TITLE 64
LEGISLATIVE RULES
DEPARTMENT OF HEALTH

SERIES 23
RADIOLOGICAL HEALTH REGULATIONS

§64-23-1. General.

1.1. Scope. -- These legislative rules establish the requirements that shall be applied to the use of sources of ionizing radiation to reduce, to an acceptable level, the risk that any person is likely to be injured by such radiation. These legislative rules are intended to be consistent with the recognized beneficial uses of sources of ionizing radiation. These legislative rules provide for the registration and applicable safety requirements of all sources of ionizing radiation including naturally occurring radioactive materials, accelerator produced radioactive material, and radiation producing equipment.

1.2. Authority. -- W. Va. Code §16-1-7

1.3. Filing Date. -- January 12, 1979

1.4. Effective Date. -- May 1, 1979

§64-23-2. Application, Enforcement, Severability

2.1. Application - Except as otherwise specifically provided, these regulations apply to all persons in West Virginia who receive, possess, use transfer, own or acquire any source of ionizing radiation, however, nothing in these regulations shall apply, except the provision for registration, to any person to the extent such person is subject to regulation by the United States nuclear regulatory commission.

For the purpose of these regulations, radiation machines and radioactive materials used by, or in the possession of, an employee within the scope of his duties shall be considered to be in the possession of the employer.

The provisions of Section 6, Radiation Protection Standards, of these regulations shall not be interpreted as limiting the intentional exposure of patients to radiation for the purpose of diagnosis or therapy by doctors of the healing arts, duly licensed by the State of West Virginia and engaged in the lawful practice of their profession or administered by other professional persons acting under the direct supervision of a licensed practitioner.

2.2. Enforcement - The enforcement of these legislative rules is vested with the director of the West Virginia department of health or his lawful designee.

2.3. Severability - If any provisions of these rules or the application thereof to any person or circumstance shall be held invalid, such invalidity shall not affect the provisions or the application of these rules which can be given effect without the invalid provisions or application, and to this end the provisions of these rules are declared to be severable.

§64-23-3. Definitions – As used in these regulations, these terms have the definitions set forth below. Additional definitions used only in a certain part will be found in that part.

3.1. Accelerator Produced Material - means any material made radioactive by exposing it in a particle accelerator.

3.2. Agency - means the West Virginia department of health.

3.3. Airborne Radioactive Area - means (i) any room, enclosure, or operating area in which airborne radioactive material exists in concentrations in excess of the amount specified in Appendix A, Table I, Column 1; or (ii) any room, enclosure, or operating area in which airborne radioactive material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix A, Table I, Column 1.

3.4. Airborne Radioactive Material - means any

airborne radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors or gases.

3.5. Byproduct Material - means 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.

3.6. Calendar Quarter - means not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be so arranged such that no day is included in more than one calendar quarter and no day in any one year is omitted from inclusion within a calendar quarter. No registrant shall change the method observed by him of determining calendar quarters for the purpose of these regulations except at the beginning of the calendar year.

3.7. Curie - means a unit of measurement of radioactivity. One curie (Ci) is that quantity of radioactive material which decays at the rate of 3.7×10^{10} disintegrations per second (dps). Commonly used submultiples of the curie are the millicurie and the microcurie. One millicurie (mCi) = 0.001 curie = 3.7×10^{7} dps. One microcurie (uCi) = 0.000001 curie = 3.7×10^{4} dps. For the purpose of these regulations, one curie of natural uranium means the sum of 3.7×10^{10} dps from U-238 plus 3.7×10^{10} dps from U-234 plus 1.7×10^{9} dps from U-235; this is equivalent to 3,000 kilograms or 6,615 pounds of natural uranium. One curie of natural thorium means the sum of 3.7×10^{10} dps from Th-232 plus 3.7×10^{10} dps from Th- 228; this is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

3.8. Dose - as used in these regulations shall mean absorbed dose or dose equivalent as appropriate.

Absorbed Dose - is the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The specific unit of absorbed dose is the rad. (See rad)

Dose Equivalent - is a quantity that expresses on a common scale for all radiation a measure of the postulated effect on a given organ. It is defined as the absorbed dose in rads times certain modifying factors. The unit of dose equivalent is the rem. (See rem)

3.9. Exposure - means the quotient of the dQ by dm where "dQ" is the absolute value of the total charge of the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass "dm" are completely stopped in air. (The special unit of exposure is the roentgen (R).)

3.10. Exposure Rate means the exposure per unit of time, such as R/min., mR/hr., etc.

3.11. Half Life - means the amount of time required for the activity of a specific radoactive material to reach one-half of its original activity.

3.12. Healing Arts means diagnostic and/or healing treatment of human and animal maladies including but not limited to the following which are duly licensed by the State of West Virginia for the lawful practice of: medicine and its associated specialties, dentistry, veterinary medicine, osteopathy, chiropractic, and podiatry.

3.13. High Radiation Area - means any area, accessible to individuals in which there exists radiation at such levels that the individual could receive in any one hour a dose to the whole body in excess of 100 millirems.

3.14. Human Use - means the internal or external administration of radiation or radioactive materials to human beings.

3.15. Individual - means any human being.

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

3.17. Installation - means the location where one or more sources of ionizing radiation are used, operated or stored.

3.18. Monitoring - means a periodic or continuous determination of the exposure rate in an area (area monitoring) or the exposure received by a person (personnel monitoring) or the measurement of contamination levels.

3.19. Natural Radioactivity - means radioactivity of naturally occurring nuclides.

3.20. Occupational Dose - means exposure of an individual to radiation (a) in a restricted area; or (b) 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 diagnosis or therapy of such individual.

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

3.22. Person - means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, political subdivision of West Virginia, any other state or political subdivision or agency thereof, and any legal successor, representative, agent or agency of the foregoing, other than the United States nuclear regulatory commission, or any successor thereto, or other federal government agencies.

3.23. Personnel Monitoring Equipment - means devices (e.g., film badges, pocket dosimeters, thermoluminescent dosimeters, etc.) designed to be worn or carried by an individual for the purpose of estimating the dose received by the individual.

3.24. Rad - means the special unit of absorbed dose. One rad equals one hundredth of a joule per kilogram of material, for example, if tissue is the material of interest, 1 rad equals 100 ergs per gram of tissue.

3.25. Radiation - means ionizing radiation, i.e., gamma rays and X-rays, alpha and beta particles, high speed electrons, neutrons, and other nuclear particles. (Same as ionizing radiation.)

3.26. Radiation Area - means any area, accessible to individuals, 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 5 consecutive days a dose in excess of 100 millirems.

3.27. Radiation Machine - means any device capable of producing radia- tion except those which produce radiation only from radioactive material.

3.28. Radiation Safety Officer - means one who has the knowledge and responsibility to apply appropriate radiation protection regulations.

3.29. Radioactive Material - means any material (solid, liquid, or gas) which emits ionizing radiation spontaneously.

3.30. Radioactivity - means the disintegration of unstable atomic nuclei by the emission of radiation.

3.31. Registrant - means any person who is registered with the agency and is legally obligated to register with the agency pursuant to these regulations.

3.32. Registration - means the filing with the agency by a registrant of all registrable items in accordance with these regulations.

3.33. Rem - means a measure of the dose of any radiation to body tissue in terms of its estimated biological effect relative to a dose received from an exposure to one roentgen (R) of x-rays. (millirem (mrem) = 0.001 rem.) For the purpose of these regulations, any of the following is considered to be equivalent to a dose of one rem:

(a) An exposure of 1 R of x, or gamma radiation

(b) A dose of 1 rad due to x, gamma, or beta radiation;

(c) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye;

(d) A dose of 0.1 rad due to neutrons or high energy protons[1].

[1]If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron absorbed dose in rads, one rem of neutron radiation may for purposes of these regulations, be assumed to be equivalent to 14 million neutrons per 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 Table 64-23A found at the end of this regulation.

3.34. Research and Development - means: (a) theoretical analysis, exploration, or experimentation; or

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

3.35. Restricted Area (controlled area) - means any area access to which is controlled by the registrant for purposes of protection of individuals from exposure to radiation and radioactive material. Restricted areas shall not include any areas used for residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

3.36. Roentgen (R) - means the special unit of exposure. One roentgen equals 2.58×10^{-4} coulombs/kilogram of air. (See Exposure.)

3.37. Sealed Source - means 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.

3.38. Source Material - means: (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 (i) uranium, (ii) thorium, or (iii) any combination thereof. Source material does not include special nuclear material.

3.39. Source of Radiation - means any radioactive material, or any device or equipment emitting or capable of producing radiation.

3.40. Survey - means the evaluation of the radiation associated with the production, use, release, disposal or presence of sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and/or equipment and measurements of radiation levels or concentrations or radioactive materials

3.41. Test - means a method for determining the characteristics or condition of sources of radiation or components thereof.

3.42. These Regulations - means Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 of the Radiological Health Regulations and any subsequent changes or additions thereto.

3.43. Unrestricted Area - means any area access to which is not controlled by the registrant for purposes of protection of individuals from exposure to radiation and radioactive material, and any area used for residential quarters.

3.44. Unrefined and Unprocessed Ore - means ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

3.45. Whole Body - means the whole body, or head and trunk, or active blood forming organs, or lens of eyes, or the gonads (this definition is not applicable to the phrase "skin of the whole body").

NOTE: Other terms not herein specifically defined shall be used in accordance with the definitions in the Recommendations of the National Council on Radiation Protection and Measurements, or any successor thereto, as published in Handbooks of the National Bureau of Standards or Reports of the NCRP.

§64-23-4. Exemptions, Inspections, Tests, Violations, Impounding Prohibitions and Communications

4.1. Exemptions - The agency may, upon application by any person or upon its own initiative, grant such exemptions or exceptions from the requirements of these regulations as it determines are authorized by law and will not result in undue hazard to public health and safety or property.

4.2. Inspections

4.2.1. Each registrant shall afford the agency, at all reasonable times, opportunity to inspect sources of radiation and the premises and facilities wherein such sources of radiation are used or stored.

4.2.2. Each registrant shall make available to the agency for inspection, upon reasonable notice, records maintained pursuant to these regulations.

4.3. Tests - Each registrant shall perform, upon instructions from the agency, or shall permit the agency to perform such reasonable tests as the agency deems appropriate or necessary including, but not limited to, tests of:

(a) Sources of ionizing radiation;

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

(c) Radiation detection and monitoring instruments; and

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

4.4. Violations - Any person violating any of the provisions of this article, for which the penalty is not otherwise provided, or any of the rules, regulations or orders issued pursuant thereto, shall be punishable by a fine of not more than two hundred dollars or by imprisonment for not more than thirty days, or both.

4.5. Impounding - In the event that an emergency exists affecting the public health and safety, the agency has the authority to impound or order the impounding of sources of radiation possessed by persons who are not equipped to observe or fail to observe the provisions of these regulations.

4.6. Prohibitions

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

4.6.2. Shoe-fitting fluoroscopic devices shall not be used or displayed.

4.7. Communications - All communications and reports concerning these regulations, and applications filed thereunder, should be addressed to the West Virginia Department of Health, Radiological Health Program, 151 Eleventh Avenue, South Charleston, WV 25303.

§64-23-5. Registration.

5.1. Purpose and Scope

5.1.1. This section provides for the registration of sources of radiation. The person having possession of any registrable item shall register such source of radiation with the agency in accordance with the requirements of this section.

5.1.2. For the purpose of Section 5 of these regulations, "facility" means the location at which one or more devices or sources are installed and/or located within one building, vehicle, or under one roof, and/or are under the same administrative control.

5.1.3. In addition to the requirements of this section, all registrants are subject to the applicable provisions of other parts of these regulations,

5.2. Exemptions

5.2.1. The following sources of radiation do not require registration:

(a) Less than 10 times the quantities of any radioactive material possessed simultaneously, listed in Appendix C of these regulations.

(b) Natural radioactive materials of an equivalent specific radioactivity not exceeding that of natural potassium, (10-9 curies/gm)

(c) Time pieces, instruments, novelties, or devices containing self- luminous elements, except during manufacture or repair of the self-luminous elements themselves. Such time pieces, instruments, novelties, or devices shall not be exempt if they are stored, used, or handled in such quantity or fashion that an individual might receive a radiation dose exceeding the limits established in 6.3.1.

(d) Domestic television receivers, providing the dose rate at 5 cm from any outer surface is less than 0.5 mrem per hour.

(e) Electronic equipment that produces radiation incidental to its operation for other purposes is exempt from the registration and notification requirements of this part, providing dose equivalent rate averaged over an area of ten (10) square centimeters does not exceed 0.5 mrem per hour at 5 cm from any accessible surface of such equipment. The production, testing, or factory servicing of such equipment shall not be exempt.

(f) Radiation-producing machines while in transit or storage incident thereto.

5.2.2. Common and contract carriers operating within this state are exempt from registration requirements to the extent that they transport or store sources of radiation in the regular course of their carriage for another or storage incident thereto.

5.3. Application for Registration of Radiation Facilities

5.3.1 The person possessing each registrable item which has not already been registered, shall:

(a) Apply for registration of such facility with the agency within thirty (30) days following the effective date of these regulations or thereafter prior to the operation of a radiation facility.

(b) Make application for registration on forms furnished by the agency and shall supply all the information required by the form and accompanying instructions.

(c) Designate on the application form an individual to be responsible for radiation protection.

5.4. Renewal of Registration

5.4.1 The person possessing each registrable item shall renew such registration with the agency at a date to be specified by the agency not later than within six (6) months of the effective date of these regulations and every three years thereafter.

5.5. Report of Changes

5.5.1. Except as provided in Section 5.5.2, the registrant shall notify the agency in writing within ten (10) days after any change which renders the information on registration no longer accurate. In the case of disposition of radiation sources, such notification shall specify the recipient of these sources.

5.5.2 The registrant is not required to notify the agency of the use of radiation sources at a temporary location other than the designated storage location, provided the initial registration shows that their use at temporary locations is normal to the conduct of the registrant's operations.

5.6 Approval not Implied

5.6.1. No person, in any advertisement, shall refer to the fact that a source of radiation is registered with the agency, and no person shall state or imply that any activity under such registration has been approved by the agency.

5.7. Vendor Obligation

5.7.1.

(a) Each person who is engaged in the business of installing or offering to install radiation sources or is engaged in the business of furnishing or offering to furnish radiation source servicing or services in this state, shall apply for registration of such services with the agency within thirty (30) days following (the effective date of these regulations) or thereafter prior to furnishing or offering to furnish any such services.

(b) Any person who sells, leases, transfers or lends radiation sources in this state shall notify the agency within thirty (30) days after the end of each calendar quarter of:

(1) The name and address of persons who have received these sources;

(2) The manufacturer and model of each source transferred;

(3) The date of transfer of each radiation source.

5.7.2. No person shall make, sell, lease, transfer, lend or install x-ray equipment or radioactive material sources or auxiliaries and supplies necessary for the safe operation of such equipment unless such supplies and equipment, when placed in operation and use, will meet the requirements of these regulations.

5.8. Out-of-State Registrable Items

5.8.1. Whenever any out-of-state registrable item is to be brought into West Virginia for any temporary use, the person proposing to bring such item into the state or his authorized agent shall give written notice to the agency at least five (5) days before such entry. The notice shall include the item type and energy characteristics; the nature, duration, and scope of use; and the exact location where the registrable item is to be used. If for a specific case, the 5-day period will impose an undue hardship on the person, he may, upon application to the agency, obtain permission to proceed sooner. In addition, the out-of-state person must:

(a) Comply with all applicable regulations of the agency; and

(b) Supply the agency with such other information as the agency may reasonably request.

5.9. Radiation Protection Requirements

5.9.1. Registrants and persons subject to 5.8.1 shall comply with all applicable requirements of these regulations, provided, however, that apart from registration, nothing in these regulations shall apply to any person to the extent that such person is subject to regulation by the United States nuclear regulatory commission and any legal successor thereof.

§64-23-6. Radiation Protection Standards.

6.1. Purpose and Scope

6.1.1. This section establishes standards for protection against radiation hazards. Except as otherwise specifically provided, this part applies to all registrants. Nothing in this part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or therapy.

6.1.2. In addition to complying with the requirements set forth in this part, every reasonable effort should be made to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in this part as practicable. The term "as far below the limits specified in this part as practicable" means as low as is practicably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety and in relation to the utilization of ionizing radiation in the public interest.

6.2. Radiation Dose to Individuals in Restricted Areas[1].

6.2.1. Except as provided in 6.2.2. no registrant shall possess, use, receive, or transfer sources of radiation in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from all sources of radiation in the registrant's possession a dose in excess of the limits specified in Table 64-23B found at the end of this regulation.

[1]For determining the doses specified in 6.2 a dose from x or gamma rays up to 10 MEV may be assumed to be equivalent to the exposure measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dose rate.

6.2.2. Radiation Doses Greater Than Table 64-23B. -- A registrant may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under 6.2.1 provided:

(a) During any calendar quarter the dose to the whole body from sources of radiation in the registrant's possession shall not exceed 3 rems; 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) rems where "N" equals the individual's age in years at his last birthday; and

(c) The registrant has determined the individual's accumulated occupational dose to the whole body on Form RH-14 or on a clear and legible record containing all the information required in that form and has otherwise complied with the requirements of 6.2. As used in 6.2.2, "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.

6.2.3. Determination of Accumulated Dose

(a) This section contains requirements which must be satisfied by registrants who propose, pursuant to 6.2.2. to permit individuals in a restricted area to receive exposure to radiation in excess of the limits specified in 6.2.1.

(b) Before permitting any individual in a restricted area to be exposed to radiation in excess of the limits specified in 6.2.1, each registrant shall:

(1) Obtain a certificate on Form RH-14 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 an occupational dose of radiation; and

(2) Calculate on Form RH-14 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

6.2.2.

(c)

(1) In the preparation of Form RH-14 or a clear and legible record containing all the information required in that form, the registrant shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the registrant obtains such reports, he shall use the dose shown in the report in preparing the form. In any case where a registrant 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: (See Table 64-23C found at the end of this regulation.)

(2) The registrant shall retain and preserve records used in preparing Form RH-14. 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 6.2.2.(b) the excess may be disregarded.

6.2.4. Exposure of Individuals to Concentrations of Radioactive Material in Restricted Areas

(a) No registrant shall possess, use, receive, or transfer radioactive material in such a manner as to cause an individual in a restricted area to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Appendix A, Table I, of Section 12. "Expose," as used in this section means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the agency pursuant to 6.2.4.(c).

(b) The limits given in Appendix A, Table 64-23A or Section 12 are based upon exposure to the concentrations specified for forty (40) hours in any period of seven (7) consecutive days. In any such period where the number of hours of exposure is less than forty (40), 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 (40), limits specified in the table shall be decreased proportionately.

(c)

(1) Except as authorized by the agency pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix A, Table I.

(2) The agency may authorize a registrant to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix A, Table I, 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 the concentrations in excess of the limits established in Appendix A, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations and a description of the methods used in deter- mining the particle sizes.

(3) The agency may authorize a registrant to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix A, Table I, 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 part for individuals in restricted areas during a 40-hour week. Each application under this subpara- graph shall contain the following information:

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

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

(iii) 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 work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance by the individual of the proposed procedures; and

(iv) The average concentrations pres-

ent in the areas occupied by individuals.

6.2.5. Exposure of Minors[2].

[2]For determining the doses specified in this section, a dose from x or gamma rays up to 10 MeV may be assumed to be equivalent to the exposure measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dose rate.

(a) No registrant shall possess, use, or transfer sources of radiation in such a manner as to cause any individual within a restricted area, who is under 18 years of age, to receive in any period of one calendar quarter from all sources of radiation in such registrant's possession a dose in excess of 10 percent of the limits specified in Table 64-23B in 6.2.1.

(b) No registrant shall possess, use, or transfer radioactive material in such a manner as to cause any individual within a restricted area, who is under 18 years of age, to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Appendix A, Table II, of Section 12. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

(c) The provisions of 6.2.4(c) shall apply to exposures subject to 6.2.5(b).

6.3. Radiation Dose to Individuals in Unrestricted Areas

6.3.1. Except as authorized by the agency pursuant to 6.3.1(b) no registrant shall possess, use, or transfer sources of radiation in such a manner as to create in any unrestricted area from such sources of radiation in his possession:

(a) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 2 millirems in any 1 hour; or

(b) Radiation levels which, if an individual were continuously present in the area could result in his receiving a dose in excess of 100 millirems in any 7 consecutive days.

6.3.2. Any person may apply to the agency for proposed limits upon levels of radiation in unrestricted areas in excess of those specified in 6.3.1. resulting from the applicant's possession or use of sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The agency will approve the proposed limits if the applicant demonstrates to the satisfaction of the agency 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.

6.3.3. Concentration in Effluents to Unrestricted Areas

(a) A registrant shall not possess, use, or transfer registered material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix A, Table II of Section 12, except as authorized pursuant to 6.9.2 or 6.3.3(b). For purposes of this section concentrations may be averaged over a period not greater than one year.

(b) Any person may apply to the agency for proposed limits higher than those specified in 6.3.3(a). The agency will approve the proposed limits if the applicant demonstrates:

(1) That the applicant has made a reasonable effort to minimize the radioactivity contained in effluents to unrestricted areas; and

(2) That it is not likely that radioactive material discharged in the effluent would result in the exposure of an individual to concentrations of radioactive material in air or water exceeding the limits specified in Appendix A, Table II of Section 12.

(c) An application for higher limits pursuant to 6.3.3(b) shall include information demonstrating that the applicant has made a reasonable effort to minimize the radioactivity discharged in effluents to unrestricted areas, and shall include, as pertinent:

(1) Information as to flow rates, total volume of effluent, peak con- centration of each radionuclide in the effluent, and concentration of each radionuclide in the effluent averaged over a period of one year at the point where the effluent leaves a stack, tube, pipe, or similar conduit;

(2) A description of the properties of the effluents, including:

(i) Chemical composition,

(ii) Physical characteristics, including suspended solids content in liquid effluents, and nature of gas or aerosol for air effluents,

(iii) The hydrogen ion concentrations (pH) of liquid effluents, and

(iv) The size range of particulates in effluents released into air;

(3) A description of the anticipated human occupancy in the unrestricted area where the highest concentration of radioactive material from the effluent is expected, and, in the case of a river or stream, a description of water uses downstream from the point of release of the effluent;

(4) Information as to the highest concentration of each radionuclide in an unrestricted area, including anticipated concentrations averaged over a period of one year:

(i) In air at any point of human occupancy, or

(ii) In water at points of use downstream from the point of release of the effluent;

(5) The background concentration of radionuclides in the receiving river or stream prior to the release of liquid effluent;

(6) A description of the environmental monitoring equipment, including sensitivity of the system, and procedures and calculations to determine concen trations of radionuclides in the unrestricted area and possible reconcentrations of radionuclides; and

(7) A description of the waste treatment facilities and procedures used to reduce the concentration of radionuclides in effluents prior to their release.

(d) For the purposes of this section, the concentration limits in Appendix A, Table II of Section 12 shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(e) In addition to limiting concentrations in effluent streams, the agency may limit quantities of radioactive material released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third (1/3) the concentration of radioactive material specified in Appendix A, Table II or Section 12.

(f) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by 6.9.3.

6.3.4. Orders Requiring Furnishing of Bioassay Services - Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the agency may incorporate registration provisions or issue an order requiring a registrant to make available to the individual appropriate bioassay services and to furnish a copy of the reports of such services to the agency.

6.4. Surveys

6.4.1. As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

6.4.2. Each registrant shall make or cause to be made such surveys as may be necessary for him to establish compliance with these regulations.

6.5. Personnel Monitoring - Each registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

6.5.1. Each individual who enters a restricted area under such circumstances that he receives, or is

likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in 6.2.1. 6.5.2 Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in 6.2.1.

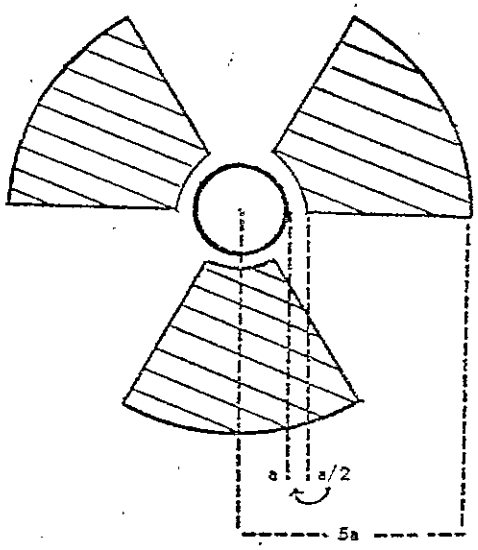
6.6. Posting, Labeling, and Caution Signals

6.6.1. Symbols and Other Contents

(a) Except as otherwise authorized by the agency, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-blade design:

Radiation Symbol

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



(b) In addition to the contents of signs and labels prescribed in this section, a registrant may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation.

6.6.2 Signs

(a) Radiation Areas - Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[3]
RADIATION AREA

(b) High Radiation Areas

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

[3]Or "DANGER."

CAUTION[3]
HIGH RADIATION AREA

(2) Each entrance or access point to a high radiation area shall be:

(i) 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 1 hour upon entry into the area; or

(ii) Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the registrant or a supervisor of the activity are made aware of the entry; or

(iii) Maintained locked except during periods when access to the area is required, with positive control over each individual entry.

(3) The controls required by 6.6.2(b)(2) shall be established in such a way that no individual will be prevented from leaving a high radiation area.

(4) In the case of a high radiation area established for a period of 30 days or less, direct surveillance to prevent unauthorized entry may be substituted for the controls required by 6.3.3(c)(2).

(5) Any registrant may apply to the agency for approval of methods not included in 6.6.2(b)(2) and (4) for controlling access to high radiation areas. The agency will approve the proposed alternatives if the registrant demon- strates that the alternative methods of control will prevent unauthorized entry into a high radiation area, and that the requirement of 6.6.2(b)(3) is met.

(c) 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[3]
AIRBORNE RADIOACTIVITY AREA

(d) Additional Requirements

(1) Each area or room in which any radioactivity material, other than natural uranium or thorium, is used or stored in an amount exceeding 10 times the quantity of radioactive material specified in Appendix B of Section 12 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[3]
RADIOACTIVE MATERIAL

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one hundred times the quantity specified in appendix B or Section 12 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

[3]Or "DANGER."

CAUTION[3]
RADIOACTIVE MATERIAL

6.6.3 Labeling Containers

(a) Except as provided in 6.6.3(c) each container of radioactive material shall bear a durable, clearly visible label identifying the radioactive contents.

(b) A label required pursuant to 6.6.3(a) shall bear the radiation caution symbol and the words:

CAUTION[3]
RADIOACTIVE MATERIAL

It shall also provide sufficient information[4] to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(c) Notwithstanding the provisions of 6.6.3(a), Labeling is not required:

(1) For containers that do not contain radioactive material in quantities greater than the applicable quantities listed in Appendix B of Section 12.

(2) For containers containing only natural uranium or thorium in quantities no greater than ten (10) times the applicable quantities listed in Appendix B of Section 12.

(3) For containers that do not contain radioactive material in concentrations greater than the applicable concentrations listed in Column 2, Table I, Appendix A or Section 12.

(4) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established by the regulations in this part;

(5) For containers when they are in transport and packaged and labeled in accordance with regulations published by the department of transportation;

(6) For containers which are accessible only to individuals authorized to handle or use them[5] or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record; and

(7) For manufacturing and process equipment such as piping and tanks.

[3]Or "Danger."

[4]As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, etc.

[5]For example, containers in locations such as water-filled canals, storage vaults, or hot cells.

6.6.4. Labeling Radiation Machines - All radiation machines shall be labeled in a manner which cautions individuals that radiation is produced when the machine is being operated.

6.6.5. Exceptions from Posting and Labeling Requirements - Notwithstanding the provisions of 6.6:

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source, provided the radiation level twelve (12) inches from the surface of the source container or housing does not exceed five (5) millirem per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs, and control of entrance or access thereto pursuant to 6.6.2(b) is not required, because of the presence of patients containing radioactive material provided that there are personnel in attendance who will take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in the regulations in this part.

(c) Caution signs are not required to be posted in areas or rooms containing radioactive material for periods of less than eight (8) hours provided that:

(1) the material is constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in this part; and

(2) such area or room is subject to the registrant's control.

(d) A room or other area is not required to be posted with a caution sign, and control is not required for each entrance or access point to a room or other area which is a high radiation area solely because of the presence of radioactive material prepared for transport and packaged and labeled in accordance with regulations of the department of transportation.

6.7. Instruction of Personnel

6.7.1. Safety Information - Each registrant shall inform individuals working in or frequenting any portion of a restricted area of the occurrence of radiation or sources of radiation in such portions of the restricted area; shall instruct such individuals in the safety problems associated with exposures to such sources of radiation and in precautions or procedures to minimize exposure; shall instruct such individuals in the applicable provisions of the agency regulations for the protection of personnel from exposures to radiation or radioactive materials.

6.8. Storage of Sources of Radiation

6.8.1. Sources of radiation shall be secured against unauthorized removal from the place of storage and shall be provided with reasonable protection against loss, leakage, or dispersion by the effects of fire or water.

6.9. Waste Disposal

6.9.1. General Requirement - No registrant shall dispose of any radioactive material except:

(a) By transfer to an authorized recipient as provided in 5.10.2;

(b) As authorized pursuant to 6.3.3, 6.9.2, 6.9.3 or 6.9.4.

6.9.2. Method of Obtaining Approval of Proposed Disposal Procedures

(a) Any person may apply to the agency for approval of proposed procedures to dispose of radioactive material in a manner not otherwise authorized in this part.

(b) Each application shall include a description of the radioactive material, including the quantities and kinds of radioactive material and levels of radioactivity involved, and the proposed manner and conditions of disposal.

(c) The application, where appropriate, should 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.

(d) The agency will not approve any application for a registration to receive radioactive material from other persons for disposal on land not owned by a

state or the federal government.

6.9.3. Disposal by Release Into Sanitary Sewerage Systems - No registrant shall discharge radioactive material into a sanitary sewerage system unless

(a) It is readily soluble or dispersible in water;

(b) The quantity of any radioactive material released into the system by the registrant in any one day does not exceed the larger of the following:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the registrant, will result in an average concentration not greater than the limits specified in Appendix A, Table I, Column 2, of Section 12; or

(2) Ten (10) times the quantity of such material specified in Appendix B of Section 12;

(c) The quantity of any radioactive material released in any one month, if diluted by the average monthly quantity of waste water released by the registrant, will not result in an average concentration exceeding the limits specified in Appendix A, Table I, Column 2, or Section 12; and

(d) The gross quantity of radioactive material released into the sewerage system by the registrant does not exceed one (1) curie per year. Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

6.9.4. Disposal by Burial in Soil - No registrant shall dispose of radioactive material by burial in soil unless:

(a) The total quantity of radioactive material buried at any one location and time does not exceed at the time of burial 1,000 times the amount specified in Appendix B of Section 12; and

(b) Burial is at a minimum of four (4) feet; and

(c) Successive burials are separated by distances of at least six (6) feet and not more than 12 burials are made in any year.

6.9.5. Disposal by Incineration - No registrant shall incinerate radioactive material for the purpose of disposal or preparation for disposal except as specifically approved by the agency pursuant to 6.3.3 and 6.9.2.

6.10. Transfer of Material

6.10.1. No registrant shall transfer radioactive material except as authorized pursuant to this section.

6.10.2. Any registrant may transfer radioactive material:

(a) To the U.S. nuclear regulatory commission;

(b) To any person authorized to receive such material under terms of a general license or its equivalent, or a specific license or equivalent licensing document, issued by the U.S. nuclear regulatory commission, or any agreement state, or to any person otherwise authorized to receive such material by the federal government or any agency thereof, or any agreement state; or,

(c) As otherwise authorized by the agency in writing.

6.11. Intrastate Transportation of Radioactive Material

6.11.1. The provisions of this part 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. nuclear regulatory commission, the U.S. department of transportation, the U.S. postal service and other federal agencies.

6.11.2. No registrant shall transport any radioactive material outside of the confines of his plant or other authorized location of use, or deliver any radioactive material to a carrier for transportation, unless the registrant complies 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 and other federal agencies regulating the transportation of radioactive material.

6.12. Records

6.12.1. Each registrant shall maintain records showing the radiation doses of all individuals for whom personnel monitoring is required under 6.5. Such records shall be kept on Form RH-15 in accordance with the instructions contained in that form, or on clear and legible records contained in that form, or on clear and legible records containing all the information required by Form RH-15. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

6.12.2. Upon termination of employment of an individual, the individual and/or agency shall, upon request, be supplied with a summary statement of that individual's radiation dose. This record shall include statements of any circumstances wherein the dose to the employee from any source of radiation, exceeded those specified in these regulations. Employee records must be kept available for inspection by the agency during the tenure of employment of an employee and for a period of five years thereafter.

6.12.3. Each registrant shall maintain records in the same units used in these regulations, showing the results of surveys required to comply with these regulations and disposals made under 6.9.

6.12.4. Records of individual exposure to radiation and to radioactive material which must be maintained pursuant to the provisions of 6.12.1 and records of bioassays, including results of whole body counting examinations, made pursuant to 6.3.4 shall be preserved indefinitely or until the agency authorizes their disposal. (Records which must be maintained pursuant to this part may be maintained in the form of microfilms.)

6.12.5. An accurate accounting for all radioactive materials shall be maintained for a radiation installation. Such records shall show radioactive materials received, produced, transferred and disposed, the amounts and form of the radioactive materials, and such information as may be necessary to account for the difference between the amount of radioactive materials, received or produced and the amount on hand. Such records shall be retained for at least five years after the final disposition of any radioactive material.

6.12.6. Copies of all records required under these regulations shall be transferred to the agency in the event of termination of the registrant's business operations and at such other times as the agency may direct.

6.13. Reports

6.13.1. Report to Employees and Others of Radiation Dosage - Each registrant, at the request of any individual employed or associated with him, shall advise such individual annually of the individual's exposure to radiation as shown in records maintained by the registrant pursuant to 6.12.1.

6.13.2. Report to Former Employees and Others of Exposure to Radiation

(a) a registrant, at the request of any individual formerly employed or associated with him (i.e., student, craftsman, etc.) shall furnish to such individual a report of his exposure to radiation as shown in records maintained pursuant to 6.12.1. Such report shall be furnished within 30 days from the time the request is made and shall cover each calendar quarter of the individuals employment or association involving exposure to radiation, or such lesser period as may be requested by the individual. The report shall also include the results of any calculations and analysis of radioactive material deposited in the body of the individual and made pursuant to the provisions of 6.3.4. The report shall be in writing and contain the following statement:

"This report is furnished to you under the provisions of the West Virginia department of health regulations entitled, Radiological Health Regulations. You should preserve this report for future reference."

(b) The individual's request should include appropriate identifying data, such as social security number and dates and locations of employment or association.

6.13.3. Reports of Theft or Loss of Sources of Radiation - Each registrant shall report by telephone or telegraph and confirm promptly by letter to the agency the theft or loss of any source of radiation immediately after such occurrence becomes known.

6.13.4. Notification of Incidents

(a) Immediate Notification - Each registrant shall immediately notify the agency by telephone or

telegraph of any incident involving any source of radiation possessed by him and which may have caused or threatens to cause:

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

(2) 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 Appendix A, Table II, Section 12; or

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

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

(b) Twenty-four Hour Notification - Each registrant shall within 24 hours notify the agency by telephone or telegraph of any incident involving any sources of radiation possessed by him and which may have caused or threatens to cause:

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

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix A, Table II, Section 12; or

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

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

(c) Any report filed with the agency pursuant to this part shall be prepared in such a manner that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

6.13.5. Reports of Overexposures and Excessive Levels and Concentrations.

(a) In addition to any notification required by 6.13.4, each registrant shall make a report in writing within 30 days to the agency of:

(1) Each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit as set forth in this part or as otherwise approved by the agency; and

(2) Any incident for which notification is required by 6.13.4; and

(3) Levels of radiation or concentrations of radioactive material (not involving excessive radiation doses to any individual) in an unrestricted area in excess of ten (10) times any applicable limit as set forth in this part or as otherwise approved by the agency.

(4) Each report required under this paragraph shall describe the extent of exposure of individuals to radiation or to radioactive material, including estimates of each individual's dose as required by 6.13.5(b); levels of radiation and concentrations of radioactive material involved; the cause of exposure, levels or concentrations; and corrective steps taken or planned to assure against a recurrence.

(b) In any case where a registrant is required pursuant to the provisions of this section to report to the agency any exposure of an individual to radiation or concentrations of radioactive material, the registrant shall no later than the making of such report to the agency also notify such individual of the nature and extent of exposure. Such notice shall be in writing and shall contain the following statement:

"This report is furnished to you under the provisions of the West Virginia department of health regulations entitled, Radiological Health Regulations. You should preserve this report for future reference."

(c) Any report filed with the agency pursuant to this section shall include for each individual exposed the name, social security number, and date of birth. The report shall be prepared so that this information is stated in a separate part of the report.

6.14. Vacating Premises

6.14.1. Each registrant shall, no less than 30 days before vacating or relinquishing possession or control of premises in which radioactive material which he has registered has been stored or used, notify the agency in writing of intent to vacate and afford the agency the opportunity to survey the premises for contamination. When deemed necessary by the agency the registrant shall decontaminate said premises in such a manner as the agency may authorize and shall not vacate or relinquish possession or control of said premises without written consent of the agency.

§64-23-7. Requirements for Radiation Usage in the Healing Arts

7.1. Scope. -- This part establishes requirements for which a registrant is responsible, for use of X-ray equipment by or under the supervision of an individual authorized by and licensed in accordance with West Virginia statutes to engage in the healing arts or veterinary medicine. The provisions of this section are in addition to, and not in substitution for, other applicable provisions of these regulations.

7.2. Definitions -- As used in this section, the following definitions apply:

(1) Added Filtration - means the filter added to the inherent filtration.

(2) Aluminum Equivalent - means the thickness of aluminum (type 1100 alloy) affording the same attenuation, under specified conditions, as the material in question. (The nominal chemical composition of type 1100 aluminum alloy is 99.00 percent minimum aluminum, 0.12 percent copper.)

(3) Barrier - (See Protective Barrier.)

(4) Collimator - means a device or mechanism by which the x-ray beam is restricted in size.

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

(6) Diagnostic-type Protective Tube Housing - means an x-ray tube housing so constructed that the leakage radiation at a distance of 1 meter from the target cannot exceed 100 milliroentgens in 1 hour when the tube is operated at its maximum continuous rated current for the maximum rated tube potential.

(7) Diaphragm - means a device or mechanism by which the x-ray beam is restricted in size.

(8) Filter - means material placed in the useful beam to absorb prefentially selected radiations.

(9) Half-value Layer (HVL) - means the thickness of specified material which attenuates the beam of radiation to an extent such that the exposure rate is reduced to one-half of its original value.

(10) Inherent Filtration - means the filtration permanently in the useful beam; it includes the window of the x-ray tube and any permanent tube or source enclosure.

(11) Interlock - means a device for precluding access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.

(12) Kilovolts Peak (kVp) - means the crest value in kilovolts of the potential of a pulsating potential generator. When only one-half of the wave is used, the value refers to the useful half of the wave.

(13) Lead Equivalent - means the thickness of lead affording the same attenuation, under specified conditions, as the material in question.

(14) Leakage Radiation - means radiation emanating from the diagnostic or therapeutic source assembly (excluding capacitor discharge machines) except for:

(a) the useful beam; and

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

(15) Primary Protective Barrier - (See Protective Barrier.)

(16) Protective Apron - means an apron made of radiation absorbing materials used to reduce radiation exposure.

(a) Primary Protective Barrier - means the material, excluding filters, placed in the useful beam, for protection purposes, to reduce the radiation exposure.

(b) Secondary Protective - barrier means a

barrier sufficient to attenuate the stray radiation to the required degree.

(18) Protective Glove - means a glove made of radiation absorbing materials used to reduce radiation exposure.

(19) Qualified Expert - means an individual who has demonstrated to the satisfaction of the agency that he possesses the knowledge and training to measure ionizing radiation, to evaluate safety techniques, and to advise regarding radiation protective needs.

(20) Registrant as used in this section - means any person who owns or possesses and administratively controls an x-ray system which is used to deliberately expose humans or animals to the useful beam of the system and is required by the provisions of Section 4 and 5 of these regulations to register with this agency.

(21) Scattered Radiation - means radiation that, during passage through matter, has been deviated in direction.

(22) Secondary Protective Barrier - (See Protective Barrier.)

(23) Source-image Distance (SID) - means the distance from the source to the center of the input surface of the image receptor.

(24) Therapeutic-type Tube Housing - means:

(a) For x-ray therapy equipment not capable of operating at 500 kVp or above, the following definition applies: An x-ray tube housing so constructed that the leakage radiation averaged over any 100 cm^2 area at a distance of one meter from the source does not exceed one roentgen in an hour when the tube is operated at its maximum rated continuous current for the maximum rated tube potential.

(b) For x-ray therapy equipment capable of operating at 500 kVp or above, the following definition applies: An x-ray tube housing so constructed that the leakage radiation averaged over any 100 cm^2 area at a distance of one meter from the source does not exceed 0.1 percent of useful beam dose rate at one meter from the source for any of its operating conditions.

(25) Useful Beam - means the radiation which passes through the tube housing port and the aperture of the beam-limiting device when the exposure switch or timer is activated.

7.3. Use of X-Ray Equipment in the Healing Arts

7.3.1. General Safety Provisions

(a) Use

(1) The registrant shall assure that all x-ray equipment under his control is operated only by individuals adequately instructed in safe operating procedures and competent in safe use of the equipment.

(2) The registrant shall provide safety rules to each individual operating x-ray equipment under his control, including any restrictions of the operating technique required for the safe operation of the particular x-ray apparatus, and require that the operator demonstrate familiarity with these rule.

(b) Shielding - Each installation shall be provided with such primary barriers and/or secondary barriers as are necessary to assure compliance with Sections 6.2, 6.2.5 and 6.3.

(c) Prohibited Use - No registrant shall operate or permit the operation of x-ray equipment unless the equipment and installation meet the applicable requirements of these regulations.

(d) New Equipment - Diagnostic x-ray systems for use on humans, and the following components manufactured or assembled after the effective date of the federal performance standard designated as Title 42, code of federal regulations Part 78 shall be subjected to the provisions of said standards: tube housing assemblies, x-ray controls, x- ray high voltage generators, fluoroscopic imaging assemblies, tables, cradles, film changers, cassette holders, and beam-limiting devices.

7.3.2. Fluoroscopic Installations

(a) Equipment

(1) The tube housing shall be of the diagnostic type.

(2) The target-to-panel or target-to-table

top distance of the equipment shall not be less than twelve (12) inches.

(3) The total filtration permanently in the useful beam, including the aluminum equivalent of table top or panel, shall not be less than the appropriate value recommended in Table 4-2.

(4) The equipment shall be so constructed that the entire cross-section of the useful beam is attenuated by a primary barrier (usually a conventional fluoroscopic screen or an image intensification mechanism). The exposure shall automatically terminate when the barrier is removed from the useful beam.

(i) For equipment installed after the effective date of this part the required lead equivalent of the barrier shall not be less than 1.5 millimeter for up to 100 kVp, 1.8 for greater than 100 and less than 125 kVp and 2.0 millimeters for 125 kVp or greater.

(ii) Collimators shall be provided to restrict the size of the useful beam to less than the area of the barrier. For conventional fluoroscopes this requirement is met if, when the adjustable diaphragm is open to its fullest extent, an unilluminated margin is left at all edges of the fluorescent screen with the screen centered in the beam at a distance of thirty-five (35) centimeters (fourteen (14) inches) from the panel or table top. The margin requirement does not apply to installations where image intensifiers are used, but a shutter shall be provided at these installations so that the length and width of the useful beam is restricted to the diameter of the input phosphor.

(iii) The tube mounting and the viewing device shall be so linked together that, under conditions of normal use, the barrier always intercepts the entire useful beam.

(iv) Collimators and adjustable diaphragms or shutters to restrict the size of the useful beam shall provide the same degree of protection as is required of the housing.

(5) The exposure switch shall be of the dead-man type.

(6) A cumulative timing device activated by the exposure switch shall be used which will either indicate elapsed exposure time by an audible signal or turn off the apparatus when the total exposure time exceeds a predetermined limit not exceeding 5 minutes in one or a series of exposures.

(7) A shielding device of at least 0.25 millimeter lead equivalent shall be provided for covering the bucky-slot during fluoroscopy.

(8) Protective drapes, or hinged, or sliding panels, of at least 0.25 millimeters lead equivalent, shall be provided between the patient and fluoroscopist to intercept scattered radiation which would otherwise reach the fluoroscopist and others near the machine. Such devices shall not substitute for wearing of a protective apron.

(9) Protective aprons of at least 0.25 millimeters lead equivalent shall be worn in the fluoroscopy room by each person, except the patient.

(10) For routine fluoroscopy, the exposure rate measured where the useful beam enters the patient shall not exceed ten (10) roentgens per minute.

(11) Mobile fluoroscopic equipment is subject to the following additional requirements:

(i) In the absence of a table top, a cone or spacer frame shall limit the source-to-skin distance to not less than thirty (30) centimeters (twelve (12) inches.)

(ii) Image intensification shall always be provided. Conventional fluoro scopic screens shall not be used.

(iii) It shall be impossible to operate the machine unless the useful beam is intercepted by the image intensifier.

(iv) The exposure rate measured at the minimum source-to-skin distance shall not exceed ten (10) roentgens per minute.

7.3.3. Diagnostic Radiographic Installations Other Than Dental and Veterinary Medical.

(a) Equipment

(1) The protective tube housing shall be of the diagnostic type.

(2) Collimators capable of restricting the

useful beam to the area of clinical interest shall be provided to define the beam and shall provide the same degree of attenuation as is required of the protective tube housing. Collimators used with photofluorographic devices shall restrict the useful beam to the area of the photofluorographic screen.

(i) Collimators shall be calibrated in terms of the size of the projected useful beam at specified source-film distances.

(ii) Except for stereoradiography, the size of the useful beam (rectangular) shall not exceed any one of the dimensions of the film by more than two (2) inches for a source-film distance of thirty-seven (37) inches or greater or one (1) inch for a source-film distance of thirty-six (36) inches or less. The size of the useful beam (circular) shall not exceed any one of the dimensions of the film by more than two (2) inches for a source-film distance of thirty-seven (37) inches or greater or one (1) inch for a source-film distance of thirty-six (36) inches or less. For photofluorographic equipment, the size of the useful beam shall be restricted to the area of the photofluorographic screen.

(iii) Adjustable collimators installed after the effective date of these regulations shall incorporate light beams to define the projected dimensions of the useful beam.

(3)

(i) The aluminum equivalent of the total filtration (inherent plus added) in the primary beam shall not be less than shown in Table 64-23D (found at the end of this regulation), except when contraindicated for a particular diagnostic procedure:

(ii) If the filter in the machine is not accessible for examination, or the total filtration is unknown, it can be assumed that the requirements of 7.3.3(3)(i) are met if the half-value layer is not less than shown in Table 64-23E found at the end of this regulation.

(4) A device shall be provided which terminates the exposure at a preset time interval or exposure. If a recycling timer is employed, it shall not be possible to make a repeat exposure without release of the exposure switch to reset the timer.

(5) The exposure switch, except for those used in cinefluoroscopy or in conjunction with "spot film" devices in fluoroscopy, shall be so arranged that it cannot be conveniently operated outside a shielded area.

(6)

(i) The control panel shall include a device, (e.g., a milliammeter) which will give positive indication of the production of x-rays whenever the x-ray tube is energized.

(ii) The control panel shall include appropriate devices, e.g., labeled control settings and/or meters, indicating the physical factors (such as kVp, mA, exposure time or whether the timing is automatic) used for the exposure.

(7) Machines equipped with beryllium window x-ray tubes shall contain keyed filter interlock switches in the tube housing and suitable indication on the control panel of the added filter in the useful beam if the total filtration permanently in the useful beam is less than 0.5 mm aluminum equivalent. The total filtration permanently in the useful beam shall be clearly indicated on the tube housing.

(b) Structural Shielding

(1) All wall, floor, and ceiling areas struck by the useful beam shall have primary barriers. Primary barriers in walls shall extend to a minimum height of seven (7) feet above the floor.

(2) Secondary barriers shall be provided in all wall, floor, and ceiling areas not having primary barriers.

(3) The operator's station at the control shall be behind a protective barrier sufficient to assure compliance with 6.2 and 6.2.5. Provisions shall be made for the operator to communicate with the patient from the operator's station.

(4) A window of lead-equivalent glass equal to that required by the adjacent barrier, or a mirror system, shall be provided and it shall be large enough and so placed that the operator can see the patient during the exposure without having to leave the protected area.

(c) Operating Procedures

(1) When a patient must be held in position for radiography, mechanical supporting or restraining devices should be used. If the patient must be held by an individual, that individual shall be protected with appropriate shielding devices such as protective gloves and apron and he shall be so positioned that no part of his body will be struck by the useful beam.

(2) Only individuals required for the radiographic procedure shall be in the radiographic room during exposure; and except for the patient, all such persons shall be equipped with appropriate protective devices.

(3) The useful beam shall be restricted to the area of clinical interest.

(4) Personnel monitoring shall be required for all individuals operating photofluorographic equipment.

(5) Gonadal shielding of not less than 0.25 mm lead equivalent shall be used for patients who have not passed the reproductive age during radiographic procedures in which the gonads are in the direct (useful) beam, except for cases in which this would interfere with the diagnostic procedure.

7.3.4. Special Requirements for Mobile Diagnostic Radiographic Installations

(a) Equipment

(1) All requirements of 7.3.3(a) apply except 7.3.3(a)(5).

(2) The exposure control switch shall be of the dead-man type and shall be so arranged that the operator can stand at least six (6) feet from the patient, the x-ray tube, and well away from the useful beam.

(3) Inherent provisions shall be made so that the equipment is not operated at source-to-skin distances of less than twelve (12) inches (30 cm).

(b) Structural Shielding

(1) When a mobile unit is used routinely in one location, it shall be considered a fixed installation subject to the shielding requirements of 7.3.1(b) and 7.3.3(b).

(c) Operating Procedures

(1) All provisions of 7.3.3(c) apply except 7.3.3(c) and 7.3.3(c) (4).

(2) Personnel monitoring shall be required for all individuals operating mobile x-ray equipment.

7.3.5. Dental Radiographic Installations

(a) Equipment

(1) The protective tube housing shall be of the diagnostic type.

(2) Diaphragms or cones shall be used for restricting the useful beam and shall provide the same degree of protection as the housing. The diameter of the useful beam at the end of the cone shall be not more than three (3) inches for intraoral radiography.

(3) A cone or spacer frame shall provide a source-to-skin distance of not less than seven (7) inches with apparatus operating above fifty (50) kVp or four (4) inches with apparatus operating at fifty (50) kVp or below for intraoral radiography.

(4)

(i) The aluminum equivalent of the total filtration (inherent plus added) in the useful beam shall not be less than that shown in Table 64-23F found at the end of this regulation.

(ii) If the filter in the machine is not accessible for examination or the total filtration is unknown, it can be assumed that the requirements of 7.3.5(a)(4)(i) are met if the half-value layer is not less than that shown in Table 64-23G found at the end of this regulation.

(5) A device shall be provided to terminate the exposure after a preset time interval or exposure. The exposure switch shall be of the dead- man type.

(6) Each installation shall be provided with a protective barrier for the operator or shall be so arranged that the operator can stand at least six (6) feet from the patient and well away from the useful beam.

(7) The tube head shall remain stationary when placed in the exposure position.

(b) Structural Shielding

(1) Dental rooms containing x-ray machines shall be provided with such primary barriers and/or secondary barriers as are necessary to assure compliance with 6.2.1, 6.2.4 and 6.2.5. No approval by the agency is required if it can be shown upon request by the agency that the limits in 6.2.5(b) will not be exceeded.

NOTE: In many cases, structural materials of ordinary walls suffice as a protective barrier without addition of special shielding material.

(c) Operating Procedures

(1)

(i) Neither the dentist nor his assistant shall hold patients or films during exposure, nor shall any individual be regularly used for this service.

(ii) Only persons required for the radiographic procedures shall be in the radiographic room during exposures.

(2) During each exposure, the operator shall stand as far as practical from the patient and outside the path of the useful beam or behind a suitable barrier.

(3) Only the patient shall be in the useful beam.

(4) Neither the tube housing nor the cone shall be hand-held during the exposure.

(5) Fluoroscopy shall not be used in dental examinations.

7.3.6. Therapeutic X-ray Installations

(a) Equipment

(1) The protective tube housing shall be of the therapeutic type.

(2) Permanent diaphragms or cones used for collimating the useful beam shall afford the same degree of protection as the tube housing. Adjustable or removable beam defining diaphragms or cones shall transmit not more than five (5) percent of the useful beam at the maximum kilovoltage and with maximum treatment filter.

(3) 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 exceed one (1) roentgen per hour at one (1) meter, or, if the radiation from the slot is accessible to the patient, thirty (30) roentgens per hour at five (5) centimeters from the external opening. Each removable filter shall be marked with its thickness and material.

(4) A filter indication system shall be used on all therapy machines using changeable filters. It shall be designed so as to permit easy recognition of any added filter in place. It shall indicate, from the control panel, the presence or absence of any filter.

(5) The x-ray tube shall be so mounted that it cannot turn or slide with respect to the housing aperture.

(6) Means shall be provided to immobilize the tube housing during stationary portal treatment.

(7) A suitable exposure control device shall be provided to terminate the exposure after a preset time interval or preset exposure or dose limit. Means shall be provided for the operator to terminate the exposure at any time.

(8) Equipment utilizing shutters to control the useful beam shall have a shutter position indicator on the control panel.

(9) The control panel shall include a device which will give positive indication of the production of x-rays whenever the x-ray tube is energized.

(b) Structural Shielding

(1) All wall, floor, and ceiling areas that can be struck by the useful beam shall be provided with primary protective barriers.

(2) All wall, floor, and ceiling areas that, because of restrictions in the orientation of the useful beam, cannot be struck by the useful beam shall be provided with secondary protective barriers.

(3) With equipment operating at voltages above one hundred and twenty-five (125) kVp, the required barriers shall be an integral part of the building. (4) With the equipment operating above one hundred and fifty (105) kVp, the control station shall be within a protective booth equipped with an interlocked door, or outside the treatment room.

(5) Interlocks shall be provided for x-ray therapy equipment capable of operating above 150 kVp so that when any door of the treatment room is opened either the machine will shut off automatically or the radiation level within the room will be reduced to an average of not more than two (2) milliroentgens per hour and a maximum of ten (10) milliroentgens per hour at a distance of one (1) meter in any direction from the target. After such shut off or reduction in output it shall be possible to restore the machine to full operation only from the control panel.

(6) Windows, mirror systems, or closed-circuit television viewing screens shall be provided to permit continuous observation of the patient during irradiation and shall be so located that the operator may see the patient and the control panel from the same position. (7) Provision shall be made for oral communication with the patient from the control room.

(8) Treatment rooms to which access is possible through more than one entrance shall be provided with flashing warning lights in a readily observable position near the outside of all access doors, which will indicate when the useful beam is "on".

(c) Operating Procedures

(1) All new installations, and existing installations not previously surveyed, shall have a protection survey made by, or under the direction of, a qualified expert. This shall also be done after any change in the installation which might produce a radiation hazard. The expert shall report his findings in writing to the person in charge of the installation, a copy of which shall be made available for inspection by the agency.

(2) The installation shall be operated in compliance with any limitations indicated by the protection survey.

(3) When a patient must be held in position for radiation therapy, mechanical supporting or restraining devices shall be used whenever feasible. If the patient must be held by an individual, that individual shall be adequately protected and he shall be positioned so that no part of his body will be struck by the useful beam and that his body is as far as possible from the edge of the useful beam. Any individual used for this purpose shall be provided with personnel monitoring.

(4) The output of each therapeutic x-ray machine shall be calibrated by, or under the direction of, a qualified expert. The calibration shall be repeated after any change in or replacement of components of the x-ray generating equipment which could cause a change in x-ray output. Check calibrations shall be made at least once a year thereafter. Records of calibrations shall be maintained by the registrant. Recalibration shall be performed at least once in every calendar year except that recalibration is not required when spot checks are made and a log record made of these spot checks. Spot checks shall be made and recorded at least monthly or after every fifty (50) operating hours, whichever is the longer time interval. A spot check measurement consists of determining the exposure rate or dose rate of a quantity related in a known manner to these entities for one typical set of operating conditions.

7.3.7. Special Requirements for X-ray Therapy Equipment Operated at Potentials of Sixty (60) kVp and Below

(a) Equipment - All provisions of 7.3.6(a) apply except that leakage radiation 5 cm from the surface of the tube housing shall not exceed 0.1 roentgen per hour.

(b) Operating Procedures

(1) Automatic timers shall be provided which will permit accurate presetting and termination of exposures as short as one second.

(2) In the therapeutic application of apparatus constructed with beryllium or other low-filtration windows, the registrant shall insure that the unfiltered radiation reaches only the part intended and that the useful beam is blocked at all times except when actually being used.

(3) Machines having an output of more than 2,000 roentgens per minute at any accessible place shall not be left unattended without the power

being shut off at the main disconnect switch in addition to the control panel switch.

(4) If the tube must be hand-held during irradiation, the operator shall wear protective gloves and a protective apron of no less than 0.5 millimeter lead equivalent.

7.3.8. Veterinary Medical Radiographic Installations

(a) Equipment

(1) The protective tube housing shall be of diagnostic type.

(2) Diaphragms or cones shall be provided for collimating the useful beam to the area of clinical interest and shall provide the same degree of protection as is required of the housing.

(3) The total filtration permanently in the useful beam shall not be less than 0.5 millimeters aluminum equivalent for machines operating up to 50 kVp, 1.5 millimeters aluminum equivalent for machines operating between 50-70 kVp and 2.5 millimeters aluminum equivalent for machines operating above 70 kVp.

(4) A device shall be provided to terminate the exposure after a preset time or exposure. (5) A dead-man type of exposure switch shall be provided, together with an electrical cord of sufficient length so that the operator can stand out of the useful beam and at least six (6) feet from the animal during all x-ray exposures.

(b) Structural Shielding

(1) All wall, ceiling, and floor areas shall be equivalent to or provided with applicable protective barriers as required in 7.3.3(b)(1) and 7.3.3(b)(2)

(c) Operating Procedures

(1) The operator shall stand well away from the useful beam and the animal during radiographic exposures.

(2) No individual other than the operator shall be in the x-ray room while exposures are being made unless such individual's assistance is required.

(3) When an animal must be held in position during radiography, mechanical supporting or restraining devices should be used. If the animal must be held by an individual, that individual shall be protected with appropriate shielding devices, such as protective gloves and apron, and he shall be so positioned that no part of his body will be struck by the useful beam. Any individual used for this purpose shall be provided with personnel monitoring.

§64-23-8. Use of Sealed Radioactive Sources in the Healing Arts

8.1. Scope - The provisions of this section apply to all registrants who use sealed sources in the healing arts and are in addition to, and not in substitution for, other applicable provisions of these regulations.

8.2. Special Requirements for the Use of Sealed Radioactive Sources in the Healing Arts

8.2.1. Interstitial, Intracavitary, and Superficial Applications

(a) Accountability, Storage, and Transit

(1) Except as otherwise specifically authorized by the agency, each registrant shall provide accountability of sealed sources and shall keep a permanent record of the issue and return of all sealed sources. A physical inventory shall be made at least every six (6) months and a written record of the inventory maintained. (2) When not in use, sealed sources and applicators containing sealed sources shall be kept in a protective enclosure of such material and wall thickness as may be necessary to assure compliance with the provisions of 6.2, 6.2.5 and 6.03.

(b) Testing Sealed Sources for Leakage and Contamination

(1) All sealed sources with a half-life greater than thirty (30) days and in any form other than gas shall be tested for leakage and/or contamination prior to initial use and at intervals not to exceed six (6) months. If there is reason to suspect that a sealed source might have been damaged, or might be leaking, it shall be tested for leakage before further use.

2) Leak tests shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample or, in the case of radium, the

escape of radon at the rate of 0.001 microcurie per 24 hours. Any test conducted pursuant to 8.2.1(b)(1) which reveals the presence of 0.005 microcurie or more of removable contamination or, in the case of radium, the escape of radon at the rate of 0.001 microcurie or more per twenty-four (24) hours shall be considered evidence that the sealed source is leaking. The registrant shall immediately withdraw the leaking source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with applicable provisions of Section 6.

(3) Leak tests results shall be recorded in units of microcuries and maintained for inspection by the agency.

(c) Radiation Surveys

(1) The maximum radiation level at a distance of one (1) meter from the patient in whom brachytherapy sources have been inserted shall be determined by measurement or calculation and preferably both. This radiation level shall be entered on the patient's chart and other signs as required under 8.2(d).

(2) The radiation levels in the patient's room and surrounding areas shall be determined, recorded, and maintained for inspection by the agency.

(3) Immediately after the removal of the brachytherapy source(s), the patient shall be surveyed with an appropriate radiation survey instrument to insure that all sealed radioactive sources have been removed. Results of the survey shall be recorded in the source utilization log and maintained for inspection by the agency.

(d) Signs and Records

(1) In addition to the requirements of 6.6, the bed, cubicle, or room of the hospital brachytherapy patient shall be marked with a sign indicating the presence of brachytherapy sources. This sign shall incorporate the radiation symbol and specify the radionuclide, the activity, date, and the individual(s) to contact for radiation safety instructions. The sign is not required provided the exception in 6.6.5(b) is met

(2) The following information shall be included in the patient's chart:

(i) The radionuclide administered, number of sources, activity in millicuries and the time and date of administration;

(ii) The maximum radiation level at 1 meter from the patient, the time the determination was made and by whom;

(iii) The radiation symbol; and

(iv) The precautionary instructions necessary to assure that the exposure of individuals does not exceed that permitted under 6.2.

8.2.2. Teletherapy

(a) Equipment

(1) The housing shall be so constructed that, at one (1) meter from the source, the maximum exposure rate does not exceed ten (10) milliroentgens per hour when the beam control mechanism is in the "off" position. The average exposure rate measured at a representative number of points about the housing, each one (1) meter from the source, shall not exceed two (2) milliroentgens per hour.

(2) For teletherapy equipment installed after the effective date of these regulations, the leakage radiation measured at one (1) meter from the source when the beam control mechanism is in the "on" position shall not exceed one (1) roentgen per hour or 0.1 percent of the exposure rate of the useful beam.

(3) Adjustable or removable beam- defining diaphragms shall allow transmission of not more than five (5) percent of the exposure rate of the useful beam.

(4) The beam control mechanism shall be of a positive design capable of acting in any position of the housing. In addition to an automatic closing device, the mechanism shall be designed so that it can be manually returned to the "off" position with a minimum risk of exposure.

(5) 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 until activated from the control panel.

(6) When any door to the treatment room

is opened, the beam control mechanism shall automatically and rapidly restore the unit to the "off" position and cause it to remain there until the unit is reactivated from the control panel.

(7) There shall be at the housing and at the control panel a warning device that plainly indicates whether the beam is on or off.

(8) The equipment shall be provided with a locking device to prevent unauthorized use.

(9) The control panel shall be provided with a timer that automatically terminates the exposure after a preset time.

(10) Teletherapy sources shall be tested for leakage and contamination in accordance with the procedures described in 8.2.1(b) except that the leak tests shall be capable of detecting 0.005 microcurie of removable contamination, and a source shall be considered to be leaking if the test reveals the presence of 0.005 microcurie or more of removable contamination. Tests of leakage may be made by wiping accessible surfaces of the housing port or collimator while the source is in the "off" position and measuring these wipes for transferred contamination.

(b) Shielding

(1) Primary protective barriers shall be provided for any area that the useful beam may strike when using the largest possible diaphragm opening. Such barriers should extend at least one (1) foot beyond the useful beam for any possible orientation.

(2) Secondary protective barriers shall be provided for all occupied areas exposed to leakage and scattered radiation.

(3) Provision shall be made to permit continuous observation of patients during irradiation.

(c) Operation

(1) No individual who is occupationally exposed to radiation shall be in the treatment room during irradiation unless he is the patient. No other individual shall be there except when it is clinically necessary.

§64-23-9. Radiation Safety Requirements for Industrial Radiographic Operations

9.1. Purpose and Scope

9.1.1. The regulations in this section establish radiation safety requirements for persons using sources of radiation for industrial radiography. The requirements of this section are in addition to and not a substitute for other requirements of these regulations. Except for those sections clearly applicable to sealed radioactive sources, both sealed sources and radiation machines are covered by this section.

9.1.2. This section applies to all registrants who use sources of radiation for industrial radiography; provided, however, that nothing in this section shall apply to uses of radiation sources in the healing arts.

9.2. Definitions

(1) Cabinet Radiography - means industrial radiography using radiation machines, or equipment, which is conducted in an enclosed, interlocked cabinet, such that the radiation machine will not operate unless all openings are securely closed, and which cabinet is so shielded that every location on the exterior meets all radiation level requirements for an unrestricted area as specified in 9.3.

(2) Industrial Radiography - means the macroscopic examination of the structure of materials by nondestructive methods utilizing sources of radiation.

(3) Radiographer - means any individual who performs or who, in attendance at the site where sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the registrant for assuring compliance with the requirements of these regulations.

(4) Radiographer's Assistant - means any individual who, under the personal supervision of a radiographer, uses sources of radiation, related handling tools, or survey instruments in industrial radiography.

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

(6) Storage Container - means a device in which

sealed sources are transported or stored.

(7) Shielded Room Radiography - means industrial radiography which is conducted in an enclosed room, the interior of which is not occupied during radiographic operations, which is so shielded that every location on the exterior meets conditions for an unrestricted area as specified in 6.3, and the only access to which is through openings which are interlocked so that the radiation machine will not operate unless all openings are securely closed.

(8) Field Radiography - means all industrial radiography other than cabinet radiography and shielded room radiography.

9.3. Special Radiation Safety Requirements for Industrial Radiography Operation

9.3.1. Limits on Radiation Levels for Radiography Exposure Devices and Storage Containers

(a) Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device.

(b) Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources or outer containers for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. The radiation levels specified are with the sealed source in the shielded (i.e., "off") position.

9.3.2. Locking of Sources of Radiation - Each source of radiation shall be provided with a lock or outer lockable container designed to prevent unauthorized or accidental production of radiation or removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a radiographer or radiographer's assistant, or as may be otherwise authorized pursuant to 9.4.4. Each storage container likewise shall be provided with a lock and kept locked when containing sealed sources except when the container is under the direct surveillance of a radiographer or radiographer's assistant.

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

9.3.4. Radiation Survey Instruments - The registrant shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this section and Section 12 of these regulations. Each radiation survey instrument shall be calibrated at intervals not to exceed one (1) year and after each instrument servicing and a record maintained of the latest date of calibration. Instrumentation required by this section shall have a range such that two milliroentgens per hour through one roentgen per hour can be measured.

9.3.5. Leak Testing, Repair, Tagging, Opening, Modification, and Replacement of Sealed Sources

(a) 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 to do so by the agency, the U.S. nuclear regulatory commission, or any agreement state.

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

(c) The leak test shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography registrant would be to test at the nearest accessible point to the sealed source storage position or other appropriate measuring point by a procedure to be approved by the agency. The applicant who desires to conduct his own leak tests shall establish adequate procedures to be followed in leak testing sealed sources for possible leakage and contamination and shall submit to the agency a description of such procedures including:

(1) Instrumentation to be used;

(2) Method of performing tests, e.g., points on equipment to be smeared and method of taking smear; and

(3) Pertinent experience of the person who will perform the test.

Records of leak test results shall be kept in units of microcuries and maintained for inspection by the agency.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this part which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The registrant shall immediately withdraw such defective equipment from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with regulations of the agency. Within 5 days after obtaining results of the test, the registrant shall file a report with the agency describing the equipment involved, the test results, and the corrective action taken.

(e) 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 (1) 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".

9.3.6. Quarterly Inventory - Each registrant shall conduct a quarterly physical inventory to account for all sources of radiation received or possessed by him. The records of the inventories shall be maintained for inspection by the agency and shall include the quantities and kinds of radioactive material, the location of all sources of radiation, and the date of the inventory.

9.3.7. Utilization Logs - Each registrant shall maintain current logs, which shall be kept available for inspection by the agency, showing for each source of radiation the following information:

(a) A description (or make and model number) of each source of radia- tion or storage container in which the sealed source is located;

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

(c) Locations where used and dates of use; and

(d) The voltage, current, and exposure time for each radiographic exposure employing a radiation machine.

9.4. Personal Radiation Safety Requirements for Radiographers and Radiographers' Assistants

9.4.1. Limitations

(a) No registrant shall permit any person to act as a radiographer as defined in these regulations until such person:

(1) Has been instructed in the subjects outlined in 9.6 of this section and shall have demonstrated understanding thereof;

(2) Has received copies of and instruction in the regulations contained in this section and the applicable sections of Section 12; and the registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(3) Has demonstrated competence to use the source of radiation, related handling tools, and survey instruments which will be employed in his assignment.

(b) No registrant shall permit any person to act as a radiographer's assistant as defined in this part until such person:

(1) Has received copies of and instructions in the registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(2) Has demonstrated competence to use under the personal supervision of the radiographer, the sources of radiation, related handling tools, and radiation survey instruments which will be employed in his assignment.

9.4.2. Operating and Emergency Procedures - The registrant's operating and emergency procedures shall include instructions in at least the following:

(a) The handling and use of sources of radiation to be employed such that no person is likely to be exposed to radiation doses in excess of the limits es-

tablished in Section 12;

(b) Methods for controlling access to radiographic areas;

(c) Methods and occasions for conducting radiation surveys;

(d) Methods and occasions for locking and securing sources of radiation;

(e) Personnel monitoring and the use of personnel monitoring equipment;

(f) Transportation to field locations, including packing of sources of radiation in the vehicles, posting of vehicles, and control of sources of radiation 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.

9.4.3. Personnel Monitoring Control

(a) No registrant shall 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 exposures 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 exposures 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 agency.

9.4.4. Security - During each radiographic operation, the radiographer or radiographers' assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in 5.4, except where the high radiation area is equipped with a control device or an alarm system as described in 6.6.2(b)(2), or where the high radiation area is locked to protect against unauthorized or accidental entry.

9.4.5. Posting - Notwithstanding any provisions in Section 6.6.5, areas in which radiography is being performed shall be conspicuously posted as required by Section 6.6.2(a) and (b).

9.4.6. Radiation Surveys and Survey Records

(a) No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in 9.3.4 is available and used at each site where radiographic exposures are made.

(b) A physical radiation survey shall be made after each radiographic exposure utilizing radiographic exposure devices or sealed sources of radioactive material to determine that the sealed source has been returned to its shielded condition.

(c) 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 or storage container as specified in 9.3.2.

(d) Records shall be kept of the surveys required by 9.4.6(c) and maintained for inspection by the agency.

9.5. Special Requirements for Radiography Employing Radiation Machines

9.5.1. Cabinet Radiography - Cabinet radiography shall be exempt from other requirements of Section 12 however, no registrant shall permit any individual to operate a cabinet radiography unit until such individual has received a copy of, and instruction in, and demonstrated an understanding of operating procedures for the unit, and has demonstrated competence in its use.

9.5.2. Shielded Room Radiography - Shielded room radiography shall be exempt from other requirements of Section 12; however,

(a) No registrant shall permit any individual to operate a radiation machine for shielded room radiography until such individual has received a copy of, and instruction in, and demonstrated an understand-

ing of operating procedures for the unit, and has demonstrated competence in its use.

(b) Each registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by, every individual who operates, who makes "set-ups", or who performs maintenance on a radiation machine for shielded room radiography.

(c) A physical radiation survey shall be conducted to determine that the radiation machine is "off" prior to each entry into the shielded room. Such surveys shall be made with a radiation measuring instrument capable of measuring radiation of the energies and at the dose rates to be encountered, which is in good working order, and which has been properly calibrated within the preceding three months or following the last instrument servicing, whichever is later.

9.5.3. Field Radiography - Field Radiography shall be exempt from 9.3.1, 9.3.3, 9.3.5, and 9.4.6; however,

(a) A physical radiation survey shall be conducted to determine that the radiation machine is "off" prior to each entry into the radiographic exposure area. Such surveys shall be made with a radiation measuring instrument capable of measuring radiation of the energies and at the dose rates to be encountered, which is in good working order, and which has been properly calibrated within the preceding three months or following the last instrument servicing, whichever is later. Survey results and records of boundary locations shall be maintained and kept available for inspection.

(b) Mobile or portable radiation machines shall be physically secured to prevent removal by unauthorized personnel.

9.6. Instruction of Industrial Radiographers

Pursuant to 9.4, an outline of the subjects to be covered in a minimum amount of instruction for radiographers is contained below:

9.6.1. Fundamentals of Radiation Safety

(a) Characteristics of gamma and x- radiation.

(b) Units of radiation dose (mrem) and quantity of radioactivity (curie).

(c) Hazards of excessive exposure of radiation.

(d) Levels of radiation from sources of radiation.

(e) Methods of controlling radiation dose.

(1) Working time.

(2) Working distances.

(3) Shielding.

9.6.2. 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.

9.6.3. Radiographic Equipment to be Used

(a) Remote handling equipment.

(b) Radiographic exposure devices and sealed sources.

(c) Storage containers.

(d) Operation and control of x-ray equipment.

9.6.4. The requirements of pertinent federal and state regulations.

9.6.5. The registrant's written operating and

emergency procedures.

§64-23-10. Radiation Safety Requirements for Analytical X-Ray Equipment

10.1. Scope - This section provides special requirements for analytical x-ray equipment. The requirements of this section are in addition to, and not in substitution for applicable requirements in other section of these regulations.

10.2. Definitions

(1) Analytical X-ray Equipment - means equipment used for x-ray diffraction of fluorescence analysis.

(2) Analytical X-ray System - means a group of components utilizing x-rays to determine the elemental composition or to examine the microstructure of materials.

(3) Fail-safe Characteristics - means a design feature which causes beam port shutters to close, or otherwise prevents emergency of the primary beam, upon the failure of a safety or warning device.

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

(5) Normal Operating Procedures - mean step-by-step instructions necessary to accomplish the analysis. These procedures shall include sample insertion and manipulation, equipment alignment, routine maintenance by the registrant, and data recording procedures which are related to radiation safety.

(6) Open-beam Configuration - means an analytical x-ray system in which an individual could accidently place some part of his body in the primary beam path during normal operation.

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

Equipment Requirements. __

10.3.1. Safety Device - A device which prevents the entry of any portion of an individual's body into the primary x-ray beam path or which causes the beam to be shut off upon entry into its path shall be provided on all open-beam configurations. A registrant may apply to the agency for an exemption from the requirement of a safety device. Such application shall include:

(a) A description of the various safety devices that have been evaluated;

(b) The reason each of these devices cannot be used; and

(c) A description of the alternative methods that will be employed to minimize the possibility of an accidental exposure, including procedures to assure that operators and others in the area will be informed of the absence of safety devices.

10.3.2. Warning Devices

(a) Open-beam configurations shall be provided with a readily discernible indication of:

(1) X-ray tube status (ON-OFF) located near the radiation source housing, if the primary beam is controlled in this manner; and/or

(2) Shutter status (OPEN-CLOSED) located near each port on the radiation source housing, if the primary beam is controlled in this manner.

(b) Warning devices shall be labeled so that their purpose is easily identified. On equipment installed after the effective date of these regulations, warning devices shall have fail-safe characteristics.

10.3.3. Ports - Unused ports on radiation source housings shall be secured in the closed position in a manner which will prevent casual opening.

10.3.4. Labeling - All analytical x-ray equipment shall be labeled with a readily discernible sign or signs bearing the radiation symbol and the words:

(a) "CAUTION - HIGH INTENSITY X-RAY BEAM," or words having a similar intent, on the x-ray housing; and

"CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENER-

GIZED," or words having a similar intent, near any switch that energizes an x-ray tube if the radiation source is an x-ray tube; or "CAUTION - RADIOACTIVE MATERIAL," or words having a similar intent, on the source housing if the radiation source is a radionuclide.

10.3.5. Shutters - On open-beam configurations installed after the effective date of these regulations, each port on the radiation source housing shall be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.

10.3.6. Warning Lights

(a) An easily visible warning light labeled with the words "X-RAY ON", or words having a similar intent, shall be located:

(1) Near any switch that energizes an x-ray tube and shall be illuminated only when the tube is energized; or

(2) In the case of a radioactive source, near any switch that opens a housing shutter, and shall be illuminated only when the shutter is open.

(b) On equipment installed after the effective date of these regulations, warning lights shall have fail-safe characteristics.

10.3.7. Radiation Source Housing - Each x-ray tube housing shall be so constructed that, with all shutters closed, the leakage radiation measured at a distance of 5 cm from its surface is not capable of producing a dose in excess of 2.5 mrem in one hour at any specified tube rating.

10.3.8. Generator Cabinet - Each x-ray generator shall be supplied with a protective cabinet which limits leakage radiation measured at a distance of 5 cm from its surface such that it is not capable of producing a dose in excess of 0.25 mrem in one hour.

10.4. Area Requirements

10.4.1. Radiation Levels - The local components of an analytical x-ray system shall be located and arranged and shall include sufficient shielding or access control such that no radiation levels exist in any area surrounding the local component group which could result in a dose to an individual present therein in excess of the dose limits given in 6.3 of these regulations. For systems utilizing x-ray tubes, these levels shall be met at any specified tube rating.

10.4.2. Surveys

(a) Radiation surveys, as required by 10.4.2. of these regulations, of all analytical x-ray systems sufficient to show compliance with 10.4.1 shall be performed:

(1) Upon installation of the equipment and at least once every twelve (12) months thereafter;

(2) Following any change in the initial arrangement, number, or type of local components in the system;

(3) Following any maintenance requiring the disassembly or removal of a local component in the system;

(4) During the performance of maintenance and alignment procedures if the procedures require the presence of a primary x-ray beam when any local component in the system is disassembled or removed;

(5) Any time a visual inspection of the local components in the system reveals an abnormal condition; and

(6) Whenever personnel monitoring devices show a significant increase over the previous monitoring period or the readings are approaching the limits specified in 6.2 of these regulations.

(b) Radiation survey measurements shall not be required if a registrant can demonstrate compliance to the satisfaction of the agency with 10.4.1 in some other manner.

10.4.3. Posting - Each area or room containing analytical x-ray equip ment shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words "CAUTION - X-RAY EQUIPMENT" or words having a similar intent.

10.5. Operating Requirements

10.5.1. Procedures - Normal operating procedures shall be written and available to all analytical x-ray equipment workers. No person shall be permit-

ted to operate analytical x-ray equipment in any manner other than that specified in the procedures unless such person has obtained written approval of the radiation safety officer.

10.5.2. Bypassing - No person shall bypass a safety device unless such person has obtained the approval of the radiation safety officer. Such approval shall be for a specified period of time. When a safety device has been bypassed, a readily discernible sign bearing the words "SAFETY DEVICE NOT WORKING," or words having a similar intent, shall be placed on the radiation source housing.

10.6. Personnel Requirements.

10.6.1. Instruction - No person shall be permitted to operate or maintain analytical x-ray equipment unless such person has received instruction in and demonstrated competence as to:

(a) Identification of radiation hazards associated with the use of the equipment;

(b) Significance of the various radiation warning and safety devices incorporated into the equipment, or the reasons they have not been installed on certain pieces of equipment and the extra precautions required in such cases;

(c) Proper operating procedures for the equipment;

(d) Symptoms of an acute localized exposure; and

(e) Proper procedures for reporting an actual or suspected exposure.

10.6.2. Personnel Monitoring

(a) Finger or wrist dosimetric devices shall be provided to and shall be used by:

(1) Analytical x-ray equipment workers using systems having an openbeam configuration and not equipped with a safety device; and

(2) Personnel maintaining analytical x-ray equipment if the maintenance procedures require the presence of a primary x-ray beam when any local component in the analytical x-ray system is disassembled or removed.

(b) Reported dose values shall not be used for the purpose of determining compliance with 6.2 of these regulations unless evaluated by a qualified expert.

§64-23-11. Radiation Safety Requirements for Particle Accelerators

11.1. Purpose and Scope

11.1.1. This section establishes procedures for the registration and use of particle accelerators.

11.1.2. In addition to the requirements of this section, all registrants are subject to the requirements of Section 4, 5, and 6. Registrants engaged in industrial radiographic operations are subject to the requirements of Section 9 and registrants engaged in the healing arts are subject to the requirements of Section 7 and/or Section 8 of these regulations.

11.2. Registration Requirements - No person shall receive, possess, use, transfer, own or acquire a particle accelerator unless such is in compliance with the registration requirements in Section 5 of these regulations.

11.3. General Requirements for the Use of Particle Accelerators

11.3.1. In addition to the requirements set forth in Section 5, a registration for the use of a particle accelerator will not be issued unless the agency determines that:

(a) The applicant is qualified by reason of training and experience to use the accelerator in question for the purpose intended in accordance with this section and Section 6 in such a manner as to minimize danger to public health and safety or property;

(b) The applicants' proposed equipment, facilities, and operating and emergency procedures are adequate to protect health and minimize danger to public health and safety or property;

(c) The issuance of the registration will not be inimical to the health and safety of the public, and the applicant satisfies any applicable special requirement in 11.4 of these regulations;

(d) The applicant has appointed a radiation safety officer;

(e) The applicant and/or his staff has substantial experience in the use of particle accelerators for the intended use;

(f) The applicant has established a radiation safety committee to approve, in advance, proposals for use of particle accelerators, whenever deemed necessary by the agency; and

(g) The applicant has an adequate training program for particle accelerator operators.

11.4. Human Use of Particle Accelerators

11.4.1. In addition to the requirements set forth in Section 5, a registration for use of a particle accelerator in the healing arts will be issued only if:

(a) Whenever deemed necessary by the agency, the registrant has appointed a medical committee of at least three members to evaluate all proposals for research, diagnostic, and therapeutic use of a particle accelerator. Membership of the committee shall include physicians expert in internal medicine, hematology, therapeutic radiology and a person experienced in depth dose calculations and protection against radiation;

(b) The individuals designated on the application as the users have substantial training and experience in deep therapy techniques or in the use of particle accelerators to treat humans; and

(c) The individual designated on the application as the user must be a physician.

11.5. Radiation Safety Requirements for the use of Particle Accelerator

11.5.1. General Provisions

(a) This subsection establishes radiation safety requirements for the use of particle accelerators which are in addition to, and not in substitution for, other applicable provisions of these regulations.

(b) The registrant shall be responsible for assuring that all requirements of this section are met.

11.5.2. Limitations

(a) No registrant shall permit any person to act as a particle accelerator operator until such person:

(1) Has been instructed in radiation safety and shall have demonstrated an understanding thereof;

(2) Has received copies of and instruction in this part and the applicable requirements of Section 6, pertinent registration conditions and the registrants' operating and emergency procedures, and

(3) Has demonstrated competence to use the particle accelerator, related equipment, and survey instruments which will be employed in his assignment.

(b) Either the radiation safety committee or the radiation safety officer shall have the authority to terminate the operations at a particle accelerator facility if such action is deemed necessary to protect health and minimize danger to public health and safety or property.

11.5.3. Shielding and Safety Design Requirements

(a) A qualified expert specifically accepted by the agency shall be consulted in the design of the particle accelerator installation and called upon to perform a radiation survey when the accelerator is first capable of producing radiation.

(b) Each particle accelerator installation shall be provided with such primary and/or secondary barriers as are necessary to assure compliance with 6.2 and 6.3.

11.5.4. Particle Accelerator Controls and Interlock Systems

(a) Instrumentation, readouts, and controls on the particle accelerator control console shall be clearly identified and easily discernible.

(b) All entrances into a target room or other high radiation area shall be provided with interlocks that shut down the machine under conditions of barrier penetration.

(c) When an interlock system has been tripped, it shall only be possible to resume operation of the accelerator by manually resetting controls at the position where the interlock has been tripped, and

lastly at the main control console.

(d) Each safety interlock shall be on a circuit which shall allow its operation independently of all other safety interlocks.

(e) All safety interlocks shall be fail safe, i.e., designed so that any defect or component failure in the interlock system prevents operation of the accelerator.

(f) A scram button or other emergency power cutoff switch shall be located and easily identifiable in all high radiation areas. Such a cutoff switch shall include a manual reset so that the accelerator cannot be restarted from the accelerator control console without resetting the cutoff switch.

11.5.5. Warning Devices

(a) All locations designated as high radiation areas, and entrances to such locations shall be equipped with easily observable flashing or rotating warning lights that operate when, and only when, radiation is being produced.

(b) Except in facilities designed for human exposure, each high radiation area shall have an audible warning device which shall be activated for 15 seconds prior to the possible creation of such high radiation area. Such warning device shall be clearly discernible in all high radiation areas and all radiation areas.

(c) Barriers, temporary or otherwise, and pathways leading to high radiation areas shall be identified in accordance with 6.6.

11.5.6. Operating Procedures

(a) Particle accelerators, when not in use, shall be secured to prevent unauthorized use.

(b) Only a switch on the accelerator control console shall be routinely used to turn the accelerator beam on and off. The safety interlock system shall not be used to turn off the accelerator beam except in an emergency.

(c) All safety and warning devices, including interlocks, shall be checked for proper operability at intervals not to exceed three months. Results of such tests shall be maintained for inspection by the agency at the accelerator facility.

(d) Electrical circuit diagrams of the accelerator, and the associated interlock systems, shall be kept current and maintained for inspection by the agency and available to the operator at each accelerator facility.

(e) If, for any reason, it is necessary to intentionally bypass a safety interlock or interlocks, such action shall be:

(1) Authorized by the radiation safety committee and/or the radiation safety officer;

(2) Recorded in a permanent log and a notice posted at the accelerator control console; and

(3) Terminated as soon as possible.

(f) A copy of the current operating and emergency procedures shall be maintained at the accelerator control panel.

11.5.7. Radiation Monitoring Requirements

(a) There shall be available at each particle accelerator facility, appropriate portable monitoring equipment which is operable and has been calibrated for the appropriate radiations being produced at the facility. Such equipment shall be tested for proper operation daily and calibrated at intervals not to exceed one year, and after servicing and repair.

(b) A radiation protection survey shall be performed and documented by a qualified expert specifically approved by the agency when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas.

(c) Radiation levels in all high radiation areas shall be continuously monitored. The monitoring devices shall be electrically independent of the accelerator control and interlock systems and capable of providing a remote and local readout with visual and/or audible alarms at both the control panel and at the entrance to high radiation areas, and other appropriate locations so that people entering or present become aware of the existence of the hazard.

(d) All area monitors shall be calibrated quarterly.

(e) Whenever applicable, periodic surveys shall be made to determine the amount of airborne particulate radioactivity present in areas of airborne hazards.

(f) Whenever applicable, periodic smear surveys shall be made to determine the degree of contamination in target and other pertinent areas.

(g) All area surveys shall be made in accordance with the written procedures established by a qualified expert or the radiation safety officer of the particle accelerator facility.

(h) Records of all radiation protection surveys, calibration results, instrumentation tests, and smear results shall be kept current and on file at each accelerator facility.

11.5.8. Ventilation Systems

(a) Adequate ventilation shall be provided in areas where airborne radioactivity may be produced.

(b) A registrant, as required by 6.3.3, shall not vent, release or otherwise discharge airborne radioactive material to an unrestricted area which exceeds the limits in Section 12, Appendix A, Table II, except as authorized pursuant to 6.9.2 or 6.3.3(b). for purposes of this paragraph, concentrations may be averaged over a period not greater than one year. Every reasonable effort should be made to maintain releases of radioactive material to unrestricted areas as far below these limits as practicable.

TABLE 64-23A

Neutron Flux equivalents

Neutron energy (MeV)	Number of neutrons per square centimeter for a dose equivalent of 1 rem (neutrons/cm2)	Average flux density to deliver 100 millirems in 40 hours (neutron/cm2 per second)
Thermal	970 X 106	670
0.0001	720 X 106	500
0.005	820 X 106	570
0.02	400 X 106	280
0.1	120 X 106	80
0.5	43 X 106	30
1.0	26 X 106	18
2.5	29 X 106	20
5.0	26 X 106	18
7.5	24 X 106	17
10.0	24 X 106	17
10 to 30	14 X 106	10

TABLE 64-23B

Radiation Protection Limits

Portion of Body	Rems Per Calendar Quarter
(a) Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	2 1/4
(b) Hands and forearms; feet and ankles	18 3/4
(c) Skin of whole body	7 1/2

TABLE 64-23C

Part of Body	Column 1 Assumed Dose in Rems for Calendar Quarters Prior to January 1, 1961	Column 2 Assumed Dose in Rems for Calendar Quarters Beginning or After January 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye	3 3/4	1 1/4

TABLE 64-23D

Filtration Required Vs. Operating Voltage

Below 50 kVp	0.5 millimeter
50-70 kVp	1.5 millimeters
Above 70 kVp	2.5 millimeters

TABLE 64-23E

Half-value Layers as a Function of Filtration and Tube Potential for Diagnostic Units

Total Filtration	Peak Potential (kVp)									
mm Al.	30	40	50	60	70	80	90	100	110	120
0.5	0.36	0.47	0.58	0.67	0.76	0.84	0.92	1.00	1.08	1.16
1.0	0.55	0.78	0.95	1.08	1.21	1.33	1.46	1.58	1.70	1.82
1.5	0.78	1.04	1.25	1.42	1.59	1.75	1.90	2.08	2.25	2.42
2.0	0.92	1.22	1.49	1.70	1.90	2.10	2.28	2.48	2.70	2.90
2.5	1.02	1.38	1.69	1.95	2.16	2.37	2.58	2.82	3.06	3.30
3.0	-	1.49	1.87	2.16	2.40	2.62	2.86	3.12	3.38	3.65
3.5	-	1.58	2.00	2.34	2.60	2.86	3.12	3.40	3.68	3.95

TABLE 64-23G

Filtration Required Vs. Operating Voltage

Operating Voltage	Minimum Total Filtration (Inherent plus added)
Below 50 kVp	0.5 millimeter
50-70 kVp	1.5 millimeters
Above 70 kVp	2.5 millimeters

TABLE 64-23G

Half-value Layers as a Function of Filtration and Tube Potential

Total Filtration mm Al.	Peak Potential (kVp)				
	45	50	70	90	100
	Typical Half-value Layers in Millimeters of Aluminum				
0.5	0.5	0.6	0.8	0.9	1.0
1.0	0.9	0.9	1.2	1.5	1.6
1.5	1.2	1.2	1.6	1.9	2.1
2.0	-	1.5	1.9	2.3	2.5
2.5	-	1.7	2.2	2.6	2.8

WEST VIRGINIA LEGISLATIVE RULES
BOARD OF HEALTH

Radiological Health Regulations

Chapter 16-1
Series XXIII
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WEST VIRGINIA LEGISLATIVE RULES
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WEST VIRGINIA LEGISLATIVE RULES
BOARD OF HEALTH

Chapter 16-1
Series 23
(1983)

Subject: Radiological Health Regulations

Section 1. General

1.1. Scope - These legislative rules establish the requirements that shall be applied to the use of sources of ionizing radiation to reduce, to an acceptable level, the risk that any person is likely to be injured by such radiation. These legislative rules are intended to be consistent with the recognized beneficial uses of sources of ionizing radiation. These legislative rules provide for the registration and applicable safety requirements of all sources of ionizing radiation including naturally occurring radioactive materials, accelerator produced radioactive material, and radiation producing equipment.

1.2. Authority - These legislative rules are issued under the authority of and are related to Chapter 16, Article 1, Section 7 of the West Virginia Code of 1931, as amended.

1.3. Filing Date - These legislative rules were filed on the 12th day of January 1979, in the Secretary of State's office.

1.4. Effective Date - These legislative rules became effective on the 1st day of May 1979.

1.5. Refiling Date - These legislative rules were refiled pursuant to Chapter 29A, Article 2, Section 5 of the West Virginia Code of 1931, as amended on the 30th day of December 1982, in the Secretary of State's office.

Section 2. Application, Enforcement, Severability

2.1. Application - Except as otherwise specifically provided, these regulations apply to all persons in West Virginia who receive, possess, use transfer, own or acquire any source of ionizing radiation, however, nothing in these regulations shall apply, except the provision for registration, to any person to the extent such person is subject to regulation by the United States nuclear regulatory commission.

For the purpose of these regulations, radiation machines and radioactive materials used by, or in the possession of, an employee within the scope of his duties shall be considered to be in the possession of the employer.

The provisions of Section 6 Radiation Protection Standards, of these regulations shall not be interpreted as limiting the intentional exposure of patients to radiation for the purpose of diagnosis or therapy by doctors of the healing arts, duly licensed by the State of West Virginia and engaged in the lawful practice of their profession or administered by other professional persons acting under the direct supervision of a licensed practitioner.

2.2. Enforcement - The enforcement of these legislative rules is vested with the director of the West Virginia department of health or his lawful designee.

2.3. Severability - If any provisions of these rules or the application thereof to any person or circumstance shall be held invalid, such invalidity shall not affect the provisions or the application of these rules which can be given effect without the invalid provisions or application, and to this end the provisions of these rules are declared to be severable.

Section 3. Definitions - As used in these regulations, these terms have the definitions set forth below. Additional definitions used only in a certain part will be found in that part.

3.1. Accelerator Produced Material - means any material made radioactive by exposing it in a particle accelerator.

3.2. Agency - means the West Virginia department of health.

3.3. Airborne Radioactive Area - means (i) any room, enclosure, or operating area in which aiborne radioactive material exists in concentrations in excess of the amount specified in Appendix A, Table I, Column 1; or (ii) any room, enclosure, or operating area in which airborne radioactive material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix A, Table I, Column 1.

3.4. Airborne Radioactive Material - means any airborne radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors or gases.

3.5. Byproduct Material - means 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.

3.6. Calendar Quarter - means not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be so arranged such that no day is included in more than one calendar quarter and no day in any one year is omitted from inclusion within a calendar

quarter. No registrant shall change the method observed by him of determining calendar quarters for the purpose of these regulations except at the beginning of the calendar year.

3.7. Curie - means a unit of measurement of radioactivity. One curie (Ci) is that quantity of radioactive material which decays at the rate of 3.7×10^{10} disintegrations per second (dps). Commonly used submultiples of the curie are the millicurie and the microcurie. One millicurie (mCi) = 0.001 curie = 3.7×10^{7} dps. One microcurie (uCi) = 0.000001 curie = 3.7×10^{4} dps. For the purpose of these regulations, one curie of natural uranium means the sum of 3.7×10^{10} dps from U-238 plus 3.7×10^{10} dps from U-234 plus 1.7×10^{9} dps from U-235; this is equivalent to 3,000 kilograms or 6,615 pounds of natural uranium. One curie of natural thorium means the sum of 3.7×10^{10} dps from Th-232 plus 3.7×10^{10} dps from Th-228; this is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

3.8. Dose - as used in these regulations shall mean absorbed dose or dose equivalent as appropriate.

Absorbed Dose - is the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The specific unit of absorbed dose is the rad. (See rad)

Dose Equivalent - is a quantity that expresses on a common scale for all radiation a measure of the postulated effect on a given organ. It is defined as the absorbed dose in rads times certain modifying factors. The unit of dose equivalent is the rem. (See rem)

3.9. Exposure - means the quotient of the dQ by dm where "dQ" is

the absolute value of the total charge of the ions of one sign produced in air when all the electrons (negatrons and positrons) liberated by photons in a volume element of air having mass "dm" are completely stopped in air. (The special unit of exposure is the roentgen [R].)

3.10. Exposure Rate means the exposure per unit of time, such as R/min., mR/hr., etc.

3.11. Half Life - means the amount of time required for the activity of a specific radoactive material to reach one-half of its original activity.

3.12. Healing Arts means diagnostic and/or healing treatment of human and animal maladies including but not limited to the following which are duly licensed by the State of West Virginia for the lawful practice of: medicine and its associated specialties, dentistry, veterinary medicine, osteopathy, chiropractic, and podiatry.

3.13. High Radiation Area - means any area, accessible to individuals in which there exists radiation at such levels that the individual could receive in any one hour a dose to the whole body in excess of 100 millirems.

3.14. Human Use - means the internal or external administration of radiation or radioactive materials to human beings.

3.15. Individual - means any human being.

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

3.17. Installation - means the location where one or more sources of ionizing radiation are used, operated or stored.

3.18. Monitoring - means a periodic or continuous determination of the exposure rate in an area (area monitoring) or the exposure received by a person (personnel monitoring) or the measurement of contamination levels.

3.19. Natural Radioactivity - means radioactivity of naturally occurring nuclides.

3.20. Occupational Dose - means exposure of an individual to radiation (a) in a restricted area; or (b) 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 diagnosis or therapy of such individual.

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

3.22. Person - means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, political subdivision of West Virginia, any other state or political subdivision or agency thereof, and any legal successor, representative, agent or agency of the foregoing, other than the United States nuclear regulatory commission, or any successor thereto, or other federal government agencies.

3.23. Personnel Monitoring Equipment - means devices (e.g., film badges, pocket dosimeters, thermoluminescent dosimeters, etc.) designed to be worn or carried by an individual for the purpose of estimating the dose received by the individual.

3.24. Rad - means the special unit of absorbed dose. One rad equals one hundredth of a joule per kilogram of material, for example, if tissue is the material of interest, 1 rad equals 100 ergs per gram of tissue.

3.25. Radiation - means ionizing radiation, i.e., gamma rays and X-rays, alpha and beta particles, high speed electrons, neutrons, and other nuclear particles. (Same as ionizing radiation.)

3.26. Radiation Area - means any area, accessible to individuals, 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 5 consecutive days a dose in excess of 100 millirems.

3.27. Radiation Machine - means any device capable of producing radiation except those which produce radiation only from radioactive material.

3.28. Radiation Safety Officer - means one who has the knowledge and responsibility to apply appropriate radiation protection regulations.

3.29. Radioactive Material - means any material (solid, liquid, or gas) which emits ionizing radiation spontaneously.

3.30. Radioactivity - means the disintegration of unstable atomic nuclei by the emission of radiation.

3.31. Registrant - means any person who is registered with the agency and is legally obligated to register with the agency pursuant to these regulations.

3.32. Registration - means the filing with the agency by a registrant of all registrable items in accordance with these regulations.

3.33. Rem - means a measure of the dose of any radiation to body

tissue in terms of its estimated biological effect relative to a dose received from an exposure to one roentgen (R) of x-rays. [millirem (mrem) = 0.001 rem.] For the purpose of these regulations, any of the following is considered to be equivalent to a dose of one rem:

(a) An exposure of 1 R of x, or gamma radiation;

(b) A dose of 1 rad due to x, gamma, or beta radiation;

(c) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye;

(d) A dose of 0.1 rad due to neutrons or high energy protons.[1]

[1] If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron absorbed dose in rads, one rem of neutron radiation may for purposes of these regulations, be assumed to be equivalent to 14 million neutrons per 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 Flux Equivalents

Neutron energy (MeV)	Number of neutrons per square centimeter for a dose equivalent of 1 rem (neutrons/cm^2)	Average flux density to deliver 100 millirems in 40 hours (neutrons/cm^2 per second)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10.0	24×10^6	17
10 to 30	14×10^6	10

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

3.35. Restricted Area (controlled area) - means any area access to which is controlled by the registrant for purposes of protection of individuals from exposure to radiation and radioactive material. Restricted areas shall not include any areas used for residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

3.36. Roentgen (R) - means the special unit of exposure. One roentgen equals 2.58×10^{-4} coulombs/kilogram of air. (see Exposure)

3.37. Sealed Source - means 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.

3.38. Source Material - means: (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 (i) uranium, (ii) thorium, or (iii) any combination thereof. Source material does not include special nuclear material.

3.39. Source of Radiation - means any radioactive material, or any device or equipment emitting or capable of producing radiation.

3.40. Survey - means the evaluation of the radiation associated with the production, use, release, disposal or presence of sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and/or equipment and measurements of radiation levels or concentrations or radioactive materials.

3.41. Test - means a method for determining the characteristics or condition of sources of radiation or components thereof.

3.42. These Regulations - means Sections 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 of the Radiological Health regulations and any subsequent changes or additions thereto.

3.43. Unrestricted Area - means any area access to which is not controlled by the registrant for purposes of protection of individuals from exposure to radiation and radioactive material, and any area used for residential quarters.

3.44. Unrefined and Unprocessed Ore - means ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

3.45. Whole Body - means the whole body, or head and trunk, or active blood forming organs, or lens of eyes, or the gonads (this definition is not applicable to the phrase "skin of the whole body").

NOTE: Other terms not herein specifically defined shall be used in accordance with the definitions in the Recommendations of the National Council on Radiation Protection and Measurements, or any successor thereto, as published in Handbooks of the National Bureau of Standards or Reports of the NCRP.

Section 4. Exemptions, Inspections, Tests, Violations, Impounding Prohibitions and Communications

4.1. Exemptions - The agency may, upon application by any person or upon its own initiative, grant such exemptions or exceptions from the requirements of these regulations as it determines are authorized by law and will not result in undue hazard to public health and safety or property.

4.2. Inspections

4.2.1. Each registrant shall afford the agency, at all reasonable times, opportunity to inspect sources of radiation and the premises and facilities wherein such sources of radiation are used or stored.

4.2.2. Each registrant shall make available to the agency for inspection, upon reasonable notice, records maintained pursuant to these regulations.

4.3. Tests - Each registrant shall perform, upon instructions from the agency, or shall permit the agency to perform such reasonable tests as the agency deems appropriate or necessary including, but not limited to, tests of:

(a) Sources of ionizing radiation;

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

(c) Radiation detection and monitoring instruments; and

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

4.4. Violations - Any person violating any of the provisions of this article, for which the penalty is not otherwise provided, or any of the

rules, regulations or orders issued pursuant thereto, shall be punishable by a fine of not more than two hundred dollars or by imprisonment for not more than thirty days, or both.

4.5. Impounding - In the event that an emergency exists affecting the public health and safety, the agency has the authority to impound or order the impounding of sources of radiation possessed by persons who are not equipped to observe or fail to observe the provisions of these regulations.

4.6. Prohibitions

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

4.6.2. Shoe-fitting fluoroscopic devices shall not be used or displayed.

4.7. Communications - All communications and reports concerning these regulations, and applications filed thereunder, should be addressed to the West Virginia Department of Health, Radiological Health Program, 151 Eleventh Avenue, South Charleston, WV 25303.

Section 5. Registration

5.1. Purpose and Scope

5.1.1. This section provides for the registration of sources of radiation. The person having possession of any registrable item shall register such source of radiation with the agency in accordance with the requirements of this section.

5.1.2. For the purpose of Section 5 of these regulations, "facility" means the location at which one or more devices or sources are installed and/or located within one building, vehicle, or under one roof, and/or are under the same administrative control.

5.1.3. In addition to the requirements of this section, all registrants are subject to the applicable provisions of other parts of these regulations,

5.2. Exemptions

5.2.1. The following sources of radiation do not require registration:

(a) Less than 10 times the quantities of any radioactive material possessed simultaneously, listed in Appendix C of these regulations.

(b) Natural radioactive materials of an equivalent specific radioactivity not exceeding that of natural potassium, (10^{-9} curies/gm)

(c) Time pieces, instruments, novelties, or devices containing self-luminous elements, except during manufacture or repair of the self-luminous elements themselves. Such time pieces, instruments, novelties, or devices shall not be exempt if they are stored, used, or handled in such quantity or fashion that an individual might receive a radiation dose exceeding the limits established in 6.3.1.

(d) Domestic television receivers, providing the dose rate at 5 cm from any outer surface is less than 0.5 mrem per hour.

(e) Electronic equipment that produces radiation incidental to its operation for other purposes is exempt from the registration and notification requirements of this part, providing dose equivalent rate averaged over an area of ten (10) square centimeters does not exceed 0.5 mrem per hour at 5 cm from any accessible surface of such equipment. The production, testing, or factory servicing of such equipment shall not be exempt.

(f) Radiation-producing machines while in transit or storage incident thereto.

5.2.2. Common and contract carriers operating within this state are

exempt from registration requirements to the extent that they transport or store sources of radiation in the regular course of their carriage for another or storage incident thereto.

5.3. Application for Registration of Radiation Facilities

5.3.1. The person possessing each registrable item which has not already been registered, shall:

(a) Apply for registration of such facility with the agency within thirty (30) days following the effective date of these regulations or thereafter prior to the operation of a radiation facility.

(b) Make application for registration on forms furnished by the agency and shall supply all the information required by the form and accompanying instructions.

(c) Designate on the application form an individual to be responsible for radiation protection.

5.4. Renewal of Registration

5.4.1 The person possessing each registrable item shall renew such registration with the agency at a date to be specified by the agency not later than within six (6) months of the effective date of these regulations and every three years thereafter.

5.5. Report of Changes

5.5.1. Except as provided in Section 5.5.2, the registrant shall notify the agency in writing within ten (10) days after any change which renders the information on registration no longer accurate. In the case of disposition of radiation sources, such notification shall specify the recipient of these sources.

5.5.2 The registrant is not required to notify the agency of the use of radiation sources at a temporary location other than the designated storage location, provided the initial registration shows that their use at temporary locations is normal to the conduct of the registrant's operations.

5.6 Approval not Implied

5.6.1. No person, in any advertisement, shall refer to the fact that a source of radiation is registered with the agency, and no person shall state or imply that any activity under such registration has been approved by the agency.

5.7. Vendor Obligation

5.7.1. (a) Each person who is engaged in the business of installing or offering to install radiation sources or is engaged in the business of furnishing or offering to furnish radiation source servicing or services in this state, shall apply for registration of such services with the agency within thirty (30) days following (the effective date of these regulations) or thereafter prior to furnishing or offering to furnish any such services.

(b) Any person who sells, leases, transfers or lends radiation sources in this state shall notify the agency within thirty (30) days after the end of each calendar quarter of:

(1) The name and address of persons who have received these sources;

(2) The manufacturer and model of each source transferred;

(3) The date of transfer of each radiation source.

5.7.2. No person shall make, sell, lease, transfer, lend or install x-ray equipment or radioactive material sources or auxiliaries and supplies

necessary for the safe operation of such equipment unless such supplies and equipment, when placed in operation and use, will meet the requirements of these regulations.

5.8. Out-of-State Registrable Items

5.8.1. Whenever any out-of-state registrable item is to be brought into West Virginia for any temporary use, the person proposing to bring such item into the state or his authorized agent shall give written notice to the agency at least five (5) days before such entry. The notice shall include the item type and energy characteristics; the nature, duration, and scope of use; and the exact location where the registrable item is to be used. If for a specific case, the 5-day period will impose an undue hardship on the person, he may, upon application to the agency, obtain permission to proceed sooner. In addition, the out-of-state person must:

(a) Comply with all applicable regulations of the agency; and

(b) Supply the agency with such other information as the agency may reasonably request.

5.9. Radiation Protection Requirements

5.9.1. Registrants and persons subject to 5.8.1 shall comply with all applicable requirements of these regulations, provided, however, that apart from registration, nothing in these regulations shall apply to any person to the extent that such person is subject to regulation by the United States nuclear regulatory commission and any legal successor thereof.

Section 6. Radiation Protection Standards

6.1. Purpose and Scope

6.1.1. This section establishes standards for protection against

radiation hazards. Except as otherwise specifically provided, this part applies to all registrants. Nothing in this part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or therapy.

6.1.2. In addition to complying with the requirements set forth in this part, every reasonable effort should be made to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as far below the limits specified in this part as practicable. The term "as far below the limits specified in this part as practicable" means as low as is practicably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety and in relation to the utilization of ionizing radiation in the public interest.

6.2. Radiation Dose to Individuals in Restricted Areas[1]

6.2.1. Except as provided in 6.2.2. no registrant shall possess, use, receive, or transfer sources of radiation in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from all sources of radiation in the registrant's possession a dose in excess of the limits specified in Table A:

[1] For determining the doses specified in 6.2 a dose from x or gamma rays up to 10 MEV may be assumed to be equivalent to the exposure measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dose rate.

Table A
Radiation Protection Limits

Portion of Body	Rems Per Calendar Quarter
(a) Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads	2 1/4
(b) Hands and forearms; feet and ankles	18 3/4
(c) Skin of whole body	7 1/2

6.2.2. Radiation Doses Greater Than Table A - A registrant may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under 6.2.1 provided:

(a) During any calendar quarter the dose to the whole body from sources of radiation in the registrant's possession shall not exceed 3 rems; 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) rems where "N" equals the individual's age in years at his last birthday; and

(c) The registrant has determined the individual's accumulated occupational dose to the whole body on Form RH-14 or on a clear and legible record containing all the information required in that form and has otherwise complied with the requirements of 6.2. As used in 6.2.2, "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.

6.2.3. Determination of Accumulated Dose

(a) This section contains requirements which must be satisfied by registrants who propose, pursuant to 6.2.2. to permit individuals in a

restricted area to receive exposure to radiation in excess of the limits specified in 6.2.1.

(b) Before permitting any individual in a restricted area to be exposed to radiation in excess of the limits specified in 6.2.1, each registrant shall:

(1) Obtain a certificate on Form RH-14 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 an occupational dose of radiation; and

(2) Calculate on Form RH-14 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 6.2.2.

(c) (1) In the preparation of Form RH-14 or a clear and legible record containing all the information required in that form, the registrant shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the registrant obtains such reports, he shall use the dose shown in the report in preparing the form. In any case where a registrant 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:

Part of Body	Column 1 Assumed Dose in Rems for Calendar Quarters Prior to January 1, 1961	Column 2 Assumed Dose in Rems for Calendar Quarters Beginning or or After January 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye	3 3/4	1 1/4

(2) The registrant shall retain and preserve records used in preparing Form RH-14. 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 6.2.2.(b) the excess may be disregarded.

6.2.4. Exposure of Individuals to Concentrations of Radioactive Material in Restricted Areas

(a) No registrant shall possess, use, receive, or transfer radioactive material in such a manner as to cause an individual in a restricted area to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Appendix A, Table I, of Section 12. "Expose," as used in this section means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the agency pursuant to 6.2.4.(c).

(b) The limits given in Appendix A, Table I, or Section 12 are based upon exposure to the concentrations specified for forty (40) hours in any period of seven (7) consecutive days. In any such period where the number of hours of exposure is less than forty (40), 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 (40), limits specified in the table shall be decreased proportionately.

(c) (1) Except as authorized by the agency pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix A, Table I.

(2) The agency may authorize a registrant to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix A, Table I, 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 the concentrations in excess of the limits established in Appendix A, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations and a description of the methods used in determining the particle sizes.

(3) The agency may authorize a registrant to expose an individual in a restricted area to airborne concentrations in excess of the limits specified in Appendix A, Table I, 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 part for individuals in restricted areas during a 40-hour week. Each application under this subparagraph shall contain the following information:

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

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

(iii) 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 work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance by the individual of the proposed procedures; and

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

6.2.5. Exposure of Minors[2]

(a) No registrant shall possess, use, or transfer sources of radiation in such a manner as to cause any individual within a restricted area, who is under 18 years of age, to receive in any period of one calendar quarter from all sources of radiation in such registrant's possession a dose in excess of 10 percent of the limits specified in Table A in 6.2.1.

(b) No registrant shall possess, use, or transfer radioactive material in such a manner as to cause any individual within a restricted area, who is under 18 years of age, to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Appendix A, Table II, of Section 12. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

[2]For determining the doses specified in this section, a dose from x or gamma rays up to 10 MeV may be assumed to be equivalent to the exposure measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of the highest dose rate.

(c) The provisions of 6.2.4(c) shall apply to exposures subject to 6.2.5(b).

6.3. Radiation Dose to Individuals in Unrestricted Areas

6.3.1. Except as authorized by the agency pursuant to 6.3.1(b) no registrant shall possess, use, or transfer sources of radiation in such a manner as to create in any unrestricted area from such sources of radiation in his possession:

(a) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 2 millirems in any 1 hour; or

(b) Radiation levels which, if an individual were continuously present in the area could result in his receiving a dose in excess of 100 millirems in any 7 consecutive days.

6.3.2. Any person may apply to the agency for proposed limits upon levels of radiation in unrestricted areas in excess of those specified in 6.3.1. resulting from the applicant's possession or use of sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The agency will approve the proposed limits if the applicant demonstrates to the satisfaction of the agency 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.

6.3.3. Concentration in Effluents to Unrestricted Areas

(a) A registrant shall not possess, use, or transfer registered material so as to release to an unrestricted area radioactive material in con-

centrations which exceed the limits specified in Appendix A, Table II of Section 12, except as authorized pursuant to 6.9.2 or 6.3.3(b). For purposes of this section concentrations may be averaged over a period not greater than one year.

(b) Any person may apply to the agency for proposed limits higher than those specified in 6.3.3(a). The agency will approve the proposed limits if the applicant demonstrates:

(1) That the applicant has made a reasonable effort to minimize the radioactivity contained in effluents to unrestricted areas; and

(2) That it is not likely that radioactive material discharged in the effluent would result in the exposure of an individual to concentrations of radioactive material in air or water exceeding the limits specified in Appendix A, Table II of Section 12.

(c) An application for higher limits pursuant to 6.3.3(b) shall include information demonstrating that the applicant has made a reasonable effort to minimize the radioactivity discharged in effluents to unrestricted areas, and shall include, as pertinent:

(1) Information as to flow rates, total volume of effluent, peak concentration of each radionuclide in the effluent, and concentration of each radionuclide in the effluent averaged over a period of one year at the point where the effluent leaves a stack, tube, pipe, or similar conduit;

(2) A description of the properties of the effluents, including:

(i) Chemical composition,

(ii) Physical characteristics, including suspended solids content in liquid effluents, and nature of gas or aerosol for air effluents,

(iii) The hydrogen ion concentrations (pH) of liquid effluents, and

(iv) The size range of particulates in effluents released into air;

(3) A description of the anticipated human occupancy in the unrestricted area where the highest concentration of radioactive material from the effluent is expected, and, in the case of a river or stream, a description of water uses downstream from the point of release of the effluent;

(4) Information as to the highest concentration of each radionuclide in an unrestricted area, including anticipated concentrations averaged over a period of one year:

(i) In air at any point of haman occupancy, or

(ii) In water at points of use downstream from the point of release of the effluent;

(5) The background concentration of radionuclides in the receiving river or stream prior to the release of liquid effluent;

(6) A description of the environmental monitoring equipment, including sensitivity of the system, and procedures and calculations to determine concentrations of radionuclides in the unrestricted area and possible reconcentrations of radionuclides; and

(7) A description of the waste treatment facilities and procedures used to reduce the concentration of radionuclides in effluents prior to their release.

(d) For the purposes of this section, the concentration limits in Appendix A, Table II of Section 12 shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to

the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(e) In addition to limiting concentrations in effluent streams, the agency may limit quantities of radioactive material released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third (1/3) the concentration of radioactive material specified in Appendix A, Table II or Section 12.

(f) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by 6.9.3.

6.3.4. Orders Requiring Furnishing of Bioassay Services - Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the agency may incorporate registration provisions or issue an order requiring a registrant to make available to the individual appropriate bioassay services and to furnish a copy of the reports of such services to the agency.

6.4. Surveys

6.4.1. As used in the regulations in this part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of radioactive materials or other sources of radiation under a specific set of conditions. When appropriate, such evaluation

includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

6.4.2. Each registrant shall make or cause to be made such surveys as may be necessary for him to establish compliance with these regulations.

6.5. Personnel Monitoring - Each registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

6.5.1. Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in 6.2.1.

6.5.2 Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in 6.2.1.

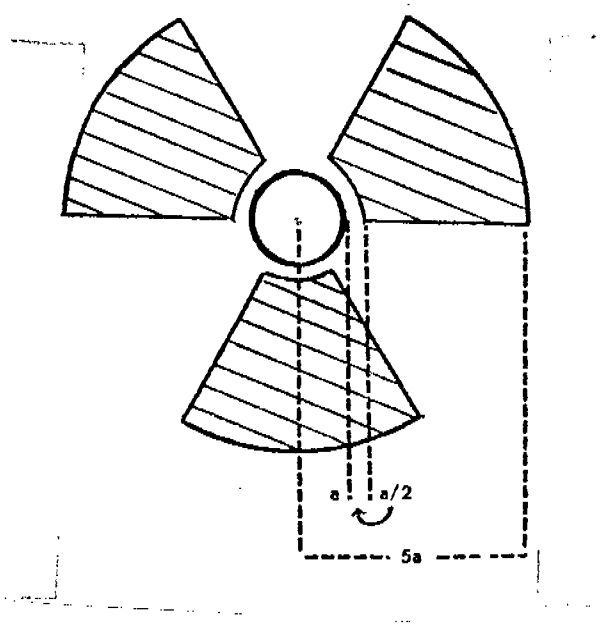
6.6. Posting, Labeling, and Caution Signals

6.6.1. Symbols and Other Contents

(a) Except as otherwise authorized by the agency, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-blade design:

Radiation Symbol

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



(b) In addition to the contents of signs and labels prescribed in this section, a registrant may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation.

6.6.2 Signs

(a) Radiation Areas - Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[3]

RADIATION AREA

(b) High Radiation Areas

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

CAUTION[3]

HIGH RADIATION AREA

(2) Each entrance or access point to a high radiation area shall be:

(i) 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 1 hour upon entry into the area; or

(ii) Equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering the high radiation area and the registrant or a supervisor of the activity are made aware of the entry; or

(iii) Maintained locked except during periods when access to the area is required, with positive control over each individual entry.

(3) The controls required by 6.6.2(b)(2) shall be established in such a way that no individual will be prevented from leaving a high radiation area.

(4) In the case of a high radiation area established for a period of 30 days or less, direct surveillance to prevent unauthorized entry may be substituted for the controls required by 6.3.3(c)(2).

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[3]Or "DANGER"

(5) Any registrant may apply to the agency for approval of methods not included in 6.6.2(b)(2) and (4) for controlling access to high radiation areas. The agency will approve the proposed alternatives if the registrant demonstrates that the alternative methods of control will prevent unauthorized entry into a high radiation area, and that the requirement of 6.6.2(b)(3) is met.

(c) 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[3]

AIRBORNE RADIOACTIVITY AREA

(d) Additional Requirements

(1) Each area or room in which any radioactivity material, other than natural uranium or thorium, is used or stored in an amount exceeding 10 times the quantity of radioactive material specified in Appendix B of Section 12 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[3]

RADIOATIVE MATERIAL

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one hundred times the quantity specified in Appendix B or Section 12 shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

---

[3]Or "DANGER"

CAUTION[3]

RADIOACTIVE MATERIAL

6.6.3 Labeling Containers

(a) Except as provided in 6.6.3(c) each container of radioactive material shall bear a durable, clearly visible label identifying the radioactive contents.

(b) A label required pursuant to 6.6.3(a) shall bear the radiation caution symbol and the words:

CAUTION[3]

RADIOACTIVE MATERIAL

It shall also provide sufficient information[4] to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(c) Notwithstanding the provisions of 6.6.3(a), Labeling is not required:

(1) For containers that do not contain radioactive material in quantities greater than the applicable quantities listed in Appendix B of Section 12.

(2) For containers containing only natural uranium or thorium in quantities no greater than ten (10) times the applicable quantities listed in Appendix B of Section 12.

(3) For containers that do not contain radioactive material in concentrations greater than the applicable concentrations listed in Column 2,

[3]Or "Danger"
[4]As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, etc.

Table I, Appendix A or Section 12.

(4) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established by the regulations in this part;

(5) For containers when they are in transport and packaged and labeled in accordance with regulations published by the department of transportation;

(6) For containers which are accessible only to individuals authorized to handle or use them[5] or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record; and

(7) For manufacturing and process equipment such as piping and tanks.

6.6.4. Labeling Radiation Machines - All radiation machines shall be labeled in a manner which cautions individuals that radiation is produced when the machine is being operated.

6.6.5. Exceptions from Posting and Labeling Requirements - Notwithstanding the provisions of 6.6:

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source, provided the radiation level twelve (12) inches from the surface of the source container or housing does not exceed five (5) millirem per hour.

[5]For example, containers in locations uch as water-filled canals, storage valuts, or hot cells.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs, and control of entrance or access thereto pursuant to 6.6.2(b) is not required, because of the presence of patients containing radioactive material provided that there are personnel in attendance who will take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in the regulations in this part.

(c) Caution signs are not required to be posted in areas or rooms containing radioactive material for periods of less than eight (8) hours provided that:

(1) the material is constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in this part; and

(2) such area or room is subject to the registrant's control.

(d) A room or other area is not required to be posted with a caution sign, and control is not required for each entrance or access point to a room or other area which is a high radiation area solely because of the presence of radioactive material prepared for transport and packaged and labeled in accordance with regulations of the department of transportation.

6.7. Instruction of Personnel

6.7.1. Safety Information - Each registrant shall inform individuals working in or frequenting any portion of a restricted area of the occurrence of radiation or sources of radiation in such portions of the restricted area; shall instruct such individuals in the safety problems associated with

exposures to such sources of radiation and in precautions or procedures to minimize exposure; shall instruct such individuals in the applicable provisions of the agency regulations for the protection of personnel from exposures to radiation or radioactive materials.

6.8. Storage of Sources of Radiation

6.8.1. Sources of radiation shall be secured against unauthorized removal from the place of storage and shall be provided with reasonable protection against loss, leakage, or dispersion by the effects of fire or water.

6.9. Waste Disposal

6.9.1. General Requirement - No registrant shall dispose of any radioactive material except:

(a) By transfer to an authorized recipient as provided in 5.10.2;

(b) As authorized pursuant to 6.3.3, 6.9.2, 6.9.3 or 6.9.4.

6.9.2. Method of Obtaining Approval of Proposed Disposal Procedures

(a) Any person may apply to the agency for approval of proposed procedures to dispose of radioactive material in a manner not otherwise authorized in this part.

(b) Each application shall include a description of the radioactive material, including the quantities and kinds of radioactive material and levels of radioactivity involved, and the proposed manner and conditions of disposal.

(c) The application, where appropriate, should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological and hydro-

logical 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.

(d) The agency will not approve any application for a registration to receive radioactive material from other persons for disposal on land not owned by a state or the federal government.

6.9.3. Disposal by Release Into Sanitary Sewerage Systems - No registrant shall discharge radioactive material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersible in water;

(b) The quantity of any radioactive material released into the system by the registrant in any one day does not exceed the larger of the following:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the registrant, will result in an average concentration not greater than the limits specified in Appendix A, Table I, Column 2, of Section 12; or

(2) Ten (10) times the quantity of such material specified in Appendix B of Section 12;

(c) The quantity of any radioactive material released in any one month, if diluted by the average monthly quantity of waste water released by the registrant, will not result in an average concentration exceeding the limits specified in Appendix A, Table I, Column 2, or Section 12; and

(d) The gross quantity of radioactive material released into the

sewerage system by the registrant does not exceed one (1) curie per year. Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

6.9.4. Disposal by Burial in Soil - No registrant shall dispose of radioactive material by burial in soil unless:

(a) The total quantity of radioactive material buried at any one location and time does not exceed at the time of burial 1,000 times the amount specified in Appendix B of Section 12; and

(b) Burial is at a minimum of four (4) feet; and

(c) Successive burials are separated by distances of at least six (6) feet and not more than 12 burials are made in any year.

6.9.5. Disposal by Incineration - No registrant shall incinerate radioactive material for the purpose of disposal or preparation for disposal except as specifically approved by the agency pursuant to 6.3.3 and 6.9.2.

6.10. Transfer of Material

6.10.1. No registrant shall transfer radioactive material except as authorized pursuant to this section.

6.10.2. Any registrant may transfer radioactive material:

(a) To the U.S. nuclear regulatory commission;

(b) To any person authorized to receive such material under terms of a general license or its equivalent, or a specific license or equivalent licensing document, issued by the U.S. nuclear regulatory commission, or any agreement state, or to any person otherwise authorized to receive such material by the federal government or any agency thereof, or any agreement state; or,

(c) As otherwise authorized by the agency in writing.

6.11. Intrastate Transportation of Radioactive Material

6.11.1. The provisions of this part 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. nuclear regulatory commission, the U.S. department of transportation, the U.S. postal service and other federal agencies.

6.11.2. No registrant shall transport any radioactive material outside of the confines of his plant or other authorized location of use, or deliver any radioactive material to a carrier for transportation, unless the registrant complies 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 and other federal agencies regulating the transportation of radioactive material.

6.12. Records

6.12.1. Each registrant shall maintain records showing the radiation doses of all individuals for whom personnel monitoring is required under 6.5. Such records shall be kept on Form RH-15 in accordance with the instructions contained in that form, or on clear and legible records contained in that form, or on clear and legible records containing all the information required by Form RH-15. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

6.12.2. Upon termination of employment of an individual, the individual and/or agency shall, upon request, be supplied with a summary state-

ment of that individual's radiation dose. This record shall include statements of any circumstances wherein the dose to the employee from any source of radiation, exceeded those specified in these regulations. Employee records must be kept available for inspection by the agency during the tenure of employment of an employee and for a period of five years thereafter.

6.12.3. Each registrant shall maintain records in the same units used in these regulations, showing the results of surveys required to comply with these regulations and disposals made under 6.9.

6.12.4. Records of individual exposure to radiation and to radioactive material which must be maintained pursuant to the provisions of 6.12.1 and records of bioassays, including results of whole body counting examinations, made pursuant to 6.3.4 shall be preserved indefinitely or until the agency authorizes their disposal. (Records which must be maintained pursuant to this part may be maintained in the form of microfilms).

6.12.5. An accurate accounting for all radioactive materials shall be maintained for a radiation installation. Such records shall show radio-active materials received, produced, transferred and disposed, the amounts and form of the radioactive materials, and such information as may be necessary to account for the difference between the amount of radioactive materials, received or produced and the amount on hand. Such records shall be retained for at least five years after the final disposition of any radioactive material.

6.12.6. Copies of all records required under these regulations shall be transferred to the agency in the event of termination of the registrant's

business operations and at such other times as the agency may direct.

6.13. Reports

6.13.1. Report to Employees and Others of Radiation Dosage - Each registrant, at the request of any individual employed or associated with him, shall advise such individual annually of the individual's exposure to radiation as shown in records maintained by the registrant pursuant to 6.12.1.

6.13.2 Report to Former Employees and Others of Exposure to Radiation

(a) a registrant, at the request of any individual formerly employed or associated with him (i.e., student, craftsman, etc.) shall furnish to such individual a report of his exposure to radiation as shown in records maintained pursuant to 6.12.1. Such report shall be furnished within 30 days from the time the request is made and shall cover each calendar quarter of the individuals employment or association involving exposure to radiation, or such lesser period as may be requested by the individual. The report shall also include the results of any calculations and analysis of radioactive material deposited in the body of the individual and made pursuant to the provisions of 6.3.4. The report shall be in writing and contain the following statement:

"This report is furnished to you under the provisions of the West Virginia department of health regulations entitled, "Radiological Health Regulations". You should preserve this report for future reference."

(b) The individual's request should include appropriate identifying data, such as social security number and dates and locations of employment

or association.

6.13.3. Reports of Theft or Loss of Sources of Radiation - Each registrant shall report by telephone or telegraph and confirm promptly by letter to the agency the theft or loss of any source of radiation immediately after such occurrence becomes known.

6.13.4. Notification of Incidents

(a) Immediate Notification - Each registrant shall immediately notify the agency by telephone or telegraph of any incident involving any source of radiation possessed by him and which may have caused or threatens to cause:

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

(2) 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 Appendix A, Table II, Section 12; or

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

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

(b) Twenty-four Hour Notification - Each registrant shall within 24 hours notify the agency by telephone or telegraph of any incident involving any sources of radiation possessed by him and which may have caused or threatens to cause:

(1) A dose to the whole body of any individual of 5 rems or more of

radiation; a dose to the skin of the whole body of any individual of 30 rems or more of radiation; or a dose to the feet, ankles, hands, or forearms of 75 rems or more of radiation; or

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix A, Table II, Section 12; or

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

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

(c) Any report filed with the agency pursuant to this part shall be prepared in such a manner that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

6.13.5. Reports of Overexposures and Excessive Levels and Concentrations

(a) In addition to any notification required by 6.13.4, each registraunt shall make a report in writing within 30 days to the agency of:

(1) Each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit as set forth in this part or as otherwise approved by the agency; and

(2) Any incident for which notification is required by 6.13.4; and

(3) Levels of radiation or concentrations of radioactive material (not involving excessive radiation doses to any individual) in an unrestricted area in excess of ten (10) times any applicable limit as set forth in this part or as otherwise approved by the agency.

(4) Each report required under this paragraph shall describe the ex-

tent of exposure of individuals to radiation or to radioactive material, including estimates of each individual's dose as required by 6.13.5(b); levels of radiation and concentrations of radioactive material involved; the cause of exposure, levels or concentrations; and corrective steps taken or planned to assure against a recurrence.

(b) In any case where a registrant is required pursuant to the provisions of this section to report to the agency any exposure of an individual to radiation or concentrations of radioactive material, the registrant shall no later than the making of such report to the agency also notify such individual of the nature and extent of exposure. Such notice shall be in writing and shall contain the following statement:

"This report is furnished to you under the provisions of the West Virginia department of health regulations entitled "Radiological Health Regulations". You should preserve this report for future reference".

(c) Any report filed with the agency pursuant to this section shall include for each individual exposed the name, social security number, and date of birth. The report shall be prepared so that this information is stated in a separate part of the report.

6.14. Vacating Premises

6.14.1. Each registrant shall, no less than 30 days before vacating or relinquishing possession or control of premises in which radioactive material which he has registered has been stored or used, notify the agency in writing of intent to vacate and afford the agency the opportunity to survey the premises for contamination. When deemed necessary by the agency the registrant shall decontaminate said premises in such a manner as

the agency may authorize and shall not vacate or relinquish possession or control of said premises without written consent of the agency.

Section 7. Requirements for Radiation Usage in the Healing Arts

7.1. Scope - This part establishes requirements for which a registrant is responsible, for use of X-ray equipment by or under the supervision of an individual authorized by and licensed in accordance with West Virginia statutes to engage in the healing arts or veterinary medicine. The provisions of this section are in addition to, and not in substitution for, other applicable provisions of these regulations.

7.2. Definitions - As used in this section, the following definitions apply:

(1) Added Filtration - means the filter added to the inherent filtration.

(2) Aluminum Equivalent - means the thickness of aluminum (type 1100 alloy) affording the same attenuation, under specified conditions, as the material in question. (The nominal chemical composition of type 1100 aluminum alloy is 99.00 percent minimum aluminum, 0.12 percent copper.)

(3) Barrier - (See Protective Barrier)

(4) Collimator - means a device or mechanism by which the x-ray beam is restricted in size.

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

(6) Diagnostic-type Protective Tube Housing - means an x-ray tube housing so constructed that the leakage radiation at a distance of 1 meter

from the target cannot exceed 100 milliroentgens in 1 hour when the tube is operated at its maximum continuous rated current for the maximum rated tube potential.

(7) Diaphragm - means a device or mechanism by which the x-ray beam is restricted in size.

(8) Filter - means material placed in the useful beam to absorb preferentially selected radiations.

(9) Half-value Layer (HVL) - means the thickness of specified material which attenuates the beam of radiation to an extent such that the exposure rate is reduced to one-half of its original value.

(10) Inherent Filtration - means the filtration permanently in the useful beam; it includes the window of the x-ray tube and any permanent tube or source enclosure.

(11) Interlock - means a device for precluding access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.

(12) Kilovolts Peak (kVp) - means the crest value in kilovolts of the potential of a pulsating potential generator. When only one-half of the wave is used, the value refers to the useful half of the wave.

(13) Lead Equivalent - means the thickness of lead affording the same attenuation, under specified conditions, as the material in question.

(14) Leakage Radiation - means radiation emanating from the diagnostic or therapeutic source assembly (excluding capacitor discharge machines) except for:

(a) the useful beam; and

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

(15) Primary Protective Barrier - (See Protective Barrier)

(16) Protective Apron - means an apron made of radiation absorbing materials used to reduce radiation exposure.

(a) Primary Protective Barrier - means the material, excluding filters, placed in the useful beam, for protection purposes, to reduce the radiation exposure.

(b) Secondary Protective - barrier means a barrier sufficient to attenuate the stray radiation to the required degree.

(18) Protective Glove - means a glove made of radiation absorbing materials used to reduce radiation exposure.

(19) Qualified Expert - means an individual who has demonstrated to the satisfaction of the agency that he possesses the knowledge and training to measure ionizing radiation, to evaluate safety techniques, and to advise regarding radiation protective needs.

(20) Registrant as used in this section - means any person who owns or possesses and administratively controls an x-ray system which is used to deliberately expose humans or animals to the useful beam of the system and is required by the provisions of Section 4 and 5 of these regulations to register with this agency.

(21) Scattered Radiation - means radiation that, during passage through matter, has been deviated in direction.

(22) Secondary Protective Barrier - (See Protective Barrier)

(23) Source-image Distance (SID) - means the distance from the

source to the center of the input surface of the image receptor.

(24) Therapeutic-type Tube Housing - means:

(a) For x-ray therapy equipment not capable of operating at 500 kVp or above, the following definition applies: An x-ray tube housing so constructed that the leakage radiation averaged over any 100 cm^2 area at a distance of one meter from the source does not exceed one roentgen in an hour when the tube is operated at its maximum rated continuous current for the maximum rated tube potential.

(b) For x-ray therapy equipment capable of operating at 500 kVp or above, the following definition applies: An x-ray tube housing so constructed that the leakage radiation averaged over any 100 cm^2 area at a distance of one meter from the source does not exceed 0.1 percent of useful beam dose rate at one meter from the source for any of its operating conditions.

(25) Useful Beam - means the radiation which passes through the tube housing port and the aperture of the beam-limiting device when the exposure switch or timer is activated.

7.3. Use of X-Ray Equipment in the Healing Arts

7.3.1. General Safety Provisions

(a) Use

(1) The registrant shall assure that all x-ray equipment under his control is operated only by individuals adequately instructed in safe operating procedures and competent in safe use of the equipment.

(2) The registrant shall provide safety rules to each individual operating x-ray equipment under his control, including any restrictions of

the operating technique required for the safe operation of the particular x-ray apparatus, and require that the operator demonstrate familiarity with these rule.

(b) Shielding - Each installation shall be provided with such primary barriers and/or secondary barriers as are necessary to assure compliance with Sections 6.2, 6.2.5 and 6.3.

(c) Prohibited Use - No registrant shall operate or permit the operation of x-ray equipment unless the equipment and installation meet the applicable requirements of these regulations.

(d) New Equipment - Diagnostic x-ray systems for use on humans, and the following components manufactured or assembled after the effective date of the federal performance standard designated as Title 42, code of federal regulations Part 78 shall be subjected to the provisions of said standards: tube housing assemblies, x-ray controls, x-ray high voltage generators, fluoroscopic imaging assemblies, tables, cradles, film changers, cassette holders, and beam-limiting devices.

7.3.2. Fluoroscopic Installations

(a) Equipment

(1) The tube housing shall be of the diagnostic type.

(2) The target-to-panel or target-to-table top distance of the equipment shall not be less than twelve (12) inches.

(3) The total filtration permanently in the useful beam, including the aluminum equivalent of table top or panel, shall not be less than the appropriate value recommended in Table 4-2.

(4) The equipment shall be so constructed that the entire cross-sec-

tion of the useful beam is attenuated by a primary barrier (usually a conventional fluoroscopic screen or an image intensification mechanism). The exposure shall automatically terminate when the barrier is removed from the useful beam.

(i) For equipment installed after the effective date of this part the required lead equivalent of the barrier shall not be less than 1.5 millimeter for up to 100 kVp, 1.8 for greater than 100 and less than 125 kVp and 2.0 millimeters for 125 kVp or greater.

(ii) Collimators shall be provided to restrict the size of the useful beam to less than the area of the barrier. For conventional fluoroscopes this requirement is met if, when the adjustable diaphragm is open to its fullest extent, an unilluminated margin is left at all edges of the fluorescent screen with the screen centered in the beam at a distance of thirtyfive (35) centimeters (fourteen [14] inches) from the panel or table top. The margin requirement does not apply to installations where image intensifiers are used, but a shutter shall be provided at these installations so that the length and width of the useful beam is restricted to the diameter of the input phosphor.

(iii) The tube mounting and the viewing device shall be so linked together that, under conditions of normal use, the barrier always intercepts the entire useful beam.

(iv) Collimators and adjustable diaphragms or shutters to restrict the size of the useful beam shall provide the same degree of protection as is required of the housing.

(5) The exposure switch shall be of the dead-man type.

(6) A cumulative timing device activated by the exposure switch shall be used which will either indicate elapsed exposure time by an audible signal or turn off the apparatus when the total exposure time exceeds a predetermined limit not exceeding 5 minutes in one or a series of exposures.

(7) A shielding device of at least 0.25 millimeter lead equivalent shall be provided for covering the bucky-slot during fluoroscopy.

(8) Protective drapes, or hinged, or sliding panels, of at least 0.25 millimeters lead equivalent, shall be provided between the patient and fluoroscopist to intercept scattered radiation which would otherwise reach the fluoroscopist and others near the machine. Such devices shall not substitute for wearing of a protective apron.

(9) Protective aprons of at least 0.25 millimeters lead equivalent shall be worn in the fluoroscopy room by each person, except the patient.

(10) For routine fluoroscopy, the exposure rate measured where the useful beam enters the patient shall not exceed ten (10) roentgens per minute.

(11) Mobile fluoroscopic equipment is subject to the following additional requirements:

(i) In the absence of a table top, a cone or spacer frame shall limit the source-to-skin distance to not less than thirty (30) centimeters [twelve (12) inches].

(ii) Image intensification shall always be provided. Conventional fluoroscopic screens shall not be used.

(iii) It shall be impossible to operate the machine unless the useful beam is intercepted by the image intensifier.

(iv) The exposure rate measured at the minimum source-to-skin distance shall not exceed ten (10) roentgens per minute.

7.3.3. Diagnostic Radiographic Installations Other Than Dental and Veterinary Medical

(a) Equipment

(1) The protective tube housing shall be of the diagnostic type.

(2) Collimators capable of restricting the useful beam to the area of clinical interest shall be provided to define the beam and shall provide the same degree of attenuation as is required of the protective tube housing. Collimators used with photofluorographic devices shall restrict the useful beam to the area of the photofluorographic screen.

(i) Collimators shall be calibrated in terms of the size of the projected useful beam at specified source-film distances.

(ii) Except for stereoradiography, the size of the useful beam (rectangular) shall not exceed any one of the dimensions of the film by more than two (2) inches for a source-film distance of thirty-seven (37) inches or greater or one (1) inch for a source-film distance of thirty-six (36) inches or less. The size of the useful beam (circular) shall not exceed any one of the dimensions of the film by more than two (2) inches for a source-film distance of thirty-seven (37) inches or greater or one (1) inch for a source-film distance of thirty-six (36) inches or less. For photofluorographic equipment, the size of the useful beam shall be restricted to the area of the photofluorographic screen.

(iii) Adjustable collimators installed after the effective date of these regulations shall incorporate light beams to define the projected dimensions of the useful beam.

(3) (i) The aluminum equivalent of the total filtration (inherent plus added) in the primary beam shall not be less than shown in Table 7-1, except when contraindicated for a particular diagnostic procedure:

Table 7-1
Filtration Required Vs. Operating Voltage

Below 50 kVp	0.5 millimeter
50-70 kVp	1.5 millimeters
Above 70 kVp	2.5 millimeters

(ii) If the filter in the machine is not accessible for examination, or the total filtration is unknown, it can be assumed that the requirements of 7.03.3(3)(i) are met if the half-value layer is not less than shown in Table 7.2.

Table 7-2
Half-value Layers as a Function of Filtration
and Tube Potential for Diagnostic Units

Total Filtration	Peak Potential (kVp)									
mm A1.	30	40	50	60	70	80	90	100	110	120
	Typical Half-value Layers in Millimeters of Aluminum									
0.5	0.36	0.47	0.58	0.67	0.76	0.84	0.92	1.00	1.08	1.16
1.0	0.55	0.78	0.95	1.08	1.21	1.33	1.46	1.58	1.70	1.82
1.5	0.78	1.04	1.25	1.42	1.59	1.75	1.90	2.08	2.25	2.42
2.0	0.92	1.22	1.49	1.70	1.90	2.10	2.28	2.48	2.70	2.90
2.5	1.02	1.38	1.69	1.95	2.16	2.37	2.58	2.82	3.06	3.30
3.0	-	1.49	1.87	2.16	2.40	2.62	2.86	3.12	3.38	3.65
3.5	-	1.58	2.00	2.34	2.60	2.86	3.12	3.40	3.68	3.95

(4) A device shall be provided which terminates the exposure at a

preset time interval or exposure. If a recycling timer is employed, it shall not be possible to make a repeat exposure without release of the exposure switch to reset the timer.

(5) The exposure switch, except for those used in cinefluoroscopy or in conjunction with "spot film" devices in fluoroscopy, shall be so arranged that it cannot be conveniently operated outside a shielded area.

(6) (i) The control panel shall include a device, (e.g., a milliammeter) which will give positive indication of the production of x-rays whenever the x-ray tube is energized.

(ii) The control panel shall include appropriate devices, e.g., labeled control settings and/or meters, indicating the physical factors (such as kVp, mA, exposure time or whether the timing is automatic) used for the exposure.

(7) Machines equipped with beryllium window x-ray tubes shall contain keyed filter interlock switches in the tube housing and suitable indication on the control panel of the added filter in the useful beam if the total filtration permanently in the useful beam is less than 0.5 mm aluminum equivalent. The total filtration permanently in the useful beam shall be clearly indicated on the tube housing.

(b) Structural Shielding

(1) All wall, floor, and ceiling areas struck by the useful beam shall have primary barriers. Primary barriers in walls shall extend to a minimum height of seven (7) feet above the floor.

(2) Secondary barriers shall be provided in all wall, floor, and ceiling areas not having primary barriers.

(3) The operator's station at the control shall be behind a protective barrier sufficient to assure compliance with 6.2 and 6.2.5. Provisions shall be made for the operator to communicate with the patient from the operator's station.

(4) A window of lead-equivalent glass equal to that required by the adjacent barrier, or a mirror system, shall be provided and it shall be large enough and so placed that the operator can see the patient during the exposure without having to leave the protected area.

(c) Operating Procedures

(1) When a patient must be held in position for radiography, mechanical supporting or restraining devices should be used. If the patient must be held by an individual, that individual shall be protected with appropriate shielding devices such as protective gloves and apron and he shall be so positioned that no part of his body will be struck by the useful beam.

(2) Only individuals required for the radiographic procedure shall be in the radiographic room during exposure; and except for the patient, all such persons shall be equipped with appropriate protective devices.

(3) The useful beam shall be restricted to the area of clinical interest.

(4) Personnel monitoring shall be required for all individuals operating photofluorographic equipment.

(5) Gonadal shielding of not less than 0.25 mm lead equivalent shall be used for patients who have not passed the reproductive age during radiographic procedures in which the gonads are in the direct (useful) beam, except for cases in which this would interfere with the diagnostic procedure.

7.3.4. Special Requirements for Mobile Diagnostic Radiographic Installations

(a) Equipment

(1) All requirements of 7.3.3(a) apply except 7.3.3(a)(5).

(2) The exposure control switch shall be of the dead-man type and shall be so arranged that the operator can stand at least six (6) feet from the patient, the x-ray tube, and well away from the useful beam.

(3) Inherent provisions shall be made so that the equipment is not operated at source-to-skin distances of less than twelve (12) inches (30 cm).

(b) Structural Shielding

(1) When a mobile unit is used routinely in one location, it shall be considered a fixed installation subject to the shielding requirements of 7.3.1(b) and 7.3.3(b).

(c) Operating Procedures

(1) All provisions of 7.3.3(c) apply except 7.3.3(c) and 7.3.3(c)(4).

(2) Personnel monitoring shall be required for all individuals operating mobile X-ray equipment.

7.3.5. Dental Radiographic Installations

(a) Equipment

(1) The protective tube housing shall be of the diagnostic type.

(2) Diaphragms or cones shall be used for restricting the useful beam and shall provide the same degree of protection as the housing. The diameter of the useful beam at the end of the cone shall be not more than three (3) inches for intraoral radiography.

(3) A cone or spacer frame shall provide a source-to-skin distance of not less than seven (7) inches with apparatus operating above fifty (50) kVp or four (4) inches with apparatus operating at fifty (50) kVp or below for intraoral radiography.

(4) (i) The aluminum equivalent of the total filtration (inherent plus added) in the useful beam shall not be less than that shown in the following table:

Table 4-3
Filtration required Vs. Operating Voltage

Operating Voltage	Minimum Total Filtration (Inherent plus added)
Below 50 kVp	0.5 millimeter
50-70 kVp	1.5 millimeters
Above 70 kVp	2.5 millimeters

(ii) If the filter in the machine is not accessible for examination or the total filtration is unknown, it can be assumed that the requirements of 7.3.5(a)(4)(i) are met if the half-value layer is not less than that shown in the following table:

Table 7-4
Half-value Layers as a Function of Filtration and Tube Potential

Total Filtration mm A1.	Peak Potential (kVp)				
	45	50	70	90	100
	Typical Half value Layers in Millimeters of Aluminum				
0.5	0.5	0.6	0.8	0.9	1.0
1.0	0.9	0.9	1.2	1.5	1.6
1.5	1.2	1.2	1.6	1.9	2.1
2.0	-	1.5	1.9	2.3	2.5
2.5	-	1.7	2.2	2.6	2.8

(5) A device shall be provided to terminate the exposure after a preset time interval or exposure. The exposure switch shall be of the dead-man type.

(6) Each installation shall be provided with a protective barrier for the operator or shall be so arranged that the operator can stand at least six (6) feet from the patient and well away from the useful beam.

(7) The tube head shall remain stationary when placed in the exposure position.

(b) Structural Shielding

(1) Dental rooms containing x-ray machines shall be provided with such primary barriers and/or secondary barriers as are necessary to assure compliance with 6.2.1, 6.2.4 and 6.2.5. No approval by the agency is required if it can be shown upon request by the agency that the limits in 6.2.5(b) will not be exceeded.

NOTE: IN many cases, structural materials of ordinary walls suffice as a protective barrier without addition of special shelding material.

(c) Operating Procedures

(1) (i) Neither the dentist nor his assistant shall hold patients or films during exposure, nor shall any individual be regularly used for this service.

(ii) Only persons required for the radiographic procedures shall be in the radiographic room during exposures.

(2) During each exposure, the operator shall stand as far as practical from the patient and outside the path of the useful beam or behind a suitable barrier.

(3) Only the patient shall be in the useful beam.

(4) Neither the tube housing nor the cone shall be hand-held during the exposure.

(5) Fluoroscopy shall not be used in dental examinations.

7.3.6. Therapeutic X-ray Installations

(a) Equipment

(1) The protective tube housing shall be of the therapeutic type.

(2) Permanent diaphragms or cones used for collimating the useful beam shall afford the same degree of protection as the tube housing. Adjustable or removable beam defining diaphragms or cones shall transmit not more than five (5) percent of the useful beam at the maximum kilovoltage and with maximum treatment filter.

(3) 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 exceed one (1) roentgen per hour at one (1) meter, or, if the radiation from the slot is accessible to the patient, thirty (30) roentgens per hour at five (5) centimeters from the external opening. Each removable filter shall be marked with its thickness and material.

(4) A filter indication system shall be used on all therapy machines using changeable filters. It shall be designed so as to permit easy recognition of any added filter in place. It shall indicate, from the control panel, the presence or absence of any filter.

(5) The x-ray tube shall be so mounted that it cannot turn or slide with respect to the housing aperture.

(6) Means shall be provided to immobilize the tube housing during stationary portal treatment.

(7) A suitable exposure control device shall be provided to terminate the exposure after a preset time interval or preset exposure or dose limit. Means shall be provided for the operator to terminate the exposure at any time.

(8) Equipment utilizing shutters to control the useful beam shall have a shutter position indicator on the control panel.

(9) The control panel shall include a device which will give positive indication of the production of x-rays whenever the x-ray tube is energized.

(b) Structural Shielding

(1) All wall, floor, and ceiling areas that can be struck by the useful beam shall be provided with primary protective barriers.

(2) All wall, floor, and ceiling areas that, because of restrictions in the orientation of the useful beam, cannot be struck by the useful beam shall be provided with secondary protective barriers.

(3) With equipment operating at voltages above one hundred and twenty-five (125) kVp, the required barriers shall be an integral part of the building.

(4) With the equipment operating above one hundred and fifty (105) kVp, the control station shall be within a protective booth equipped with an interlocked door, or outside the treatment room.

(5) Interlocks shall be provided for x-ray therapy equipment capable of operating above 150 kVp so that when any door of the treatment room is

opened either the machine will shut off automatically or the radiation level within the room will be reduced to an average of not more than two (2) milliroentgens per hour and a maximum of ten (10) milliroentgens per hour at a distance of one (1) meter in any direction from the target. After such shut off or reduction in output it shall be possible to restore the machine to full operation only from the control panel.

(6) Windows, mirror systems, or closed-circuit television viewing screens shall be provided to permit continuous observation of the patient during irradiation and shall be so located that the operator may see the patient and the control panel from the same position.

(7) Provision shall be made for oral communication with the patient from the control room.

(8) Treatment rooms to which access is possible through more than one entrance shall be provided with flashing warning lights in a readily observable position near the outside of all access doors, which will indicate when the useful beam is "on".

(c) Operating Procedures

(1) All new installations, and existing installations not previously surveyed, shall have a protection survey made by, or under the direction of, a qualified expert. This shall also be done after any change in the installation which might produce a radiation hazard. The expert shall report his findings in writing to the person in charge of the installation, a copy of which shall be made available for inspection by the agency.

(2) The installation shall be operated in compliance with any limitations indicated by the protection survey.

(3) When a patient must be held in position for radiation therapy, mechanical supporting or restraining devices shall be used whenever feasible. If the patient must be held by an individual, that individual shall be adequately protected and he shall be positioned so that no part of his body will be struck by the useful beam and that his body is as far as possible from the edge of the useful beam. Any individual used for this purpose shall be provided with personnel monitoring.

(4) The output of each therapeutic x-ray machine shall be calibrated by, or under the direction of, a qualified expert. The calibration shall be repeated after any change in or replacement of components of the x-ray generating equipment which could cause a change in x-ray output. Check calibrations shall be made at least once a year thereafter. Records of calibrations shall be maintained by the registrant. Recalibration shall be performed at least once in every calendar year except that recalibration is not required when spot checks are made and a log record made of these spot checks. Spot checks shall be made and recorded at least monthly or after every fifty (50) operating hours, whichever is the longer time interval. A spot check measurement consists of determining the exposure rate or dose rate of a quantity related in a known manner to these entities for one typical set of operating conditions.

7.3.7. Special Requirements for X-ray Therapy Equipment Operated at Potentials of Sixty (60) kVp and Below

(a) Equipment - All provisions of 7.3.6(a) apply except that leakage radiation 5 cm from the surface of the tube housing shall not exceed 0.1 roentgen per hour.

(b) Operating Procedures

(1) Automatic timers shall be provided which will permit accurate presetting and termination of exposures as short as one second.

(2) In the therapeutic application of apparatus constructed with beryllium or other low-filtration windows, the registrant shall insure that the unfiltered radiation reaches only the part intended and that the useful beam is blocked at all times except when actually being used.

(3) Machines having an output of more than 2,000 roentgens per minute at any accessible place shall not be left unattended without the power being shut off at the main disconnect switch in addition to the control panel switch.

(4) If the tube must be hand-held during irradiation, the operator shall wear protective gloves and a protective apron of no less than 0.5 millimeter lead equivalent.

7.3.8. Veterinary Medical Radiographic Installations

(a) Equipment

(1) The protective tube housing shall be of diagnostic type.

(2) Diaphragms or cones shall be provided for collimating the useful beam to the area of clinical interest and shall provide the same degree of protection as is required of the housing.

(3) The total filtration permanently in the useful beam shall not be less than 0.5 millimeters aluminum equivalent for machines operating up to 50 kVp, 1.5 millimeters aluminum equivalent for machines operating between 50-70 kVp and 2.5 millimeters aluminum equivalent for machines operating above 70 kVp.

(4) A device shall be provided to terminate the exposure after a preset time or exposure.

(5) A dead-man type of exposure switch shall be provided, together with an electrical cord of sufficient length so that the operator can stand out of the useful beam and at least six (6) feet from the animal during all X-ray exposures.

(b) Structural Shielding

(1) All wall, ceiling, and floor areas shall be equivalent to or provided with applicable protective barriers as required in 7.3.3(b)(1) and 7.3.3(b)(2).

(c) Operating Procedures

(1) The operator shall stand well away from the useful beam and the animal during radiographic exposures.

(2) No individual other than the operator shall be in the x-ray room while exposures are being made unless such individual's assistance is required.

(3) When an animal must be held in position during radiography, mechanical supporting or restraining devices should be used. If the animal must be held by an individual, that individual shall be protected with appropriate shielding devices, such as protective gloves and apron, and he shall be so positioned that no part of his body will be struck by the useful beam. Any individual used for this purpose shall be provided with personnel monitoring.

Section 8. Use of Sealed Radioactive Sources in the Healing Arts

8.1. Scope - The provisions of this section apply to all registrants

who use sealed sources in the healing arts and are in addition to, and not in substitution for, other applicable provisions of these regulations.

8.2. Special Requirements for the Use of Sealed Radioactive Sources in the Healing Arts

8.2.1. Interstitial, Intracavitary, and Superficial Applications

(a) Accountability, Storage, and Transit

(1) Except as otherwise specifically authorized by the agency, each registrant shall provide accountability of sealed sources and shall keep a permanent record of the issue and return of all sealed sources. A physical inventory shall be made at least every six (6) months and a written record of the inventory maintained.

(2) When not in use, sealed sources and applicators containing sealed sources shall be kept in a protective enclosure of such material and wall thickness as may be necessary to assure compliance with the provisions of 6.2, 6.2.5 and 6.03.

(b) Testing Sealed Sources for Leakage and Contamination

(1) All sealed sources with a half-life greater than thirty days and in any form other than gas shall be tested for leakage and/or contamination prior to initial use and at intervals not to exceed six (6) months. If there is reason to suspect that a sealed source might have been damaged, or might be leaking, it shall be tested for leakage before further use.

(2) Leak tests shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample or, in the case of radium, the escape of radon at the rate of 0.001 microcurie per 24 hours. Any test conducted pursuant to 8.2.1(b)(1) which reveals the presence of

0.005 microcurie or more of removable contamination or, in the case of radium, the escape of radon at the rate of 0.001 microcurie or more per 24 hours shall be considered evidence that the sealed source is leaking. The registrant shall immediately withdraw the leaking source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with applicable provisions of Section 6.

(3) Leak tests results shall be recorded in units of microcuries and maintained for inspection by the agency.

(c) Radiation Surveys

(1) The maximum radiation level at a distance of one (1) meter from the patient in whom brachytherapy sources have been inserted shall be determined by measurement or calculation and preferably both. This radiation level shall be entered on the patient's chart and other signs as required under 8.2(d).

(2) The radiation levels in the patient's room and surrounding areas shall be determined, recorded, and maintained for inspection by the agency.

(3) Immediately after the removal of the brachytherapy source(s), the patient shall be surveyed with an appropriate radiation survey instrument to insure that all sealed radioactive sources have been removed. Results of the survey shall be recorded in the source utilization log and maintained for inspection by the agency.

(d) Signs and Records

(1) In addition to the requirements of 6.6, the bed, cubicle, or room of the hospital brachytherapy patient shall be marked with a sign indicating

the presence of brachytherapy sources. This sign shall incorporate the radiation symbol and specify the radionuclide, the activity, date, and the individual(s) to contact for radiation safety instructions. The sign is not required provided the exception in 6.6.5(b) is met.

(2) The following information shall be included in the patient's chart:

(i) The radionuclide administered, number of sources, activity in millicuries and the time and date of administration;

(ii) The maximum radiation level at 1 meter from the patient, the time the determination was made and by whom;

(iii) The radiation symbol; and

(iv) The precautionary instructions necessary to assure that the exposure of individuals does not exceed that permitted under 6.2.

8.2.2. Teletherapy

(a) Equipment

(1) The housing shall be so constructed that, at one (1) meter from the source, the maximum exposure rate does not exceed ten (10) milliroentgens per hour when the beam control mechanism is in the "off" position. The average exposure rate measured at a representative number of points about the housing, each one (1) meter from the source, shall not exceed two (2) milliroentgens per hour.

(2) For teletherapy equipment installed after the effective date of these regulations, the leakage radiation measured at one (1) meter from the source when the beam control mechanism is in the "on" position shall not exceed one (1) roentgen per hour or 0.1 percent of the exposure rate of the useful beam.

(3) Adjustable or removable beam-defining diaphragms shall allow transmission of not more than five (5) percent of the exposure rate of the useful beam.

(4) The beam control mechanism shall be of a positive design capable of acting in any position of the housing. In addition to an automatic closing device, the mechanism shall be designed so that it can be manually returned to the "off" position with a minimum risk of exposure.

(5) 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 until activated from the control panel.

(6) When any door to the treatment room is opened, the beam control mechanism shall automatically and rapidly restore the unit to the "off" position and cause it to remain there until the unit is reactivated from the control panel.

(7) There shall be at the housing and at the control panel a warning device that plainly indicates whether the beam is on or off.

(8) The equipment shall be provided with a locking device to prevent unauthorized use.

(9) The control panel shall be provided with a timer that automatically terminates the exposure after a preset time.

(10) Teletherapy sources shall be tested for leakage and contamination in accordance with the procedures described in 8.2.1(b) except that the leak tests shall be capable of detecting 0.005 microcurie of removable contamination, and a source shall be considered to be leaking if the test

reveals the presence of 0.005 microcurie or more of removable contamination. Tests of leakage may be made by wiping accessible surfaces of the housing port or collimator while the source is in the "off" position and measuring these wipes for transferred contamination.

(b) Shielding

(1) Primary protective barriers shall be provided for any area that the useful beam may strike when using the largest possible diaphragm opening. Such barriers should extend at least one (1) foot beyond the useful beam for any possible orientation.

(2) Secondary protective barriers shall be provided for all occupied areas exposed to leakage and scattered radiation.

(3) Provision shall be made to permit continuous observation of patients during irradiation.

(c) Operation

(1) No individual who is occupationally exposed to radiation shall be in the treatment room during irradiation unless he is the patient. No other individual shall be there except when it is clinically necessary.

Section 9. Radiation Safety Requirements for Industrial Radiographic Operations

9.1. Purpose and Scope

9.1.1. The regulations in this section establish radiation safety requirements for persons using sources of radiation for industrial radiography. The requirements of this section are in addition to and not a substitute for other requirements of these regulations. Except for those sections clearly applicable to sealed radioactive sources, both sealed sources and radiation machines are covered by this section.

9.1.2. This section applies to all registrants who use sources of radiation for industrial radiography; provided, however, that nothing in this section shall apply to uses of radiation sources in the healing arts.

9.2. Definitions

(1) Cabinet Radiography - means industrial radiography using radiation machines, or equipment, which is conducted in an enclosed, interlocked cabinet, such that the radiation machine will not operate unless all openings are securely closed, and which cabinet is so shielded that every location on the exterior meets all radiation level requirements for an unrestricted area as specified in 9.3.

(2) Industrial Radiography - means the macroscopic examination of the structure of materials by nondestructive methods utilizing sources of radiation.

(3) Radiographer - means any individual who performs or who, in attendance at the site where sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the registrant for assuring compliance with the requirements of these regulations.

(4) Radiographer's Assistant - means any individual who, under the personal supervision of a radiographer, uses sources of radiation, related handling tools, or survey instruments in industrial radiography.

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

(6) Storage Container - means a device in which sealed sources are transported or stored.

(7) Shielded Room Radiography - means industrial radiography which is conducted in an enclosed room, the interior of which is not occupied during radiographic operations, which is so shielded that every location on the exterior meets conditions for an unrestricted area as specified in 6.3, and the only access to which is through openings which are interlocked so that the radiation machine will not operate unless all openings are securely closed.

(8) Field Radiography - means all industrial radiography other than cabinet radiography and shielded room radiography.

9.3. Special Radiation Safety Requirements for Inudstrial Radiography Operation

9.3.1. Limits on Radiation Levels for Radiography Exposure Devices and Storage Containers

(a) Radiographic exposure devices measuring less than four (4) inches from the sealed source storaage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device.

(b) Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for sealed sources or outer containers for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface. The radiation levels

specified are with the sealed source in the shielded (i.e., "off") position.

9.3.2. Locking of Sources of Radiation - Each source of radiation shall be provided with a lock or outer lockable container designed to prevent unauthorized or accidental production of radiation or removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a radiographer or radiographer's assistant, or as may be otherwise authorized pursuant to 9.4.4. Each storage container likewise shall be provided with a lock and kept locked when containing sealed sources except when the container is under the direct surveillance of a radiographer or radiographer's assistant.

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

9.3.4. Radiation Survey Instruments - The registrant shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this section and Section 12 of these regulations. Each radiation survey instrument shall be calibrated at intervals not to exceed one (1) year and after each instrument servicing and a record maintained of the latest date of calibration. Instrumentation required by this section shall have a range such that two milliroentgens per hour through one roentgen per hour can be measured.

9.3.5. Leak Testing, Repair, Tagging, Opening, Modification, and Replacement of Sealed Sources

(a) 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 to do so by the agency, the U.S. nuclear regulatory commission, or any agreement state.

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

(c) The leak test shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography registrant would be to test at the nearest accessible point to the sealed source storage position or other appropriate measuring point by a procedure to be approved by the agency. The applicant who desires to conduct his own leak tests shall establish adequate procedures to be followed in leak testing sealed sources for possible leakage and contamination and shall submit to the agency a description of such procedures including:

(1) Instrumentation to be used;

(2) Method of performing tests, e.g., points on equipment to be smeared and method of taking smear; and

(3) Pertinent experience of the person who will perform the test.

Records of leak test results shall be kept in units of microcuries and maintained for inspection by the agency.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this part which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is

leaking. The registrant shall immediately withdraw such defective equipment from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with regulations of the agency. Within 5 days after obtaining results of the test, the registrant shall file a report with the agency describing the equipment involved, the test results, and the corrective action taken.

(e) 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 (1) 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".

9.3.6. Quarterly Inventory - Each registrant shall conduct a quarterly physical inventory to account for all sources of radiation received or possessed by him. The records of the inventories shall be maintained for inspection by the agency and shall include the quantities and kinds of radioactive material, the location of all sources of radiation, and the date of the inventory.

9.3.7. Utilization Logs - Each registrant shall maintain current logs, which shall be kept available for inspection by the agency, showing for each source of radiation the following information:

(a) A description (or make and model number) of each source of radiation or storage container in which the sealed source is located;

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

(c) Locations where used and dates of use; and

(d) The voltage, current, and exposure time for each radiographic exposure employing a radiation machine.

9.4. Personal Radiation Safety Requirements for Radiographers and Radiographers' Assistants

9.4.1. Limitations

(a) No registrant shall permit any person to act as a radiographer as defined in these regulations until such person:

(1) Has been instructed in the subjects outlined in 9.6 of this section and shall have demonstrated understanding thereof;

(2) Has received copies of and instruction in the regulations contained in this section and the applicable sections of Section 12; and the registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(3) Has demonstrated competence to use the source of radiation, related handling tools, and survey instruments which will be employed in his assignment.

(b) No registrant shall permit any person to act as a radiographer's assistant as defined in this part until such person:

(1) Has received copies of and instructions in the registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(2) Has demonstrated competence to use under the personal supervision of the radiographer, the sources of radiation, related handling tools, and radiation survey instruments which will be employed in his assignment.

9.4.2. Operating and Emergency Procedures - The registrant's oper-

ating and emergency procedures shall include instructions in at least the following:

(a) The handling and use of sources of radiation to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Section 12;

(b) Methods for controlling access to radiographic areas;

(c) Methods and occasions for conducting radiation surveys;

(d) Methods and occasions for locking and securing sources of radiation;

(e) Personnel monitoring and the use of personnel monitoring equipment;

(f) Transportation to field locations, including packing of sources of radiation in the vehicles, posting of vehicles, and control of sources of radiation 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.

9.4.3. Personnel Monitoring Control

(a) No registrant shall 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 exposures 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 exposures 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 agency.

9.4.4. Security - During each radiographic operation, the radiographer or radiographers' assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in 5.4, except where the high radiation area is equipped with a control device or an alarm system as described in 6.6.2(b)(2), or where the high radiation area is locked to protect against unauthorized or accidental entry.

9.4.5. Posting - Notwithstanding any provisions in Section 6.6.5, areas in which radiography is being performed shall be conspicuously posted as required by Section 6.6.2(a) and (b).

9.4.6. Radiation Surveys and Survey Records

(a) No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in 9.3.4 is available and used at each site where radiographic exposures are made.

(b) A physical radiation survey shall be made after each radiographic exposure utilizing radiographic exposure devices or sealed sources of radioactive material to determine that the sealed source has been returned to its shielded condition.

(c) 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 or storage container as specified in 9.3.2.

(d) Records shall be kept of the surveys required by 9.4.6(c) and maintained for inspection by the agency.

9.5. Special Requirements for Radiography Employing Radiation Machines

9.5.1. Cabinet Radiography - Cabinet radiography shall be exempt from other requirements of Section 12 however, no registrant shall permit any individual to operate a cabinet radiography unit until such individual has received a copy of, and instruction in, and demonstrated an understanding of operating procedures for the unit, and has demonstrated competence in its use.

9.5.2. Shielded Room Radiography - Shielded room radiography shall be exempt from other requirements of Section 12; however,

(a) No registrant shall permit any individual to operate a radiation machine for shielded room radiography until such individual has received a copy of, and instruction in, and demonstrated an understanding of operating procedures for the unit, and has demonstrated competence in its use.

(b) Each registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by, every individual who operates, who makes "set-ups", or who performs maintenance on a radiation machine for shielded room radiography.

(c) A physical radiation survey shall be conducted to determine that the radiation machine is "off" prior to each entry into the shielded room. Such surveys shall be made with a radiation measuring instrument capable

of measuring radiation of the energies and at the dose rates to be encountered, which is in good working order, and which has been properly calibrated within the preceding three months or following the last instrument servicing, whichever is later.

9.5.3. Field Radiography - Field Radiography shall be exempt from 9.3.1, 9.3.3, 9.3.5, and 9.4.6; however,

(a) A physical radiation survey shall be conducted to determine that the radiation machine is "off" prior to each entry into the radiographic exposure area. Such surveys shall be made with a radiation measuring instrument capable of measuring radiation of the energies and at the dose rates to be encountered, which is in good working order, and which has been properly calibrated within the preceding three months or following the last instrument servicing, whichever is later. Survey results and records of boundary locations shall be maintained and kept available for inspection.

(b) Mobile or portable radiation machines shall be physically secured to prevent removal by unauthorized personnel.

9.6. Instruction of Industrial Radiographers

Pursuant to 9.4, an outline of the subjects to be covered in a minimum amount of instruction for radiographers is contained below:

9.6.1. Fundamentals of Radiation Safety

(a) Characteristics of gamma and x-radiation.

(b) Units of radiation dose (mrem) and quantity of radioactivity (curie).

(c) Hazards of excessive exposure of radiation.

(d) Levels of radiation from sources of radiation.

(e) Methods of controlling radiation dose.

(1) Working time.

(2) Working distances.

(3) Shielding.

9.6.2. 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.

9.6.3. Radiographic Equipment to be Used

(a) Remote handling equipment.

(b) Radiographic exposure devices and sealed sources.

(c) Storage containers.

(d) Operation and control of X-ray equipment.

9.6.4. The requirements of pertinent federal and state regulations.

9.6.5. The registrant's written operating and emergency procedures.

Section 10. Radiation Safety Requirements for Analytical X-Ray Equipment

10.1. Scope - This section provides special requirements for analytical x-ray equipment. The requirements of this section are in addition to, and not in substitution for applicable requirements in other section of these regulations.

10.2. Definitions

(1) Analytical X-ray Equipment - means equipment used for x-ray diffraction of fluorescence analysis.

(2) Analytical X-ray System - means a group of components utilizing x-rays to determine the elemental composition or to examine the microstructure of materials.

(3) Fail-safe Characteristics - means a design feature which causes beam port shutters to close, or otherwise prevents emergency of the primary beam, upon the failure of a safety or warning device.

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

(5) Normal Operating Procedures - mean step-by-step instructions necessary to accomplish the analysis. These procedures shall include sample insertion and manipulation, equipment alignment, routine maintenance by the registrant, and data recording procedures which are related to radiation safety.

(6) Open-beam Configuration - means an analytical x-ray system in which an individual could accidently place some part of his body in the primary beam path during normal operation.

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

10.3. Equipment Requirements

10.3.1. Safety Device - A device which prevents the entry of any portion of an individual's body into the primary x-ray beam path or which causes the beam to be shut off upon entry into its path shall be provided on all open-beam configurations. A registrant may apply to the agency for an exemption from the requirement of a safety device. Such application shall include:

(a) A description of the various safety devices that have been evaluated;

(b) The reason each of these devices cannot be used; and

(c) A description of the alternative methods that will be employed to minimize the possibility of an accidental exposure, including procedures to assure that operators and others in the area will be informed of the absence of safety devices.

10.3.2. Warning Devices

(a) Open-beam configurations shall be provided with a readily discernible indication of:

(1) X-ray tube status (ON-OFF) located near the radiation source housing, if the primary beam is controlled in this manner; and/or

(2) Shutter status (OPEN-CLOSED) located near each port on the radiation source housing, if the primary beam is controlled in this manner.

(b) Warning devices shall be labeled so that their purpose is easily identified. On equipment installed after the effective date of these regulations, warning devices shall have fail-safe characteristics.

10.3.3. Ports - Unused ports on radiation source housings shall be

secured in the closed position in a manner which will prevent casual opening.

10.3.4. Labeling - All analytical x-ray equipment shall be labeled with a readily discernible sign or signs bearing the radiation symbol and the words:

(a) "CAUTION - HIGH INTENSITY X-RAY BEAM," or words having a similar intent, on the x-ray housing; and

"CAUTION RADIATION - THIS EQUIPMENT PRODUCES RADIATION WHEN ENERGIZED," or words having a similar intent, near any switch that energizes an x-ray tube if the radiation source is an x-ray tube; or "CAUTION - RADIOACTIVE MATERIAL," or words having a similar intent, on the source housing if the radiation source is a radionuclide.

10.3.5. Shutters - On open-beam configurations installed after the effective date of these regulations, each port on the radiation source housing shall be equipped with a shutter that cannot be opened unless a collimator or a coupling has been connected to the port.

10.3.6. Warning Lights

(a) An easily visible warning light labeled with the words "X-RAY ON", or words having a similar intent, shall be located:

(1) Near any switch that energizes an x-ray tube and shall be illuminated only when the tube is energized; or

(2) In the case of a radioactive source, near any switch that opens a housing shutter, and shall be illuminated only when the shutter is open.

(b) On equipment installed after the effective date of these regulations, warning lights shall have fail-safe characteristics.

10.3.7. Radiation Source Housing - Each x-ray tube housing shall be so constructed that, with all shutters closed, the leakage radiation measured at a distance of 5 cm from its surface is not capable of producing a dose in excess of 2.5 mrem in one hour at any specified tube rating.

10.3.8. Generator Cabinet - Each x-ray generator shall be supplied with a protective cabinet which limits leakage radiation measured at a distance of 5 cm from its surface such that it is not capable of producing a dose in excess of 0.25 mrem in one hour.

10.4. Area Requirements

10.4.1. Radiation Levels - The local components of an analytical x-ray system shall be located and arranged and shall include sufficient shielding or access control such that no radiation levels exist in any area surrounding the local component group which could result in a dose to an invididual present therein in excess of the dose limits given in 6.3 of these regulations. For systems utilizing x-ray tubes, these levels shall be met at any specified tube rating.

10.4.2. Surveys

(a) Radiation surveys, as required by 10.4.2. of these regulations, of all analytical x-ray systems sufficient to show compliance with 10.4.1 shall be performed:

(1) Upon installation of the equipment and at least once every 12 months thereafter;

(2) Following any change in the initial arrangement, number, or type of local components in the system;

(3) Following any maintenance requiring the disassembly or removal of a local component in the system;

(4) During the performance of maintenance and alignment procedures if the procedures require the presence of a primary x-ray beam when any local component in the system is disassembled or removed;

(5) Any time a visual inspection of the local components in the system reveals an abnormal condition; and

(6) Whenever personnel monitoring devices show a significant increase over the previous monitoring period or the readings are approaching the limits specified in 6.2 of these regulations.

(b) Radiation survey measurements shall not be required if a registrant can demonstrate compliance to the satisfaction of the agency with 10.4.1 in some other manner.

10.4.3. Posting - Each area or room containing analytical x-ray equipment shall be conspicuously posted with a sign or signs bearing the radiation symbol and the words "CAUTION - X-RAY EQUIPMENT" or words having a similar intent.

10.5. Operating Requirements

10.5.1. Procedures - Normal operating procedures shall be written and available to all analytical x-ray equipment workers. No person shall be permitted to operate analytical x-ray equipment in any manner other than that specified in the procedures unless such person has obtained written approval of the radiation safety officer.

10.5.2. Bypassing - No person shall bypass a safety device unless such person has obtained the approval of the radiation safety officer. Such approval shall be for a specified period of time. When a safety device has been bypassed, a readily discernible sign bearing the words "SAFETY

DEVICE NOT WORKING," or words having a similar intent, shall be placed on the radiation source housing.

10.6. Personnel Requirements

10.6.1. Instruction - No person shall be permitted to operate or maintain analytical x-ray equipment unless such person has received instruction in and demonstrated competence as to:

(a) Identification of radiation hazards associated with the use of the equipment;

(b) Significance of the various radiation warning and safety devices incorporated into the equipment, or the reasons they have not been installed on certain pieces of equipment and the extra precautions required in such cases;

(c) Proper operating procedures for the equipment;

(d) Symptoms of an acute localized exposure; and

(e) Proper procedures for reporting an actual or suspected exposure.

10.6.2. Personnel Monitoring

(a) Finger or wrist dosimetric devices shall be provided to and shall be used by:

(1) Analytical x-ray equipment workers using systems having an openbeam configuration and not equipped with a safety device; and

(2) Personnel maintaining analytical x-ray equipment if the maintenance procedures require the presence of a primary x-ray beam when any local component in the analytical x-ray system is disassembled or removed.

(b) Reported dose values shall not be used for the purpose of

determining compliance with 6.2 of these regulations unless evaluated by a qualified expert.

Section 11. Radiation Safety Requirements for Particle Accelerators

11.1. Purpose and Scope

11.1.1. This section establishes procedures for the registration and use of particle accelerators.

11.1.2. In addition to the requirements of this section, all registrants are subject to the requirements of Section 4, 5, and 6. Registrants engaged in industrial radiographic operations are subject to the requirements of Section 9 and registrants engaged in the healing arts are subject to the requirements of Section 7 and/or Section 8 of these regulations.

11.2. Registration Requirements - No person shall receive, possess, use, transfer, own or acquire a particle accelerator unless such is in compliance with the registration requirements in Section 5 of these regulations.

11.3. General Requirements for the Use of Particle Accelerators

11.3.1. In addition to the requirements set forth in Section 5, a registration for the use of a particle accelerator will not be issued unless the agency determines that:

(a) The applicant is qualified by reason of training and experience to use the accelerator in question for the purpose intended in accordance with this section and Section 6 in such a manner as to minimize danger to public health and safety or property;

(b) The applicants' proposed equipment, facilities, and operating and emergency procedures are adequate to protect health and minimize danger to public health and safety or property;

(c) The issuance of the registration will not be inimical to the health and safety of the public, and the applicant satifies any applicable special requirement in 11.4 of these regulations;

(d) The applicant has appointed a radiation safety officer;

(e) The applicant and/or his staff has substantial experience in the use of particle accelerators for the intended use;

(f) The applicant has established a radiation safety committee to approve, in advance, proposals for use of particle accelerators, whenever deemed necessary by the agency; and

(g) The applicant has an adequate training program for particle accelerator operators.

11.4. Human Use of Particle Accelerators

11.4.1. In addition to the requirements set forth in Section 5, a registration for use of a particle accelerator in the healing arts will be issued only if:

(a) Whenever deemed necessary by the agency, the registrant has appointed a medical committee of at least three members to evaluate all proposals for research, diagnostic, and therapeutic use of a particle accelerator. Membership of the committee shall include physicians expert in internal medicine, hematology, therapeutic radiology and a person experienced in depth dose calculations and protection against radiation;

(b) The individuals designated on the application as the users have substantial training and experience in deep therapy techniques or in the use of particle accelerators to treat humans; and

(c) The individual designated on the application as the user must be a physician.

11.5. Radiation Safety Requirements for the use of Particle Accelerator

11.5.1. General Provisions

(a) This subsection establishes radiation safety requirements for the use of particle accelerators which are in addition to, and not in substitution for, other applicable provisions of these regulations.

(b) The registrant shall be responsible for assuring that all requirements of this section are met.

11.5.2. Limitations

(a) No registrant shall permit any person to act as a particle accelerator operator until such person:

(1) Has been instructed in radiation safety and shall have demonstrated an understanding thereof;

(2) Has received copies of and instruction in this part and the applicable requirements of Section 6, pertinent registration conditions and the registrants' operating and emergency procedures, and

(3) Has demonstrated competence to use the particle accelerator, related equipment, and survey instruments which will be employed in his assignment.

(b) Either the radiation safety committee or the radiation safety officer shall have the authority to terminate the operations at a particle accelerator facility if such action is deemed necessary to protect health and minimize danger to public health and safety or property.

11.5.3. Shielding and Safety Design Requirements

(a) A qualified expert specifically accepted by the agency shall be

consulted in the design of the particle accelerator installation and called upon to perform a radiation survey when the accelerator is first capable of producing radiation.

(b) Each particle accelerator installation shall be provided with such primary and/or secondary barriers as are necessary to assure compliance with 6.2 and 6.3.

11.5.4. Particle Accelerator Controls and Interlock Systems

(a) Instrumentation, readouts, and controls on the particle accelerator control console shall be clearly identified and easily discernible.

(b) All entrances into a target room or other high radiation area shall be provided with interlocks that shut down the machine under conditions of barrier penetration.

(c) When an interlock system has been tripped, it shall only be possible to resume operation of the accelerator by manually resetting controls at the position where the interlock has been tripped, and lastly at the main control console.

(d) Each safety interlock shall be on a circuit which shall allow its operation independently of all other safety interlocks.

(e) All safety interlocks shall be fail safe, i.e., designed so that any defect or component failure in the interlock system prevents operation of the accelerator.

(f) A scram button or other emergency power cutoff switch shall be located and easily identifiable in all high radiation areas. Such a cutoff switch shall include a manual reset so that the accelerator cannot be restarted from the accelerator control console without resetting the cutoff switch.

11.5.5. Warning Devices

(a) All locations designated as high radiation areas, and entrances to such locations shall be equipped with easily observable flashing or rotating warning lights that operate when, and only when, radiation is being produced.

(b) Except in facilities designed for human exposure, each high radiation area shall have an audible warning device which shall be activated for 15 seconds prior to the possible creation of such high radiation area. Such warning device shall be clearly discernible in all high radiation areas and all radiation areas.

(c) Barriers, temporary or otherwise, and pathways leading to high radiation areas shall be identified in accordance with 6.6.

11.5.6. Operating Procedures

(a) Particle accelerators, when not in use, shall be secured to prevent unauthorized use.

(b) Only a switch on the accelerator control console shall be routinely used to turn the accelerator beam on and off. The safety interlock system shall not be used to turn off the accelerator beam except in an emergency.

(c) All safety and warning devices, including interlocks, shall be checked for proper operability at intervals not to exceed three months. Results of such tests shall be maintained for inspection by the agency at the accelerator facility.

(d) Electrical circuit diagrams of the accelerator, and the associated interlock systems, shall be kept current and maintained for inspection by

the agency and available to the operator at each accelerator facility.

(e) If, for any reason, it is necessary to intentionally bypass a safety interlock or interlocks, such action shall be:

(1) Authorized by the radiation safety committee and/or the radiation safety officer;

(2) Recorded in a permanent log and a notice posted at the accelerator control console; and

(3) Terminated as soon as possible.

(f) A copy of the current operating and emergency procedures shall be maintained at the accelerator control panel.

11.5.7. Radiation Monitoring Requirements

(a) There shall be available at each particle accelerator facility, appropriate portable monitoring equipment which is operable and has been calibrated for the appropriate radiations being produced at the facility. Such equipment shall be tested for proper operation daily and calibrated at intervals not to exceed one year, and after servicing and repair.

(b) A radiation protection survey shall be performed and documented by a qualified expert specifically approved by the agency when changes have been made in shielding, operation, equipment, or occupancy of adjacent areas.

(c) Radiation levels in all high radiation areas shall be continuously monitored. The monitoring devices shall be electrically independent of the accelerator control and interlock systems and capable of providing a remote and local readout with visual and/or audible alarms at both the control panel and at the entrance to high radiation areas, and other appropriate

locations so that people entering or present become aware of the existence of the hazard.

(d) All area monitors shall be calibrated quarterly.

(e) Whenever applicable, periodic surveys shall be made to determine the amount of airborne particulate radioactivity present in areas of airborne hazards.

(f) Whenever applicable, periodic smear surveys shall be made to determine the degree of contamination in target and other pertinent areas.

(g) All area surveys shall be made in accordance with the written procedures established by a qualified expert or the radiation safety officer of the particle accelerator facility.

(h) Records of all radiation protection surveys, calibration results, instrumentation tests, and smear results shall be kept current and on file at each accelerator facility.

11.5.8. Ventilation Systems

(a) Adequate ventilation shall be provided in areas where airborne radioactivity may be produced.

(b) A registrant, as required by 6.3.3, shall not vent, release or otherwise discharge airborne radioactive material to an unrestricted area which exceeds the limits in Section 12, Appendix A, Table II, except as authorized pursuant to 6.9.2 or 6.3.3(b). For purposes of this paragraph, concentrations may be averaged over a period not greater than one year. Every reasonable effort should be made to maintain releases of radioactive material to unrestricted areas as far below these limits as practicable.

SECTION 12

APPENDIX

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Actinium (89)	Ac 227	S	$2x10^{-12}$	$6x10^{-5}$	$8x10^{-14}$	$2x10^{-6}$
		I	$3x10^{-11}$	$9x10^{-3}$	$9x10^{-13}$	$3x10^{-4}$
	Ac 228	S	$8x10^{-8}$	$3x10^{-3}$	$3x10^{-9}$	$9x10^{-5}$
		I	$2x10^{-8}$	$3x10^{-3}$	$6x10^{-10}$	$9x10^{-5}$
Americium (95)	Am 241	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$2x10^{-5}$
	Am 242, m	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$3x10^{-10}$	$3x10^{-3}$	$9x10^{-12}$	$9x10^{-5}$
	Am 242	S	$4x10^{-8}$	$4x10^{-3}$	$1x10^{-9}$	$1x10^{-4}$
		I	$5x10^{-8}$	$4x10^{-3}$	$2x10^{-9}$	$1x10^{-4}$
	Am 243	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	Am 244	S	$4x10^{-6}$	$1x10^{-1}$	$1x10^{-7}$	$5x10^{-3}$
		I	$2x10^{-5}$	$1x10^{-1}$	$8x10^{-7}$	$5x10^{-3}$
Antimony (51)	Sb 122	S	$2x10^{-7}$	$8x10^{-4}$	$6x10^{-9}$	$3x10^{-5}$
		I	$1x10^{-7}$	$8x10^{-4}$	$5x10^{-9}$	$3x10^{-5}$
	Sb 124	S	$2x10^{-7}$	$7x10^{-4}$	$5x10^{-9}$	$2x10^{-5}$
		I	$2x10^{-8}$	$7x10^{-4}$	$7x10^{-10}$	$2x10^{-5}$
	Sb 124	S	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$3x10^{-8}$	$3x10^{-3}$	$9x10^{-10}$	$1x10^{-4}$
Argon (18)	A 37	Sub[2]	$6x10^{-3}$		$1x10^{-4}$	
	A 41	Sub	$2x10^{-6}$		$4x10^{-8}$	
Arsenic (33)	As 73	S	$2x10^{-6}$	$1x10^{-2}$	$7x10^{-8}$	$5x10^{-4}$
		I	$4x10^{-7}$	$1x10^{-2}$	$1x10^{-8}$	$5x10^{-4}$
	As 74	S	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$5x10^{-5}$
		I	$1x10^{-7}$	$2x10^{-3}$	$4x10^{-9}$	$5x10^{-5}$
	As 76	S	$1x10^{-7}$	$6x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
		I	$1x10^{-7}$	$6x10^{-4}$	$3x10^{-9}$	$2x10^{-5}$
	As 77	S	$5x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$8x10^{-5}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$8x10^{-5}$
Astatine (85)	At 211	S	$7x10^{-9}$	$5x10^{-5}$	$2x10^{-10}$	$2x10^{-6}$
		I	$3x10^{-8}$	$2x10^{-3}$	$1x10^{-9}$	$7x10^{-5}$
Barium (56)	Ba 131	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$4x10^{-7}$	$5x10^{-3}$	$1x10^{-8}$	$2x10^{-4}$
	Ba 140	S	$1x10^{-7}$	$8x10^{-4}$	$4x10^{-9}$	$3x10^{-5}$
		I	$4x10^{-8}$	$7x10^{-4}$	$1x10^{-9}$	$2x10^{-5}$
Berkelium (97)	Bk 249	S	$9x10^{-10}$	$2x10^{-2}$	$3x10^{-11}$	$6x10^{-4}$
		I	$1x10^{-7}$	$2x10^{-2}$	$4x10^{-9}$	$6x10^{-4}$
	Bk 250	S	$1x10^{-7}$	$6x10^{-3}$	$5x10^{-9}$	$2x10^{-4}$
		I	$1x10^{-6}$	$6x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
Beryllium (4)	Be 7	S	$6x10^{-6}$	$5x10^{-2}$	$2x10^{-7}$	$2x10^{-3}$
		I	$1x10^{-6}$	$5x10^{-2}$	$4x10^{-8}$	$2x10^{-3}$
Bismuth (83)	Bi 206	S	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
		I	$1x10^{-7}$	$1x10^{-3}$	$5x10^{-9}$	$4x10^{-5}$
	Bi 207	S	$2x10^{-7}$	$2x10^{-3}$	$6x10^{-9}$	$6x10^{-5}$
		I	$1x10^{-8}$	$2x10^{-3}$	$5x10^{-10}$	$6x10^{-5}$
	Bi 210	S	$6x10^{-9}$	$1x10^{-3}$	$2x10^{-10}$	$4x10^{-5}$
		I	$6x10^{-9}$	$1x10^{-3}$	$2x10^{-10}$	$4x10^{-5}$
	Bi 212	S	$1x10^{-7}$	$1x10^{-2}$	$3x10^{-9}$	$4x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-2}$	$7x10^{-9}$	$4x10^{-4}$
Bromine (35)	Br 82	S	$1x10^{-6}$	$8x10^{-3}$	$4x10^{-8}$	$3x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
Cadmium (48)	Cd 109	S	$5x10^{-8}$	$5x10^{-3}$	$2x10^{-9}$	$2x10^{-4}$
		I	$7x10^{-8}$	$5x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
	Cd 115 m	S	$4x10^{-8}$	$7x10^{-4}$	$1x10^{-9}$	$3x10^{-5}$
		I	$4x10^{-8}$	$7x10^{-4}$	$1x10^{-9}$	$3x10^{-5}$
	Cd 115	S	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$3x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	S	2×10^{-11}	7×10^{-4}	7×10^{-13}	2×10^{-5}
		I	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}		1×10^{-6}	
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-6}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134 m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58 M	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	3×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254 m	S	5×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152 (T/2=9.2 hrs.)	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152 (T/2=13 yrs.)	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm 254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-6}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]			Table I		Table II	
				Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Holmium (67)	Ho	166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H	3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			Sub	2×10^{-3}		4×10^{-5}	
Indium (49)	In	113 m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
			I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In	114 m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	2×10^{-6}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In	115 m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In	115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
			I	3×10^{-6}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I	125	S	5×10^{-9}	4×10^{-5}	8×10^{-11}	2×10^{-7}
			I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I	126	S	8×10^{-9}	5×10^{-5}	9×10^{-11}	3×10^{-7}
			I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I	129	S	2×10^{-9}	1×10^{-5}	2×10^{-11}	6×10^{-8}
			I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I	131	S	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I	132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I	133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I	134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-5}
			I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I	135	S	1×10^{-7}	7×10^{-4}	1×10^{-9}	4×10^{-6}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir	190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir	192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
			I	3×10^{-6}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir	194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe	55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
			I	1×10^{-6}	7×10^{-2}	3×10^{-8}	2×10^{-3}
	Fe	59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	5×10^{-6}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr	85 m	Sub	6×10^{-6}	.....	1×10^{-7}	.....
	Kr	85	Sub	1×10^{-5}	.....	3×10^{-7}	.....
	Kr	87	Sub	1×10^{-6}	.....	2×10^{-8}	.....
	Kr	88	Sub	1×10^{-6}	.....	2×10^{-8}	.....
Lanthanum (57)	La	140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
			I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb	203	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb	210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
			I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb	212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
			I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu	177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn	52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn	54	S	4×10^{-7}	4×10^{-3}	1×10^{-9}	1×10^{-4}
			I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn	56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}

See footnotes at end of table

APPENDIX A
CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND
(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Mercury (80)	Hg 197 m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np 237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np 239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni 59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
		I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni 63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni 65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb 93 m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb 95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb 97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os 185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os 191 m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os 191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os 193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd 103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
		I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd 109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P 32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt 191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt 193 m	S	7×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Pt 197 m	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
		I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
	Pt 197	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Plutonium (94)	Pu 238	S	2×10^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
		I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
		I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Pu 242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu 243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu 244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K 42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa 230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
		I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa 231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}
	Ra 228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
		I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}		1×10^{-8}	
		I				
	Rn 222	S	1×10^{-7}		3×10^{-9}	
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-2}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103 m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]		Table I		Table II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110 m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85 m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc 96 m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97 m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99 m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125 m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127 m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]			Table I		Table II	
				Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Te	129 m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
			I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te	129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
			I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te	131 m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te	132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb	160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl	200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl	201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl	202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl	204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	Th	228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
			I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th	230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
			I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	Th	232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
			I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	Th	natural	S	3×10^{-11}	3×10^{-5}	1×10^{-12}	1×10^{-6}
			I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
	Th	234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm	170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
			I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm	171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
			I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn	113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn	125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W	181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W	185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	W	187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U	230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
			I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U	232	S	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
			I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U	233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	234	S	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	235	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U	236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
			I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U	238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
			I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U	240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}

See footnotes at end of table

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of appendix)

Element (atomic number)	Isotope[1]			Table I		Table II	
				Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	U	natural	S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
			I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V	48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
			I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe	131 m	Sub	2×10^{-5}		4×10^{-7}	
	Xe	133 m	Sub	1×10^{-5}		3×10^{-7}	
	Xe	133	Sub	1×10^{-6}		3×10^{-7}	
	Xe	135	Sub	4×10^{-6}		1×10^{-7}	
Ytterbium (70)	Yb	175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y	90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
			I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y	91 m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
			I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y	91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
			I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y	92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y	93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)	Zn	65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
			I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn	69 m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn	69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
			I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr	93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr	95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
			I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr	97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours			Sub	1×10^{-6}		3×10^{-8}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours				3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.				6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

See footnotes at end of table

[1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in a semi-spherical infinite cloud of airborne material.

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 Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should 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 Appendix "A" 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_a, C_b, and C_c, and if the applicable MPC's are MPC_a, and MPC_b, and MPC_c respectively, then the concentrations shall be limited so that the following relationship exists:

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

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix "A" shall be:

a. For purposes of Table I, Col. 1 ..... 6×10^{-13}
b. For purposes of Table I, Col. 2 ..... 4×10^{-7}
c. For purposes of Table II, Col. 1 ..... 2×10^{-14}
d. For purposes of Table II, Col. 2 ..... 3×10^{-8}

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 Appendix "A" 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 Appendix "A" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "A" for any radionuclide which is not known to be absent from the mixture; or,

c. Element (atomic number, and isotope	Table I		Table II	
	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, Table II only), Pb 210, Po 210, at 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	.....	9×10^{-5}	.....	3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, Table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	.....	6×10^{-5}	.....	2×10^{-6}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, Table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present	.....	2×10^{-5}	.....	6×10^{-7}
If it is known that (I 129, Table II only), Ra 226, and Ra 228 are not present	.....	3×10^{-6}	.....	1×10^{-7}
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	3×10^{-9}	..	1×10^{-10}	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}	.....	1×10^{-11}	.....

Element (atomic number and isotope	Table I		Table II	
	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
If it is known that alpha-emitters and Ac 227 are not present	$3x10^{-11}$	-------	$1x10^{-12}$	-------
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249, and Cf 251 are not present	$3x10^{-12}$	. .	$1x10^{-13}$	. .....

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 Table I, Column 1, $1x10^{-10}$ uc/ml gross alpha activity; or $2.5x10^{-11}$ uc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Column 1, $3x10^{-12}$ uc/ml gross alpha activity; or $8x10^{-13}$ 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_a) to the concentration limit for that radionuclide specified in Table II of Appendix "A" (MPC_a) does not exceed 1/10, (i.e., $\frac{C_a}{MPC_a} \leqq \frac{1}{10}$) and (b) the sum of such ratios for all radionuclides considered as not present in the mixture does not exceed ¼, (i.e., $\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \ldots \leqq ¼$).

APPENDIX B

Material	Microcuries
Americium-241 (Am)	0.01
Antimony-122 (Sb)	100
Antimony-124 (Sb)	10
Antimony-125 (Sb)	10
Arsenic-73 (As)	100
Arsenic-74 (As)	10
Arsenic-76 (As)	10
Arsenic-77 (As)	100
Barium-131 (Ba)	10
Barium-133 (Ba)	10
Barium-140 (Ba)	10
Bismuth-210 (Bi)	1
Bromine-82 (Br)	10
Cadmium-109 (Cd)	10
Cadmium-115m (Cd)	10
Cadmium-115 (Cd)	100
Calcium-45 (Ca)	10
Calcium-47 (Ca)	10
Carbon-14 (C)	100
Cerium-141 (Ce)	100
Cerium-143 (Ce)	100
Cerium-144 (Ce)	1
Cesium-131 (Cs)	1,000
Cesium-134m (Cs)	100
Cesium-134 (Cs)	1
Cesium-135 (Cs)	10
Cesium-136 (Cs)	10
Cesium-137 (Cs)	10
Chlorine-36 (Cl)	10
Chlorine-38 (Cl)	10
Chromium-51 (Cr)	1,000
Cobalt-58m (Co)	10
Cobalt 58 (Co)	10
Cobalt-60 (Co)	1
Copper-64 (Cu)	100
Dysprosium-165 (Dy)	10
Dysprosium-166 (Dy)	100
Erbium-169 (Er)	100
Erbium-171 (Er)	100
Europium-152 (9.2 h) (Eu)	100
Europium-152 (13 yr) (Eu)	1
Europium-154 (Eu)	1
Europium-155 (Eu)	10
Fluorine-18 (F)	1,000

Material	Microcuries
Gadolinium-153 (Gd)	10
Gadolinium-159 (Gd)	100
Gallium-72 (Ga)	10
Germanium-71 (Ge)	100
Gold-198 (Au)	100
Gold-199 (Au)	100
Hafnium-181 (Hf)	10
Holmium-166 (Ho)	100
Hydrogen-3 (h)	1,000
Indium-113m (In)	100
Indium-114m (In)	10
Indium-115m (In)	100
Indium-115 (In)	10
Iodine-125 (I)	1
Iodine-126 (I)	1
Iodine-129 (I)	0.1
Iodine-131 (I)	1
Iodine-132 (I)	10
Iodine-133 (I)	1
Iodine-134 (I)	10
Iodine-135 (I)	10
Iridium-192 (Ir)	10
Iridium-194 (Ir)	100
Iron-55 (Fe)	100
Iron-59 (Fe)	10
Krypton-85 (Kr)	100
Krypton-87 (Kr)	10
Lanthanum-140 (La)	10
Lutetium-177 (Lu)	100
Manganese-52 (Mn)	10
Manganese-54 (Mn)	10
Manganese-56 (Mn)	10
Mercury-197m (Hg)	100
Mercury-197 (Hg)	100
Mercury-203 (Hg)	10
Molybdenum-99 (Mo)	100
Neodymium-147 (Nd)	100
Neodymium-149 (Nd)	100
Nickel-59 (Ni)	100
Nickel-63 (Ni)	10
Nickel-65 (Ni)	100
Niobium-93m (Nb)	10
Niobium-95 (Nb)	10
Niobium-97 (Nb)	10
Osmium-185 (Os)	10

Material	Microcuries
Osmium-191m (Os)	100
Osmium-191 (Os)	100
Osmium-193 (Os)	100
Palladium-103 (Pd)	100
Palladium-109 (Pd)	100
Phosphorus-32 (P)	10
Platinum-191 (Pt)	100
Platinum-193m (Pt)	100
Platinum-193 (Pt)	100
Platinum-197m (Pt)	100
Platinum-197 (Pt)	100
Plutonium-239 (Pu)	0.01
Polonium-210 (Po)	0.1
Potassium-42 (K)	10
Praseodymium-142 (Pr)	100
Praseodymium-143 (Pr)	100
Promethium-147 (Pm)	10
Promethium-149 (Pm)	10
Radium-226 (Ra)	0.01
Rhenium-186 (Re)	100
Rhenium-188 (Re)	100
Rhodium-103m (Rh)	100
Rhodium-105 (Rh)	100
Rubidium-86 (Rb)	10
Rubidium-87 (Rb)	10
Ruthenium-97 (Ru)	100
Ruthenium-103 (Ru)	10
Ruthenium-105 (Ru)	10
Ruthenium-106 (Ru)	1
Samarium-151 (Sm)	10
Samarium-153 (Sm)	100
Scandium-46 (Sc)	10
Scandium-47 (Sc)	100
Scandium-48 (Sc)	10
Selenium-75 (Se)	10
Silicon-31 (Si)	100
Silver-105 (Ag)	10
Silver-110m (Ag)	1
Silver-111 (Ag)	100
Sodium-24 (Na)	10
Strontium-85 (Sr)	10
Strontium-89 (Sr)	1
Strontium-90 (Sr)	0.1
Strontium-91 (Sr)	10
Strontium-92 (Sr)	10

Material	Microcuries
Sulphur-35 (S)	100
Tantalum-182 (Ta)	10
Technetium-96 (Tc)	10
Technetium-97m (Tc)	100
Technetium-97 (Tc)	100
Technetium-99m (Tc)	100
Technetium-99 (Tc)	10
Tellurium-125m (Te)	10
Tellurium-127m (Te)	10
Tellurium-127 (Te)	100
Tellurium-129m (Te)	10
Tellurium-129 (Te)	100
Tellurium-131m (Te)	10
Tellurium-132 (Te)	10
Terbium-160 (Tb)	10
Thallium-200 (Tl)	100
Thallium-201 (Tl)	100
Thallium-202 (Tl)	100
Thallium-204 (Tl)	10
Thorium (natural) (Th)[1]	100
Thulium-170 (Tm)	10
Thulium-171 (Tm)	10
Tin-113 (Sn)	10
Tin-125 (Sn)	10
Tungsten-181 (W)	10
Tungsten-185 (W)	10
Tungsten-187 (W)	100
Uranium (natural) (U)[2]	100
Uranium-233 (U)	0.01
Uranium-234 (U)	
Uranium-235 (U)	0.01
Vanadium-48 (V)	10
Xenon-131m (Xe)	1,000
Xenon-133 (Xe)	100
Xenon-135 (Xe)	100
Ytterbium-175 (Yb)	100
Yttrium-90 (Y)	10
Yttrium-91 (Y)	10
Yttrium-92 (Y)	100
Yttrium-93 (Y)	100
Zinc-65 (Zn)	10
Zinc-69m (Zn)	100
Zinc-69 (Zn)	1,000
Zirconium-93 (Zr)	10

Material	Microcuries
Zirconium-95 (Zr)	10
Zirconium-97 (Zr)	10
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.01
Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition	0.1

NOTE: For purposes of 6.6, 6.9.3 and 6.9.4 where there is involved a combination of isotopes in known amounts, the limit for the combination should 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"). Example: For purposes of 6.9.4, if a particular batch contains 20,000 µCi of Au-198 and 50,000 µCi of C-14, it may also include not more than 300 µCi of I-131. This limit was determined as follows:

20,000 µCi Au-198/100,000 µCi + 50,000 µCi C-14/100,000 µCi
+ 300 µCi I-131/1,000 µCi = 1

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in 6.9.4.

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[1]Based on alpha disintegration rate of Th-232, Th-230 and their daughter products

[2]Based on alpha disintegration rate of U-238, U-234, and U-235.

APPENDIX C

Radioactive Material	Column I Not as a Sealed Source (microcuries)	Column II As a Sealed Source (microcuries)
Rhodium 105 (Rh 105)	10	10
Rubidium 86 (Rb 86)	10	10
Ruthenium 106—Rhodium 106 (RuRh 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
Strontium 89 (Sr 89)	1	10
Strontium 90—Yttrium 90 (SrY)	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 radioactive material not listed above	1	10

PART 9.0

APPENDIX C

Radioactive Material	Column I Not as a Sealed Source (microcuries)	Column II As a Sealed Source (microcuries)
Antimony (Sb 124)	1	10
Arsenic 76 (As 76)	10	10
Arsenic 77 (As 77)	10	10
Barium 140—Lanthanum 140 (BaLa 140)	1	10
Beryllium (Be 7)	50	50
Cadmium 109—Silver 109 (CdAg 109)	10	10
Calcium 45 (Ca 45)	10	10
Carbon 14 (C 14)	50	50
Cerium 144—Praseodymium (CePr 144)	1	10
Cesium—Barium 137 (CsBa 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 (PdRh 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
Rhenium 186 (Re 186)	10	10
Radium 226 (Ra 226)	0.1	1

APPENDIX D

EXPOSURE FORM INFORMATION

Form RH-14 Occupational External Radiation Exposure History and Instructions

Form RH-15 Current Occupational External Radiation Exposure and Instructions

RH-14

WEST VIRGINIA DEPARTMENT OF HEALTH

OCCUPATIONAL EXTERNAL RADIATION EXPOSURE HISTORY

See Instructions on following page

IDENTIFICATION

1. NAME (Print-Last, First and Middle)

2. SOCIAL SECURITY NO.

3. DATE OF BIRTH (Month, Day, Year)

4. AGE IN FULL YEARS(N)

OCCUPATIONAL EXPOSURE-PREVIOUS HISTORY

5. PREVIOUS EMPLOYMENTS INVOLVING RADIATION EXPOSURE--LIST NAME AND ADDRESS OF EMPLOYER	6. DATES OF EMPLOYMENT (From-to)	7. PERIODS OF EXPOSURE	PREVIOUS DOSE HISTORY	
			8. WHOLE BODY (REM)	9. RECORD OR CALCULATED (INSERT ONE)

10. REMARKS	11. ACCUMULATED OCCUPATIONAL DOSE--TOTAL	

13. CALCULATIONS-PERMISSIBLE DOSE

WHOLE BODY:

(A) PERMISSIBLE ACCUMULATED DOSE 5(N-18) = _____ = REM

(B) TOTAL EXPOSURE TO DATE (FROM ITEM 11) = _____ REM

(C) UNUSED PART OF PERMISSIBLE ACCUMULATED DOSE (A-B) = _____ REM

12. CERTIFICATION: I CERTIFY THAT THE EXPOSURE HISTORY LISTED IN COLUMNS 5, 6, AND 7 IS CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

EMPLOYEE'S SIGNATURE DATE

14. NAME OF LICENSEE

IN File 31

INSTRUCTIONS FOR PREPARATION OF FORM RH-14

This form or a clear and legible record containing all the information required on this form must be prepared by each or registrant of the West Virginia department of health who, pursuant to 6.2.1 and 6.2.2, proposes to expose an individual to a radiation dose in excess of the amounts specified in 6.2.1 of the regulations in Section 6, "Radiation Protection Standards." The requirement for completion of this form is contained in 6.2.3 of that regulation. The information contained in this form is used for estimating the external separation Form RH-14 shall be completed for each individual to be exposed to a radiation dose in excess of the limits specified in 6.2.1 of Section 6 of the West Virginia department of health regulations.

Listed below by item are instructions and additional information directly pertinent to completing this form:

Identification

Item 1. Self-explanatory

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory

Item 4. Enter the age in full years. This is call "N" when used in calculating the Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

Occupational Exposure

Item 5. List the name and address of each previous employer and the address of employment. Start with the most recent employer and work back. Include only those period of employment since the eighteenth birthday involving occupa-

tional exposure to radiation. For periods of self-employment, insert the work "self-employed."

Item 6. Give the dates of employment.

Item 7. List periods during which occupational exposure to radiation occurred.

Item 8. List the dose recorded for each period of exposure from records of previous occupational exposure of the individual as calculated under 6.2.3. Dose is to be given in rem. "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.

Item 9. After each entry in Item 8 indicate in Item 9 whether dose is obtained from records or calculated in accordance with 6.2.3.

Item 10. Self-explanatory.

Total Accumulated Occupations Dose (Whole Body)

Item 11. The total for the whole body is obtained by summation of all values in Item 8.

Certification

Item 12. Upon completion of the report, the employee must certify that the information in Column 5, 6, and 7 is accurate and complete to the best of his knowledge. The date is the date of his signature.

Calculations

Item 13. The lifetime accumulated occupational dose for each individual and the permissible dose under 6.2.2 are obtained by carrying out the following steps: The value for N should

be taken from Item 4. Subtract 18 from N and multiply the difference by 5 rem. (For example, John Smith, age 32; N=32, PAD=5 (32-18)=70 rem.) Enter total exposure to date from Item 11. Subtract (b) from (a) and enter the difference under (c). The value in (c) represents the unused part of the permissible accumulated dose. This value for permissible dose is to be carried forward to Form RH-15, "Current Occupational External Radiation Exposure (Whole Body)."

Item 14. Self-explanatory.

RH-15

CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

See Instructions on following page

IDENTIFICATION

1. NAME (Print-Last, first and middle)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (Month, day, year)	4. NAME OF LICENSEE/REGISTRANT

OCCUPATIONAL EXPOSURE

5. Dose Recorded for (Specify Whole body; skin of whole body; or hands and forearms, feet and ankles.)	6. Whole Body Dose Status (rem)	7. Method of Monitoring (e.g., Film Badge-FB; Pocket Chamber-PC; Calculations-Calc.) X or Gamma _____ Beta _____ Neutrons _____

8. Period of Exposure (From-to)	DOSE FOR THE PERIOD (rem)				13. Running total for Calendar Quarter (rem)
	9. X or Gamma	10. Beta	11. Neutron	12. Total	

LIFETIME ACCUMULATED DOSE

14. Previous Total (rem)	15. Total Quarterly Dose Date Rem	16. Total Accumulated Dose (rem)	17. Perm. Acc. Dose 5 (N-18) (rem)	18. Unused Part of Permissible Accumulated Dose (rem)

INSTRUCTIONS FOR PREPARATION OF FORM RH-15

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form is required pursuant to 6.12 of "Radiation Protection Standards," as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under 6.5. Note that a separate Form RH-15 is to be used for recording external exposure to (1) the whole body; (2) skin of whole body; (3) hands and forearms; or (4) feet and ankles, as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form:

Identification

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory.

Item 4. Self-explanatory.

Occupational Exposure

Item 5. "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. Unless the lenses of the eyes are protected with eye shields, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 300 mg/cm^2 or less. When the lenses of the eyes are protected with eye shields having a tissue equivalent thick-

ness of at least 700 mg/cm^2, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 1,000 mg/cm^2 or less.

Dose recorded as dose to the skin of the whole body, hands and forearms, or feet and ankles should include the dose delivered through a tissue equivalent absorber having a thickness of 7 mg/cm^2 or less. The dose to the skin of the body, hands and forearms, or feet and ankles should be recorded on separate forms unless the dose to thse parts of the body has been included as dose to the whole body on a form maintained for recording whole body exposure.

Item 6. This item need be completed only when the sheet is used to record whole body exposures and the licensee or registrant is exposing the individual under the provisions of 6.2.2 which allows up to 3 rems per quarter to the whole body. Enter in this item the unused part of permissible accumulated dose taken from previous records of exposure, i.e., Item 18 of the preceding Form RH-15 or Item 13 of Form RH-14 if the individual's exposure during employment with the licensee or registrant begins with this record.

Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.

Item 8. Doses received over a period of less than a calendar quarter need not be separately entered on the form provided that the licensee or registrant maintains a current

record of the doses received by the individual which have not as yet been entered on the form. The period of exposure should have not as yet been entered on the form. The period of exposure should specify the day the measurement of that exposure was initiated and the day on which it was terminated. For example, if only quarterly doses are entered, the period of expousre for the first calendar quarter of 1962 might be taken as running from Monday, January 1, 1962, through Friday, March 30, 1962, and would be indicated in this item as Jan. 1, 1962-Mar. 30, 1962. If weekly doses are entered, a film badge issued Monday morning, January 1, 1962, and picked up Friday, January 5, 1962, would be indicated as Jan. 1, 1962-Jan. 5, 1962.

Items 9, 10 and 11. Self-explanatory. The values are to be given in rem. All measurements are to be interpreted in the best method known and in accordance with 3.32. Where calculations are made to determine dose, a copy of such calculations is to be maintained in conjunction with this record. In any case where the dose for a calendar quarter is less than 10% of the value specified in 6.2.1, the phrase "less than 10% may be entered in lieu of a numberical value

Item 12. Add the values under Items 9, 10 and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10% may be disregarded.

Item 13. The running total is to be maintained on the basis of calendar quarters. 3.6 defines calendar quarter. No entry

need be made in this item if only calendar quarter radiation doses are recorded in Items 9, 10, 11, and 12.

Lifetime Accumulated Dose (Whole Body)

Note: If the licensee or registrant chooses to keep the individual's exposure below that permitted in 6.2.1, Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 (or in Item 12 if quarterly doses are entered in Item 12) should not exceed 1 1/4 rem.

If an individual is exposed under the provisions of 6.2.2, complete Items 14 through 18 at the end of each calendar quarter and when the sheet is filled. Values in Item 13, when in the middle of a calendar quarter, and values in Item 18, must be brought forward to next sheet for each individual.

Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., from Item 16 of Form RH-15 or Item 11 of Form RH-14). The total occupational radiation dose received by the individual must be entered in this item, including any occupational dose received from sources of radiation not licensed or registered by the West Virginia department of health during any calendar quarter after completing Form RH-14 and personnel monitoring equipment was not worn by the individual, it should be assumed that the individual received a dose of 1 1/4 rems during each such calendar quarter.

Item 15. Enter the total calendar quarter dose from Item 13 (or from Item 12 if quarterly doses are entered in Item 12) and the date designating the end of the calendar quarter in which

the dose was received (e.g., March 30, 1962.)

Item 16. Add Item 14 and Item 15 and enter that sum.

Item 17. Obtain the Permissible Accumulated Dose (PAD) in rem for the WHOLE BODY, "N" is equal to the number of years of age of the individual on his last birthday. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, age 32; N=32, PAD=5(32-18)=70 rem).

Item 18. Determine the unused part of the PAD by subtracting Item 16 from 17. The unused part of the PAD is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.