TITLE 10 - ATOMIC ENERGY
Chapter 1 - Atomic Energy Commission

PART 20 - STANDARDS FOR PROTECTION AGAINST RADIATION

In July 1955 the Commission issued for public comment a proposed regulation to establish general standards for protection of licensees, their employees, and the public against radiation hazards arising out of the possession or use of special nuclear, source, or byproduct material under license issued by AEC. In preparing the effective regulation published below, the Commission has had the benefit of numerous comments and suggestions received since publication of the proposed rules. A number of changes suggested by those comments have been incorporated in the following regulation.

The regulation establishes standards which must be followed in handling radioactive materials which are subject to the licensing authority of the Commission and provides procedures whereby deviations from such standards may be authorized on a case-to-case basis. The regulation prescribes limits which govern exposure of personnel to radiation and concentrations of radioactive material, concentrations of radioactive material which may be discharged into air and water, and disposal of radioactive wastes. It also establishes certain precautionary procedures and administrative controls.

The standards established by this regulation will be found to agree substantially with those published by the National Committee on Radiation Protection in N.B.S. Handbook 52 "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water", and N.B.S. Handbook 59 "Permissible Dose from External Sources of Ionizing Radiation." The National Committee on Radiation Protection has under review recommendations to limit cumulative exposures over periods of years. The Commission is giving consideration to appropriate amendments to its regulations to deal with this cumulative exposure problem.

Limitations upon levels of radiation and concentrations of radioactive material in areas affected by

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but not controlled by the licensee are contained principally in Section 20.102 ("Permissible Levels of Radiation in Unrestricted Areas) 20.103 ("Concentrations in Effluents to Unrestricted Areas"), and the sections on waste disposal. The sections are designed to assure that individuals in unrestricted areas do not receive exposure in excess of 10% of the limits established for persons exposed in restricted areas. For this purpose, the sections limit levels of radiation and concentrations of radioactive material that may be created in unrestricted areas by licensees without special authorization from the AEC, to extremely low levels. These levels are believed to be sufficiently low to assure that there is no reasonable probability of individuals in unrestricted areas receiving exposures in excess of 10% of the permissible levels for restricted areas. Procedures are incorporated in those sections, however, with which the Commission may authorize licensees in special cases to create higher levels in unrestricted areas when the circumstances of the particular case are such as to permit reasonable assurance that individuals in the unrestricted areas will not receive exposures in excess of 10% of the limitation established for restricted areas.

It is believed that the standards incorporated in these regulations provide, in accordance with present knowledge a very substantial margin of safety for exposed individuals. It is believed also that the standards are practical from the standpoint of licensees. It should be emphasized that the standards are subject to change with the development of new knowledge, with significant increase in the average exposure of the whole population to radiation, and with other experience in the administration of the Commission's regulatory program.

Pursuant to the Administrative Procedures Act, Public Law th Congress, 2d Session, the following rules are published as a document subject to codification to be effective 30 days after publication in the Federal Register.

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GENERAL PROVISIONS

Sec.

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ENFORCEMENT

AUTHORITY: §§ 20.1 to 20.601 issued under 161(b), 68 Stat 948, 42USC2201.

GENERAL PROVISIONS

Section 20.1 Purpose

(a) The regulations in this Part establish standards for protection against radiation hazards arising out of activities under licenses issued by the Atomic Energy Commission and are issued pursuant to the Atomic Energy Act of 1954 (68 Stat. 919).

(b) The use of radioactive material or other sources of radiation not licensed by the Commission is not subject to the regulations in this Part. However, it is the purpose of these regulations to control the possession, use, and transfer of licensed material by any licensee in such a manner that exposure to such material and to radiation from such material, when added to exposures to unlicensed radioactive material and to other unlicensed sources of radiation in the possession of the licensee, and to radiation therefrom, does not exceed the standards of radiation protection prescribed in the regulations in this Part.

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Section 20.2 Scope

The regulations in this Part apply to all persons who receive, possess, use or transfer byproduct material, source material, or special nuclear material under a general or specific license issued by the Commission pursuant to the regulations in Part 30, 40, or 70 of this Chapter.

Section 20.3 Definitions

(a) As used in this Part,

(1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;

(2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;

(3) "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;

(4) "Commission" means the Atomic Energy Commission or its duly authorized representatives;

(5) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government;

(6) "Individual" means any human being;

(7) "Licensed material" means source material, special nuclear material, or byproduct material

received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this Chapter;

(8) "License" means a license issued under the regulations in Part 30, 40, or 70 of this Chapter. "Licensee" means the holder of such license;

(9) "Person" means (1) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission, any State, any foreign government or nation or any political subdivision of any such government or nations, or other entity; and (2) any legal successor, representative, agent, or agency of the foregoing;

(10) "Radiation" means any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light;

(11) "Radioactive material" includes any such material whether or not subject to licensing control by the Commission;

(12) "Restricted area" means any area access to which is controlled by the licensee. "Restricted area" shall not include any areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area;

(13) "Source material" means any material except special nuclear material, which contains by weight one-twentieth of one percent (0.05%) or more of (1) uranium, (2) thorium, or (3) any combination thereof;

(14) "Special nuclear material" means (1) plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission, pursuant to the provisions of section 51 of the act, determines to be special nuclear material, but does not include source material; or (2) any material artificially enriched by any of the foregoing but does not include source material;

(15) "Unrestricted area" means any area entry into which is not controlled by the licensee, and any area used for residential quarters.

(b) Definitions of certain other words and phrases as used in this Part are set forth in other sections, including:

(1) "Airborne radioactivity area" defined in section 20.203;

(2) "Radiation area" and "high radiation area" defined in section 20.202;

(3) "Personnel monitoring equipment" defined in section 20.202;

(4) "Survey" defined in section 20.201;

(5) Units of measurement of dose (rad, rem) defined in section 20.4;

(6) Units of measurement of radioactivity defined in section 20.5.

Section 20.4 Units of Radiation Dose

(a) "Dose," as used in this Part, is the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. When the regulations in this Part specify a dose during a period of time, the dose means the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of

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time. Several different units of dose are in current use. Definitions of units as used in this Part are set forth below.

(b) The rad, as used in this Part, is a measure of the dose of any ionizing radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) = 0.001 rad)

(c) The rem, as used in this Part, is a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen (r) of X-rays (One millirem (mrem) = 0.001 rem). The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For the purpose of the regulations in this Part, any of the following is considered to be equivalent to a dose of one rem:

(1) a dose of 1 r due to X- or gamma radiation;

(2) a dose of 1 rad due to X-, gamma, or beta radiation;

(3) a dose of 0.1 rad due to neutrons or high energy protons;

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

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

Neutron Energy	Number of Neutrons per Square Centimeter Equivalent to a Dose of one Rem
Thermal	960 x 10^6
0.0001 Mev	480 "
0.01 "	480 "
0.1 "	96 "
0.5 "	38 "
1 "	29 "
2 "	19 "
3 Mev and higher	14

Section 20.5 Units of Radioactivity

(a) Radioactivity is commonly, and for purposes of the regulations in this Part shall be, measured in terms of disintegrations per unit time or in curies. One curie (c) = 3.7 x 10^{10} disintegrations per second (dps) = 2.2 x 10^{12} disintegrations per minute (dpm). A commonly used submultiple of the curie is the microcurie (μc). One μc = 0.000001 c = 3.7 x 10^4 dps = 2.2 x 10^6 dpm.

NOTE: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing maximum permissible concentrations in air and water of these materials, as in Appendix "B" of this Part, the activity stated is that of the parent isotope. In some cases, the fact that daughter products may contribute to the total dose has been taken into account in the determination of the maximum permissible concentration of the parent isotopes. In the tables of Appendix "B" this is indicated by writing Ba^{140} + La^{140}, Sr^{90} + Y^{90}, Rn^{222} + dr, Ra^{226} + 1/2 dr, etc.

Example. In Column 1, Table I, Appendix "B" the maximum permissible concentration of Ba^{140} in air for occupational use is 2 + 10^{-7} μ c/ml. This is the maximum permissible concentration regardless of whether or not any

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of the La^{140} which may have resulted from the decay of the Ba^{140} is present or not. However, the value given for Ba^{140} is less than it would be if La^{140} were a stable isotope, not only because of the possibility of La^{140} in the air but principally because, if the Ba^{140} is inhaled, its radioactive decay in the body will result in the production of La^{140} in the body.

(b) Radon. Airborne radioactivity of radon and its decay products may be determined by measurement of the activity of one or more decay products on dust filtered from the air. For purposes of the regulations in this Part, the limit prescribed here will be considered to be met if the measured radioactivity of one or more decay products (for example, RaC') does not exceed that which would result from the occurrence, at the time of sampling, or 1×10^{-7} microcuries, per milliliter of air, of Rn^{222} and each of its short-lived decay products, RaA, RaB, RaC, and RaC'. For this purpose, due allowance shall be made for changes in the radioactivity of the measured decay products from time of sampling through the period of measurement.

(c) Natural uranium and natural thorium. Natural uranium and natural thorium occur as mixtures of isotopes of the respective elements. In the case of uranium or of thorium, the number of microcuries shall be determined by dividing the total rate, in dpm, of alpha emissions from the mixture by 2.2×10^6 dpm per μ c.

Section 20.6 Interpretations

Except as specifically authorized by the Commission in writing, no interpretation of the meaning of the regulations in this Part by any officer or employee of the Commission other than a written interpretation by the General Counsel will be recognized to be binding upon the Commission.

Section 20.7 Communications

All communications and reports concerning the regulations in this Part, and applications filed under

them, should be addressed to the Atomic Energy Commission, 1901 Constitution Avenue, N.W., Washington 25, D.C., Attention: Division of Civilian Application.

PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

Section 20.101 Exposure of Individuals in Restricted Areas

(a) Exposure to Radiation

(1) Except as provided in subparagraph (2), no licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual in a restricted area to receive in any period of seven consecutive days from radioactive material and other sources of radiation in the licensee's possession a dose in excess of the limits specified in Appendix "A" of this Part.

(2) A licensee may permit an individual in a restricted area to receive a dose in excess of the limits established in subparagraph (1), provided (i) that the dose during any period of 7 consecutive days does not exceed three times the limits specified in Appendix "A", and (ii) that the dose during any period of 13 consecutive weeks does not exceed 10 times the limits specified in Appendix "A".

(b) No licensee shall possess, use or transfer licensed material in such a manner as to cause any individual in a restricted area to be exposed to airborne radioactive material possessed by the licensee in an average concentration in excess of the limits specified in Appendix "B", Table I, of this Part.

The limits given in Appendix "B", Table I, are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period where the

number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c) Exposure of Minors

No licensee shall possess, use, or transfer licensed material in such a manner as to cause any individual under 18 years of age within a restricted area to receive in any period of seven consecutive days from radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10% of the limits specified in Appendix "A" of this Part, or to be exposed to airborne radioactive material possessed by the licensee in a concentration in excess of the limits specified in Appendix "B", Table II, of this Part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

Section 20.102 Permissible Levels of Radiation in Unrestricted Areas

(a) There may be included in any application for a license or for amendment of a license proposed limits upon levels of radiation in unrestricted areas resulting from the applicant's possession or use of radioactive material and other sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Commission will approve the proposed limits if the applicant demonstrates that the proposed limits are not likely to cause any individual to receive a dose in any period of seven consecutive days in excess of 10% of the limits specified in Appendix "A" of the regulations in this Part.

(b) Except as authorized by the Commission pursuant to paragraph (a) of this section, no licensee shall possess, use, or transfer licensed material in such a manner as to create in any unrestricted area from radioactive material and other sources of radiation in his possession:

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

(2) 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 seven consecutive days.

20.103 Concentrations in Effluents to Unrestricted

(a) There may be included in any application for a or for amendment of a license proposed limits upon ations of licensed and other radioactive material into air or water in unrestricted areas as a result pplicant's proposed activities. Such applications nclude information as to anticipated average con- ons and anticipated occupancy times for each un- ed area involved. The Commission will approve the limits if the applicant demonstrates that it is ly that any individual will be exposed to concentra- excess of the limits specified in Appendix "B", Table his Part. For purposes of this paragraph, concentra- y be averaged over periods not greater than one

(b) Except as authorized by the Commission to Section 20.302 or paragraph (a) of this section, see shall possess, use, or transfer licensed material a manner as to release into air or water in any un- ed area any concentration of radioactive material in f the limits specified in Appendix "B", Table II. oses of this paragraph, concentrations may be aver- r periods not greater than one year.

(c) For purposes of this section, determinations e concentration of radioactive material shall be h respect to the point where such material leaves ricted area. Where the radioactive material leaves ricted area in a stack, tube, pipe, or similar the determination may be made with respect to the ere the material leaves such conduit.

(d) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems (see Section 20.303).

Section 20.104 Medical Diagnosis, Therapy, and Research

Nothing in the regulations in this Part shall be interpreted as limiting the intentional exposure of patients to radiation for the purpose of medical diagnosis or medical therapy.

Section 20.105 Measures to be Taken after Excessive Exposures

In the event that any individual in a restricted area receives a dose or is exposed to concentrations of radioactive material in excess of the permissible limits established in section 20.101, the licensee shall limit the weekly dose or exposure of the individual to 10% of such permissible limit until such time as the average weekly dose or exposure to the individual for the period beginning with the week in which the excessive dose or exposure occurred is less than the permissible limit established in section 20.101.

PRECAUTIONARY PROCEDURES

Section 20.201 Surveys

(a) 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.

(b) Each licensee shall make or cause to be made such surveys as may be necessary for him to comply with the regulations in this Part.

Section 20.202 Personnel Monitoring

(a) Each licensee shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in excess of 25% of the limits specified in Appendix "A";

(2) Each individual who enters a high radiation area.

(b) As used in this Part,

(1) "personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.);

(2) "radiation area" means any area, accessible to personnel, in which there exists radiation, originating in whole or in part within licensed material, at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirem, or in any 5 consecutive days a dose in excess of 150 millirem;

(3) "high radiation area" means any area, accessible to personnel, in which there exists radiation originating in whole or in part within licensed material at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

Section 20.203 Caution Signs, Labels, and Signals

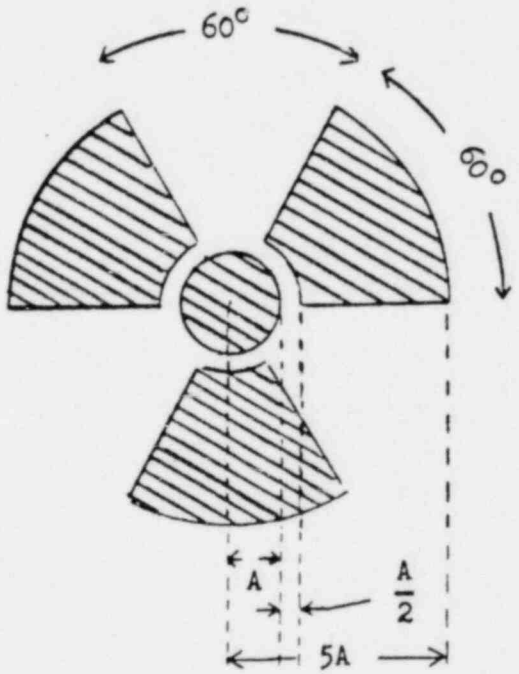
(a) (1) Except as otherwise authorized by the Commission, symbols prescribed by this section shall use the conventional radiation caution colors (magenta or purple on yellow background).

The symbol prescribed by this section is the conventional three-bladed design:

Radiation Symbol

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

2. Background is to be yellow.



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

(b) Radiation Areas

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

CAUTION*
RADIATION AREA

(c) 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*
HIGH RADIATION AREA

(2) Each high radiation area shall be equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirem in one hour upon entry into the area or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the licensee or a supervisor of the activity are made aware of the entry. In the case of a high radiation area established for a period of 30 days or less, such control device is not required.

(d) Airborne Radioactivity Areas

(1) As used in the regulations in this Part, "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix "B", Table I, Column 1; or (ii) any room, enclosure, or operating area in which airborne radioactive material composed wholly or partly of licensed material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25% of the amounts specified in Appendix "B", Table I, Column 1.

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*or "DANGER"

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

CAUTION*
AIRBORNE RADIOACTIVITY AREA

(e) Additional Requirements

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

CAUTION*
RADIOACTIVE MATERIAL(S)

(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 "C" shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION*
RADIOACTIVE MATERIAL(S)

(f) Containers

(1) Each container in which is transported, stored, or used a quantity of any licensed material (other than natural uranium or thorium) greater than the quantity of such material specified in Appendix "C" shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

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*or "DANGER"

CAUTION*
RADIOACTIVE MATERIAL

(2) Each container in which natural uranium or thorium is transported, stored, or used in a quantity greater than ten times the quantity specified in Appendix "C" shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION*
RADIOACTIVE MATERIAL

(3) Notwithstanding the provisions of subparagraphs (1) and (2) a label shall not be required:

(i) if the concentration of the material in the container does not exceed that specified in Appendix "B", Table I, Column 2, or

(ii) for laboratory containers, such as beakers, flasks, and test tubes, used transiently in laboratory procedures, when the user is present.

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

Section 20.204 Exceptions from Posting Requirements

Notwithstanding the provisions of section 20.203,

(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 inches from the surface of the source container or housing does not exceed five millirem per hour.

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* or "DANGER"

(more)

(b) Rooms or other areas in hospitals are not required to be posted with caution signs because of the presence of patients containing byproduct material provided that there are personnel in attendance 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 the regulations in this Part.

(c) Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in the regulations in this Part and (2) such area or room is subject to the licensee's control.

Section 20.205 Exemptions for Radioactive Materials Packaged for Shipment

Radioactive materials packaged and labeled in accordance with regulations of the Interstate Commerce Commission shall be exempt from the labeling and posting requirements of section 20.203 during shipment, provided that the inside containers are labeled in accordance with the provisions of section 20.203(f).

Section 20.206 Instruction of Personnel

All individuals working in or frequenting any portion of a restricted area shall be informed of the occurrence of radioactive materials or of radiation in such portion, and shall be instructed in the hazards of excessive exposure to such materials or radiation and in precautions or procedures to minimize exposure.

Section 20.207 Storage of Licensed Material

Licensed materials stored in an unrestricted area shall be secured against unauthorized removal from the place of storage.

WASTE DISPOSAL

Section 20.301 General Requirement

No licensee shall dispose of licensed material except:

(1) By transfer to an authorized recipient as provided in the regulations in Part 30, 40, or 70, whichever may be applicable; or

(2) As authorized pursuant to section 20.302; or

(3) As provided in section 20.303 or 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in section 20.103 (Concentrations in Effluents to Unrestricted Areas).

Section 20.302 Method for Obtaining Approval of Proposed Disposal Procedures

Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this Chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application 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.

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Section 20.303 Disposal by Release into Sanitary Sewerage Systems

No licensee shall discharge licensed material into a sanitary sewerage system unless:

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

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of (1) or (2) following:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix "B", Table I, Column 2; or

(2) ten times the quantity of such material specified in Appendix "C"; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix "B", Table I, Column 2; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

Section 20.304 Disposal by Burial in Soil

No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix "C"; and

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

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

RECORDS, REPORTS, AND NOTIFICATION

Section 20.401 Records of Surveys, Radiation Monitoring, and Disposal

(a) Each licensee shall maintain records showing the radiation exposures of all individuals subject to personnel monitoring control under Section 20.202 of the regulations in this Part.

(b) Each licensee shall maintain records showing the name of each individual exposed to radiation pursuant to Section 20.101(a)(2) and the weekly dose of each such individual for the 13 consecutive weeks of highest cumulative weekly dose.

(c) Each licensee shall maintain records in the same units used in the Appendices to this Part, showing the results of surveys required by Section 20.201(b), and disposals made under Sections 20.302, 20.303, and 20.304.

Section 20.402 Reports of Theft or Loss of Licensed Material

Each licensee shall report promptly to the Commission, after its occurrence becomes known to the licensee, any loss or theft of licensed material in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

Section 20.501 Applications for Exemptions

The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this Part as it determines are authorized by law and will not result in undue hazard to life or property.

Section 20.502 Additional Requirements

The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this Part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

ENFORCEMENT

Section 20.601 Violations

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

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APPENDIX "A"

Permissible Weekly Dose

Conditions of Exposure		Dose in Critical Organs (mrem)			
Parts of Body	Radiation	Skin, at Basal Layer of Epidermis	Blood Forming Organs	Gonads	Lens of Eye
Whole Body	Any Radiation with Half-value-layer greater than 1 mm of soft tissue	600[a]	300[a]	300[a]	300[a]
Whole Body	Any Radiation with Half-value-layer less than 1 mm of soft tissue	1500	300	300	300
Hands and Forearms or Feet and Ankles or Head and Neck	Any Radiation	1500[b]			

a) For exposures of the whole body to X or gamma rays up to 3 Mev, this condition may be assumed to be met if the "air dose" does not exceed 300 mr, provided the dose to the gonads does not exceed 300 mrem. "Air dose" means that the dose is measured by an appropriate instrument in air in the region of highest dosage rate to be occupied by an individual, without the presence of the human body or other absorbing and scattering material.

b) Exposure of these limited portions of the body under these conditions does not alter the total weekly dose of 300 mrem permitted to the bloodforming organs in the main portion of the body, to the gonads, or to the lens of the eye.

(more)

APPENDIX "B"

Permissible Concentrations in Air and Water Above Natural Background

Material	Table I		Table II	
	Column 1 Air (2)	Column 2 Water(3)	Column 1 Air (2)	Column 2 Water(3)
A^{41}	1.6×10^{-6}	1.4×10^{-3}	5×10^{-8}	5×10^{-5}
Ag^{105}	3.6×10^{-5}	5	1.2×10^{-6}	1.6×10^{-1}
Ag^{111}	1×10^{-4}	13	3×10^{-6}	4×10^{-1}
Am^{241}	8×10^{-11}	4×10^{-4}	3×10^{-12}	1.3×10^{-5}
As^{76}	7×10^{-6}	6×10^{-1}	2×10^{-7}	2×10^{-2}
At^{211}	9×10^{-10}	6×10^{-6}	3×10^{-11}	2×10^{-7}
Au^{198}	3.4×10^{-7}	9×10^{-3}	1.1×10^{-8}	3×10^{-4}
Au^{199}	8×10^{-7}	2×10^{-2}	2.5×10^{-8}	7×10^{-4}
$Ba^{140} + La^{140}$	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
Be^{7}	1.3×10^{-5}	3	4×10^{-7}	1×10^{-1}
C^{14}	1.4×10^{-6}	1×10^{-2}	5×10^{-8}	3.6×10^{-4}
Ca^{45}	9×10^{-8}	1.5×10^{-3}	3×10^{-9}	5×10^{-5}
$Cd^{109} + Ag^{109}$	2×10^{-7}	2×10^{-1}	7×10^{-9}	7×10^{-3}
$Ce^{144} + Pr^{144}$	2×10^{-8}	1×10^{-1}	7×10^{-10}	3.6×10^{-3}
Cl^{36}	1×10^{-6}	7×10^{-3}	4×10^{-8}	2.4×10^{-4}
Cm^{242}	5×10^{-10}	2.7×10^{-3}	1.8×10^{-11}	1×10^{-4}
Co^{60}	3.4×10^{-6}	5×10^{-2}	1.2×10^{-7}	1.8×10^{-3}
Cr^{51}	2.4×10^{-5}	1.4	8×10^{-7}	5×10^{-2}
$Cs^{137} + Ba^{137}$	6×10^{-7}	4.5×10^{-3}	2×10^{-8}	1.5×10^{-4}
Cu^{64}	2×10^{-5}	2.5×10^{-1}	6×10^{-7}	8×10^{-3}

(1) Air concentrations are given in microcuries per milliliter of air.
(2) Water concentrations are given in microcuries per milliliter of water. These figures also apply to foodstuffs in microcuries per gram (wet-weight).

	Table I		Table II	
Material	Column 1 Air (2)	Column 2 Water(3)	Column 1 Air (2)	Column 2 Water(3)
Eu^{154}	2×10^{-8}	1×10^{-1}	6×10^{-10}	3×10^{-3}
F^{18}	3.5×10^{-4}	2.6	1.2×10^{-5}	9×10^{-2}
Fe^{55}	1.8×10^{-6}	1.3×10^{-2}	6×10^{-8}	4×10^{-4}
Fe^{59}	5×10^{-8}	3.3×10^{-4}	1.5×10^{-9}	1.1×10^{-5}
Ga^{72}	1×10^{-5}	26	3.4×10^{-7}	9×10^{-1}
Ge^{71}	1×10^{-4}	27	3.6×10^{-6}	9×10^{-1}
H^3 (HTO or T_2O)	7×10^{-5}	5×10^{-1}	2.5×10^{-6}	1.6×10^{-2}
Ho^{166}	1×10^{-5}	70	3×10^{-7}	2.3
I^{131}	9×10^{-9}	9×10^{-5}	3×10^{-10}	3×10^{-6}
Ir^{190}	2.2×10^{-6}	4×10^{-2}	7×10^{-8}	1.3×10^{-3}
Ir^{192}	1.5×10^{-7}	2.7×10^{-3}	5×10^{-9}	9×10^{-5}
K^{42}	6×10^{-6}	4×10^{-2}	2×10^{-7}	1.4×10^{-3}
La^{140}	4×10^{-6}	3.4	1.4×10^{-7}	1.1×10^{-1}
Lu^{177}	1.5×10^{-5}	70	5×10^{-7}	2.4
Mn^{56}	8×10^{-6}	5×10^{-1}	3×10^{-7}	1.5×10^{-2}
Mo^{99}	5×10^{-3}	40	1.8×10^{-4}	1.4
Na^{24}	5×10^{-6}	2.4×10^{-2}	1.6×10^{-7}	8×10^{-4}
Nb^{95}	1.3×10^{-6}	1.2×10^{-2}	4×10^{-8}	4×10^{-4}
Ni^{59}	5×10^{-5}	7×10^{-1}	1.6×10^{-6}	2.5×10^{-2}
P^{32}	4×10^{-7}	6×10^{-4}	1.4×10^{-8}	2×10^{-5}
Pb^{203}	2×10^{-5}	4×10^{-1}	6×10^{-7}	1.4×10^{-2}
$Pb^{103} + Rh^{103}$	2×10^{-6}	3×10^{-2}	7×10^{-8}	1×10^{-3}
Pm^{147}	6×10^{-7}	3	2×10^{-8}	1×10^{-1}
Po^{210}(sol.)	6×10^{-10}	9×10^{-5}	2×10^{-11}	3×10^{-6}
Po^{210}(insol.)	2×10^{-10}	-	7×10^{-12}	-
Pr^{143}	2.3×10^{-6}	1	7×10^{-8}	3.6×10^{-2}
Pu^{239}(sol.)	6×10^{-12}	4.5×10^{-6}	2×10^{-13}	1.5×10^{-7}

Material	Table I Column 1 Air (2)	Table I Column 2 Water(3)	Table II Column 1 (Air (2)	Table II Column 2 Water(3)
Pu^{239}(insol.)	6×10^{-12}	-	2×10^{-13}	-
Ra^{226} + 1/2 dr.	2.4×10^{-11}	1.2×10^{-7}	8×10^{-13}	4×10^{-9}
Rb^{86}	1.1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
Re^{183}	2.4×10^{-5}	2.4×10^{-1}	8×10^{-7}	8×10^{-3}
Rh^{105}	3×10^{-6}	5×10^{-2}	1×10^{-7}	1.6×10^{-3}
Rn^{222} + dr.	1×10^{-7}	6×10^{-6}	3.3×10^{-9}	2×10^{-7}
Ru^{106} + Rh^{106}	8×10^{-8}	4×10^{-1}	2.6×10^{-9}	1.3×10^{-2}
S^{35}	3×10^{-6}	1.5×10^{-2}	1×10^{-7}	5×10^{-4}
Sc^{46}	2×10^{-7}	1	7×10^{-9}	3.6×10^{-2}
Sm^{151}	4×10^{-8}	6×10^{-1}	1.3×10^{-9}	2×10^{-2}
Sn^{113}	1.7×10^{-6}	5×10^{-1}	6×10^{-8}	1.6×10^{-2}
Sr^{89}	6×10^{-8}	2×10^{-4}	2×10^{-9}	7×10^{-6}
Sr^{90} + Y^{90}	6×10^{-10}	2.4×10^{-6}	2×10^{-11}	8×10^{-8}
Tc^{96}	8×10^{-6}	8×10^{-2}	3×10^{-7}	3×10^{-3}
Te^{127}	3×10^{-7}	8×10^{-2}	1×10^{-8}	3×10^{-3}
Te^{129}	1.2×10^{-7}	3.3×10^{-2}	4×10^{-9}	1.1×10^{-3}
Th^{234}	2×10^{-6}	10	6×10^{-8}	3×10^{-1}
Th-natural(sol.)	5×10^{-11}	1.5×10^{-6}	1.7×10^{-12}	5×10^{-8}
Th-natural(insol.)	5×10^{-11}	-	1.7×10^{-12}	-
Tm^{170}	1.5×10^{-7}	8×10^{-1}	5×10^{-9}	2.5×10^{-3}
U-natural (sol.)*	5×10^{-11}	2×10^{-4}	1.7×10^{-12}	7×10^{-6}
U-natural (insol.)*	5×10^{-11}	-	1.7×10^{-12}	-
U^{233} (sol.)	4×10^{-10}	4.5×10^{-4}	1×10^{-11}	1.5×10^{-5}
U^{233} (insol.)	5×10^{-11}	-	1.6×10^{-12}	-
V^{48}	3×10^{-6}	1.5	1×10^{-7}	5×10^{-2}
Xe^{133}	1.3×10^{-5}	1.3×10^{-2}	4×10^{-7}	4×10^{-4}
Xe^{135}	5×10^{-6}	4×10^{-3}	1.7×10^{-7}	1.4×10^{-4}
Y^{91}	1.2×10^{-7}	6×10^{-1}	4×10^{-9}	2×10^{-2}

	Table I		Table II	
Material	Column 1 Air (2)	Column 2 Water(3)	Column 1 Air (2)	Column 2 Water(3)
Zn^{65}	6×10^{-6}	2×10^{-1}	2×10^{-7}	6×10^{-3}
Unidentified beta or gamma emitters or any undetermined mixtures of beta or gamma emitters			1×10^{-9}	1×10^{-7}
Unidentified alpha emitters or any undetermined mixtures of alpha emitters			5×10^{-12}	1×10^{-7}

*For enriched uranium the same radioactivities per unit volume as those for natural uranium are applicable. It should be noted that the contribution of U-234 to the gross activity of enriched uranium is 20-40 times that of the U-235.

APPENDIX "C"

Material	Microcuries
Ag^{105}	1
Ag^{111}	10
As^{76}, As^{77}	10
Au^{198}	10
Au^{199}	10
$Ba^{140} + La^{140}$	1
Be^{7}	50
C^{14}	50
Ca^{45}	10
$Cd^{109} + Ag^{109}$	10
$Ce^{144} + Pr^{144}$	1
Cl^{36}	1
Co^{60}	1
Cr^{51}	50
$Cs^{137} + Ba^{137}$	1
Cu^{64}	50
Eu^{154}	1
F^{18}	50
Fe^{55}	50
Fe^{59}	1
Ga^{72}	10
Ge^{71}	50
H^{3} (HTO or H_2^3O)	250
I^{131}	10
In^{114}	1
Ir^{192}	10

Material	Microcuries
K^{42}	10
La^{140}	10
Mn^{52}	1
Mn^{56}	50
Mo^{99}	10
Na^{22}	10
Na^{24}	10
Nb^{95}	10
Ni^{59}	1
Ni^{63}	1
P^{32}	10
$Pd^{103} + Rh^{103}$	50
Pd^{109}	10
Pm^{147}	10
Po^{210}	0.1
Pr^{143}	10
Pu^{239}	1
Ra^{226}	0.1
Rb^{86}	10
Re^{186}	10
Rh^{105}	10
$Ru^{106} + Rh^{106}$	1
S^{35}	50
Sb^{124}	1
Sc^{46}	1
Sm^{153}	10
Sn^{113}	10
Sr^{89}	1
$Sr^{90} + Y^{90}$	0.1

Materials	Microcuries
Ta^{182}	10
Tc^{96}	1
Tc^{99}	1
Te^{127}	10
Te^{129}	1
Th (natural)	50
Tl^{204}	50
Tritium - See H^3	250
U (natural)	50
U^{233}	1
U^{234}-U^{235}	50
V^{48}	1
W^{185}	10
Y^{90}	1
Y^{91}	1
Zn^{65}	10
Unidentified radicactive materials or any of the above in unknown mixtures	0.1

NOTE: For purposes of sections 20.203 and 20.304, 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

(more)

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 section 20.304, if a particular batch contains 2,000 μc of Au^{198} and 25,000 μc of C^{14}, it may also include not more than 3,000 μc of I^{131}. This limit was determined as follows:

$$\frac{2{,}000\ \mu c}{10{,}000\ \mu c}\ Au^{198} + \frac{25{,}000\ \mu c}{50{,}000\ \mu c}\ C^{14} + \frac{3{,}000\ \mu c}{10{,}000\ \mu c}\ I^{131} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1000 as provided in section 20.304.

NOTE: The record keeping and reporting requirements contained herein have been approved by the Bureau of the Budget in accordance with the Federal Reports Act of 1942.

VIOLATIONS

SCHEDULES

APPEALS

AUTHORITY: §§ 30.1 to 30.90 issued under 60 Stat. 755-775 as amended; 42 U. S. C. 1801-1819.

SOURCE: §§ 30.1 to 30.90 appear at 16 F. R. 3251, Apr. 13, 1951, except as otherwise noted.

GENERAL PROVISIONS

§ 30.1 *Scope.* The regulations in this part establish instructions and standards governing the procurement, delivery, possession, use, transfer (including export), and disposal of radioisotopes (a) originating in or procured from the facilities of the Commission or of a distributor, or (b) originating in domestic facilities not owned by the Commission but distributed by or through the Commission or a distributor, or (c) originating in any foreign nuclear reactor for shipment into the United States. The regulations in this part do not apply to source and fissionable materials as defined in this part, or to any radioactive material not covered by the immediately preceding sentence.

§ 30.2 *Definitions.* As used in this part:

(a) *Commission.* "Commission" means the United States Atomic Energy Commission created by the Atomic Energy Act of 1946, or its duly authorized representative.

(b) *Distributor.* "Distributor" means any person to the extent that such person is engaged in operating Commission-owned laboratories, plants, or other facilities under a contract with the Commission and is engaged in the distribution of radioisotopes for the Commission.

(c) *Fissionable material.* "Fissionable material" means fissionable material as defined in section 5 (a) (1) of the Atomic Energy Act of 1946 and in the regulations contained in Part 70, Definition of Fissionable Material, of this chapter.

(d) *One millicurie.* "One millicurie" means that amount of radioactive material which disintegrates at the rate of 37 million atoms per second.

(e) *Person.* "Person" means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, the United States or any agency thereof, any government other than the United States, any political subdivision of any such government, and any legal successor, representative, agent, or agency of the foregoing, or other entity, but shall not include the Commission or officers or employees of the Commission in the exercise of duly authorized functions.

(f) *Radioisotope.* "Radioisotope" means any radioactive material yielded in or made radioactive by exposure to the radiation incident to the processes of producing or utilizing fissionable material. "Radioisotope" also means any other radioactive material.

(g) *Roentgen (=r).* "Roentgen (=r)" means that quantity of X or gamma radiation such that the associated corpuscular emission per 0.001293 gram of air produces, in air, ions carrying 1 electrostatic unit of electricity of either sign.

(h) *Roentgen-equivalent-man (=rem).* "Roentgen-equivalent-man (=rem)" means that quantity of radiation that when absorbed by mammalian tissue produces an effect equivalent to the absorption by this tissue of one roentgen of X or gamma radiation.

(i) *Roentgen-equivalent-physical (=rep).* "Roentgen-equivalent-physical (=rep)" means that dose of ionizing radiation that is capable of producing energy absorption of 93 ergs per gram of tissue.

(j) *Service irradiation.* "Service irradiation" means the exposure of materials of any kind to radiation in accordance with instructions and at the request of some person.

(k) *Source material.* "Source material" means source material as defined in section 5 (b) (1) of the Atomic Energy Act of 1946 and in the regulations contained in Part 40, Control of Source Material, of this chapter.

§ 30.3 *Amendment.* Nothing in this part shall limit the authority of the Commission to issue or amend its regulations in accordance with law.

§ 30.4 *Communications.* All communications about the regulations in this part or any authorization issued under them should be addressed to the United States Atomic Energy Commission, Post Office Box E, Oak Ridge, Tennessee, Attention: Isotopes Division.

EXEMPTIONS

§ 30.10 *Persons operating Commission-owned facilities.* The regulations in this part do not apply to persons to the extent that such persons operate Commission-owned facilities in carrying out programs on behalf of the Commission. In such cases, the acquisition, transfer, use, and disposal of radioisotopes are governed by the contracts between such persons and the Commission, and internal bulletins, instructions and directives issued by the Commission.

§ 30.11 *Transfer to the Commission.* The actions of any person in transferring or delivering radioisotopes to the Commission are not subject to the regulations in this part. The exemption provided in this section does not, however, relieve any person from the obligation to comply with shipping requirements otherwise provided by law. (See § 30.41.)

§ 30.12 *Carriers.* Common and contract carriers transporting radioisotopes in the normal course of business are exempt from the regulations in this part.

§ 30.13 *Items and quantities.* (a) Sections 30.20 through 30.61, inclusive, do not apply to any item listed in § 30.70 *Schedule A*, nor to any quantity listed in § 30.71 *Schedule B*: *Provided, however*, That no person shall, except as otherwise permitted by the regulations contained in this part, effect an increase in the radioactivity of such scheduled items or quantities by adding other radioactive material thereto, by combining the radioisotopes from two or more such items or quantities, or by altering them in any other manner so as to increase thereby the rate of radiation exposure of himself or others above the original rate therefrom.

(b) In addition the Commission may, upon application of any interested party, exempt specific items from the application of all or any portion of the regulations in this part subject to such conditions as the Commission may establish whenever the Commission determines that the possession, use, or transfer, of such items will not endanger health or present a hazard to life or property.

approval for procurement, and its issuance shall be based upon the representations in the application and shall be subject to and in accordance with the regulations in this part and the terms and conditions stated in the application.

§ 30.31 *Nontransferability.* The persons to whom an authorization has been issued shall be deemed the holder thereof, and none of the rights or privileges conferred by the authorization shall be transferable.

§ 30.32 *Expiration.* An authorization shall be valid only for the period stated thereon; it shall expire at the end of such period without the necessity of notice or warning from the Commission. The holder shall not order radioisotopes after the period of validity stated on the authorization has run.

§ 30.33 *Modification.* Upon written request from the holder of an authorization for a modification of its terms, the Commission will usually consider the request without requiring a separate application, and it may modify the authorization by giving written notice to the holder or by issuing a supplemental authorization.

§ 30.34 *Revocation.* Any authorization may be annulled, suspended, or revoked at any time in the discretion of the Commission upon a determination by the Commission that the public health or safety requires such action, or that the holder has wilfully failed to comply with any term or condition to which his authorization may be subject. In the absence of such determination, no annulment, suspension, or revocation of any authorization will be made except upon request of the holder thereof, or unless conduct or other facts meriting such action shall have been called to the attention of the holder previously in writing, and unless he shall have been accorded opportunity to comply with all lawful requirements but shall have failed to do so.

POSSESSION, TRANSFER, USE

§ 30.40 *Limitations.* No person shall possess, use, or transfer radioisotopes except as permitted by a valid authorization from the Commission or as otherwise permitted by the regulations in this part. When transferring any non-exempt items or quantities of radioisotopes, the transferor shall limit delivery to the locations, materials, and quantities stated in the transferee's authorization.

§ 30.41 *Authorized use.* Each person authorized by the Commission to use radioisotopes shall confine his use to the locations and purposes approved by the Commission on his authorization, and such use is subject to all applicable laws, regulations of the Commission, and terms and conditions stated in the application for such material.

NOTE: Shipment and use of radioisotopes may also be subject to control by other authority; see, for example, (a) Federal Food, Drug, and Cosmetic Act and the general regulations for its enforcement (21 CFR Chapter I), (b) Rules and Regulations of the Interstate Commerce Commission (49 CFR Chapter I), (c) Civil Air Regulations (14 CFR Chapter II), (d) Postal Laws and Regulations (39 CFR Chapter I), and (e) laws and regulations of State or other local authority.

RECORDS, REPORTS, INSPECTIONS

§ 30.50 *General records.* Each person who possesses or uses radioisotopes shall keep permanent records showing the receipt, use, storage, delivery, and disposal of such radioisotopes, and the safety measures used to protect health. These records shall be accurate and complete and shall be made available to the Commission upon request.

§ 30.51 *Overexposure records.* No report of the overexposure of a person to radioisotopes need be forwarded to the Commission, but where an overexposure is believed to have occurred, the occurrence and its observed effect upon the overexposed person shall be recorded in detail and filed with the general records.

§ 30.52 *Reports of use.* Upon written request from the Commission, any person who uses radioisotopes shall report fully the use made, stating substantially those facts required by §§ 30.50 and 30.51 to be recorded.

§ 30.53 *Reports of transfer.* In the absence of written waiver by the commission, any person who transfers radioisotopes to another person shall promptly report to the Commission each delivery made, indicating the name and location of the transferee, transferee's authorization number, type and amount of material transferred, and date of delivery.

§ 30.54 *Inspections.* Each person who possesses or uses radioisotopes shall permit the Commission, at all reasonable times, to make such inspections of the facilities wherein materials are stored or used as the Commission deems necessary, and shall make available to the Commission the records required by §§ 30.50 and 30.51.

VIOLATIONS

§ 30.60 *Right to recall.* The Commission may withhold or recall radioisotopes from any person when it is determined by the Commission that such person (a) is not equipped to observe the health and safety standards established by the Commission, or has failed to do so; or (b) has used the material in a manner other than as disclosed in the application therefor; or (c) has used the material in violation of any law or of any regulation of the Commission.

§ 30.61 *Other action.* Any person who violates any provision of the regulations in this part, or who, in connection with the regulations in this part, wilfully conceals a material fact or furnishes false information to the Commission, may be prohibited by the Commission from making or obtaining further deliveries of radioisotopes or using, possessing, or storing them, and may be required to return to the Commission all radioisotopes remaining on hand. Violation of the regulations contained in this part or the furnishing of false information in connection with applications, statements and reports thereunder may also be a crime under the provision of the Atomic Energy Act of 1946 or of 18 U. S. C. 1001, act of June 25, 1948, 62 Stat. 749.

SCHEDULES

§ 30.70 *Schedule A: Exempt items.* (See § 30.13.) None.

§ 30.71 *Schedule B: Exempt quantities.* (See § 30.13.)

(a) *Alpha emitters.* None.

(b) *Beta and gamma emitters.* Not more than a combined total of 0.011 millicurie, made up as follows:

(1) Half-lives no greater than 30 days: Not more than 0.010 millicurie.

(2) Half-lives greater than 30 days: Not more than 0.001 millicurie.

(c) *Neutron emitters.* None.

NOTE: The quantities listed in Schedule B are not to be interpreted or considered as having any bearing on the determination of safe permissible levels of personnel exposure or for waste disposal. It is the Commission's intention to publish at a later date and incorporate in this part appropriate health and safety standards.

milk in the said marketing area, and it is hereby further determined that:

(1) The refusal or failure of such handlers to sign said proposed marketing agreement tends to prevent the effectuation of the declared policy of the act;

(2) The issuance of this order amending the order is the only practical means, pursuant to the declared policy of the act, of advancing the interests of producers of milk which is produced for sale in the said marketing area; and

(3) The issuance of this order amending the order is approved or favored by at least two thirds of the producers who participated in a referendum and who, during the determined representative period (October 1956), were engaged in the production of milk for sale in the said marketing area.

Order relative to handling. It is therefore ordered, that on and after the effective date hereof, the handling of milk in the Cleveland, Ohio, marketing area shall be in conformity to and in compliance with the terms and conditions of the aforesaid order, as amended, and as hereby further amended, and the aforesaid order, as amended, is hereby further amended as follows:

1. In § 975.30 (b) following the phrase "such plant shall" delete the words "upon written application to the market administrator on or before January 31 of any year" and substitute therefor "unless written advice to the contrary is furnished the market administrator on or before January 31".

2. Add the following as § 975.52 (c):

(c) Where producer milk is transferred in bulk from a pool plant to the pool plant of another handler, and the operators of such plants have so requested the market administrator in writing prior to the delivery period within which the transfer occurred, the maximum allowance for shrinkage pursuant to § 975.51 (c) (2) with respect to such milk shall be divided equally between the transferor and transferee plants.

3. Delete § 975.61 and substitute therefor the following:

§ 975.61 *Class I milk prices.* The respective minimum prices per hundredweight to be paid by each handler, f. o. b. his plant for milk received from producers or from a pool plant of a cooperative association, during the delivery period which is classified as Class I milk, shall be as follows as computed by the market administrator:

(a) Add to the basic formula price the following amount for the period indicated:

Delivery period:	Amount
February through July	$1.40
All others	1.85

(b) Add or subtract a "supply-demand adjustment" computed as follows:

(1) With respect to receipts and utilization of the Cleveland and Akron-Stark County, Ohio, marketing areas during the first and second months preceding the delivery period, combine into separate totals:

(i) The total quantity of milk received from producers defined in § 975.8 and § 980.7 of the order regulating the handling of milk in the Akron-Stark County, Ohio, marketing area; and

(ii) The gross quantity of milk utilized as Class I at pool plants pursuant to § 975.30 and to § 980.5 of this chapter, exclusive of interhandler and intermarket transfers between such plants.

(2) Divide the result obtained in subparagraph (1) (i) of this paragraph by that obtained in subparagraph (1) (ii) of this paragraph, multiply by 100, and round to the nearest whole number. This result shall be known as the "current utilization percentage."

(3) Compute a "deviation percentage" by subtracting from the current utilization percentage computed in subparagraph (2) of this paragraph the "standard utilization percentage" shown below:

Month for which the price is being computed	Standard utilization percentage
January	123
February	126
March	130
April	133
May	135
June	144
July	149
August	144
September	131
October	125
November	123
December	122

(4) Determine the amount of the supply-demand adjustment from the following schedule:

Deviation percentage:	Amount of supply-demand adjustment (cents)
+13 or over	−35
+10 or +11	−19
+7 or +8	−13
+4 or +5	−7
+2 or −2	0
−4 or −5	+7
−7 or −8	+13
−10 or −11	+19
−13 or below	+25

When the deviation percentage does not fall within the tabulated brackets, the adjustment shall be determined by the adjacent bracket which is the same as or nearest to the bracket used in the previous month.

4. Effective July 1, 1957, delete § 975.66 and substitute therefor the following:

§ 975.66 *Quota rules.* (a) Except as provided in paragraph (b) of this section, an eligible milk quota shall apply to deliveries of milk by the producer for whose account that milk was delivered to a handler(s) during the quota forming period.

(b) A daily quota may be transferred during the period of April through June by notifying the market administrator in writing before the first day of any delivery period that such quota is to be transferred to the person named in such notice, but under the following conditions only:

(1) In the event of the death of a producer, the entire daily quota may be transferred to a member of such producer's immediate family who carries on the dairy operation on the same farm;

(2) If a quota is held jointly and such joint holding is terminated on the basis of written notice to the market administrator from the joint holders, the entire daily quota may be transferred to one of the joint holders, or divided in accordance with such notice between the former joint holders if they continue dairy farm operations.

5. Delete § 975.71 and substitute therefor the following:

§ 975.71 *Location adjustment to handlers.* In computing the value of such quantities of milk as are received at a pool plant located 40 miles or more, by the shortest highway distance from the Public Square in Cleveland, Ohio, as determined by the market administrator, and classified as Class I or Class II milk, there shall be deducted:

(a) 13 cents per hundredweight, if such distance is more than 40 miles but not more than 60 miles; and

(b) 20 cents per hundredweight, if such distance is more than 60 miles but not more than 74 miles, and 2 cents per hundredweight additional for each 14 miles or fraction thereof in excess of 74 miles.

(c) For the purpose of determining the respective quantities of Class I and Class II milk subject to the location adjustment, each pool handler's utilization of Class I and Class II milk during the month at pool plants as defined in § 975.30 (a) shall be allocated first to receipts of milk from producers' farms at such plants and then to the receipts of producer milk from pool plants as defined in § 975.30 (b) in the order of their nearness to the Public Square in Cleveland, Ohio, by shortest highway distance as determined by the market administrator.

6. In § 975.73 (c) delete "§ 975.81 (b)" and substitute therefor "§ 975.71".

7. In § 975.75 (a) delete "§ 975.73 (a) through (c)" and substitute therefor "§ 975.73 (a) through (e)".

8. In § 975.81 (a) delete "30 miles" and substitute therefor "40 miles".

(Sec. 5, 49 Stat. 753 as amended; 7 U. S. C. 608c)

Issued at Washington, D. C., this 24th day of January 1957, to be effective on and after February 1, 1957, with respect to all amendments other than that to § 975.66 (numbered 4 herein) which shall be effective on and after July 1, 1957.

[SEAL] EARL L. BUTZ,
Assistant Secretary.

[F. R. Doc. 57-663; Filed, Jan. 30, 1957; 8:51 a. m.]

TITLE 10—ATOMIC ENERGY

Chapter I—Atomic Energy Commission

PART 20—STANDARDS FOR PROTECTION AGAINST RADIATION

In July 1955 the Commission issued for public comment a proposed regulation to establish general standards for protection of licensees, their employees, and the public against radiation hazards arising out of the possession or use of special nuclear, source, or byproduct material under license issued by AEC. In preparing the effective regulation published below, the Commission has had

the benefit of numerous comments and suggestions received since publication of the proposed rules. A number of changes suggested by those comments have been incorporated in the following regulation.

The regulation establishes standards which must be followed in handling radioactive materials which are subject to the licensing authority of the Commission and provides procedures whereby deviations from such standards may be authorized on a case-to-case basis. The regulation prescribes limits which govern exposure of personnel to radiation and concentrations of radioactive material, concentrations of radioactive material which may be discharged into air and water, and disposal of radioactive wastes. It also establishes certain precautionary procedures and administrative controls.

The standards established by this regulation will be found to agree substantially with those published by the National Committee on Radiation Protection in N. B. S. Handbook 52 "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," and N. B. S. Handbook 59 "Permissible Dose from External Sources of Ionizing Radiation." The National Committee on Radiation Protection has under review recommendations to limit cumulative exposures over periods of years. The Commission is giving consideration to appropriate amendments to its regulations to deal with this cumulative exposure problem.

Limitations upon levels of radiation and concentrations of radioactive material in areas affected by but not controlled by the licensee are contained principally in § 20.102 ("Permissible Levels of Radiation in Unrestricted Areas"), § 20.103 ("Concentrations in Effluents to Unrestricted Areas"), and the sections on waste disposal. The sections are designed to assure that individuals in "unrestricted areas" do not receive exposure in excess of 10 percent of the limits established for persons exposed in restricted areas. For this purpose, the sections limit levels of radiation and concentrations of radioactive material which may be created in unrestricted areas by licensees, without special authorization from the AEC, to extremely low levels. These levels are believed to be sufficiently low to assure that there is no reasonable probability of individuals in unrestricted areas receiving exposures in excess of 10 percent of the permissible levels for restricted areas. Procedures are incorporated in those sections, however, under which the Commission may authorize licensees in specific cases to create higher levels in unrestricted areas where the circumstances of the particular case are such as to provide reasonable assurance that individuals in the unrestricted areas will not receive exposures in excess of 10 percent of the limitation established for restricted areas.

It is believed that the standards incorporated in these regulations provide, in accordance with present knowledge, a very substantial margin of safety for exposed individuals. It is believed also that the standards are practical from the standpoint of licensees. It should be emphasized that the standards are subject to change with the development of new knowledge, with significant increase in the average exposure of the whole population to radiation, and with further experience in the administration of the Commission's regulatory program.

Pursuant to the Administrative Procedures Act, Public Law 404, 79th Congress, 2d Session, the following rules are published as a document subject to codification to be effective 30 days after publication in the FEDERAL REGISTER.

GENERAL PROVISIONS

AUTHORITY: §§ 20.1 to 20.601 issued under sec. 161 (b), 68 Stat 948, 42 U. S. C. 2201.

GENERAL PROVISIONS

§ 20.1 *Purpose.* (a) The regulations in this part establish standards for protection against radiation hazards arising out of activities under licenses issued by the Atomic Energy Commission and are issued pursuant to the Atomic Energy Act of 1954 (68 Stat. 919).

(b) The use of radioactive material or other sources of radiation not licensed by the Commission is not subject to the regulations in this part. However, it is the purpose of the regulations in this part to control the possession, use, and transfer of licensed material by any licensee in such a manner that exposure to such material and to radiation from such material, when added to exposures to unlicensed radioactive material and to other unlicensed sources of radiation in the possession of the licensee, and to radiation therefrom, does not exceed the standards of radiation protection prescribed in the regulations in this part.

§ 20.2 *Scope.* The regulations in this part apply to all persons who receive, possess, use or transfer byproduct material, source material, or special nuclear material under a general or specific license issued by the Commission pursuant to the regulations in Part 30, 40, or 70 of this chapter.

§ 20.3 *Definitions.* (a) As used in this part:

(1) "Act" means the Atomic Energy Act of 1954 (68 Stat. 919) including any amendments thereto;

(2) "Airborne radioactive material" means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors, or gases;

(3) "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;

(4) "Commission" means the Atomic Energy Commission or its duly authorized representatives;

(5) "Government agency" means any executive department, commission, independent establishment, corporation, wholly or partly owned by the United States of America which is an instrumentality of the United States, or any board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of the Government;

(6) "Individual" means any human being;

(7) "Licensed material" means source material, special nuclear material, or byproduct material received, possessed, used, or transferred under a general or specific license issued by the Commission pursuant to the regulations in this chapter;

(8) "License" means a license issued under the regulations in Part 30, 40, or 70 of this chapter. "Licensee" means the holder of such license;

(9) "Person" means (i) any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission, any State, any foreign government or nation or any political subdivision of any such government or nations, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing;

(10) "Radiation" means any or all of the following: alpha rays, beta rays, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but not sound or radio waves, or visible, infrared, or ultraviolet light;

(11) "Radioactive material" includes any such material whether or not subject to licensing control by the Commission;

the radiation caution symbol and the words:

CAUTION[1]
HIGH RADIATION AREA

(2) Each high radiation area shall be equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirem in one hour upon entry into the area or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the licensee or a supervisor of the activity are made aware of the entry. In the case of a high radiation area established for a period of 30 days or less, such control device is not required.

(d) *Airborne radioactivity areas.* (1) As used in the regulations in this part, "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations in excess of the amounts specified in Appendix B, Table I, Column 1 of this part; or (ii) any room, enclosure, or operating area in which airborne radioactive material composed wholly or partly of licensed 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 B, Table I, Column 1 of this part.

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

CAUTION[1]
AIRBORNE RADIOACTIVITY AREA

(e) *Additional requirements.* (1) Each area or room in which licensed material is used or stored and which contains any radioactive material (other than natural uranium or thorium) in an amount exceeding 10 times the quantity of such material specified in Appendix C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[1]
RADIOACTIVE MATERIAL(S)

(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 C of this part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION[1]
RADIOACTIVE MATERIAL(S)

(f) *Containers.* (1) Each container in which is transported, stored, or used a quantity of any licensed material (other than natural uranium or thorium) greater than the quantity of such material specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION[1]
RADIOACTIVE MATERIAL

(2) Each container in which natural uranium or thorium is transported, stored, or used in a quantity greater than ten times the quantity specified in Appendix C of this part shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

CAUTION[1]
RADIOACTIVE MATERIAL

(3) Notwithstanding the provisions of subparagraphs (1) and (2) a label shall not be required:

(i) If the concentration of the material in the container does not exceed that specified in Appendix B, Table I, Column 2 of this part, or

(ii) For laboratory containers, such as beakers, flasks, and test tubes, used transiently in laboratory procedures, when the user is present.

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

§ 20.204 *Exceptions from posting requirements.* Notwithstanding the provisions of § 20.203,

(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 inches from the surface of the source container or housing does not exceed five millirem per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs because of the presence of patients containing byproduct material provided that there are personnel in attendance 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 the regulations in this part.

(c) Caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that (1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in the regulations in this part and; (2) such area or room is subject to the licensee's control.

§ 20.205 *Exemptions for radioactive materials packaged for shipment.* Radioactive materials packaged and labeled in accordance with regulations of the Interstate Commerce Commission shall be exempt from the labeling and posting requirements of § 20.203 during shipment, provided that the inside containers are labeled in accordance with the provisions of § 20.203 (f).

§ 20.206 *Instruction of personnel.* All individuals working in or frequenting any portion of a restricted area shall be informed of the occurrence of radioactive materials or of radiation in such portion, and shall be instructed in the hazards of excessive exposure to such materials or radiation and in precautions or procedures to minimize exposure.

§ 20.207 *Storage of licensed material.* Licensed materials stored in an unrestricted area shall be secured against unauthorized removal from the place of storage.

WASTE DISPOSAL

§ 20.301 *General requirement.* No licensee shall dispose of licensed material except:

(1) By transfer to an authorized recipient as provided in the regulations in Part 30, 40, or 70 of this chapter, whichever may be applicable; or

(2) As authorized pursuant to § 20.302; or

(3) As provided in § 20.303 or § 20.304, applicable respectively to the disposal of licensed material by release into sanitary sewerage systems or burial in soil, or in § 20.103 (Concentrations in Effluents to Unrestricted Areas).

§ 20.302 *Method for obtaining approval of proposed disposal procedures.* Any licensee or applicant for a license may apply to the Commission for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations in this chapter. Each application should include a description of the licensed material and any other radioactive material involved, including the quantities and kinds of such material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application 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.

§ 20.303 *Disposal by release into sanitary sewerage systems.* No licensee shall discharge licensed material into a sanitary sewerage system unless:

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

(b) The quantity of any licensed or other radioactive material released into the system by the licensee in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration equal to the limits specified in Appendix B, Table I, Column 2 of this part; or

(2) Ten times the quantity of such material specified in Appendix C of this part; and

(c) The quantity of any licensed or other radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits spec-

[1] Or "Danger."

ified in Appendix B, Table I, Column 2 of this part; and

(d) The gross quantity of licensed and other radioactive material released into the sewerage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

§ 20.304 *Disposal by burial in soil.* No licensee shall dispose of licensed material by burial in soil unless:

(a) The total quantity of licensed and other radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix C of this part; and

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

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

RECORDS, REPORTS, AND NOTIFICATION

§ 20.401 *Records of surveys, radiation monitoring, and disposal.* (a) Each licensee shall maintain records showing the radiation exposures of all individuals subject to personnel monitoring control under § 20.202 of the regulations in this part.

(b) Each licensee shall maintain records showing the name of each individual exposed to radiation pursuant to § 20.101 (a) (2) and the weekly dose of each such individual for the 13 consecutive weeks of highest cumulative weekly dose.

(c) Each licensee shall maintain records in the same units used in the appendices to this part, showing the results of surveys required by § 20.201 (b), and disposals made under §§ 20.302, 20.303, and 20.304.

§ 20.402 *Reports of theft or loss of licensed material.* Each licensee shall report promptly to the Commission, after its occurrence becomes known to the licensee, any loss or theft of licensed material in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

EXCEPTIONS AND ADDITIONAL REQUIREMENTS

§ 20.501 *Applications for exemptions.* The Commission may, upon application by any licensee or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not result in undue hazard to life or property.

§ 20.502 *Additional requirements.* The Commission may, by rule, regulation, or order, impose upon any licensee such requirements, in addition to those established in the regulations in this part, as it deems appropriate or necessary to protect health or to minimize danger to life or property.

ENFORCEMENT

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

APPENDIX A

PERMISSIBLE WEEKLY DOSE

Conditions of exposure		Dose in critical organs (mrem)			
Parts of body	Radiation	Skin, at basal layer of epidermis	Blood forming organs	Gonads	Lens of eye
Whole body	Any radiation with half-value-layer greater than 1 mm of soft tissue	[1] 600	[1] 300	[1] 300	[1] 300
Whole body	Any radiation with half-value-layer less than 1 mm of soft tissue	1,500	300	300	300
Hands and forearms or feet and ankles or head and neck	Any radiation	[2] 1,500			

[1] For exposures of the whole body to X or gamma rays up to 3 mev, this condition may be assumed to be met if the "air dose" does not exceed 300 mr, provided the dose to the gonads does not exceed 300 mrem. "Air dose" means that the dose is measured by an appropriate instrument in air in the region of highest dosage rate to be occupied by an individual, without the presence of the human body or other absorbing and scattering material.

[2] Exposure of these limited portions of the body under these conditions does not alter the total weekly dose of 300 mrem permitted to the bloodforming organs in the main portion of the body, to the gonads, or to the lens of the eye.

APPENDIX B

PERMISSIBLE CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

Material	Table I		Table II	
	Column 1 [1] Air (2)	Column 2 [2] Water (3)	Column 1 [1] Air (3)	Column 2 [2] Water (3)
Ac^{227}	1.6×10^{-8}	1.4×10^{-4}	5×10^{-8}	5×10^{-4}
Ag^{105}	3.6×10^{-8}	5	1.2×10^{-8}	1.6×10^{-4}
Ag^{110}	1×10^{-8}	13	3×10^{-8}	4×10^{-4}
Am^{241}	8×10^{-11}	4×10^{-4}	3×10^{-10}	1.3×10^{-3}
As^{76}	7×10^{-8}	8×10^{-4}	2×10^{-7}	2×10^{-3}
At^{211}	9×10^{-10}	6×10^{-4}	3×10^{-9}	2×10^{-3}
Au^{198}	3.4×10^{-7}	9×10^{-4}	1.1×10^{-6}	3×10^{-3}
Au^{199}	8×10^{-7}	2×10^{-3}	2.5×10^{-6}	7×10^{-3}
$Ba^{140}+La^{140}$	2×10^{-8}	6×10^{-4}	6×10^{-8}	2×10^{-3}
Be^{7}	1.3×10^{-4}	3	4×10^{-7}	1×10^{-2}
Ca^{45}	1.4×10^{-9}	1×10^{-4}	5×10^{-9}	3.6×10^{-4}
$Cd^{109}+Ag^{109}$	9×10^{-9}	1.8×10^{-4}	3×10^{-8}	5×10^{-4}
$Ce^{144}+Pr^{144}$	2×10^{-7}	2×10^{-4}	7×10^{-8}	7×10^{-4}
Cl^{36}	2×10^{-6}	1×10^{-3}	7×10^{-6}	3.6×10^{-3}
Cm^{242}	1×10^{-8}	7×10^{-4}	4×10^{-8}	2.4×10^{-3}
Co^{60}	5×10^{-10}	2.7×10^{-4}	1.8×10^{-9}	1×10^{-3}
Cr^{51}	3.4×10^{-6}	8×10^{-3}	1.2×10^{-5}	1.6×10^{-2}
$Cs^{137}+Ba^{137}$	2.4×10^{-8}	1.4	8×10^{-8}	5×10^{-3}
Cu^{64}	6×10^{-7}	4.5×10^{-4}	2×10^{-6}	1.5×10^{-3}
Eu^{155}	7×10^{-9}	2.5×10^{-3}	6×10^{-8}	8×10^{-3}
Fe^{55}	2×10^{-6}	1×10^{-3}	6×10^{-6}	2×10^{-2}
Fe^{59}	2.7×10^{-8}	2.6	1.2×10^{-7}	9×10^{-3}
Ga^{72}	1.8×10^{-8}	1.3×10^{-4}	6×10^{-8}	4×10^{-3}
Gd^{153}	5×10^{-9}	3.3×10^{-3}	1.5×10^{-8}	1.1×10^{-2}
Ge^{71}	1×10^{-4}	20	3.4×10^{-7}	9×10^{-2}
H^3 (HTO or T_2O)	1×10^{-4}	27	3.6×10^{-6}	9×10^{-2}
Hf^{181}	7×10^{-8}	5×10^{-4}	2.5×10^{-7}	1.6×10^{-3}
Hg^{203}	1×10^{-6}	70	3×10^{-6}	2.3
I^{131}	9×10^{-9}	9×10^{-4}	3×10^{-11}	3×10^{-3}
Ir^{192}	2.2×10^{-6}	4×10^{-3}	7×10^{-6}	1.3×10^{-2}
Ir^{194}	1.5×10^{-7}	2.7×10^{-3}	5×10^{-7}	9×10^{-3}
K^{42}	6×10^{-6}	4×10^{-3}	2×10^{-7}	1.4×10^{-2}
La^{140}	4×10^{-8}	3.6	1.4×10^{-7}	1.1×10^{-2}
Lu^{177}	1.5×10^{-6}	70	5×10^{-6}	2.4
Mn^{54}	8×10^{-8}	5×10^{-3}	2×10^{-7}	1.5×10^{-2}
Mo^{99}	5×10^{-8}	40	1.8×10^{-6}	1.4
Na^{24}	5×10^{-6}	2.4×10^{-3}	1.6×10^{-7}	8×10^{-3}
Nb^{95}	1.3×10^{-8}	1.2×10^{-3}	4×10^{-8}	4×10^{-3}
Nb^{97}	5×10^{-6}	7×10^{-3}	1.6×10^{-5}	2.5×10^{-2}
Nd^{147}	4×10^{-7}	8×10^{-3}	1.4×10^{-6}	2×10^{-2}
Np^{237}	2×10^{-9}	4×10^{-3}	6×10^{-9}	1.4×10^{-2}
$Os^{185}+Rh^{185}$	2×10^{-8}	3×10^{-3}	7×10^{-8}	1×10^{-2}
Pm^{147}	6×10^{-7}	3	2×10^{-6}	1×10^{-2}
Po^{210} (soluble)	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-3}
Po^{210} (insoluble)	2×10^{-9}		7×10^{-9}	
Pr^{143}	3.3×10^{-6}	1	7×10^{-6}	3.6×10^{-3}
Pu^{239} (soluble)	6×10^{-12}	4.5×10^{-5}	2×10^{-11}	1.5×10^{-4}
Pu^{239} (insoluble)	6×10^{-12}		2×10^{-11}	
$Ra^{226}+1/2$ dr	2.4×10^{-11}	1.2×10^{-7}	8×10^{-10}	4×10^{-4}
Rb^{86}	1.1×10^{-6}	9×10^{-4}	4×10^{-6}	3×10^{-3}
Re^{186}	2.4×10^{-6}	2.4×10^{-3}	8×10^{-6}	8×10^{-3}
Rh^{103}	3×10^{-6}	5×10^{-3}	1×10^{-5}	1.6×10^{-2}
$Rh^{105}+dr$	1×10^{-7}	8×10^{-3}	3.3×10^{-6}	2×10^{-2}
$Ru^{106}+Rh^{106}$	8×10^{-9}	4×10^{-3}	3.6×10^{-8}	1.3×10^{-2}
S^{35}	3×10^{-6}	1.5×10^{-3}	1×10^{-5}	5×10^{-3}
Sc^{46}	2×10^{-7}	1	7×10^{-7}	3.6×10^{-3}
Sm^{147}	6×10^{-6}	8×10^{-3}	1.3×10^{-5}	2×10^{-2}
Sn^{113}	1.7×10^{-8}	5×10^{-3}	6×10^{-8}	1.6×10^{-2}
Sr^{89}	6×10^{-8}	2×10^{-3}	2×10^{-7}	7×10^{-3}
$Sr^{90}+Y^{90}$	6×10^{-10}	2.4×10^{-3}	2×10^{-9}	8×10^{-3}
Te^{132}	8×10^{-9}	8×10^{-3}	3×10^{-8}	3×10^{-2}

See footnotes at end of table.