sup>-5</sup>          | 7x10 <sup>-11</sup> | 6x10 <sup>-7</sup> | 3x10 <sup>-12</sup> |
|                 | (insol.) | 5x10 <sup>-4</sup>          | 6x10 <sup>-11</sup> | 2x10 <sup>-5</sup> | 2x10 <sup>-12</sup> |
| Vanadium 48     | (sol.)   | 9x10 <sup>-4</sup>          | 2x10 <sup>-7</sup>  | 3x10 <sup>-5</sup> | 6x10 <sup>-9</sup>  |
|                 | (insol.) | 8x10 <sup>-4</sup>          | 6x10 <sup>-8</sup>  | 3x10 <sup>-5</sup> | 2x10 <sup>-9</sup>  |
| Xenon 131m      | (imm.)   | ....                        | 2x10 <sup>-5</sup>  | ....               | 4x10 <sup>-7</sup>  |
| Xenon 133       | (imm.)   | ....                        | 10 <sup>-5</sup>    | ....               | 3x10 <sup>-7</sup>  |
| Xenon 133m      | (imm.)   | ....                        | 1x10 <sup>-5</sup>  | ....               | 3x10 <sup>-7</sup>  |
| Xenon 135       | (imm.)   | ....                        | 4x10 <sup>-6</sup>  | ....               | 10 <sup>-7</sup>    |
| Ytterbium 175   | (sol.)   | 3x10 <sup>-3</sup>          | 7x10 <sup>-7</sup>  | 10 <sup>-4</sup>   | 2x10 <sup>-8</sup>  |
|                 | (insol.) | 3x10 <sup>-3</sup>          | 6x10 <sup>-7</sup>  | 10 <sup>-4</sup>   | 2x10 <sup>-8</sup>  |
| Yttrium 90      | (sol.)   | 6x10 <sup>-4</sup>          | 10 <sup>-7</sup>    | 2x10 <sup>-5</sup> | 4x10 <sup>-9</sup>  |
|                 | (insol.) | 6x10 <sup>-4</sup>          | 10 <sup>-7</sup>    | 2x10 <sup>-5</sup> | 3x10 <sup>-9</sup>  |
| Yttrium 91m     | (sol.)   | 0.1                         | 2x10 <sup>-5</sup>  | 0.003              | 8x10 <sup>-7</sup>  |
|                 | (insol.) | 0.1                         | 2x10 <sup>-5</sup>  | 0.003              | 6x10 <sup>-7</sup>  |
| Yttrium 91      | (sol.)   | 8x10 <sup>-4</sup>          | 4x10 <sup>-8</sup>  | 3x10 <sup>-5</sup> | 10 <sup>-9</sup>    |
|                 | (insol.) | 8x10 <sup>-4</sup>          | 3x10 <sup>-8</sup>  | 3x10 <sup>-5</sup> | 10 <sup>-9</sup>    |
| Yttrium 92      | (sol.)   | 2x10 <sup>-3</sup>          | 4x10 <sup>-7</sup>  | 6x10 <sup>-5</sup> | 10 <sup>-8</sup>    |
|                 | (insol.) | 2x10 <sup>-3</sup>          | 3x10 <sup>-7</sup>  | 6x10 <sup>-5</sup> | 10 <sup>-8</sup>    |
| Yttrium 93      | (sol.)   | 8x10 <sup>-4</sup>          | 2x10 <sup>-7</sup>  | 3x10 <sup>-5</sup> | 6x10 <sup>-9</sup>  |
|                 | (insol.) | 8x10 <sup>-4</sup>          | 10 <sup>-7</sup>    | 3x10 <sup>-5</sup> | 5x10 <sup>-9</sup>  |
| Zinc 65         | (sol.)   | 3x10 <sup>-3</sup>          | 10 <sup>-7</sup>    | 10 <sup>-4</sup>   | 4x10 <sup>-9</sup>  |
|                 | (insol.) | 5x10 <sup>-3</sup>          | 6x10 <sup>-8</sup>  | 2x10 <sup>-4</sup> | 2x10 <sup>-9</sup>  |
| Zinc 69m        | (sol.)   | 2x10 <sup>-3</sup>          | 4x10 <sup>-7</sup>  | 7x10 <sup>-5</sup> | 10 <sup>-8</sup>    |
|                 | (insol.) | 2x10 <sup>-3</sup>          | 3x10 <sup>-7</sup>  | 6x10 <sup>-5</sup> | 10 <sup>-8</sup>    |
| Zinc 69         | (sol.)   | 0.05                        | 7x10 <sup>-6</sup>  | 0.002              | 2x10 <sup>-7</sup>  |
|                 | (insol.) | 0.05                        | 9x10 <sup>-6</sup>  | 0.002              | 3x10 <sup>-7</sup>  |
| Zirconium 93    | (sol.)   | 0.02                        | 10 <sup>-7</sup>    | 8x10 <sup>-4</sup> | 4x10 <sup>-9</sup>  |
|                 | (insol.) | 0.02                        | 3x10 <sup>-7</sup>  | 8x10 <sup>-4</sup> | 10 <sup>-8</sup>    |

| Radionuclide                     |          | Occupational<br>40-hr. Week |                     | Non-Occupational   |                     |
|----------------------------------|----------|-----------------------------|---------------------|--------------------|---------------------|
|                                  |          | Water<br>uc/ml              | Air<br>uc/ml        | Water<br>uc/ml     | Air<br>uc/ml        |
| Column                           |          | A                           | B                   | C                  | D                   |
| Zirconium 95                     | (sol.)   | 2x10 <sup>-3</sup>          | 10 <sup>-7</sup>    | 6x10 <sup>-5</sup> | 4x10 <sup>-9</sup>  |
|                                  | (insol.) | 2x10 <sup>-3</sup>          | 3x10 <sup>-8</sup>  | 6x10 <sup>-5</sup> | 10 <sup>-9</sup>    |
| Zirconium 97                     | (sol.)   | 5x10 <sup>-4</sup>          | 10 <sup>-7</sup>    | 2x10 <sup>-5</sup> | 4x10 <sup>-9</sup>  |
|                                  | (insol.) | 5x10 <sup>-4</sup>          | 9x10 <sup>-8</sup>  | 2x10 <sup>-5</sup> | 3x10 <sup>-9</sup>  |
| Unidentified<br>Radionuclide (s) |          | 3x10 <sup>-7</sup>          | 1x10 <sup>-12</sup> | 10 <sup>-8</sup>   | 4x10 <sup>-14</sup> |

#### NOTE:

Abbreviations— sol. = soluble  
insol. = insoluble  
imm. = immersion  
m = metastable

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this section shall be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values shall be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in this Section for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides A, B, and C are present in concentrations C<sub>a</sub>, C<sub>b</sub> and C<sub>c</sub>, and if the applicable MPC's are MPC<sub>a</sub> and MPC<sub>b</sub> and MPC<sub>c</sub>, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \frac{C_c}{MPC_c} = 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of this section shall be:
  - a. For purposes of Column A — 3x10<sup>-7</sup>
  - b. For purposes of Column B — 1x10<sup>-12</sup>
  - c. For purposes of Column C — 1x10<sup>-8</sup>
  - d. For purposes of Column D — 4x10<sup>-14</sup>
3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Section 7.5 for the radionuclide in the mixture having the lowest concentration limit; or

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Section 7.5 are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Section 7.5 for any radionuclide which is not known to be absent from the mixture; or

| c. Element (atomic number) and isotope                                                                                                                     | Table 1                  |                            | Table II                 |                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|----------------------------|--------------------------|----------------------------|
|                                                                                                                                                            | Col. 1<br>Air<br>(uc/ml) | Col. 2<br>Water<br>(uc/ml) | Col. 1<br>Air<br>(uc/ml) | Col. 2<br>Water<br>(uc/ml) |
| If it is known that Sr 90, I 129, Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, and Th-nat are not present ..... | ....                     | 9x10 <sup>-5</sup>         | ....                     | 3x10 <sup>-6</sup>         |
| If it is known that Sr 90, I 129, Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, and Th-nat are not present .....                                         | ....                     | 6x10 <sup>-5</sup>         | ....                     | 2x10 <sup>-6</sup>         |
| If it is known that Sr 90, Pb 210, Ra 226 and Ra 228 are not present .....                                                                                 | ....                     | 2x10 <sup>-5</sup>         | ....                     | 6x10 <sup>-7</sup>         |
| If it is known that Ra 226 and Ra 228 are not present .....                                                                                                | ....                     | 3x10 <sup>-6</sup>         | ....                     | 1x10 <sup>-7</sup>         |
| If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241 and Bk 249 are not present .....                               | 3x10 <sup>-9</sup>       | ....                       | 1x10 <sup>-10</sup>      | ....                       |
| If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228 and Pu 241 are not present .....                                                             | 3x10 <sup>-10</sup>      | ....                       | 1x10 <sup>-11</sup>      | ....                       |
| If it is known that alpha-emitters and Ac 227 are not present .....                                                                                        | 3x10 <sup>-11</sup>      | ....                       | 1x10 <sup>-12</sup>      | ....                       |
| If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, and Cf 249 are not present .....                                               | 3x10 <sup>-12</sup>      | ....                       | 1x10 <sup>-13</sup>      | ....                       |
| If Pa 231, Pu 239, Pu 240, Pu 242 and Cf 249 are not present .....                                                                                         | 2x10 <sup>-12</sup>      | ....                       | 7x10 <sup>-14</sup>      | ....                       |

4. If the mixture of radionuclides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Section 7.5, Column B, 1x10<sup>-10</sup> uc/ml gross alpha activity; or 2.5x10<sup>-11</sup> uc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Section 7.5, Column D, 3x10<sup>-12</sup> uc/ml gross alpha activity; or 8x10<sup>-13</sup> uc/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C<sub>a</sub>) to the concentration limit for that radionuclide specified in Columns C and D of Section 7.5 (MPC<sub>a</sub>) does not exceed 1/10, i.e.,

$$\frac{C_a}{MPC_a} \leq \frac{1}{10}$$

and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4; i.e.,

$$\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \dots \leq \frac{1}{4}$$

## SECTION 8—RADIATION SURVEYS AND PERSONNEL MONITORING

### 8.1 Surveys Inside Controlled Areas

8.1.1 Controlled areas shall be surveyed by, or under the direction of, a qualified individual to determine if the installation is maintained and operations are conducted in compliance with this Code.

8.1.2 Radiation levels shall be determined with the use of suitable instruments and methods.

8.1.3 Surveys shall be made of the air for radioactive content when the average concentrations may exceed one-fourth the amount specified in Section 7.5, Column B, or prorated values when more than one isotope is present.

8.1.4 Installations where unsealed radioactive materials are stored or used shall be periodically surveyed for contamination of surfaces. These surveys shall be conducted in a manner to insure that the levels of surface contamination are below those which could lead to exposures amounting to 10% of the limits specified in Sections 7.1.1 or 7.1.4.

8.1.5 The record of a survey shall contain, but shall not be limited to, the radiation levels, the time the

radiation is produced, the workweek and the fraction of the workweek that any individual may be exposed to the radiation and, when required, the radioactive air concentrations and surface contaminations.

8.1.6 Subsequent surveys shall be conducted at such times and as frequently as may be necessary to assure that the controlled areas and operations therein remain in compliance with this Code.

## **8.2 Surveys Outside Controlled Areas**

Surveys shall be made outside controlled areas at sufficient intervals and locations as may be necessary to insure compliance with Sections 7.2 and 7.3.

## **8.3 Statement in Lieu of Actual Survey**

A written statement signed by a qualified individual and including his calculations and analysis of the dose rates in the vicinity of a radiation source may be acceptable in place of the survey required in Section 8.1 and Section 8.2, except when radioactive-air contamination or surface contamination is involved.

## **8.4 Use of Personnel-Monitoring Equipment**

Each owner shall supply appropriate personnel-monitoring equipment to and shall require that it be used by:

(1) Each individual who enters a controlled area under such circumstances that he receives or is likely to receive, a dose in excess of 25 millirems in any period of 7 consecutive days; and

(2) Each individual under 18 years of age who enters a controlled area under such circumstances that he receives or is likely to receive, a dose in excess of 10 millirems in any period of 7 consecutive days; and

(3) Each individual who enters a high-radiation area.

(4) At least one visitor in a group of visitors entering a controlled area.

All individuals required to wear personnel-monitoring equipment shall be instructed in its proper use and purpose. Records shall be kept in accordance with Section 9.1.

When an individual working on the premises of an owner, but not employed by him, is wearing personnel-monitoring equipment provided by his employer, the owner of the radiation source shall not be required to provide additional personnel-monitoring equipment.

## **8.5 Requirements for Bio-assays**

Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Department may incorporate license provisions or issue an order requiring the owner to have appropriate bio-assays made and to furnish the Department with copies of such bio-assays.

# **SECTION 9—RECORDS**

## **9.1 Personnel-Monitoring Records**

9.1.1 Clear and legible records shall be maintained by the owner for calendar quarters on Form RH-26, or on a clear and legible form containing all the information required on RH-26. These records shall show the radiation exposures of all individuals who are required to wear personnel-monitoring equipment according to Section 8.4, and any required bio-assays according to Section 8.5.

9.1.2 Each employee, at his request, shall be supplied by the owner with an annual statement of his radiation exposure record and any bio-assays.

9.1.3 At the request of an individual formerly employed by the owner, each owner shall furnish such individual a report of his exposure to radiation, including bio-assays, as shown in records maintained by the owner pursuant to Section 9.1.1. Such report shall be furnished within 30 days from the time the request is made, or within 60 days from termination of employment, whichever is later. The report shall cover each calendar quarter of the individual's employment involving exposure to radiation.

9.1.4 When an individual working on the premises of an owner, but not employed by him, is required by the owner to wear personnel-monitoring equipment, the owner of the radiation source shall furnish such individual's employer within 90 days a statement of the individual's radiation record and this shall be incorporated in the individual's exposure record.

9.1.5 Each report or statement required by Sections 9.1.2, 9.1.3 or 9.1.4 shall contain the following statement: "This report is furnished to you under the provisions of Section 9 of the New Jersey Radiation Protection Code. You should preserve this report for future reference."

9.1.6 The exposure records on each employee shall be preserved during the course of his employment and for at least ten years after termination of employment. Exposure records of other persons shall be preserved for at least ten years.

9.1.7 These records or true copy of same shall be made available to the Department on request.

## **9.2 Records of Surveys**

9.2.1 Records shall be maintained showing the results of such surveys as are required pursuant to Section 8.

9.2.2 The records of each survey shall be retained for at least ten years.

9.2.3 These records or true copy of same shall be made available to the Department on request.

9.2.4 The owner of any installation covered in Sections 17, 18 and 19 of Chapter II shall submit to the Department within 30 days of receipt a copy of each report of radiation surveys made in compliance with Section 8.

### 9.3 Records of Radioactive Materials

9.3.1 An accurate accounting for all radioactive materials shall be maintained for a radiation installation. Such records shall show radioactive materials received, produced, and disposed, the amounts and form of the radioactive materials, and any other information as may be necessary to account for the difference between the amount of radioactive material received or produced and the amount on hand.

9.3.2 Such records shall be retained for at least two years after the final disposition of any radioactive material.

9.3.3 These records or true copy of same shall be made available to the Department on request.

### 9.4 Records of Sealed Source Testing

Records of the results of sealed source testing shall be kept at least two years.

### 9.5 Records from Discontinued Installations

The discontinuance of a radiation installation does not relieve the owner from the responsibility of retaining the records required by this Section. Such owner may, however, request the Department to accept the records. The acceptance of such records by the Department relieves the owner of subsequent responsibility only in respect to their preservation as required by this Code.

## SECTION 10—RADIOACTIVE CONTAMINATION CONTROL

### 10.1 General Precautions

All work with radioactive materials shall be carried out under such conditions as to minimize the radioactive contamination of the area and of the person(s) working therein.

### 10.2 Personnel and Material Contamination

10.2.1 When the nature of the work is such that an individual or his clothing may become contaminated, the individual and his clothing shall be suitably monitored.

10.2.2 Any contamination which might lead to exposures greater than 10% of the limits specified in Sections 7.1.1 or 7.1.4, shall be removed from the contaminated individual before that individual is permitted to leave the area.

10.2.3 No clothing, equipment, or other material having contamination which might lead to exposures greater than those specified in Section 10.2.2, shall be permitted to leave the area except as radioactive material.

### 10.3 Decontamination of Premise

Radioactively contaminated premises shall be decontaminated so that individuals using these premises shall not receive exposures greater than those listed in Section 10.2.2.

### 10.4 Sealed Source Testing

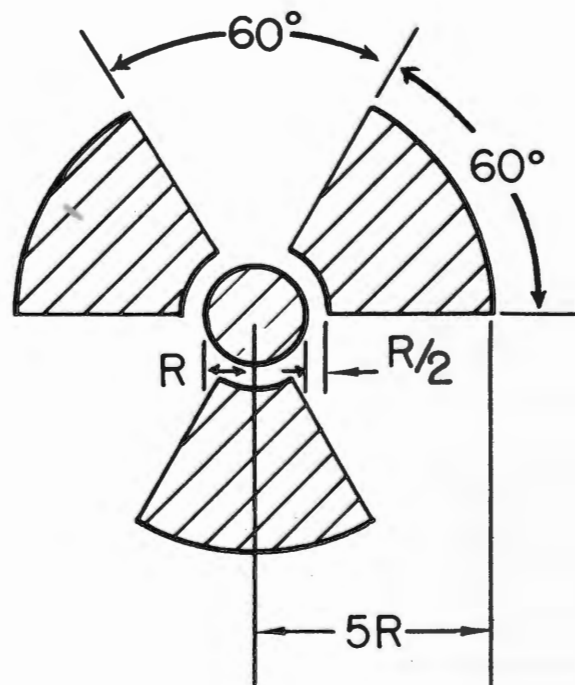
Unless otherwise specified in a Federal agency license, or a State license, sealed sources containing more than 10 times the exempt quantities of Section 4.6, Column B, or more than 10 times the generally licensed quantities of Section 5.18, shall be leak tested as follows: sealed sources, except tritium and krypton, shall be tested for leakage at intervals of not longer than six months. Records of all sealed source testing shall be kept in accordance with Section 9.4.

## SECTION 11—LABELING, POSTING, AND CONTROLS

### 11.1 General Requirement

11.1.1 All signs and labels required by this section shall use the conventional radiation caution symbol shaped and colored as follows:

RADIATION CAUTION SYMBOL



1. Cross-hatched area is to be magenta or purple.
2. Background is to be yellow.

11.1.2 In addition to the language prescribed in the various paragraphs of this Section, any supplementary information which might be appropriate in aiding individuals to minimize exposure to radiation or to radioactive materials may be provided on or near such required signs or labels.

## **11.2 Radiation Areas**

Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

**CAUTION**  
**RADIATION AREA**      or      **DANGER**  
**RADIATION AREA**

## **11.3 High-Radiation Areas**

11.3.1 Each high-radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

**CAUTION**  
**HIGH RADIATION AREA**

or

**DANGER**  
**HIGH RADIATION AREA**

11.3.2 Each high-radiation area shall be under direct, constant surveillance to protect against unauthorized or accidental entry unless:

(a) It is equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in one hour upon entry into the area, or

(b) It is equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the owner or the supervisor of the activity are made aware of the entry, or

(c) It is locked to protect against unauthorized or accidental entry, and the owner or the supervisor of the activity maintains direct personal control over access to the key.

## **11.4 Airborne Radioactivity Areas**

Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

**CAUTION**  
**AIRBORNE RADIOACTIVITY AREA**

or

**DANGER**  
**AIRBORNE RADIOACTIVITY AREA**

## **11.5 Areas Containing Radioactive Materials**

11.5.1 Each area or room in which radioactive material (other than natural uranium or thorium) is used or stored in an amount greater than 10 times that

listed in Section 11.9 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

**CAUTION**  
**RADIOACTIVE MATERIAL(S)**

or

**DANGER**  
**RADIOACTIVE MATERIAL(S)**

11.5.2 Each area or room in which natural uranium or thorium is used or stored in an amount exceeding 100 times the quantity listed in Section 11.9 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

**CAUTION**  
**RADIOACTIVE MATERIAL(S)**

or

**DANGER**  
**RADIOACTIVE MATERIAL(S)**

## **11.6 Labeling of Equipment and Containers**

11.6.1 Any equipment or container in which radioactive material (other than natural uranium or thorium) is transported, stored, or used, in an amount greater than that specifically listed in Section 11.9 shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

**CAUTION**  
**RADIOACTIVE MATERIAL**

or

**DANGER**  
**RADIOACTIVE MATERIAL**

11.6.2 Each container in which natural uranium or thorium is transported, stored, or used in a quantity greater than 10 times the quantity listed in Section 11.9 shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

**CAUTION**  
**RADIOACTIVE MATERIAL**

or

**DANGER**  
**RADIOACTIVE MATERIAL**

**11.6.3** Where containers are used for storage, the labels required in this paragraph shall state also the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

**11.6.4** All radiation-producing machines capable, when operated, of producing a radiation area shall be labeled in a manner which cautions individuals of this fact.

### 11.7 Removal of Signs and Labels

All radiation caution signs and labels which may have been posted at a time when they were required shall be removed when the condition which originally required the posting no longer exists.

### 11.8 Exceptions from Posting and Labeling Requirements

**11.8.1** Radiation areas and high-radiation areas which result from the operation of therapeutic x-ray machines operated at potentials of 60 kv and below or from the operation of diagnostic x-ray machines shall be exempt from the posting requirements of Sections 11.2, 11.3 and 11.6.4 provided that the operator of the equipment has taken precautions to insure that no individual other than the patient shall be in the radiation area.

**11.8.2** Rooms or other areas in hospitals are not required to be posted with radiation caution signs because of the presence of patients containing radioactive material provided that there are personnel in attendance who shall take the precautions necessary to prevent the exposure of any individual other than the patient to radiation or radioactive material in excess of the limits established in this Code.

**11.8.3** A room or area is not required to be posted with a radiation caution sign because of the presence of a sealed source provided the radiation level 12 inches from the surface of the source container or source housing does not exceed 5 millirems per hour.

**11.8.4** Radiation caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than 8 hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any other individual to radiation or radioactive materials in excess of the limits established in these regulations, and (2) such area or room is subject to the user's control.

**11.8.5** Laboratory containers such as beakers, flasks and test tubes need not be labeled if they are being used transiently in laboratory procedures when the user is present.

**11.8.6** A container in which radioactive material is transported, stored, or used need not be labeled, if the concentration of the material in the container does not exceed that specified in Section 7.5, Column A.

**11.8.7** Radioactive materials packaged and labeled in accordance with regulations of the appropriate

Federal agency shall be exempt from the labeling and posting requirements of this Section during shipment, provided that the inside containers are labeled in accordance with the provisions of Section 11.6.

### 11.9 Labeling, Posting and Disposal Quantities of Radioactive Materials

| Material                                     | Microcuries | Material                                                                         | Microcuries |
|----------------------------------------------|-------------|----------------------------------------------------------------------------------|-------------|
| Ag <sup>105</sup> .....                      | 1           | Pd <sup>103</sup> + Rh <sup>103</sup> .....                                      | 50          |
| Ag <sup>111</sup> .....                      | 10          | Pd <sup>109</sup> .....                                                          | 10          |
| As <sup>76</sup> .....                       | 10          | Pm <sup>147</sup> .....                                                          | 10          |
| As <sup>77</sup> .....                       | 10          | Po <sup>210</sup> .....                                                          | 0.1         |
| Au <sup>198</sup> .....                      | 10          | Pr <sup>143</sup> .....                                                          | 10          |
| Au <sup>199</sup> .....                      | 10          | Pu <sup>239</sup> .....                                                          | 1           |
| Ba <sup>140</sup> + La <sup>140</sup> .....  | 1           | Ra <sup>226</sup> .....                                                          | 0.1         |
| Be <sup>7</sup> .....                        | 50          | Rb <sup>86</sup> .....                                                           | 10          |
| C <sup>14</sup> .....                        | 50          | Re <sup>186</sup> .....                                                          | 10          |
| Ca <sup>45</sup> .....                       | 10          | Rh <sup>105</sup> .....                                                          | 10          |
| Cd <sup>109</sup> + Ag <sup>109</sup> .....  | 10          | Ru <sup>106</sup> + Rh <sup>106</sup> .....                                      | 1           |
| Ce <sup>144</sup> + Pr <sup>144</sup> .....  | 1           | S <sup>35</sup> .....                                                            | 50          |
| Cf <sup>254</sup> .....                      | 1           | Sb <sup>124</sup> .....                                                          | 1           |
| Co <sup>60</sup> .....                       | 1           | Sc <sup>46</sup> .....                                                           | 1           |
| Cr <sup>51</sup> .....                       | 50          | Sm <sup>153</sup> .....                                                          | 10          |
| Cs <sup>137</sup> + Ba <sup>137</sup> .....  | 1           | Sn <sup>113</sup> .....                                                          | 10          |
| Cu <sup>64</sup> .....                       | 50          | Sr <sup>89</sup> .....                                                           | 1           |
| Eu <sup>154</sup> .....                      | 1           | Sr <sup>90</sup> + Y <sup>90</sup> .....                                         | 0.1         |
| F <sup>18</sup> .....                        | 50          | Ta <sup>182</sup> .....                                                          | 10          |
| Fe <sup>55</sup> .....                       | 50          | Tc <sup>96</sup> .....                                                           | 1           |
| Fe <sup>59</sup> .....                       | 1           | Tc <sup>99</sup> .....                                                           | 1           |
| Ga <sup>72</sup> .....                       | 10          | Te <sup>127</sup> .....                                                          | 10          |
| Ge <sup>71</sup> .....                       | 50          | Te <sup>129</sup> .....                                                          | 1           |
| H <sup>3</sup> (HTO or H <sup>3</sup> O) ... | 250         | Th (natural) .....                                                               | 50          |
| I <sup>131</sup> .....                       | 10          | Tl <sup>204</sup> .....                                                          | 50          |
| In <sup>114</sup> .....                      | 1           | Tritium (See H <sup>3</sup> ) .....                                              | 250         |
| Ir <sup>192</sup> .....                      | 10          | U (natural) .....                                                                | 50          |
| K <sup>42</sup> .....                        | 10          | U <sup>233</sup> .....                                                           | 1           |
| Kr <sup>85</sup> .....                       | 5           | U <sup>234</sup> -U <sup>235</sup> .....                                         | 50          |
| La <sup>140</sup> .....                      | 10          | V <sup>48</sup> .....                                                            | 1           |
| Mn <sup>52</sup> .....                       | 1           | W <sup>185</sup> .....                                                           | 10          |
| Mn <sup>56</sup> .....                       | 50          | Y <sup>90</sup> .....                                                            | 1           |
| Mo <sup>99</sup> .....                       | 10          | Y <sup>91</sup> .....                                                            | 1           |
| Na <sup>22</sup> .....                       | 10          | Zn <sup>65</sup> .....                                                           | 10          |
| Na <sup>24</sup> .....                       | 10          | Unidentified radioactive materials or any of the above in unknown mixtures ..... | 0.1         |
| Nb <sup>95</sup> .....                       | 10          |                                                                                  |             |
| Ni <sup>59</sup> .....                       | 1           |                                                                                  |             |
| Ni <sup>63</sup> .....                       | 1           |                                                                                  |             |
| P <sup>32</sup> .....                        | 10          |                                                                                  |             |

**NOTE:** For purposes of Sections 11.5 and 11.6, where there is involved a combination of isotopes in known amounts, the limit for the combination shall be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity").

## SECTION 12 — STORAGE OF RADIATION SOURCES

Sources of radiation shall be secured against unauthorized removal from the place of storage.

## **SECTION 13 — DISPOSAL OF RADIOACTIVE MATERIALS**

### **13.1 General Requirements**

The disposal of radioactive materials is permitted only to the extent and under the conditions specified in Sections 13.2 through 13.7.

### **13.2 Disposal by Release into Sanitary Sewerage Systems**

13.2.1 An owner may discharge radioactive material into a sanitary sewerage system providing:

- (a) It is readily soluble or dispersible in water; and
- (b) The quantity of any radioactive material released into the system by the owner in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:
  - (1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the owner, will result in an average concentration not greater than the limits specified in Section 7.5, Column A, or prorated values if more than one isotope is released; or
  - (2) Ten times the quantity of such material specified in Section 11.9; and
- (c) The quantity of any radioactive material released in any one month, if diluted by the average monthly quantity of sewage released by the owner, will not result in an average concentration exceeding the limits specified in Section 7.5, Column A, or prorated values if more than one isotope is released; and
- (d) The gross quantity of radioactive material released into the sewerage system by the owner does not exceed one curie per year.

13.2.2 Radioactive wastes excreted by humans shall be exempt from the limitations of Section 13.2.1.

### **13.3 Disposal by Discharges into the Air, Ground Waters or Surface Waters**

13.3.1 An owner may dispose of radioactive material into the air outside a controlled area provided the concentration at the point where the material leaves the controlled area is not in excess of the concentration specified in Section 7.5, Column D, or prorated values if more than one isotope is discharged. Where the material is discharged through a stack, tube, pipe, or similar conduit, the determination may be made with respect to the point where the material leaves such conduit. For purposes of this paragraph, concentrations may be averaged over periods not greater than one year.

13.3.2 No owner shall dispose of radioactive material into surface waters or into ground waters without specific, prior permission in writing from the Department.

### **13.4 Disposal by Burial in the Soil**

13.4.1 No owner shall dispose of radioactive material by burial in the soil without prior approval in writing from the Department.

13.4.2 Sites that have been used for burial of radioactive materials shall not be converted to other uses except with the written permission of the Department.

13.4.3 The owner of any burial ground shall notify the Department in writing not less than 30 days in advance of any transfer of title to the property involved.

### **13.5 Disposal by Transfer to a Radioisotope Disposal Service**

13.5.1 An owner may dispose of radioactive materials by transfer to a radioisotope disposal service providing this service has been approved by the Department to receive such materials.

13.5.2 An owner may dispose of radioactive materials by transfer to a person who is authorized to receive such material under a license issued by the Department, a Federal agency, or any agreement state.

### **13.6 Disposal by Incineration**

No owner shall incinerate radioactive materials for the purpose of disposal or preparation for disposal except as specifically approved by the Department in writing.

### **13.7 Disposal by a Specially Approved Method**

Any person may apply to the Department for approval of proposed procedures to dispose of radioactive material in a manner not otherwise authorized in this Section. Each application shall include a description of the radioactive material, including the quantities and kinds of radioactive material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application, where appropriate, shall also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

## **SECTION 14 — TRANSPORTATION**

### **14.1 Intrastate Transportation of Radioactive Materials**

The provisions of this Section apply to transportation of radioactive material, or the delivery of radioactive material to a carrier for transportation, which is not subject to the rules and regulations of the U.S. Department of Transportation, the U.S. Atomic Energy Commission or the Post Office.

### **14.2 Requirements**

No radioactive material shall be transported outside the confines of the plant or other authorized location of use, and no radioactive material shall be delivered to a carrier for transportation, unless there is compliance

with all requirements, appropriate to the mode of transportation, relating to the packaging of the radioactive material and to the marking and labeling of the package and transporting vehicle, of the rules and regulations, as amended, of the U.S. Department of Transportation, the U.S. Atomic Energy Commission or the Post Office, to the same extent as if the transportation were subject to the rules and regulations of any such agency.

## **SECTION 15 — EMERGENCY PRECAUTIONS**

All owners of radioactive materials shall make a study of radiation hazards which may arise from radiation incidents, theft of radioactive materials, fires, floods, windstorms and other disasters within and near the installation with regard to protection of:

Tenants and employees  
Emergency workers  
General public  
Fire fighters

Such studies shall be made for radioactive materials on hand and shall be made in advance of the receipt of additional radioactive materials.

An emergency operational plan, prepared from these studies, shall inform all persons concerned of their duties and responsibilities. This plan shall be made available to the Department on request.

## **SECTION 16 — REPORTS OF THEFTS AND RADIATION INCIDENTS**

### **16.1 Reports of Theft or Loss of Radioactive Materials**

The owner from whose possession a theft or loss occurs shall immediately notify the Department by telephone and telegraph of any theft or loss of radioactive material in such quantities and under such circumstances that a substantial radiation hazard and/or contamination hazard may result.

### **16.2 Reportable Radiation Incidents**

#### **16.2.1 Immediate Notification**

The owner shall immediately notify the Department by telephone and telegraph of any radiation incident which may have caused or threatens to cause:

(a) Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual to 150 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms of any individual to 375 rems or more of radiation; or

(b) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Section 7.5, Columns C and D, or prorated values if more than one isotope is released; or

(c) A loss of one working week or more of the operation of any facilities affected; or

(d) Damage to property in excess of \$100,000.

(e) The names of any individuals who have been exposed to radiation levels specified above shall not be included in this report.

#### **16.2.2 Twenty-four Hour Notification**

The owner shall notify the Department within 24 hours by telephone and telegraph of any radiation incident which may have caused or threatens to cause:

(a) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands or forearms to 75 rems or more of radiation; or

(b) The release of radioactive material in concentrations which, if averaged over a period of twenty-four hours, would exceed 500 times the limit specified for such materials in Section 7.5, Columns C and D, or prorated values if more than one isotope is released; or

(c) A loss of one day or more of the operation of any facilities affected; or

(d) Damage to property in excess of \$1,000.

(e) The names of any individuals who have been exposed to radiation levels specified above shall not be included in this report.

#### **16.2.3 Written Reports**

**16.2.3.1** The owner shall notify the Department in writing within 30 days of:

(a) Each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit of Section 7 or of a licensee's license; or

(b) Any incident for which notification is required by Sections 16.2.1 and 16.2.2; or

(c) Levels of radiation or concentrations of radioactivity (not involving exposure of any individual in excess of any applicable limit of Section 7) outside a controlled area in excess of 10 times the limits of Sections 7.2 and 13 or of a licensee's license.

These reports shall describe the extent of exposure of individuals to radiation or to radioactive materials, the levels of radiation and concentrations of radioactive materials involved, the cause of the exposure, levels, or concentrations and corrective steps taken or planned to assure against a recurrence.

**16.2.3.2** In each case where Section 16.2.3.1 (a) requires a report to the Department of exposure of an individual, the owner shall:

(a) Delete from the report all references to the names and addresses of individuals so exposed. The identity of such individuals shall be privileged and shall be submitted as a separate document of such report; and

(b) Concurrently give written notification to the individual of the nature and extent of the exposure.

Such notice shall contain the following statement: "This report is furnished to you under the provisions of Section 16 of the New Jersey Radiation Protection Code. You should preserve this report for future reference."

## **CHAPTER II — SPECIAL REQUIREMENTS**

### **SECTION 17 — THERAPEUTIC INSTALLATIONS**

#### **17.0 Scope**

This section covers therapeutic installations used in the healing arts. The provisions of this section are in addition to, and not in substitution for, the applicable provisions of Chapter I.

#### **17.1 Prohibited Use**

No registrant shall operate or permit the operation of x-ray equipment used in the healing arts unless the equipment and installation meet the applicable requirements of these regulations.

#### **17.2 Therapeutic X-Ray Installations Operated at Potentials Above 60 Kvp**

##### **17.2.1 Equipment**

**17.2.1.1** The tube housing shall be of the therapeutic type.

**17.2.1.2** Permanent diaphragms or cones used for collimating the useful beam shall afford the same degree of protection as the housing. Adjustable or removable beam-limiting diaphragms or cones shall transmit not more than 5 per cent of the useful beam obtained at the maximum kilovoltage and with maximum filter.

**17.2.1.3** The filter system shall be so arranged as to minimize the possibility of error in filter selection and alignment. Filters shall be secured in place to prevent them from dropping out during treatment. The filter slot shall be so constructed that the radiation escaping through it does not produce a dose rate in excess of 1r/hr at 1 meter.

**17.2.1.4** The x-ray tube shall be so mounted that it cannot turn or slide with respect to the aperture. Housing shall be marked so as to permit the accurate reproduction of the target-to-skin distance.

**17.2.1.5** Means shall be provided to immobilize the tube housing during stationary portal treatment.

**17.2.1.6** Rectifier tubes shall be shielded or located so that no individual is exposed to radiation doses in excess of those specified in Section 7.

**17.2.1.7** A timer shall be provided to terminate the exposure after a pre-set time regardless of what other exposure limiting devices are present.

**17.2.1.8** Lead rubber, lead foil, or any other material used for limiting the field shall transmit not more than 5 per cent of the useful beam.

**17.2.1.9** All therapeutic x-ray producing machines which nominally can operate above 100 kvp and which are purchased after the effective date of this code shall

have a beam monitoring device to indicate any change in output due to incorrect filter, milliamperage or kilovoltage. The use of this monitoring device shall not be a substitute for the requirement of calibration in Section 17.2.3.1

##### **17.2.2 Structural Design**

**17.2.2.1** Shielding of the therapy room shall be a permanent part of the building. Portable shields shall not be used as a substitute for structural shielding.

**17.2.2.2** All wall, floor, and ceiling areas that can be struck by the useful beam, plus a border of one foot, shall be provided with primary protective barriers. All wall, floor, and ceiling areas that because of mechanical or electrical restrictions cannot be struck by the useful beam shall be provided with secondary protective barriers. The radiation levels outside these barriers shall satisfy the requirements of Section 7.

**17.2.2.3** Interlocks shall be provided so that when any door to the treatment room is opened the machine will be shut off automatically or the radiation level within the room shall be reduced to a maximum of 10 mr/hr at a distance of 1 meter in any direction from the target. After such a shut-off or reduction in output, it shall be possible to restore the machine to full operation only from the control panel.

**17.2.2.4** Control apparatus for the x-ray equipment shall have the required protective barrier between it and the treatment area. Access to the treatment area from the control apparatus shall be through an interlocked door.

**17.2.2.5** Windows, mirror systems, or closed-circuit television viewing screens used for observing the patient shall be so located that the operator can see the patient and the control panel from the same position.

##### **17.2.3 Conditions of Operation**

**17.2.3.1** The radiation field produced by the x-ray machine shall be so calibrated that the dose rate is accurately known for all operating conditions used in radiation treatment. Check calibrations shall be made on an annual basis. Recalibrations shall be required after each x-ray tube replacement and after any changes or replacement in the generating apparatus which could effect a change in the dose rate.

**17.2.3.2** Whenever any therapeutic x-ray machine equipped with a beam monitoring device is operated above 100 kvp, the beam monitoring device shall be used to indicate any change in output due to incorrect filter, milliamperage, or kilovoltage.

**17.2.3.3** No person except the patient shall be in the treatment room during exposure.

**17.2.3.4** Both the control panel and the patient shall be kept under observation during exposure.

**17.2.3.5** Any machine left unattended shall have the control switch turned off and also shall have the power to the control switch disconnected.

17.2.3.6 Personnel monitoring equipment shall be used as required by Section 8.4.

### **17.3 Therapeutic X-ray Installations Operated at Potentials of 60 Kvp and Below**

#### **17.3.1 Equipment**

17.3.1.1 Tube housing shall be of the therapeutic type.

17.3.1.2 Permanent diaphragms or cones used for collimating the useful beam shall afford the same degree of protection as the housing.

17.3.1.3 Adjustable or removable beam-limiting diaphragms or cones shall transmit not more than 5 per cent of the useful beam obtained at the maximum kilovoltage and with maximum filter.

17.3.1.4 The filter system shall be so arranged as to minimize the possibility of error in filter selection or alignment. Filters shall be secured in place to prevent them from dropping out or becoming misaligned during treatment. The filter slot shall be so constructed that the radiation escaping through it does not produce a dose rate in excess of 1.0 r/hr at 1 meter.

17.3.1.5 For contact therapy, the leakage radiation at the surface of the tube housing shall not exceed 0.1 r/hr.

17.3.1.6 The x-ray tube shall be so mounted that it cannot turn or slide with respect to the aperture. The housing shall be marked so as to permit the accurate reproduction of the target-to-skin distance.

17.3.1.7 The tube housing shall be mechanically immobilized during stationary portal treatment.

17.3.1.8 A timer shall be used which can be accurately pre-set to terminate automatically exposures as short as one second.

17.3.1.9 There shall be on the control panel some easily discernible device which will give positive indication that the tube is energized.

17.3.1.10 Lead rubber, lead foil or any other material used for limiting the field shall transmit not more than 5 per cent of the useful beam.

#### **17.3.2. Structural Shielding**

Permanent structural shielding or portable shields shall be used as necessary to insure that no person other than the patient receives a dose in excess of the limits specified in Section 7.

#### **17.3.3 Conditions of Operation**

17.3.3.1 The radiation field produced by the x-ray machine shall be so calibrated that the dose rate is accurately known for all operating conditions used in radiation treatment. Check calibrations shall be made on an annual basis. Recalibration shall be required after each x-ray tube replacement and after any changes or replacement in the generating apparatus which could effect a change in the dose rate.

17.3.3.2 No individual other than the patient shall

be permitted in the treatment room during x-ray treatment unless he wears a protective apron of a least  $\frac{1}{4}$  mm lead equivalent.

17.3.3.3 The x-ray tube shall not be hand held during irradiation, except when necessary and then only if the operator wears protective gloves and apron of at least  $\frac{1}{4}$  mm lead equivalent.

17.3.3.4 Apparatus constructed with beryllium or other low-filtration windows shall have a cap of 0.5 mm lead covering the aperture window of the tube housing when the apparatus is not being used.

17.3.3.5 Both the control panel and the patient shall be kept under observation during exposure.

17.3.3.6 Any machine left unattended shall have both the control switch turned off and the power to the control switch disconnected.

17.3.3.7 Personnel monitoring equipment shall be used as required by Section 8.4.

### **17.4 Teletherapy Apparatus Utilizing Radioactive Materials**

#### **17.4.1 Equipment**

17.4.1.1 The source housing and collimating devices shall be so constructed that at 1 meter in any direction from the source in the "off" position, the maximum dose rate shall not exceed 10 mr/hr and the average shall not exceed 2 mr/hr.

17.4.1.2 The leakage radiation shall not exceed 0.1 per cent of the useful beam when both are measured at 1 meter from the source and with the control mechanism in the "on" position. This limit does not apply to source housings where the leakage radiation at 1 meter is less than 1 r/hr.

17.4.1.3 Adjustable beam-limiting diaphragms shall allow transmission of not more than 5 per cent of the useful beam dose rate outside the useful beam.

17.4.1.4 In the "on" position, the moving part shall always come to rest with the source and the beam collimating device accurately aligned. If a liquid "on-off" device is used, repeated operation of the device shall not cause a variation of more than 5 per cent in exposure rate in the "on" position.

17.4.1.5 The control mechanism shall be of a positive design, capable of acting in any position of the housing.

17.4.1.6 Whatever the "on-off" shutter mechanism (solid, liquid, slide, wheels, or shutters), the closing device shall be so designed as to return automatically to the "off" position in the event of any breakdown or interruption of the activating force and shall stay in the "off" position when the force goes on again until reactivated from the control.

17.4.1.7 The equipment, in addition to the automatic closing device, shall be so designed that it can be manually turned off with a minimum risk of exposure. The moving parts shall be so designed that it is highly improbable for projections, breakages, loose

screws, dirt, or failure of any part to impede the closing of the source.

**17.4.1.8** There shall be a warning device at the source housing and on the control panel that plainly indicates whether the apparatus is "on" or "off". This device shall be directly actuated by the moving part that changes the apparatus from the "off" to the "on" position.

**17.4.1.9** The controls shall be provided with a timer that automatically terminates the exposure after a pre-set time.

**17.4.1.10** The beam shall be provided with a locking device to prevent unauthorized use.

#### **17.4.2 Structural Design**

**17.4.2.1** Shielding of the therapy room shall be a permanent part of the building.

**17.4.2.2** All wall, floor, and ceiling areas that can be struck by the useful beam, plus a border of one foot, shall be provided with primary protective barriers. All wall, floor, and ceiling areas that because of mechanical or electrical restrictions cannot be struck by the useful beam shall be provided with secondary protective barriers. The radiation levels outside these barriers shall satisfy the requirements of Section 7.

**17.4.2.3** Interlocks shall be provided so that when any door to the teletherapy room is opened the teletherapy apparatus shall be shut off automatically. After such a shut-off, it shall be possible to restore the apparatus to full operation only from the control panel.

**17.4.2.4** Windows, mirror systems, or closed-circuit television viewing screens used for observing the patient shall be so located that the operator can see the patient and the control panel from the same position.

#### **17.4.3 Conditions of Operation**

**17.4.3.1** The output of the teletherapy apparatus shall be calibrated. It shall be recalibrated whenever the source is replaced.

**17.4.3.2** No individual, except the patient, shall be in the treatment room during exposure.

**17.4.3.3** Both the control panel and the patient shall be kept under observation during exposure.

**17.4.3.4** Personnel monitoring equipment shall be used as required by Section 8.4.

### **SECTION 18 — MEDICAL DIAGNOSTIC X-RAY INSTALLATIONS**

#### **18.0 Scope**

This section covers fluoroscopic and radiographic installations used in all the healing arts, except dentistry. Section 19 gives the regulations for dental radiographic installations. The provisions of this section are in addition to, and not in substitution for, the applicable provisions of Chapter I.

#### **18.1 Prohibited Use**

No registrant shall operate or permit the operation of x-ray equipment used in the healing arts unless the equipment and installation meet the applicable requirements of these regulations.

#### **18.2 Medical Fluoroscopic Installations**

##### **18.2.1 Equipment**

**18.2.1.1** The tube housing shall be of a diagnostic type.

**18.2.1.2** The distance from the target to the panel or to the table top shall not be less than 12 inches.

**18.2.1.3** A cone shall extend from the tube housing to a point as near as is practical to the panel or table top. Its walls shall provide the same degree of protection as is required of the housing.

**18.2.1.4** An adjustable diaphragm system shall be provided on all fluoroscopes, except those with image intensifiers, to restrict the size of the useful beam so that the fluoroscopic screen has an unilluminated border when the diaphragm system is open to the fullest extent and the screen is 15 inches from the table top or panel. Orthodiascopes shall be exempt from the requirements of this section.

**18.2.1.5** The tube mounting and the fluoroscopic screen shall be linked together so that during use the fluoroscopic screen always fully intercepts the useful beam. Orthodiascopes shall be exempt from the requirements of this section.

**18.2.1.6** Adjustable diaphragms or shutters to restrict the size of the useful beam shall provide a minimum of 1.5 mm lead equivalent protection.

**18.2.1.7** The total filtration permanently in the useful beam shall be equal to at least 2.5 mm aluminum equivalent, or the half-value layer shall be not less than 2.5 mm aluminum equivalent.

**18.2.1.8** The fluoroscopic screen shall be covered with a transparent protective material such that under normal operating conditions the dose rate measured 5 cm from the viewer's side of the screen shall not be more than 20 mr/hr without a patient and with the screen 8 inches from the table top or panel.

**18.2.1.9** With apparatus using an image intensifier, a protective shield shall be provided so that the useful beam does not produce a radiation hazard to the operator or other personnel in a fluoroscopic room.

**18.2.1.10** A manually reset, cumulative timing device shall be used which will automatically indicate elapsed exposure time and either turn off the apparatus automatically or give an audible signal when the total exposure exceeds a predetermined limit given in one or a series of exposures. The device shall have a maximum range of 5 minutes.

**18.2.1.11** For routine fluoroscopy, the exposure rate measured at the panel or table top shall not exceed 5 r/min.

**18.2.1.12** A bucky slot cover and shielding between patient and fluoroscopist shall be used and shall provide protection equivalent to at least 0.5 mm of lead. Such accessory shielding shall not substitute for the wearing of a protective apron as required in Section 18.2.3.2.

### **18.2.2 Structural Shielding**

Permanent structural shielding and/or protective barriers shall be used as necessary to insure that no person other than the patient receives a dose in excess of the limits specified in Section 7.

### **18.2.3 Operating Procedures**

**18.2.3.1** Fluoroscopic equipment shall be operated only by authorized instructed individuals.

**18.2.3.2** Protective gloves and apron of at least 1/4 mm lead equivalent shall be worn by the fluoroscopist during every examination.

**18.2.3.3** Only individuals required for the fluoroscopic procedure shall be in the fluoroscopic room during exposure. The exposure of such individuals shall be controlled by the use of shielding and protective clothing as necessary to insure that they are not exposed to radiation doses in excess of those permitted by Section 7. They shall use personnel monitoring equipment as required by Section 8.4.

**18.2.3.4** Orthodiascopes shall be operated so that the viewing screen shall always intercept the useful beam.

## **18.3 Medical Radiographic Installations**

### **18.3.1 Equipment**

**18.3.1.1** The tube housing shall be of a diagnostic type.

**18.3.1.2** Diaphragms or cones shall be provided for collimating the useful beam and shall provide the same degree of protection as is required of the housing. Except as noted below, after July 1, 1969, all new or used x-ray machines sold or otherwise transferred shall be equipped with adjustable, rectangular collimators fitted with a light beam system for delineating the edges of the collimated x-ray beam. Single purpose machines, such as mass chest x-ray equipment used for adults only, may use a fixed collimator provided it is accurately adjusted for the fixed source-film distance used and that alignment techniques are satisfactory.

**18.3.1.3** For voltages greater than 50 Kvp, the total filtration permanently in the useful beam shall be not less than 2.5 mm aluminum equivalent, or the half-value layer shall be not less than 2.5 mm aluminum equivalent. For voltages up to 50 Kvp, the total filtration in the useful beam shall not be less than 0.5 mm of aluminum equivalent; this requirement may be assumed to have been met if a conventional diagnostic tube is employed, but if a beryllium window tube is employed, an appropriate added filter is required.

**18.3.1.4** An automatic device shall be provided to terminate the exposure after a pre-set time or exposure.

**18.3.1.5** The exposure switch shall be a dead-man type and shall be arranged so that it can only be operated when the operator is within a shielded area. The timer switch button when depressed shall not energize the x-ray tube when the timer is in the "off" or "O" position. Exposure switches for "spot-film" devices used in conjunction with fluoroscopic tables shall be exempted from this shielding requirement, providing the requirements of Section 18.2.1.5 are satisfied.

### **18.3.2 Structural Shielding**

Permanent structural shielding and/or protective barriers shall be used as necessary to insure that no person other than the patient receives a dose in excess of the limits specified in Section 7.

### **18.3.3 Operating Procedures**

Only individuals required for the radiographic procedure shall be in the radiographic room during exposure. The exposure of such individuals shall be controlled by the use of shielding and protective clothing as necessary to insure that they are not exposed to radiation doses in excess of those permitted by Section 7. They shall use personnel monitoring equipment as required by Section 8.4.

## **18.4 Mobile or Portable Diagnostic Equipment**

### **18.4.1 Equipment**

**18.4.1.1** All requirements of Section 18.3.1 apply except 18.3.1.5.

**18.4.1.2** Such equipment shall be provided with collimating cones, or collimating diaphragms and spacer frames, to limit the target-to-skin distance to not less than 12 inches and to limit the size of the useful beam.

**18.4.1.3** The exposure control switch shall be of the dead-man type and shall be so arranged that the operator can stand at least 6 feet from the patient for all exposures. The timer switch button when depressed shall not energize the x-ray tube when the timer is "off" or "O" position.

### **18.4.2 Structural Shielding**

A unit used routinely in one location shall be considered a permanent installation and shall comply with the requirements of Section 18.3.2.

### **18.4.3 Operating Procedures**

**18.4.3.1** No employee who is otherwise occupationally exposed in a radiology installation shall be permitted to hold patients during exposure.

**18.4.3.2** A mobile or portable fluoroscopic unit may be used only if:

- (a) image intensification is used,
- (b) operation of the machine is impossible without a collimating cone or a diaphragm in place,
- (c) the dose rate at the minimum target-to-skin distance does not exceed 5 r/min.,

(d) all individuals not required for the fluoroscopic procedure are removed from the room or protected by portable shields, and

(e) the exposure of individuals required for the fluoroscopic procedure is controlled by the use of shielding and protective clothing as necessary to insure that they are not exposed to radiation doses in excess of those permitted by Section 7.

18.4.3.3 Personnel monitoring equipment shall be used by all operating personnel.

18.4.3.4 A collimating cone, or a diaphragm and spacer frame, shall be used in all exposures to limit the size of the useful beam and to insure a target-to-skin distance of not less than 12 inches.

## 18.5 Chest Photofluorographic Installations

### 18.5.1 Equipment

18.5.1.1 All provisions of Section 18.3.1 apply.

18.5.1.2 A collimator shall restrict the useful beam to the area of the fluorographic screen.

18.5.1.3 All chest photofluorographic machines purchased after the effective date of this code shall have the fluorographic screen mechanically linked to the tube housing so that the fluorographic screen always intercepts the useful beam.

### 18.5.2 Structural Shielding

18.5.2.1 For permanent installations, all provisions of Section 18.3.2 apply.

18.5.2.2 For permanent installations, a primary protective barrier shall be provided wherever the useful beam can strike. If the apparatus is so designed that the useful beam can strike only the fluoroscopic screen, this barrier may be placed around the hood and camera or immediately behind the camera, thus obviating the need for primary protective barriers elsewhere.

18.5.2.3 For permanent installations, secondary protective barriers shall be provided in those walls not having primary protective barriers.

18.5.2.4 For movable installations, structural shielding and/or protective barriers shall be used as necessary to insure that no individual other than the patient shall receive a dose in excess of the limit specified in Section 7.

### 18.5.3 Operating Procedures

18.5.3.1 Operating procedures shall be established so that no individual other than the patient shall receive a dose in excess of the limit specified in Section 7.

18.5.3.2 Personnel monitoring equipment shall be used as required by Section 8.4.

## SECTION 19—DENTAL RADIOGRAPHIC INSTALLATIONS

### 19.0 Scope

This section covers dental radiographic installations. Provisions of this section are in addition to, and not in substitution for the applicable provisions of Chapter I.

### 19.1 Prohibited Use

No registrant shall operate or permit the operation of x-ray equipment used in the practice of dentistry unless the equipment and installation meet the applicable requirements of these regulations.

### 19.2 Equipment

19.2.1 The tubing housing shall be of a diagnostic type.

19.2.2 Diaphragms or cones shall be used for collimating the useful beam and shall provide the same degree of protection as the housing. For intraoral radiography, the diameter of the useful beam at the end of the cone in contact with the patient shall be no greater than 2.75 inches. All new and used machines purchased after July 1, 1969, shall use only open-end cones.

19.2.3 A cone or spacer frame shall provide a target-to-skin distance of not less than 7 inches with apparatus operating above 50 kvp or not less than 4 inches with apparatus operating at or below 50 kvp.

19.2.4 The total filtration permanently in the useful beam shall be not less than:

| KVP      | Equivalent to mm Aluminum |
|----------|---------------------------|
| < 70     | 1.5                       |
| 70 to 90 | 2.0                       |
| > 90     | 2.5                       |

These requirements shall be assumed to have been met if the half-value layers are not less than the aluminum equivalents listed in the table.

19.2.5 The exposure control switch shall be of the dead-man type. A device shall be provided to terminate the exposure after a pre-set time or exposure. The timer switch button when depressed shall not energize the x-ray tube when the timer is in the "off" position.

19.2.6 The control switch shall be so located, or shall be provided with a cord sufficiently long, to enable the operator to stand at least 6 feet from the patient and well out of the path of the useful beam.

19.2.7 Those diagnostic tubes which are supplied from a common high or low voltage supply and which have separate control switches at their respective locations shall also have a separate dead-man switch, a separate timer and either a separate tube voltage meter or indicator light at each location. Those diagnostic tubes which are supplied from a common high or low voltage supply and which can be operated only from a common control panel may have only one dead-man switch, timer and tube voltage meter or indicator light.

### 19.3 Structural Shielding

19.3.1 Permanent structural shielding and/or protective barriers shall be used as necessary to insure that no person other than the patient being x-rayed receives a dose in excess of the limit specified in Section 7.

19.3.2 When dental x-ray units are installed in adjacent rooms, or adjacent areas of the same room, protective barriers shall be provided between the rooms or areas when necessary to comply with Section 7.

#### **19.4 Operating Procedures**

19.4.1 No individual shall be in the path of the useful beam except the patient being x-rayed.

19.4.2 During each exposure, the operator shall be at least 6 feet from the patient or shall be behind a protective barrier.

19.4.3 The film shall not be held by the dentist or assistant during any exposure.

19.4.4 Fluoroscopy shall not be used in dental examinations.

19.4.5 Neither the tube housing nor the pointer cone shall be hand held during exposures.

19.4.6 Personnel monitoring equipment shall be used as required by Section 8.4.

### **SECTION 20 — FLUOROSCOPIC SHOE FITTING MACHINES**

No person shall operate, permit to be operated, maintain or display any fluoroscopic shoe fitting machine.

### **SECTION 21 — RESERVED**

### **SECTION 22 — INDUSTRIAL AND NON-MEDICAL RADIOGRAPHY**

#### **22.1 Scope**

The regulations in this Section establish radiation-safety requirements for persons utilizing sealed sources, radiographic-exposure devices or radiation-producing machines for industrial and non-medical radiography. The requirements of this Section are in addition to the requirements of Chapter I. This Section does not apply to radiography in any of the healing arts.

#### **22.2 Registration and Licensing Requirements**

##### **22.2.1 Registration of Radiation-Producing Machines, Sealed Sources and Radiographic-Exposure Devices**

All owners of radiation-producing machines, and all owners of sealed sources or radiographic exposure devices utilizing radiation sources not subject to specific State license requirements, must register them in accordance with the requirements of Section 4.

##### **22.2.2 Licensing of Sealed Sources and Radiographic-Exposure Devices**

The possession or use of sealed sources or radiographic-exposure devices, either of which utilize radioactive materials specified in Section 5.1, are subject to the licensing requirements of Section 5.

#### **22.3 Equipment Control**

##### **22.3.1 Permissible Levels of Radiation from**

### **Radiographic-Exposure Devices and Storage Containers**

Radiographic-exposure devices, measuring less than 4 inches from the sealed-source storage position to any exterior surface of the device, shall not produce a radiation level in excess of 50 milliroentgens per hour at least 6 inches from any exterior surface of the device. Radiographic-exposure devices measuring a minimum of 4 inches from the sealed-source storage position to any exterior surface of the device, and all storage containers for sealed sources or for radiographic-exposure devices, shall not produce a radiation level in excess of 200 milliroentgens per hour at any exterior surface, and 10 milliroentgens per hour at 1 meter from any exterior surface. The radiation levels specified are with the sealed source in the shielded (i.e., "off") position.

##### **22.3.2 Locking of Radiation-Producing Machines, Radiographic-Exposure Devices and Storage Containers**

Each radiation-producing machine shall be provided with a lock designed to prevent unauthorized use of the equipment. Each radiographic-exposure device and each storage container shall be provided with a lock or outer locked container designed to prevent unauthorized or accidental removal of a sealed source or its change from a shielded to an unshielded position. All the above devices shall be kept locked at all times except when under the direct surveillance of a radiographer or of a radiographer's assistant or as provided in Section 22.5.1.

##### **22.3.3 Storage Precautions**

Locked radiographic-exposure devices and storage containers shall be physically secure to prevent tampering or removal by unauthorized personnel.

##### **22.3.4 Radiation-Survey Instruments**

The owner shall maintain sufficient calibrated and operable radiation-survey instruments to make physical radiation surveys as required by Section 22.5.3 and by Section 8. Calibration of each radiation-survey instrument shall be checked at intervals not to exceed three months and the instrument shall be recalibrated after each servicing involving other than battery replacement. Records shall be maintained of the latest date of calibration and of the dates of succeeding checks. This instrumentation shall have a range such that 2 milliroentgens per hour through 1 roentgen per hour can be measured to a precision of plus or minus 20 percent.

##### **22.3.5 Handling of Sealed Sources**

The replacement of any sealed source fastened to or contained in a radiographic-exposure device and leak testing, repair, tagging, opening or any other modification of any sealed source shall be performed only by persons specifically authorized by the Department, a Federal agency or any other state.

##### **22.3.6 Leak Testing of Sealed Sources**

Sealed sources are to be leak-tested under the following conditions and requirements:

(a) Each sealed source shall be tested for leakage at intervals not to exceed 6 months. In the absence of a certificate from a transferor that a test has been made within the 6 months prior to the transfer, the sealed source shall not be put into use until tested.

(b) The leak test shall be capable of detecting the presence of 0.005 microcuries of removable contamination on the sealed source. A test made at the nearest accessible point to the sealed source storage position may be an acceptable leak test.

(c) Leak tests shall be carried out only by individuals and by procedures both of which require prior approval by the Department. Approval will be based upon a description of:

- (i) Instrumentation to be used,
- (ii) Method of performing test including points on equipment to be tested, and
- (iii) Pertinent experience of person who will perform the test.

(d) Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Department.

#### **22.3.7 Requirements with Regard to Leaking Sources**

Any test conducted pursuant to Section 22.3.6 which reveals the presence of 0.005 microcuries or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The owner shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired in accordance with Section 22.3.5 or to be disposed of in accordance with Section 13. Within five days after obtaining results of the test, a report shall be filed with the Department describing the equipment involved, the test results, and the corrective action taken.

#### **22.3.8 Labeling of Sealed Sources**

A sealed source which is not fastened to or contained in a radiographic-exposure device shall have permanently attached to it a durable tag at least one inch square, bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger—Radioactive Material—Do Not Handle—Notify Civil Authorities if Found."

#### **22.3.9 Quarterly Inventory**

Each owner shall conduct a quarterly physical inventory to account for all sealed sources received and possessed. The records of the inventories shall be maintained for inspection by the Department, and shall include the quantities and kinds of radioactive materials, location of sealed sources, and the date of the inventory.

#### **22.3.10 Utilization Logs**

Each owner shall maintain current logs, which shall be kept available for inspection by the Department at the address specified in the license, showing for each

radiation source the following information:

(a) A description (or make and model number) of the radiation-producing machine, or of the radiographic-exposure device or storage container in which the sealed source is located;

(b) The identity of the radiographer to whom assigned; and

(c) The plant or site where used and dates of use.

### **22.4 Personal Radiation Safety Requirements for Radiographers and Radiographer's Assistants**

#### **22.4.1 Training Requirements for Radiographers**

The owner shall not permit any person to act as a radiographer until such person:

(a) Has been instructed in the subjects outlined in Section 22.4.2 and shall have demonstrated understanding thereof;

(b) Has received copies of and instructions in the applicable sections of this Code, and the owner's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(c) Has demonstrated competence to use the radiation-producing machines, radiographic-exposure devices, sealed sources, related handling tools and survey instruments which will be employed in his assignment.

#### **22.4.2 Outline of Course for Radiographer's Training**

##### *I. Fundamentals of radiation safety*

- A. Characteristics of gamma and x-radiation
- B. Units of radiation dose and quantity of radioactivity
- C. Hazards of excessive exposure to radiation
- D. Levels of radiation from radiation-producing machines and radioactive materials
- E. Methods of controlling radiation dose
  - 1. Working time
  - 2. Working distances
  - 3. Shielding

##### *II. Radiation detection instrumentation to be used*

- A. Use of radiation survey instruments
  - 1. Operation
  - 2. Calibration
  - 3. Limitations
- B. Survey techniques
- C. Use of personnel-monitoring equipment
  - 1. Film badges
  - 2. Pocket dosimeters
  - 3. Pocket chambers

##### *III. Radiographic equipment to be used*

- A. Radiation-producing machines
- B. Radiographic-exposure devices
- C. Storage containers
- D. Remote handling equipment

##### *IV. The requirements of pertinent Federal and State regulations*

*V. The owner's written operating and emergency procedures*

**22.4.3 Training Requirements for Radiographer's Assistants**

The owner shall not permit any person to act as a radiographer's assistant until such person:

- (a) Has received copies of and instructions in the owner's operating and emergency procedures, and shall have demonstrated understanding thereof; and
- (b) Has demonstrated competence to use under the personal supervision of the radiographer the radiation-producing machines, radiographic exposure devices, sealed sources, related handling tools and radiation-survey instruments which will be employed in his assignment.

**22.4.4 Operating and Emergency Procedures**

The owner shall draw up written operating and emergency procedures; these shall include instructions in at least the following:

- (a) The handling and use of radiation-producing machines, sealed sources and radiographic exposure devices to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Section 7;
- (b) Methods and occasions for conducting radiation surveys;
- (c) Methods for controlling access to radiographic areas;
- (d) Methods and occasions for locking and securing radiation-producing machines, radiographic-exposure devices, storage containers and sealed sources;
- (e) Personnel monitoring and the use of personnel-monitoring equipment;
- (f) Transporting sealed sources to field locations, including packing of radiographic-exposure devices and storage containers in the vehicles, posting of vehicles and control of the sealed sources during transportation;
- (g) Minimizing exposure of persons in the event of an accident;
- (h) The procedure for notifying proper persons in the event of an accident; and
- (i) Maintenance of records.

**22.4.5 Personnel-Monitoring Control**

(a) The owner shall not permit any person to act as a radiographer or as a radiographer's assistant unless, at all times during radiographic operations, each such person shall wear a film badge and either a pocket dosimeter or pocket chamber. Pocket dosimeters and pocket chambers shall be capable of measuring doses from zero to at least 200 milliroentgens. A film badge shall be assigned to and worn by only one person.

(b) Pocket dosimeters and pocket chambers shall be read and doses recorded daily. A film badge shall be immediately processed if a pocket chamber or pocket dosimeter is discharged beyond its range. The film-

badge reports received from the film-badge processor and records of pocket dosimeter and pocket-chamber readings shall be maintained for inspection by the Department.

**22.5 Precautionary Procedures in Radiographic Operations**

**22.5.1 Security**

During each radiographic operation the radiographer or radiographer's assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high-radiation area, as defined in Section 2.21, except:

- (a) Where the high-radiation area is equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in 1 hour upon entry into the area, or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the owner or the supervisor of the activity are made aware of the entry, or
- (b) Where the high-radiation area is locked to protect against unauthorized or accidental entry.

**22.5.2 Posting**

Notwithstanding any provisions in Section 11.8, areas in which radiography is being performed shall be conspicuously posted as required by Sections 11.2 and 11.3.

**22.5.3 Radiation Surveys and Survey Records**

No radiographic operation shall be conducted unless calibrated and operable radiation-survey instrumentation as described in Section 22.3.4 is available and used at each site where radiographic exposures are made. In addition to the requirements of Section 8, radiation surveys shall be made and recorded as follows:

- (a) Physical radiation surveys shall be made as necessary during radiographic exposures to determine compliance with Section 7.
- (b) A physical radiation survey shall be made after each radiographic exposure employing a sealed source to determine that the sealed source has been returned to its shielded condition.
- (c) After radiographic operations employing a sealed source or sources, a physical radiation survey shall be made to determine that each sealed source is in its shielded condition prior to securing the radiographic-exposure device and storage container as specified in Section 22.3.2.
- (d) Clear and legible records shall be kept of the surveys required by paragraphs (a) and (c) of this section and maintained for inspection by the Department.

## **SECTION 23—MAJOR NUCLEAR FACILITIES**

### **23.0 Scope**

This section contains special requirements for major nuclear facilities including nuclear reactors, nuclear fuel fabrication plants, nuclear fuel reprocessing plants, and nuclear waste handling or disposal facilities. The intent of the section is to insure that individuals outside of these facilities receive no radiation exposures from environmental contamination or direct radiation that are in excess of the limits of Section 7.2 and 7.3.

### **23.1 Other Requirements**

The requirements of this section are in addition to all other applicable sections of this Code.

### **23.2 Facility Description and Required Monitoring Program**

**23.2.1** Any person desiring to construct a major nuclear facility within this State shall submit a general description of the proposed facility with a discussion of probable and maximum potential radioactive discharges. This description shall be submitted to the Department for evaluation; this shall be done as early as possible but not less than six months prior to start of construction. The description shall include:

- (a) A general description of the proposed facility.
- (b) The nature of and the proposed rates of discharge of radioactive contaminants to the environment and/or the nature of and amounts of radioactive materials subject to temporary or permanent storage.
- (c) The proposed methods of limiting the discharge of radioactive contaminants to the atmosphere.
- (d) The proposed methods of limiting the discharge of radioactive contaminants to ground or surface waters.
- (e) The proposed methods of disposal of radioactive or radioactively contaminated materials.
- (f) Preliminary description of the proposed radiological monitoring program.

As used in this section, the term "construction" shall be deemed to include pouring the foundation for, or the installation of, any portion of the permanent facility on the site, but does not include: (1) Site exploration, site excavation, preparation of the site for construction of the facility, including the driving of

piles, and construction of roadways, railroad spurs, and transmission lines; (2) Procurement or manufacture of components of the facility; (3) Construction of non-nuclear facilities (such as turbo-generators and turbine buildings) and temporary buildings (such as construction equipment storage sheds) for use in connection with the construction of the facility.

**23.2.2** Any person desiring to operate a major nuclear facility within this State shall develop an adequate program of radiological monitoring consistent with the hazard from actual or potential discharges. The proposed program shall be submitted to the Department for evaluation as to its adequacy as early as possible but at least 6 months prior to the start of operation. The proposed radiological monitoring program shall include revised statements of the information required in Section 23.2.1 (a), (b), (c), (d), (e), (f), and it shall also include:

(g) An analysis of the ability of the in-facility effluent monitoring system to measure the quantities and kinds of radioactive materials discharged under normal and under accident conditions.

(h) An analysis of the ability to predict the effect of such releases on environmental contamination and radiation levels.

(i) A description of the off-site environmental monitoring system, if any, with the kinds of instruments, their sensitivity, and use.

### **23.3 Operation**

**23.3.1** The owner of an existing major nuclear facility shall submit the information required in Section 23.2.2 within one month of March 1, 1969 if he has not already done the effective equivalent of this.

**23.3.2** Operation of a major nuclear facility and its monitoring program shall be consistent with all provisions of this Code.

### **23.4 Emergency Plans**

The owner of every major nuclear facility shall make emergency operational plans in accordance with Section 15. These shall be submitted to the Department prior to the start of operation.

### **23.5 Radiation Incidents**

The owner of every major nuclear facility shall report any radiation incident in accordance with Section 16.