



NORTH AMERICAN INSPECTION, INC.

P.O. BOX 88  
LAURYS STATION, PA. 18059

3020982



***North American Inspection, Inc.***

3906 MAIN STREET  
LAURYS STATION, PENNSYLVANIA 18059

RADIOGRAPHY OPERATIONS MANUAL

DATE ISSUED: February 23, 1985

ISSUED TO: Thomas T. Martin, Director  
U.S.N.R.C. Region I

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MANUAL TRANSMITTAL AND REVISION RECEIPT FORM

MANUAL NO. \_\_\_\_\_ DATE \_\_\_\_\_ MANUAL TYPE RSO - \_\_\_\_\_

RADIOGRAPHY OPERATIONS MANUAL

MANUAL HOLDER \_\_\_\_\_

"MANUAL CHANGES"

1. REMOVE AND DISPOSE OF THE FOLLOWING: \_\_\_\_\_

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2. INSERT THE FOLLOWING REVISIONS: \_\_\_\_\_

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"RECEIPT OF MANUAL TRANSMITTAL OR REVISION STATEMENT"

THE REVISIONS LISTED IN ITEM "2" HAVE BEEN INSERTED IN MANUAL NO. \_\_\_\_\_  
ASSIGNED TO ME, AND THE SUPERSEDED REVISIONS LISTED IN ITEM "1"  
HAVE BEEN REMOVED AND DESTROYED.

SIGNED BY NAII RADIOGRAPHER OR ASST. \_\_\_\_\_

COMPANY \_\_\_\_\_ TITLE \_\_\_\_\_ DATE \_\_\_\_\_

SIGN AND RETURN TO N.A.I.I.'S TECHNICAL DIRECTOR

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## "POLICY STATEMENT"

### RADIATION SAFETY PROGRAM

The procedures and regulations contained herein, are required to provide a uniform and adequate Radiation Safety Program for use of radiation emitting devices used by NORTH AMERICAN INSPECTION, INC.

The Technical Director and/or Radiation Safety Officer (R.S.O.) has the complete authority in implementing the requirements and procedures contained in this program.

Failure of an employee to comply with the procedures and/or regulations set forth herein, shall be just cause for termination from NORTH AMERICAN INSPECTION, INC.

NORTH AMERICAN INSPECTION, INC.

Robert K. Shumway,  
President

RKS:jb



## "DEFINITIONS"

ACTIVATION.....	The process by which neutrons bombard stable atoms to make them radioactive.
AGREEMENT STATE.....	A State which has accepted regulatory authority over byproduct material from the U.S.N.R.C.
ALPHA PARTICLE.....	A positively charged particle emitted by certain radioactive materials. It is made up of two (2) neutrons and two (2) protons, hence it is identical to the nucleus of a helium atom.
ATOM.....	A particle of matter indivisible by chemical means. It is the fundamental building block of chemical elements.
ATOMIC NUMBER.....	Denotes the number of protons in the nucleus, the number of positive charges in the nucleus, and the number of orbiting electrons.
AUTHORIZED PERSONNEL.....	As used in this part - means personnel qualified as Radiographers and Radiographer Assistants in accordance with USNRC - 10-CFR - Part 34 or applicable licensed state regulations.
BACKSCATTER.....	Radiation scattered from the floor, walls, equipment, and other items in the area of a radiation source.

DEFINITIONS: (continued)

- COMPTON SCATTERING (continued).....photon is scattered at an angle to the original photon path.
- CONTAMINATION.....The presence of unwanted radioactive matter, or the "soiling" of objects or materials with "radioactive dirt".
- CURIE.....The basic unit used to describe the intensity of radioactivity in a sample of material. One (1) curie equals 37 billion disintegrations per second, or approximately the radioactivity of one (1) gram of Radium.
- DECAY.....The spontaneous radioactive transformation of one (1) nuclide into a different energy state of the same nuclide. Every decay process has a definite half-life. (see half-life)
- DECONTAMINATION.....The removal of radioactive contaminants from surface, as by cleaning and washing with chemicals.
- DOSE.....The amount of ionizing radiation energy absorbed per unit mass of irradiated material at a specific location; such as, a part of the human body. Measured in rems and rads.
- DOSE RATE.....The radiation dose delivered per unit time and measured, for instance, in rems per hour. (see dose)
- DOSIMETER.....A device that measures radiation dose. It contains an ionization chamber.



DEFINITIONS: (continued)

- BETA PARTICLE (BETA RAY).....An elementary particle emitted from a nucleus during radioactive decay. It has a single electrical charge and a mass equal to 1/1840 that of a proton. Beta particles are easily stopped by a thin sheet of metal. A negatively charged beta particle is physically identical to the electron. If the beta particle is positively charged, it is called a positron. Beta radiation may cause skin burns and beta emitters are harmful if inhaled or ingested.
- BY-PRODUCT MATERIAL.....In atomic energy law, any radioactive material (except source or fissionable material) obtained in the process of producing or using source or fissionable material. Includes fission products and many other radioisotopes produced in nuclear reactors.
- CALIBRATION.....As used in this part - means to check the accuracy of radiation measuring instruments against a known standard and correct as required.
- CESIUM-137.....A radioisotope of the element Cesium.
- COBALT-60.....A radioisotope of the element Cobalt.
- COLLIMATOR.....A beam shaping device which utilizes shielding material to restrict the direction in which radiation is emitted.
- COMPTON SCATTERING.....A process in which a photon transfers a portion of its energy to an orbital electron in matter and a lower energy



DEFINITIONS: (continued)

- DOSIMETER CHARGER.....A device used to charge a dosimeter.
- ELECTROMAGNETIC RADIATION.....Radiation consisting of electric and magnetic waves that travel at the speed of light. e.g. light, radio waves, gamma-rays, x-rays. All can be transmitted through a vacuum.
- GEIGER COUNTER.....A radiation detection and measuring instrument. It contains a gas-filled tube which discharges electrically when ionizing radiation passes through it. Discharges are counted to measure the radiations intensity.
- GENETIC EFFECTS OF RADIATION.....Effects that produce changes in those cells of organisms which give rise to egg or sperm cells and therefore affect offspring of the exposed individuals.
- 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.
- HALF-LIFE.....The time in which half the atoms in a radioactive substance disintegrate. Half-lives vary from millionths of a second to billions of years.



DEFINITIONS: (continued)

HALF-LIFE - BIOLOGICAL.....	The time required for a biological system, such as a man or an animal, to eliminate by natural processes, half the amount of a substance which has entered it.
HALF-VALUE LAYER.....	Is that thickness of material required to absorb one-half of the impinging radiation.
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 (1) hour a dose in excess of 100 millirem.
ELECTRON.....	An elementary particle with a unit negative electrical charge and a mass 1/1840 that of the proton. Electrons surround the atoms positively charged nucleus and determine the atoms chemical properties.
ELEMENT.....	One of the 104 known chemical substances that cannot be divided into simpler substances by chemical means. e.g. hydrogen, lead uranium.
EMERGENCY PROCEDURE.....	Procedure to be followed by radiographers and radiographer assistants in the event of an accident, equipment malfunction or uncontrolled conditions existing while engaging in radiographic activities.
ENCAPSULATION.....	The process of sealing radioactive materials to prevent contamination.



DEFINITIONS: (continued)

EXPOSURE.....	Radiation intensity multiplied by time.
FILM BADGE.....	A package of photographic film worn like a badge by workers in the nuclear industry to measure exposure to ionizing radiation. The absorbed dose can be calculated by the degree of film darkening caused by the irradiation.
GAMMA-RAYS.....	High energy short wavelength electromagnetic radiation emitted by a nucleus. Energies of gamma-rays are usually between 0.010 and 10 MEV x-rays also occur in this energy range, but are not of nuclear origin. Gamma-radiation usually accompanies alpha and beta emissions and always accompanies fission. Gamma-rays are very penetrating and are best attenuated by dense materials like lead and depleted uranium.
HOT CELLS.....	A heavily shielded enclosure in which radioactive materials can be handled remotely through the use of manipulators and viewed through shielded windows so that there is no danger to personnel.
INDUCED RADIOACTIVITY.....	Radioactivity that is created by bombarding a substance with neutrons in a reactor or with charged particles produced by particle accelerators.
INVERSE SQUARE LAW.....	(at a distance from a point source) The intensity of radiation received varies as the inverse square of the distance of the source.



DEFINITIONS: (continued)

- ION.....An atom or molecule that has lost or gained one or more electrons. By such "ionization" it becomes electrically charged.
- IONIZATION.....The process of adding electrons to, or knocking electrons from, atoms or molecules thereby creating ions. High temperatures, electrical discharges, and nuclear radiation can cause ionization.
- IONIZATION CHAMBER.....An instrument that detects and measures ionizing radiation by observing the electrical current created when radiation ionizes gas in the chamber, making it a conductor of electricity.
- IONIZING RADIATION.....Any radiation that directly or indirectly displaces electrons from the orbital shell of atoms. e.g. alpha, beta, gamma-radiation.
- IRIDIUM 192.....A radioisotope of the element Iridium.
- ISOTOPE.....Atoms with the same atomic number (same chemical element) but different atomic weights. An equivalent statement is that the nuclei have the same number of protons but different numbers of neutrons. Thus  ${}^6\text{C}^{12}$ ,  ${}^6\text{C}^{13}$ , and  ${}^6\text{C}^{14}$  are isotopes of the element carbon, the subscripts denoting their common atomic numbers, the superscripts denoting the varying atomic weights.
- LEAK TEST.....A test on sealed sources to assure that radioactive material is not being released



DEFINITIONS: (continued)

LICENSED MATERIAL.....	Source material, special nuclear material, or byproduct material received, possessed, used, or transferred under a general or special license issued by the Nuclear Regulatory Commission.
MASS NUMBER.....	The sum of the neutrons and protons in a nucleus. The mass number of Uranium 235 is 235. It is the nearest whole number to the atoms actual atomic weight.
MAXIMUM PERMISSIBLE DOSE (MPD).....	That dose of ionizing radiation which competent authorities have established as the maximum that can be absorbed without undue risk to human health. 5 (N-18)
MEV.....	Million electron volts.
MILLI.....	A prefix that divides a basic unit by one thousand.
NEUTRON.....	An uncharged elementary particle with a mass nearly equal to that of the proton. The isolated neutron is unstable and decays with a half-life of about 13 minutes into an electron, proton, and neutrino. Neutrons sustain the fission chain reaction in a nuclear reactor.
NONDESTRUCTIVE TESTING.....	Testing to detect internal and concealed defects in materials using techniques that do not damage or destroy the items being tested.
NUCLEAR REACTOR.....	A device by means of which a fission chain reaction can be initiated, maintained, and controlled. Its essential

DEFINITIONS: (continued)

- NUCLEAR REACTOR (continued).....component is a core with a fissionable fuel. It usually has a moderator, a reflector, shielding, and control mechanisms.
- NUCLEUS.....The small, positively charged core of an atom. It is only about 1/10,000 the diameter of the atom but contains nearly all the mass. Except for ordinary hydrogen, all nuclei contain both protons and neutrons.
- OCCUPATIONAL DOSE.....Includes exposure of an individual to radiation (1) in a Restricted Area; or (2) in the course of employment in which the individuals duties involved exposure to radiation; provided that "Occupational Dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.
- OPERATING PROCEDURE(S).....As used in this part - instructions to be "STRICTLY" followed for radiographic activities.
- PERSON.....Means (1) any individual, corporation, partnership, firm, association, trust, estate, government agency other than the commission, and 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.

DEFINITIONS: (continued)

PERSONNEL MONITORING EQUIPMENT.....	Means device 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.
PHOTOELECTRIC EFFECT.....	A process by which electromagnetic radiation imparts energy to matter.
PHOTON.....	A discrete quantity of electromagnetic energy. Photons have momentum but no mass or electrical charge.
PROJECTOR.....	As used in this part - a radiographic exposure device containing a licensed radioactive isotope for industrial radiography applications.
PROTON.....	An elementary particle with a single positive electrical charge and a mass approximately 1840 times that of the electron. The atomic number of an atom is equal to the number of protons in its nucleus.
RAD.....	Radiation absorbed dose. The basic unit of absorbed dose of ionizing radiation. One rad is equal to the absorption of 100 ergs of radiation energy per gram of matter.
RADIATION.....	The propagation of energy through matter or space in the form of waves. In atomic physics the term has been extended to include fast-moving particles. (alpha and beta rays, free neutrons, etc) Gamma-rays and x-rays, of particular interest in atomic



DEFINITIONS: (continued)

- RADIATION (continued).....physics, are electromagnetic radiation in which energy is propagated in packets called photons.
- 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 (1) hour a dose in excess of five (5) millirem, or in any five (5) consecutive days, a dose in excess of one hundred (100) millirems.
- RADIATION SAFETY OFFICER (R.S.O.).....An individual engaged in the practices of providing radiation protection. He is the representative appointed by the licensee for liaison with the Nuclear Regulatory Commission.
- RADIATION SAFETY.....The process of using an instrument (survey meter) to measure the presence of ionizing radiation.
- RADIATION SURVEY METER.....An instrument that instantly measures radiation rate or intensity. Used for monitoring Radiation Area.
- RADIOACTIVE.....Atoms which are energetically unstable and decay to a stable condition by emitting radiation are said to be radioactive.
- RADIOGRAPHER.....Means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and



DEFINITIONS: (continued)

- RADIOGRAPHER (continued).....who is responsible to the licensee for assuring compliance with the requirements of these regulations and the conditions of the license.
- RADIOGRAPHER'S ASSISTANT.....Means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or survey instruments in radiography.
- RADIOGRAPHIC EXPOSURE DEVICE.....Means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purposes of making a radiographic exposure. This may also refer to machines which produce ionizing radiation.
- RADIOGRAPHY.....Means the examination of the structure of materials by nondestructive methods utilizing sealed sources of by-product material and other sources of ionizing radiation.
- RADIOISOTOPE.....An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. More than 1300 natural and artificial radioisotopes have been identified.
- REDUCTION FACTOR.....Dose rate without a shield divided by the dose rate with a shield interposed between source and a point at which radiation is measured.





DEFINITIONS: (continued)

REGISTRATION STATES.....	States that "do not" have jurisdictional licensing control of radioactive material but are governed by the U.S.N.R.C. regulatory requirements. However, these states require that radiation producing devices used within their state be <u>registered</u> .
RELATIVE BIOLOGICAL EFFECTIVENESS - (RBE).....	The relative effectiveness of a given kind of ionizing radiation in producing a biological response as compared with 250,000 electron volt gamma-rays.
REM.....	Roentgen equivalent man. A unit of absorbed radiation dose in biological matter. It is equal to the absorbed dose in rads multiplied by the relative biological effectiveness of the radiation.
RESTRICTED AREA.....	Means any area to which access is controlled by the licensee.
ROENTGEN.....	A unit of exposure dose of ionizing radiation. It is that amount of gamma or x-rays required to produce ions carrying one (1) electrostatic unit of electrical charge in one (1) cubic centimeter of dry air under standard conditions.
SCATTERING.....	A process that changes a particles or photons trajectory. Scattering is caused by collisions with atoms, nuclei, and other particles. If the scattered particles energy is unchanged by the collision, elastic scattering prevails; if there

DEFINITIONS: (continued)

- SCATTERING (continued).....is a change in energy, the process is called inelastic scattering.
- SEALED SOURCE.....Means any by-product material that is encased in a capsule designed to prevent leakage or escape of the by-product material.
- SHIELD.....A layer or mass of material used to reduce the passage of ionizing radiation.
- SOURCE.....A radioactive material packaged so as to produce radiation for experimental or industrial use. In this manual, the term "source" also refers to the "target" of an x-ray tube.
- SOURCE PIPE POSITIONER.....A source positioning device for making single wall exposures on piping by means of a radiographic access hole or opening.
- STABLE ISOTOPE.....A nuclide that does not undergo radioactive decay.
- STORAGE CONTAINER.....Means a device in which sealed sources are transported or stored.
- 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.



DEFINITIONS: (continued)

SURVEY METER.....	A portable instrument which measures dose rate of exposure or radiation intensity.
UNRESTRICTED AREA.....	Means any area into which entry is not controlled by the licensee, and any area used for residential quarters.
U.S.N.R.C.....	United States Nuclear Regulatory Commission.
WASTE, RADIOACTIVE.....	Equipment and materials (from nuclear operations) which are radioactive and for which there is no further use.
X-RAY.....	Penetrating electromagnetic radiation emitted when the inner orbital electrons of an atom are excited and release energy. Thus, the radiation is not nuclear in origin and is generated in practice by bombarding a metallic target with high-speed electrons.

UNITED STATES NUCLEAR REGULATORY COMMISSION  
RULES and REGULATIONS

TITLE 10, CHAPTER 1, CODE OF FEDERAL REGULATIONS—ENERGY

**PART  
19**

**NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS;  
INSPECTIONS**

**Sec.**

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- 19.2 Scope.
- 19.3 Definitions.
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Authority: Secs. 52, 53, 54, 103, 104, 181, 186, 56 Stat. 330, 331, 332, 336, 337, 346, 358, as amended; sec. 234, 33 Stat. 444, as amended (42 U.S.C. 2033, 2034, 2111, 2133, 2134, 2201, 2206, 2207); sec. 371, 56 Stat. 1242, as amended by Pub. L. 94-78, 56 Stat. 413 (42 U.S.C. 5841); Pub. L. 95-601, sec. 12, 92 Stat. 2961 (42 U.S.C. 5851).

For the purposes of sec. 221, 56 Stat. 358, as amended (42 U.S.C. 2207); §§ 19.11(a), (c), (d), and (e) and 19.12 are issued under sec. 181b, 56 Stat. 348, as amended (42 U.S.C. 2201(b)); and §§ 19.13 and 19.14(a) are issued under sec. 181c, 56 Stat. 350, as amended (42 U.S.C. 2201(c)).

**§ 19.1 Purpose.**

The regulations in this part establish requirements for notices, instructions, and reports by licensees to individuals participating in licensed activities, and options available to such individuals in connection with Commission inspections of licensees to ascertain compliance with the provisions of the Atomic Energy Act of 1954, as amended, Title II of the Energy Reorganization Act of 1974, and regulations, orders, and licenses thereunder regarding radiological working conditions.

**§ 19.2 Scope.**

The regulations in this part apply to all persons who receive, possess, use, or transfer material licensed by the Nuclear Regulatory Commission pursuant to the regulations in Parts 30 through 35, 40, 60, 61, 70 or 72 of this chapter, including persons licensed to operate a production or utilization facility pursuant to Part 50 of this chapter and persons licensed to possess power reactor spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter.

**§ 19.3 Definitions.**

As used in this part:

(a) "Act" means the Atomic Energy Act of 1954, (56 Stat. 919) including any amendments thereto;

(b) "Commission" means the United States Nuclear Regulatory Commission;

(c) "Worker" means an individual engaged in activities licensed by the Commission and controlled by a licensee, but does not include the licensee.

(d) "License" means a license issued under the regulations in Parts 30 through 35, 40, 60, 61, 70 or 72 of this chapter, including licenses to operate a production or utilization facility pursuant to Part 50 of this chapter and licenses to possess power reactor spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter. "Licensee" means the holder of such a license.

(e) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "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.

**§ 19.4 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.

**§ 19.5 Communications.**

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Director, Office of Inspection and Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. Communications, reports, and applications may be delivered in person at the Commission's offices at 1717 H Street, NW., Washington, D.C.; or at 7920 Norfolk Avenue, Bethesda, Maryland.

**§ 19.11 Posting of notices to workers.**

(a) Each licensee shall post current copies of the following documents: (1) The regulations in this part and in Part 20 of this chapter; (2) the license, license conditions, or documents incorporated into a license by reference, and amendments thereto; (3) the operating procedures applicable to licensed activities; (4) any notice of violation involving radiological working conditions, proposed imposition of civil penalty, or order issued pursuant to Subpart E of Part 2 of this chapter, and any response from the licensee.

(b) If posting of a document specified in paragraph (a) (1), (2) or (3) of this section is not practicable, the licensee may post a notice which describes the document and states where it may be examined.

(c) Each licensee and applicant shall post Form NRC-1, (Revision 6-82 or later) "Notice to Employees," as required by Parts 30, 40, 50, 60, 70, 72, and 150 of this chapter.

(d) Documents, notices, or forms posted pursuant to this section shall appear in a sufficient number of places to permit individuals engaged in licensed activities to observe them on the way to or from any particular licensed activity location to which the document applies, shall be conspicuous, and shall be replaced if defaced or altered.

(e) Commission documents posted pursuant to paragraph (a) (4) of this section shall be posted within 2 working days after receipt of the documents from the Commission; the licensee's response, if any, shall be posted within 2 working days after dispatch by the licensee. Such documents shall remain posted for a minimum of 3 working days or until action correcting the violation has been completed, whichever is later.

**§ 19.12 Instructions to workers.**

All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area; shall be instructed in the health protection problems associated with exposure to such radioactive materials or radiation, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed; shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of Commission regulations



# PART 19 • NOTICES, INSTRUCTIONS, AND REPORTS TO WORKERS: INSPECTIONS

and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas: shall be instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of Commission regulations and licenses or unnecessary exposure to radiation or to radioactive material; shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and shall be advised as to the radiation exposure reports which workers may request pursuant to § 19.13. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area.

## § 19.13 Notifications and reports to individuals.

(a) Radiation exposure data for an individual, and the results of any measurements, analyses, and calculations of radioactive material deposited or retained in the body of an individual, shall be reported to the individual as specified in this section. The information reported shall include data and results obtained pursuant to Commission regulations, orders or license conditions, as shown in records maintained by the licensee pursuant to Commission regulations. Each notification and report shall be in writing; include appropriate identifying data such as the name of the licensee, the name of the individual, the individual's social security number; include the individual's exposure information; and contain the following statement:

This report is furnished to you under the provisions of the Nuclear Regulatory Commission regulation 10 CFR Part 19. You should preserve this report for further reference.

(b) At the request of any worker, each licensee shall advise such worker annually of the worker's exposure to radiation or radioactive material as shown in records maintained by the licensee pursuant to § 20.401(a) and (c).

(c) At the request of a worker formerly engaged in licensed activities controlled by the licensee, each licensee shall furnish to the worker a report of the worker's exposure to radiation or radioactive material. Such report shall be furnished within 30 days from the time the request is made, or within 30 days after the exposure of the individual has been determined by the licensee, whichever is later; shall cover, within the period of time specified in the request, each calendar quarter in which the worker's activities involved exposure to radiation from radioactive materials licensed by the Commission; and shall include the dates and locations of licensed activities in which the worker participated during this period.

(d) When a licensee is required pursuant to § 20.406 or § 20.408 of this chapter to report to the Commission any exposure of an individual to radiation or radioactive material, the licensee shall also provide the individual a report on his exposure data included therein. Such

report shall be transmitted at a time not later than the transmittal to the Commission.

(e) At the request of a worker who is terminating employment in a given calendar quarter with the licensee in work involving radiation dose, or of a worker who, while employed by another person, is terminating assignment to work involving radiation dose in the licensee's facility in that calendar quarter, each licensee shall provide to each such worker, or to the worker's designee, at termination, a written report regarding the radiation dose received by that worker from operations of the licensee during that specifically identified calendar quarter or fraction thereof, or provide a written estimate of that dose if the finally determined personnel monitoring results are not available at that time. Estimated doses shall be clearly indicated as such.

## § 19.14 Presence of representatives of licensee and workers during inspections.

(a) Each licensee shall afford to the Commission at all reasonable times opportunity to inspect materials, activities, facilities, premises, and records pursuant to the regulations in this chapter.

(b) During an inspection, Commission inspectors may consult privately with workers as specified in § 19.15. The licensee or licensee's representative may accompany Commission inspectors during other phases of an inspection.

(c) If, at the time of inspection, an individual has been authorized by the workers to represent them during Commission inspections, the licensee shall notify the inspectors of such authorization and shall give the workers' representative an opportunity to accompany the inspectors during the inspection of physical working conditions.

(d) Each workers' representative shall be routinely engaged in licensed activities under control of the licensee and shall have received instructions as specified in § 19.12.

(e) Different representatives of licensee and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection. However, only one workers' representative at a time may accompany the inspectors.

(f) With the approval of the licensee and the workers' representative an individual who is not routinely engaged in licensed activities under control of the licensee, for example, a consultant to the licensee or to the workers' representative, shall be afforded the opportunity to accompany Commission inspectors during the inspection of physical working conditions.

(g) Notwithstanding the other provisions of this section, Commission inspectors are authorized to refuse to permit accompaniment by any individual who

deliberately interferes with a fair and orderly inspection. With regard to areas containing information classified by an agency of the U.S. Government in the interest of national security, an individual who accompanies an inspector may have access to such information only if authorized to do so. With regard to any area containing proprietary information, the workers' representative for that area shall be an individual previously authorized by the licensee to enter that area.

## § 19.15 Consultation with workers during inspections.

(a) Commission inspectors may consult privately with workers concerning matters of occupational radiation protection and other matters related to applicable provisions of Commission regulations and licenses to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.

(b) During the course of an inspection any worker may bring privately to the attention of the inspectors, either orally or in writing, any past or present condition which he has reason to believe may have contributed to or caused any violation of the act, the regulations in this chapter, or license condition, or any unnecessary exposure of an individual to radiation from licensed radioactive material under the licensee's control. Any such notice in writing shall comply with the requirements of § 19.18(a).

(c) The provisions of paragraph (b) of this section shall not be interpreted as authorization to disregard instructions pursuant to § 19.12.

## § 19.16 Requests by workers for inspections.

(a) Any worker or representative of workers who believes that a violation of the Act, the regulations in this chapter, or license conditions exists or has occurred in license activities with regard to radiological working conditions in which the worker is engaged, may request an inspection by giving notice of the alleged violation to the Director of Inspection and Enforcement, to the Director of the appropriate Commission Regional Office, or to Commission inspectors. Any such notice shall be in writing, shall set forth the specific grounds for the notice, and shall be signed by the worker or representative of workers. A copy shall be provided the licensee by the Director of Inspection and Enforcement, Regional Office Director,

or the inspector no later than at the time of inspection except that, upon the request of the worker giving such notice, his name and the name of individuals referred to therein shall not appear in such copy or on any record published, released, or made available by the Commission, except for good cause shown.

(b) If, upon receipt of such notice, the Director of Inspection and Enforcement or Regional Office Director determines that the complaint meets the requirements set forth in paragraph (a) of this section, and that there are reasonable grounds to believe that the alleged violation exists or has occurred, he shall cause an inspection to be made as soon as practicable, to determine if such alleged violation exists or has occurred. Inspections pur-

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suant to this section need not be limited to matters referred to in the complaint.

## § 19.17 Inspections not warranted: informal review.

(a) If the Director of Inspection and Enforcement or of the appropriate Regional Office determines, with respect to a complaint under § 19.16, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, he shall notify the complainant in writing of such determination. The complainant may obtain review of such determination by submitting a written statement of position with the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, who will provide the licensee with a copy of such statement by certified mail, excluding, at the request of the complainant, the name of the complainant. The licensee may submit an opposing written statement of position with the Executive Director for Operations who will provide the complainant with a copy of such statement by certified mail. Upon the request of the complainant, the Executive Director for Operations or his designee may hold an informal conference in which the complainant and the licensee may orally present their views. An informal conference may also be held at the request of the licensee, but disclosure of the identity of the complainant will be made only following receipt of written authorization from the complainant. After considering all written and oral views presented, the Executive Director for Operations shall affirm, modify, or reverse the determination of the Director of Inspection and Enforcement or of the appropriate Regional Office and furnish the complainant and the licensee a written notification of his decision and the reason therefor.

(b) If the Director of Inspection and Enforcement or of the appropriate Regional Office determines that an inspection is not warranted because the requirements of § 19.16(a) have not been met, he shall notify the complainant in writing of such determination. Such determination shall be without prejudice to the filing of a new complaint meeting the requirements of § 19.16(a).

## § 19.30 Violations.

An injunction or other court order may be obtained prohibiting any violation of any provision of the Act or Title II of the Energy Reorganization Act of 1974, or any regulation or order issued thereunder.

A court order may be obtained for the payment of a civil penalty imposed pursuant to section 234 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act or any rule, regulation, or order issued thereunder, or any term, condition or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. 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.

## § 19.31 Application 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.

## § 19.32 Discrimination prohibited.

No person shall on the ground of sex be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity licensed by the Nuclear Regulatory Commission. This provision will be enforced through agency provisions and rules similar to those already established, with respect to racial and other discrimination, under title VI of the Civil Rights Act of 1964. This remedy is not exclusive, however, and will not prejudice or cut off any other legal remedies available to a discriminatee.

## § 19.33 Employee protection.

Employment discrimination by a licensee or a contractor or subcontractor of a licensee against an employee for engaging in protected activities under this part or Parts 30, 40, 50, 60, 70, 72, or 150 of this chapter is prohibited.

UNITED STATES NUCLEAR REGULATORY COMMISSION  
RULES and REGULATIONS

TITLE 10, CHAPTER 1, CODE OF FEDERAL REGULATIONS—ENERGY

**PART  
20**

**STANDARDS FOR PROTECTION AGAINST RADIATION**

**PART 20—STANDARDS FOR  
PROTECTION AGAINST RADIATION**

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Authority: Secs. 53, 53, 53, 51, 103, 104, 101, 98 Stat. 930, 933, 935, 936, 937, 948, as amended, (42 U.S.C. 2073, 2083, 2095, 2111, 2133, 2134, 2201); sec. 201, as amended, 202, 206, Pub. L. 93-438, 88 Stat. 1242, 1244, 1246, Pub. L. 94-79, 88 Stat. 413 (42 U.S.C. 5841, 5842, 5846).

For the purposes of sec. 223, 68 Stat. 556, as amended, (42 U.S.C. 2273), §§ 20.101, 20.102, 20.103(a) (b), and (f), 20.104 (a) and (b), 20.105(b), 20.106(a), 20.201, 20.202(a), 20.206, 20.207, 20.301, 20.303, 20.304 and 20.305 are issued under sec. 181b, 68 Stat. 948, as amended, (42 U.S.C. 2201(b)); and §§ 20.102, 20.103(e), 20.401-20.407, 20.408(b) and 20.409 are issued under sec. 181c, 68 Stat. 950, as amended, (42 U.S.C. 2201(c)).

**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 Nuclear Regulatory Commission and are issued pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974.

(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 the total dose to an individual (including exposures to licensed and unlicensed radioactive material and to other unlicensed sources of radiation, whether in the possession of the licensee or any other person, but not including exposures to radiation from natural background sources or medical diagnosis and therapy) does not exceed the standards of radiation protection prescribed in the regulations in this part.

(c) In accordance with recommendations of the Federal Radiation Council, approved by the President, persons engaged in activities under licenses issued by the Nuclear Regulatory Commission pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974

should, in addition to complying with the requirements set forth in this part, make every reasonable effort to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable. The term "as low as is reasonably achievable" means as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest.

§ 20.2 Scope.

The regulations in this part apply to all persons who receive, possess, use, or transfer material licensed pursuant to the regulations in Parts 30 through 35.40, 60, 61, 70, or 72 of this chapter, including persons licensed to operate a production or utilization facility pursuant to Part 50 of this chapter and persons licensed to possess power reactor spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter.

§ 20.3

§ 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) "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 such that no day is included in more than one calendar quarter or omitted from inclusion within a calendar quarter. No licensee shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.



# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

(5) "Commission" means the Nuclear Regulatory Commission or its duly authorized representatives;

(6) "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;

(7) "Individual" means any human being;

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

(9) "License" means a license issued under the regulations in Parts 30 through 35, 40, 60, 61, 70 or 72 of this chapter. "Licensee" means the holder of such license;

(10) "Occupational dose" includes exposure of an individual to radiation (i) in a restricted area; or (ii) in the course of employment in which the individual's duties involve exposure to radiation, provided, that "occupational dose" shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

(11) "Person" means: (i) Any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, Government agency other than the Commission or the Department (except that the Department shall be considered a person within the meaning of the regulations in this part to the extent that its facilities and activities are subject to the licensing and related regulatory authority of the Commission pursuant to section 202 of the Energy Reorganization Act of 1974 (88 Stat. 1244)), any State, any foreign government or nation or any political subdivision of any such government or nation, or other entity; and (ii) any legal successor, representative, agent, or agency of the foregoing.

(12) "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;

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

(14) "Restricted area" means any area access to which is controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials. "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;

(15) "Source material" means: (i) Uranium or thorium, or any combination thereof, in any physical or chemical form; or (ii) ores which contain by weight one-twentieth of one percent (0.05%) or more of (a) uranium, (b) thorium or (c) any combination thereof. Source material does not include special nuclear material.

(16) "Special nuclear material" means: (i) 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 (ii) any material artificially enriched by any of the foregoing but does not include source material;

(17) "Unrestricted area" means any area access to which is not controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive materials, and any area used for residential quarters.

(18) "Department" means the Department of Energy established by the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565, 42 U.S.C. 7101 *et seq.*) to the extent that the Department, or its duly authorized representatives, exercises functions formerly vested in the U.S. Atomic Energy Commission, its Chairman, members, officers and components and transferred to the U.S. Energy Research and Development Administration and to the Administrator thereof pursuant to sections 104 (b), (c) and (d) of the Energy Reorganization Act of 1974 (Pub. L. 93-438, 88 Stat. 1233

at 1237, 42 U.S.C. 5814) and retransferred to the Secretary of Energy pursuant to section 301(a) of the Department of Energy Organization Act (Pub. L. 95-91, 91 Stat. 565 at 577-578, 42 U.S.C. 7151).

(19) "Termination" means the end of employment with the licensee or, in the case of individuals not employed by the licensee, the end of a work assignment in the licensee's restricted areas in a given calendar quarter, without expectation or specific scheduling of reentry into the licensee's restricted areas during the remainder of that calendar quarter.

(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 § 20.203;

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

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

(4) "Survey" defined in § 20.201;

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

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

## § 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 time. Several different units of dose are in current use. Definitions of units as used in this part are set forth in paragraphs (b) and (c) of this section.

(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 tissues 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;

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(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 paragraph (c)(3) of this section, 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 FLUX DOSE EQUIVALENTS

Neutron energy (Mev)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm <sup>2</sup> )	Average flux to deliver 100 millirem in 40 hours (neutrons/cm <sup>2</sup> sec.)
Thermal	$970 \times 10^4$	670
0.0001	$720 \times 10^4$	500
0.005	$820 \times 10^4$	570
0.02	$400 \times 10^4$	280
0.1	$120 \times 10^4$	80
0.5	$43 \times 10^4$	30
1.0	$26 \times 10^4$	18
2.5	$29 \times 10^4$	20
5.0	$26 \times 10^4$	18
7.5	$24 \times 10^4$	17
10	$24 \times 10^4$	17
10 to 30	$14 \times 10^4$	10

(d) For determining exposures to X or gamma rays up to 3 Mev, the dose limits specified in §§ 20.101 to 20.104, inclusive, may be assumed to be equivalent to the "air dose". For the purpose of this part "air dose" means that the dose is measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dosage rate.

## § 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 =  $3.7 \times 10^{10}$  disintegrations per second (dps) =  $2.2 \times 10^{12}$  disintegrations per minute (dpm). Commonly used submultiples of the curie are the millicurie and the microcurie:

(1) One millicurie (mCi) = 0.001 curie (Ci) =  $3.7 \times 10^7$  dps.

(2) One microcurie (μCi) = 0.000001 curie =  $3.7 \times 10^4$  dps.

(b) [Deleted 40 FR 50704.]

(c) [Deleted 39 FR 23990.]

## § 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.

## § 20.7 Communications.

Except where otherwise specified in this part, all communications and reports concerning the regulations in this part should be addressed to the Executive Director for Operations, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. Communications, reports, and applications may be delivered in person at the Commission's offices at 1717 H Street NW., Washington, D.C.; or at 7920 Norfolk Avenue, Bethesda, Maryland.

## PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

### § 20.101 Radiation dose standards for individuals in restricted areas.

(a) In accordance with the provisions of § 20.102(a), and except as provided in paragraph (b) of this section, 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 one calendar quarter from radioactive material and other sources of radiation a total occupational dose in excess of the standards specified in the following table:

#### REMS PER CALENDAR QUARTER

1. Whole body, head and trunk, active blood-forming organs, lens of eyes, or gonads	1 1/4
2. Hands and forearms, feet and ankles	18 1/2
3. Skin of whole body	7 1/2

(b) A licensee may permit an individual in a restricted area to receive a total occupational dose to the whole body greater than that permitted under paragraph (a) this section, provided:

(1) During any calendar quarter the total occupational dose to the whole body shall not exceed 3 rems; and

(2) 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

(3) The licensee has determined the individual's accumulated occupational dose to the whole body on Form NRC-4, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of § 20.102. As used in paragraph (b), "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.

### § 20.102 Determination of prior dose.

(a) Each licensee shall require any individual, prior to first entry of the individual into the licensee's restricted area during each employment or work assignment under such circumstances that the individual will receive or is likely to receive in any period of one calendar quarter an occupational dose in excess of 25 percent of the applicable standards specified in § 20.101(a) and § 20.104(a), to disclose in a written, signed statement, either: (1) That the individual had no prior occupational dose during the current calendar quarter, or (2) the nature and amount of any occupational dose which the individual may have received during that specifically identified current calendar quarter from sources of radiation possessed or controlled by other persons. Each licensee shall maintain records of such statements until the Commission authorizes their disposition.

(b) Before permitting, pursuant to § 20.101(b), any individual in a restricted area to receive an occupational radiation dose in excess of the standards specified in § 20.101(a), each licensee shall:

(1) Obtain a certificate on Form NRC-4, 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 NRC-4 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 § 20.101(b).

(c)(1) In the preparation of Form NRC-4, or a clear and legible record containing all the information required in that form, the licensee shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee obtains

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such reports, the licensee shall use the dose shown in the report in preparing the form. In any case where a licensee 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 exposure in rems for calendar quarters prior to Jan. 1, 1961	Column 2— Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye	3%	1%

(2) The licensee shall retain and preserve records used in preparing Form NRC-4 until the Commission authorizes their disposition.

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 paragraph (b) of § 20.101, the excess may be disregarded.

## § 20.103 Exposure of individuals to concentrations of radioactive materials in air in restricted areas.

(a)(1) No licensee shall possess, use, or transfer licensed material in such a manner as to permit any individual in a restricted area to inhale a quantity of radioactive material in any period of one calendar quarter greater than the quantity which would result from inhalation for 40 hours per week for 13 weeks at uniform concentrations of radioactive material in air specified in Appendix B, Table I, Column 1.<sup>123</sup> If

the radioactive material is of such form that intake by absorption through the skin is likely, individual exposures to radioactive material shall be controlled so that the uptake of radioactive material by any organ from either inhalation or absorption or both routes of intake<sup>124</sup> in any calendar quarter does not exceed that which would result from inhaling such radioactive material for 40 hours per week for 13 weeks at uniform concentrations specified in Appendix B, Table I, Column 1.

(2) No licensee shall possess, use, or transfer mixtures of U-234, U-235, and U-238 in soluble form in such a

manner as to permit any individual in a restricted area to inhale a quantity of such material in excess of the intake limits specified in Appendix B, Table I, Column 1 of this part. If such soluble uranium is of a form such that absorption through the skin is likely, individual exposures to such material shall be controlled so that the uptake of such material by any organ from

either inhalation or absorption or both routes of intake<sup>125</sup> does not exceed that which would result from inhaling such material at the limits specified in Appendix B, Table I, Column 1 and footnote 4 thereto.

(3) For purposes of determining compliance with the requirements of this section the licensee shall use suitable measurements of concentrations of radioactive materials in air for detecting and evaluating airborne radioactivity in restricted areas and in addition, as appropriate, shall use measurements of radioactivity in the body, measurements of radioactivity excreted from the body, or any combination of such measurements as may be necessary for timely detection and assessment of individual intakes of radioactivity by exposed individuals. It is assumed that an individual inhales radioactive material at the airborne concentration in which he is present unless he uses respiratory protective equipment pursuant to paragraph (c) of this section. When assessment of a particular individual's intake of radioactive material is necessary, intakes less than those which would result from inhalation for 2 hours in any one day or for 10 hours in any one week at uniform concentrations specified in Appendix B, Table I, Column 1 need not be included in such assessment, provided that for any assessment in excess of these amounts the entire amount is included.

(b)(1) The licensee shall, as a precautionary procedure, use process or other engineering controls, to the extent practicable, to limit concentrations of radioactive materials in air to levels below those which delimit an airborne radioactivity area as defined in § 20.203(d)(1)(ii).

(2) When it is impracticable to apply process or other engineering controls to limit concentrations of radioactive material in air below those defined in § 20.203(d)(1)(ii), other precautionary procedures, such as increased surveillance, limitation of working times, or provision of respiratory protective equipment, shall be used to maintain intake of radioactive material by any individual within any period of seven consecutive days as far below that intake of radioactive material which

would result from inhalation of such material for 40 hours at the uniform concentrations specified in Appendix B, Table I, Column 1 as is reasonably achievable. Whenever the intake of radioactive material by any individual exceeds this 40-hour control measure, the licensee shall make such evaluations and take such actions as are necessary to assure against recurrence. The licensee shall maintain records of such occurrences, evaluations, and actions taken in a clear and readily identifiable form suitable for summary review and evaluation.

(c) When respiratory protective equipment is used to limit the inhalation of airborne radioactive material pursuant to paragraph (b)(2) of this section, the licensee shall use equipment that is certified or had certification extended by the National Institute for Occupational Safety and Health/Mine Safety and Health Administration (NIOSH/MSHA). The licensee may make allowance for this use of respiratory protective equipment in estimating exposures of individuals to this material provided that:

<sup>123</sup>Since the concentration specified for tritium oxide vapor assumes equal intakes by skin absorption and inhalation, the total intake permitted is twice that which would result from inhalation alone at the concentration specified for H 3 S in Appendix B, Table I, Column 1 for 40 hours per week for 13 weeks.

<sup>124</sup>For radon-222, the limiting quantity is that inhaled in a period of one calendar year. For radioactive materials designated "Suo" in the "Isotope" column of the table, the concentration value specified is based upon exposure to the material as an external radiation source. Individual exposures to these materials may be accounted for as part of the limitation on individual dose in § 20.101. These nuclides shall be subject to the precautionary procedures required by § 20.103(b)(1).

<sup>125</sup>Multiply the concentration values specified in Appendix B, Table I, Column 1, by  $6.3 \times 10^4$  ml to obtain the quarterly quantity limit. Multiply the concentration value specified in Appendix B, Table I, Column 1, by  $2.5 \times 10^4$  ml to obtain the annual quantity limit for Rn-222.

<sup>126</sup>Significant intake by ingestion or injection is presumed to occur only as a result of circumstances such as accident, inadvertence, poor procedure, or similar special conditions. Such intakes must be evaluated and accounted for by techniques and procedures as may be appropriate to the circumstances of the occurrence. Exposures so evaluated shall be included in determining whether the limitation on individual exposures in § 20.103(a)(1) has been exceeded.

<sup>127</sup>Regulatory guidance on assessment of individual intakes of radioactive material is given in Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program," single copies of which are available from the Office of Standards Development, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, upon written request.



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(1) The licensee selects respiratory protective equipment that provides a protection factor greater than the multiple by which peak concentrations of airborne radioactive materials in the working area are expected to exceed the values specified in Appendix B, Table I, Column 1 of this part. The equipment so selected shall be used so that the average concentration of radioactive material in the air that is inhaled during any period of uninterrupted use in an airborne radioactivity area, on any day, by any individual using the equipment, does not exceed the values specified in Appendix B, Table I, Column 1 of this part. For the purposes of this paragraph, the concentration of radioactive material in the air that is inhaled when respirators are worn may be estimated by dividing the ambient concentration in air by the protection factor specified in Appendix A of this part. If the exposure is later found to be greater than estimated, the corrected value shall be used; if the exposure is later found to be less than estimated, the corrected value may be used.

(2) The licensee maintains and implements a respiratory protection program that includes, as a minimum: air sampling sufficient to identify the hazard, permit proper equipment selection and estimate exposures; surveys and bioassays as appropriate to evaluate actual exposures; written procedures regarding selection, fitting, and maintenance of respirators, and testing of respirators for operability immediately prior to each use; written procedures regarding supervision and training of personnel and issuance records; and determination by a physician prior to initial use of respirators, and at least every 12 months thereafter, that the individual user is physically able to use the respiratory protective equipment.

(3) A written policy statement on respirator usage shall be issued covering such things as: use of practicable engineering controls instead of respirators; routine, nonroutine, and emergency use of respirators; and periods of respirator use and relief from respirator use. The licensee shall advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other condition that might require such relief.

(4) The licensee uses equipment within limitations for type and mode of use and provides proper visual, communication, and other special capabilities (such as adequate skin protection) when needed.

(d) Unless otherwise authorized by the Commission, the licensee shall not assign protection factors in excess of

those specified in Appendix A of this part in selecting and using respiratory protective equipment. The Commission may authorize a licensee to use higher protection factors on receipt of an application (1) describing the situation for which a need exists for higher protection factors, and (2) demonstrating that the respiratory protective equipment will provide these higher protection factors under the proposed conditions of use.

(e) Where equipment of a particular type has not been tested and certified, or had certification extended, by NIOSH/MSHA, or where there is no existing schedule for test and

certification of certain equipment, the licensee shall not make allowance for this equipment without specific authorization by the Commission. An application for this authorization must include a demonstration by testing, or on the basis of reliable test information, that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use.

(f) Only equipment that has been specifically certified or had certification extended for emergency use by NIOSH/MSHA shall be used as emergency devices.

(g) The licensee shall notify, in writing, the Director of the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office listed in Appendix D at least 30 days before the date that respiratory protective equipment is first used under the provisions of this section.

### § 20.104 Exposure of minors.

(a) No licensee shall possess, use, or transfer licensed material 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 radioactive material and other sources of radiation in the licensee's possession a dose in excess of 10 percent of the limits specified in the table in paragraph (a) of § 20.101.

(b) No licensee shall possess, use or transfer licensed 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 possessed by the licensee in an average 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.

(c) The provisions of §§ 20.103(b)(2) and 20.103(c) shall apply to exposures subject to paragraph (b) of this section except that the references in §§ 20.103(b)(2) and 20.103(c) to Appendix B, Table I, Column 1 shall be deemed to be references to Appendix B, Table II, Column 1.

### § 20.105 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 to the whole body in any period of one calendar year in excess of 0.5 rem.

(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.

(c) In addition to other requirements of this part, licensees engaged in uranium fuel cycle operations subject to the provisions of 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," shall comply with that part.

### § 20.106 Radioactivity in effluents to unrestricted areas.

(a) A licensee shall not possess, use, or transfer licensed material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix B, Table II of this part, except as authorized pursuant to § 20.302 or paragraph (b) of this section. For purposes of this section concentrations may be averaged over a period not greater than one year.

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(b) An application for a license or amendment may include proposed limits higher than those specified in paragraph (a) of this section. The

Commission 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 B, Table II of this part.

(c) An application for higher limits pursuant to paragraph (b) of this section 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 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 concentrations of radionuclides in the unrestricted area and possible recon-

centrations of radionuclides.

(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 B, Table II of this part 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 Commission may limit quantities of radioactive materials 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 the concentration of radioactive materials specified in Appendix B, Table II of this part.

(f) The provisions of paragraphs (a) through (e) of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by § 20.303.

(g) In addition to other requirements of this part, licensees engaged in uranium fuel cycle operations subject to the provisions of 40 CFR Part 190, "Environmental Radiation Protection Standard for Nuclear Power Operations," shall comply with that part.

### § 20.107 Medical diagnosis and therapy.

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.

### § 20.108 Orders requiring furnishing of bio-assay services.

Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Commission may incorporate appropriate provisions in any license, directing the licensee to make available to the individual appropriate bio-assay services and to furnish a copy of the reports of such services to the Commission.

## PRECAUTIONARY PROCEDURES

### § 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 (1) may be necessary for the licensee to comply with the regulations in this part, and (2) are reasonable under the circumstances to evaluate the extent of radiation hazards that may be present.

### § 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 any calendar quarter in excess of 25 percent of the applicable value specified in paragraph (a) of § 20.101.

(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 paragraph (a) of § 20.101.

(3) 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 100 millirems;

(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.

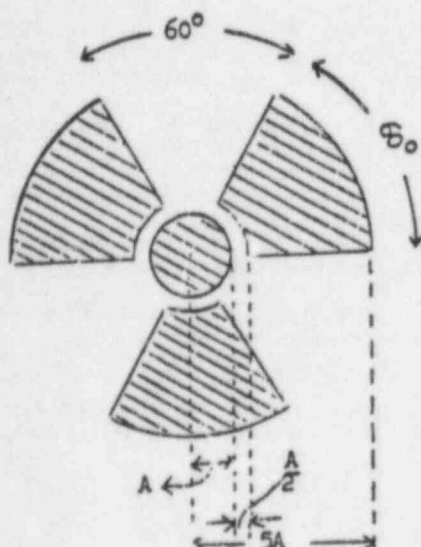
# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## § 20.203 Caution signs, labels, signals and controls.

(a) *General.* (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<sup>1</sup>

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<sup>1</sup>

HIGH RADIATION AREA

<sup>1</sup>Or "Danger"

(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 licensee 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 paragraph (c)(2) of this section 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 paragraph (c)(2) of this section.

(5) Any licensee, or applicant for a license, may apply to the Commission for approval of methods not included in paragraphs (c)(2) and (4) of this section for controlling access to high radiation areas. The Commission will approve the proposed alternatives if the licensee or applicant demonstrates that the alternative methods of control will prevent unauthorized entry into a high radiation area, and that the requirement of paragraph (c)(3) of this section is met.

(6) Each area in which there may exist radiation levels in excess of 500 rems in one hour at one meter from a sealed radioactive source<sup>2</sup> that is used to irradiate materials shall:

(i) Have each entrance or access point equipped with entry control devices which shall function automatically to prevent any individual from inadvertently entering the area when such radiation levels exist; permit deliberate entry into the area only after a control device is actuated that shall cause the radiation level within the area, from the sealed source, to be reduced below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour; and prevent operation of the source if the source would produce radiation levels in the area that could result in a dose to an individual in excess of 100 mrem in one hour. The entry control devices required by this paragraph (c)(6) shall be established in such a way that no individual will be prevented from leaving the area.

(ii) Be equipped with additional control devices such that upon failure of the entry control devices to function as required by paragraph (c)(6)(i) of this section the radiation level within the area, from the sealed source, shall be reduced below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour; and visible and audible alarm signals shall be generated to make an individual attempting to enter the area aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of such failure of the entry control devices.

(iii) Be equipped with control devices such that upon failure or removal of physical radiation barriers other than the source's shielded storage container the radiation level from the source shall be reduced below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour; and visible and audible alarm signals shall be generated to make potentially affected individuals aware of the hazard and the licensee or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier. When the shield for the stored source is a liquid, means shall be provided to monitor the integrity of the shield and to signal, automatically, loss of adequate shielding. Physical radiation barriers that com-

<sup>2</sup>This paragraph (c)(6) does not apply to radioactive sources that are used in teletherapy, in radiography, or in completely self-shielded irradiators in which the source is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual. This paragraph (c)(6) also does not apply to sources from which the radiation is incidental to some other use nor to nuclear reactor generated radiation other than radiation from byproduct, source, or special nuclear materials that are used in sealed sources in non-self-shielded irradiators.

<sup>3</sup>These requirements apply after Mar. 14, 1978. Each person licensed to conduct activities to which this paragraph (c)(6) applies and who is not in compliance with the provisions of this paragraph on Mar. 14, 1978, shall file with the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, on or before June 14, 1978, information describing in detail the actions taken or to be taken to achieve compliance with this paragraph by Dec. 14, 1978, and may continue activities in conformance with present license conditions and the provisions of the previously effective § 20.2034 until such compliance is achieved. For such persons compliance must be achieved not later than Dec. 14, 1978.



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prise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of this paragraph (c)(6)(iii).

(iv) Be equipped with devices that will automatically generate visible and audible alarm signals to alert personnel in the area before the source can be put into operation and in sufficient time for any individual in the area to operate a clearly identified control device which shall be installed in the area and which can prevent the source from being put into operation.

(v) Be controlled by use of such administrative procedure and such devices as are necessary to assure that the area is cleared of personnel prior to each use of the source preceding which use it might have been possible for an individual to have entered the area.

(vi) Be checked by a physical radiation measurement to assure that prior to the first individual's entry into the area after any use of the source, the radiation level from the source in the area is below that at which it would be possible for an individual to receive a dose in excess of 100 mrem in one hour.

(vii) Have entry control devices required in paragraph (c)(6)(i) of this section which have been tested for proper functioning prior to initial operation with such source of radiation on any day that operations are not uninterruptedly continued from the previous day or before resuming operations after any unintended interruption, and for which records are kept of the dates, times, and results of such tests of function. No operations other than those necessary to place the source in safe condition or to effect repairs on controls shall be conducted with such source unless control devices are functioning properly. The licensee shall submit an acceptable schedule for more complete periodic tests of the entry control and warning systems to be established and adhered to as a condition of the license.

(viii) Have those entry and exit portals that are used in transporting materials to and from the irradiation area, and that are not intended for use by individuals, controlled by such devices and administrative procedures as are necessary to physically protect and warn against inadvertent entry by any individual through such portals. Exit portals for processed materials shall be equipped to detect and signal the presence of loose radiation sources that are carried toward such an exit and to automatically prevent such loose sources from being carried out of the area.

(7) Licensees with, or applicants for, licenses for radiation sources that are within the purview of paragraph (c)(6) of this section, and that must be used in a variety of positions or in peculiar locations, such as open fields or forests, that make it impracticable to comply with certain requirements of paragraph (c)(6) of this section, such as those for the automatic control of radiation levels, may apply to the Director, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, for approval, prior to use of safety measures that are alternative to those specified in paragraph (c)(6) of this section, and that will provide at least an equivalent degree of personnel protection in the use of such sources. At least one of the alternative measures must include an entry-preventing interlock control based on a physical measurement of radiation that assures the absence of high radiation levels before an individual can gain access to an area where such sources are used.

(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<sup>1</sup>

#### 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:

<sup>1</sup>Or "Danger".

<sup>2</sup>As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, mass enrichment, etc.

### CAUTION<sup>1</sup>

#### RADIOACTIVE MATERIAL(S)

(2) Each area or room in which natural uranium or thorium is used or stored in any 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<sup>1</sup>

#### RADIOACTIVE MATERIAL(S)

(f) *Containers.* (1) Except as provided in paragraph (f)(3) of this section, each container of licensed material shall bear a durable, clearly visible label identifying the radioactive contents.

(2) A label required pursuant to paragraph (f)(1) of this section shall bear the radiation caution symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL". It shall also provide sufficient information<sup>2</sup> to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(3) Notwithstanding the provisions of paragraph (f)(1) of this section labeling is not required:

(i) For containers that do not contain licensed materials in quantities greater than the applicable quantities listed in Appendix C of this part.

(ii) For containers containing only natural uranium or thorium in quantities no greater than 10 times the applicable quantities listed in Appendix C of this part.

(iii) For containers that do not contain licensed materials in concentrations greater than the applicable concentrations listed in Appendix B, Table I, Column 2, of this part.

(iv) 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 materials in excess of the limits established by the regulations in this part.

(v) For containers when they are in transport and packaged and labeled in accordance with regulations of the Department of Transportation.

(vi) For containers which are accessible<sup>3</sup> only to individuals authorized to handle or use them, or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record.

(vii) For manufacturing or process equipment, such as nuclear reactors, reactor components, piping, and tanks.



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(4) Each licensee shall, prior to disposal of an empty uncontaminated container to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

## § 20.204 Same: exceptions.

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, and control of entrance or access thereto pursuant to § 20.203(c) is not required, because of the presence of patients containing by-product 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 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.

(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 materials prepared for transport and packaged and labeled in accordance with regulations of the Department of Transportation.

<sup>1</sup> For example, containers in locations such as water-filled canals, storage vaults, or hot cells.

## § 20.205 Procedures for picking up, receiving, and opening packages.

(a)(1) Each licensee who expects to receive a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section shall:

(i) If the package is to be delivered to the licensee's facility by the carrier, make arrangements to receive the package when it is offered for delivery by the carrier; or

(ii) If the package is to be picked up by the licensee at the carrier's terminal, make arrangements to receive notification from the carrier of the arrival of the package, at the time of arrival.

(2) Each licensee who picks up a package of radioactive material from a carrier's terminal shall pick up the package expeditiously upon receipt of notification from the carrier of its arrival.

(b)(1) Each licensee, upon receipt of a package of radioactive material, shall monitor the external surfaces of the package for radioactive contamination caused by leakage of the radioactive contents, except:

(i) Packages containing no more than the exempt quantity specified in the table in this paragraph;

(ii) Packages containing no more than 10 millicuries of radioactive material consisting solely of tritium, carbon-14, sulfur-35, or iodine-125;

(iii) Packages containing only radioactive material as gases or in special form;

(iv) Packages containing only radioactive material in other than liquid form (including Mo-99/Tc-99m generators) and not exceeding the Type A quantity limit specified in the table in this paragraph; and

(v) Packages containing only radionuclides with half-lives of less than 30 days and a total quantity of no more than 100 millicuries.

The monitoring shall be performed as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or eighteen hours if received after normal working hours.

(2) If removable radioactive contamination in excess of 0.01 microcuries (22,000 disintegrations per minute) per 100 square centimeters of package surface is found on the external surfaces of the package, the licensee shall immediately notify<sup>1</sup> the final delivering carrier and, by telephone and telegraph, mailgram or facsimile, the appropriate Nuclear Regulatory Commission Inspection and Enforcement Regional Office shown in Appendix D of this part.

TABLE OF EXEMPT AND TYPE A QUANTITIES

Transport group <sup>1</sup>	Exempt quantity limit (in millicuries)	Type A quantity limit (in curies)
I	0.1	0.001
II	0.1	0.050
III	1	3
IV	1	20
V	1	20
VI	1	1000
VII	25,000	1000
Special Form	1	20

<sup>1</sup>The definitions of "transport group" and "special form" are specified in § 71.4 of this chapter.

<sup>2</sup>The reporting requirements in § 20.205 have been approved by GAO under number B-180 225 (R 0054).

(c)(1) Each licensee, upon receipt of a package containing quantities of radioactive material in excess of the Type A quantities specified in paragraph (b) of this section, other than those transported by exclusive use vehicle, shall monitor the radiation levels external to the package. The package shall be monitored as soon as practicable after receipt, but no later than three hours after the package is received at the licensee's facility if received during the licensee's normal working hours, or 18 hours if received after normal working hours.

(2) If radiation levels are found on the external surface of the package in excess of 200 millirem per hour, or at three feet from the external surface of the package in excess of 10 millirem per hour,

the licensee shall immediately notify by telephone and telegraph mailgram, or facsimile, the director of the appropriate NRC Regional Office listed in Appendix D, and the final delivering carrier.

(d) Each licensee shall establish and maintain procedures for safely opening packages in which licensed material is received, and shall assure that such procedures are followed and that due consideration is given to special instructions for the type of package being opened.

## § 20.206 Instruction of personnel.

Instructions required for individuals working in or frequenting any portion of a restricted area are specified in § 19.12 of this chapter.

## § 20.207 Storage and control of licensed materials in unrestricted areas.

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

(b) Licensed materials in an unrestricted area and not in storage shall be

tended under the constant surveillance and immediate control of the licensee.

#### WASTE DISPOSAL

##### § 20.301 General requirement.

No licensee shall dispose of licensed material except:

(a) By transfer to an authorized recipient as provided in the regulations in Parts 30, 40, 60, 61, 70 or 72 of this chapter, whichever may be applicable; or

(b) As authorized under § 20.302 or Part 61 of this chapter; or

(c) As provided in § 20.303, applicable to the disposal of licensed material by release into sanitary sewerage systems, or in § 20.306 for disposal of specific wastes, or in § 20.106 (Radioactivity in effluents to unrestricted areas).

##### § 20.302 Method for obtaining approval of proposed disposal procedures.

(a) 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.

(b) The Commission will not approve any application for a license for disposal of licensed material at sea unless the applicant shows that sea disposal offers less harm to man or the environment than other practical alternative methods of disposal.

##### § 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 paragraphs (b)(1) or (2) of this section.

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

(d) The gross quantity of licensed and other radioactive material, excluding hydrogen-3 and carbon-14, released into the sewerage system by the licensee does not exceed one curie per year. The quantities of hydrogen-3 and carbon-14 released into the sanitary sewerage system may not exceed 5 curies per year for hydrogen-3 and 1 curie per year for carbon-14. Excreta from individuals undergoing medical diagnosis or therapy with radioactive material shall be exempt from any limitations contained in this section.

##### § 20.305 Treatment or disposal by incineration.

No licensee shall treat or dispose of licensed material by incineration, except for materials listed under § 20.306 or as specifically approved by the Commission pursuant to §§ 20.106(b) and 20.302.

##### § 20.306 Disposal of specific wastes.

Any licensee may dispose of the following licensed material without regard to its radioactivity:

(a) 0.05 microcuries or less of hydrogen-3 or carbon-14, per gram of medium, used for liquid scintillation counting; and

(b) 0.05 microcuries or less of hydrogen-3 or carbon-14, per gram of animal tissue averaged over the weight of the entire animal; provided however, tissue may not be disposed of under this section in a manner that would permit its use either as food for humans or as animal feed.

(c) Nothing in this section, however, relieves the licensee of maintaining records showing the receipt, transfer and disposal of such byproduct material as specified in § 30.51 of this chapter; and

(d) Nothing in this section relieves the licensee from complying with other applicable Federal, State and local regulations governing any other toxic or hazardous property of these materials.

##### § 20.311 Transfer for disposal and manifests.

(a) Purpose. The requirements of this section are designed to control transfers of radioactive waste intended for disposal at a land disposal facility and establish a manifest tracking system and supplement existing requirements concerning transfers and recordkeeping for such wastes. The reporting and recordkeeping requirements contained in this section have been approved by the Office of Management and Budget; OMB approval No. 0150-0014.

(b) Each shipment of radioactive waste to a licensed land disposal facility must be accompanied by a shipment manifest that contains the name, address, and telephone number of the person generating the waste. The manifest shall also include the name, address, and telephone number or the name and EPA hazardous waste identification number of the person transporting the waste to the land disposal facility. The manifest must also indicate as completely as practicable: a physical description of the waste; the volume; radionuclide identity and quantity; the total radioactivity; and the principal chemical form. The solidification agent must be specified. Waste containing more than 0.1% chelating agents by weight must be identified and the weight percentage of the chelating agent estimated. Wastes classified as Class A, Class B, or Class C in § 61.55 of this chapter must be clearly identified as such in the manifest. The total quantity of the radionuclides H-3, C-14, Tc-99 and I-129 must be shown. The manifest required by this paragraph may be shipping papers used to meet Department of Transportation or

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Environmental Protection Agency regulations or requirements of the receiver, provided all the required information is included. Copies of manifests required by this section may be legible carbon copies or legible photocopies.

(c) Each manifest must include a certification by the waste generator that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Commission. An authorized representative of the waste generator shall sign and date the manifest.

(d) Any generating licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector shall comply with the requirements in paragraphs (d)(1) through (8) of this section. Any generating licensee who transfers waste to a licensed waste processor who treats or repackages waste shall comply with the requirements of paragraphs (d)(4) through (8) of this section. A licensee shall:

(1) Prepare all wastes so that the waste is classified according to § 61.55 and meets the waste characteristics requirements in § 61.56 of this chapter;

(2) Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with § 61.55 of this chapter;

(3) Conduct a quality control program to assure compliance with §§ 61.55 and 61.56 of this chapter; the program must include management evaluation of audits;

(4) Prepare shipping manifests to meet the requirements of §§ 20.311 (b) and (c) of this part;

(5) Forward a copy of the manifest to the intended recipient, at the time of shipment; or, deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest or equivalent documentation from the collector;

(6) Include one copy of the manifest with the shipment;

(7) Retain a copy of the manifest and documentation of acknowledgement of receipt as the record of transfer of licensed material as required by Parts 30, 40, and 70 of this chapter; and,

(8) For any shipments or any part of a shipment for which acknowledgement of receipt has not been received within the times set forth in this section, conduct an investigation in accordance with paragraph (h) of this section.

(e) Any waste collector licensee who handles only prepackaged waste shall:

(1) Acknowledge receipt of the waste from the generator within one week of receipt by returning a signed copy of the manifest or equivalent documentation;

(2) Prepare a new manifest to reflect consolidated shipments; the new manifest shall serve as a listing or index for the detailed generator manifests. Copies of the generator manifests shall be a part of the new manifest. The waste collector may prepare a new manifest without attaching the generator manifests, provided the new manifest contains for each package the information specified in paragraph (b) of this section. The collector licensee shall certify that nothing has been done to the waste which would invalidate the generator's certification;

(3) Forward a copy of the new manifest to the land disposal facility operator at the time of shipment;

(4) Include the new manifest with the shipment to the disposal site;

(5) Retain a copy of the manifest and documentation of acknowledgement of receipt as the record of transfer of licensed material as required by Parts 30, 40, and 70 of this chapter, and retain information from generator manifests until disposition is authorized by the Commission; and,

(6) For any shipments or any part of a shipment for which acknowledgement of receipt is not received within the times set forth in this section, conduct an investigation in accordance with paragraph (h) of this section.

(f) Any licensed waste processor who treats or repackages wastes shall:

(1) Acknowledge receipt of the waste from the generator within one week of receipt by returning a signed copy of the manifest or equivalent documentation;

(2) Prepare a new manifest that meets the requirements of paragraphs (b) and (c) of this section. Preparation of the new manifest reflects that the processor is responsible for the waste;

(3) Prepare all wastes so that the waste is classified according to § 61.55 and meets the waste characteristics requirements in § 61.56 of this chapter;

(4) Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with §§ 61.55 and 61.57 of this chapter;

(5) Conduct a quality control program to assure compliance with §§ 61.55 and 61.56 of this chapter. The program shall include management evaluation of audits;

(6) Forward a copy of the new manifest to the disposal site operator or waste collector at the time of shipment, or deliver to a collector at the time the waste is collected, obtaining acknowledgement of receipt in the form of a signed copy of the manifest or

equivalent documentation by the collector;

(7) Include the new manifest with the shipment;

(8) Retain copies of original manifests and new manifests and documentation of acknowledgement of receipt as the record of transfer of licensed material required by Parts 30, 40, and 70 of this chapter; and

(9) For any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this section, conduct an investigation in accordance with paragraph (h) of this section.

(g) The land disposal facility operator shall:

(1) Acknowledge receipt of the waste within one week of receipt by returning a signed copy of the manifest or equivalent documentation to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. The returned copy of the manifest or equivalent documentation shall indicate any discrepancies between materials listed on the manifest and materials received;

(2) Maintain copies of all completed manifests or equivalent documentation until the Commission authorizes their disposition; and

(3) Notify the shipper (i.e., the generator, the collector, or processor) and the Director of the nearest Commission Regional Office listed in Appendix D of this part when any shipment or part of a shipment has not arrived within 60 days after the advance manifest was received.

(h) Any shipment or part of a shipment for which acknowledgement is not received within the times set forth in this section, must:

(1) Be investigated by the shipper if the shipper has not received notification of receipt within 20 days after transfer; and

(2) Be traced and reported. The investigation shall include tracing the shipment and filing a report with the nearest Commission Regional Office listed in Appendix D of this part. Each licensee who conducts a trace investigation shall file a written report with the nearest Commission's Regional office within 2 weeks of completion of the investigation.



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§ 20.401 Records of surveys, radiation monitoring, and disposal.

(a) Each licensee shall maintain records showing the radiation exposures of all individuals for whom personnel monitoring is required under § 20.202 of the regulations in this part. Such records shall be kept on Form NRC-5, in accordance with the instructions contained in that form or on clear and legible records containing all the information required by Form NRC-5. The doses entered on the forms or records shall be for periods of time not exceeding one calendar quarter.

(b) Each licensee shall maintain records in the same units used in this part, showing the results of surveys required by § 20.201(b), monitoring required by §§ 20.205(b) and 20.205(c), and disposals made under §§ 20.302, 20.303, removed § 20.304,<sup>1</sup> and Part 61 of this chapter.

(c)(1) Records of individual exposure to radiation and to radioactive material which must be maintained pursuant to the provisions of paragraph (a) of this section and records of bioassays, including results of whole body counting examinations, made pursuant to § 20.108, shall be preserved until the Commission authorizes disposition.

(2) Records of the results of surveys and monitoring which must be maintained pursuant to paragraph (b) of this section shall be preserved for two years after completion of the survey except that the following records shall be maintained until the Commission authorizes their disposition: (i) Records of the results of surveys to determine compliance with § 20.103(a); (ii) in the absence of personnel monitoring data, records of the results of surveys to determine external radiation dose; and (iii) records of the results of surveys used to evaluate the release of radioactive effluents to the environment.

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(3) Records of disposal of licensed materials made pursuant to §§ 20.302, 20.303, removed § 20.304, and Part 61 of this chapter are to be maintained until the Commission authorizes their disposition.

(4) Records which must be maintained pursuant to this part may be the original or a reproduced copy or microform if such reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage for the period specified by Commission regulations.

(5) If there is a conflict between the Commission's regulations in this part, license condition, or technical specification, or other written Commission approval or authorization pertaining to the retention period for the same type of record, the retention period specified in the regulations in this part for such records shall apply unless the Commission pursuant to § 20.501, has granted a specific exemption from the record retention requirements specified in the regulations in this part.

## § 20.402 Reports of theft or loss of licensed material.

(a)(1) Each licensee shall report to the Commission, by telephone, immediately after it determines that a loss or theft of licensed material has occurred in such quantities and under such circumstances that it appears to the licensee that a substantial hazard may result to persons in unrestricted areas.

(2) Reports must be made as follows:

(i) Licensees having an installed Emergency Notification System shall make the reports to the NRC Operations Center in accordance with § 50.72 of this chapter.

(ii) All other licensees shall make reports to the Administrator of the appropriate NRC Regional Office listed in Appendix D of this part.

(b) Each licensee who makes a report under paragraph (a) of this section shall, within 30 days after learning of the loss or theft, make a report in writing to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, D.C. 20555, with a copy to the appropriate NRC Regional Office listed in Appendix D of this part. The report shall include the following information:

(1) A description of the licensed material involved, including kind, quantity, chemical, and physical form;

(2) A description of the circumstances under which the loss or theft occurred;

(3) A statement of disposition or probable disposition of the licensed material involved;

(4) Radiation exposures to individ-

uals, circumstances under which the exposures occurred, and the extent of possible hazard to persons in unrestricted areas;

(5) Actions which have been taken, or will be taken, to recover the material; and

(6) Procedures or measures which have been or will be adopted to prevent a recurrence of the loss or theft of licensed material.

(c) Subsequent to filing the written report the licensee shall also report any substantive additional information on the loss or theft which becomes available to the licensee, within 30 days after he learns of such information.

(d) Any report filed with the Commission pursuant to this section shall be so prepared that names of individuals who may have received exposure to radiation are stated in a separate part of the report.

(e) For holders of an operating license for a nuclear power plant, the events included in paragraph (b) of this section must be reported in accordance with the procedures described in § 50.73 (b), (c), (d), (e), and (g) of this chapter and must include the information required in paragraph (b) of this section. Events reported in accordance with § 50.73 of this chapter need not be reported by a duplicate report under paragraph (b) of this section.

## § 20.403 Notifications of incidents.

(a) *Immediate notification.* Each licensee shall immediately report any events involving byproduct, source, or special nuclear material possessed by the licensee that may have caused or threatens to cause:

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

(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 B, Table II of this part; 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 \$200,000.

(b) *Twenty-four hour notification.*

Each licensee shall, within 24 hours of discovery of the event, report any event involving licensed material possessed by the licensee that may have caused or threatens to cause:

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

(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 B, Table II of this part; or

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

(4) Damage to property in excess of \$2,000.

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

(d) Reports made by licensees in response to the requirements of this section must be made as follows:

(1) Licensees that have an installed Emergency Notification System shall make the reports required by paragraphs (a) and (b) of this section to the NRC Operations Center in accordance with § 50.72 of this chapter.

(2) All other licensees shall make the reports required by paragraphs (a) and (b) of this section by telephone and by telegram, mailgram, or facsimile to the Administrator of the appropriate NRC Regional Office listed in Appendix D of this part.

## § 20.404 [Reserved]

## § 20.405 Reports of overexposures and excessive levels and concentrations.

(a)(1) In addition to any notification required by § 20.403 of this part, each licensee shall make a report in writing concerning any one of the following types of incidents within 30 days of its occurrence:

(i) Each exposure of an individual to radiation in excess of the applicable limits in §§ 20.101 or 20.104(a) of this part, or the license;

(ii) Each exposure of an individual to radioactive material in excess of the applicable limits in §§ 20.103(a)(1), 20.103(a)(2), or 20.104(b) of this part, or in the license;



(iii) Levels of radiation or concentrations of radioactive material in a restricted area in excess of any other applicable limit in the license;

(iv) Any incident for which notification is required by § 20.403 of this part; or

(v) Levels of radiation or concentrations of radioactive material (whether or not involving excessive exposure of any individual) in an unrestricted area in excess of ten times any applicable limit set forth in this part or in the license.

(2) Each report required under paragraph (a)(1) of this section must describe the extent of exposure of individuals to radiation or to radioactive material, including:

(i) Estimates of each individual's exposure as required by paragraph (b) of this section;

(ii) Levels of radiation and concentrations of radioactive material involved;

(iii) The cause of the exposure, levels or concentrations; and

(iv) Corrective steps taken or planned to prevent a recurrence.

(b) Any report filed with the Commission pursuant to paragraph (a) of this section shall include for each individual exposed the name, social security number, and date of birth, and an estimate of the individual's exposure. The report shall be prepared so that this information is stated in a separate part of the report.

(c)(1) In addition to any notification required by § 20.403 of this part, each licensee shall make a report in writing of levels of radiation or releases of radioactive material in excess of limits specified by 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," or in excess of license conditions related to compliance with 40 CFR Part 190.

(2) Each report submitted under paragraph (c)(1) of this section must describe:

(i) The extent of exposure of individuals to radiation or to radioactive material;

(ii) Levels of radiation and concentrations of radioactive material involved;

(iii) The cause of the exposure, levels, or concentrations; and

(iv) Corrective steps taken or planned to assure against a recurrence, including the schedule for achieving conformance with 40 CFR Part 190 and with associated license conditions.

(d) For holders of an operating license for a nuclear power plant, the incidents included in paragraphs (a) or (c) of this section must be reported in accordance

with the procedures described in paragraphs 50.73 (b), (c), (d), (e), and (g) of this chapter and must also include the information required by paragraphs (a) and (c) of this section. Incidents reported in accordance with § 50.73 of this chapter need not be reported by a duplicate report under paragraphs (a) or (c) of this section.

(e) All other licensees who make reports under paragraphs (a) or (c) of this section shall, within 30 days after learning of the overexposure or excessive level or concentration, make a report in writing to the U.S. Nuclear Regulatory Commission, Document Control Desk, Washington, D.C. 20555, with a copy to the appropriate NRC Regional Office listed in Appendix D of this part.

#### § 20.406 [Reserved]

#### § 20.407 Personnel monitoring reports.

Each person described in § 20.408 of this part shall, within the first quarter of each calendar year, submit to the Director of Management and Program Analysis, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, the reports specified in paragraphs (a) and (b) of this section covering the preceding calendar year.<sup>1</sup> All other persons specifically licensed by the Commission shall, within the first quarter of calendar years 1979 and 1980, submit to the Director of Management and Program Analysis, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, the reports specified in paragraphs (a) and (b) of this section covering the preceding calendar years 1978 and 1979.<sup>2</sup>

(a) A report of either (1) the total number of individuals for whom personnel monitoring was required under § 20.202(a) or § 34.33(a) of this chapter during the calendar year; or (2) the total number of individuals for whom personnel monitoring was provided during the calendar year; *Provided, however, That such total includes at least the number of individuals required to be reported under paragraph (a)(1) of this section. The report shall indicate whether it is submitted in accordance with paragraph (a)(1) or (a)(2) of this section. If personnel monitoring was not required to be provided to any individual by the licensee under §§ 20.202(a) or 34.33(a) of this chapter during the calendar year, the licensee shall submit a negative report indicating that such personnel monitoring was not required.*

(b) A statistical summary report of the personnel monitoring information recorded by the licensee for individuals for whom personnel monitoring was either required or provided, as described in paragraph (a) of this section, indicating the number of individuals whose total whole body exposure recorded during the previous calendar

year was in each of the following estimated exposure ranges:

Estimated whole body exposure range (rads) <sup>1</sup>	Number of individuals in each range
No measurable exposure	
Measurable exposure less than 0.1	
0.1 to 0.25	
0.25 to 0.5	
0.5 to 0.75	
0.75 to 1	
1 to 2	
2 to 3	
3 to 4	
4 to 5	
5 to 6	
6 to 7	
7 to 8	
8 to 9	
9 to 10	
10 to 11	
11 to 12	
12+	

<sup>1</sup>Individual values exactly equal to the values separating exposure ranges shall be reported in the higher range.

The low exposure range data are required in order to obtain better information about the exposures actually recorded. This section does not require improved measurements.

#### § 20.408 Reports of personnel monitoring on termination of employment or work.

(a) This section applies to each person licensed by the Commission to:

(1) Operate a nuclear reactor designed to produce electrical or heat energy pursuant to § 50.21(b) or § 50.22 of this chapter or a testing facility as defined in § 50.2(r) of this chapter;

(2) Possess or use byproduct material for purposes of radiography pursuant to Parts 30 and 34 of this chapter;

(3) Possess or use at any one time, for purposes of fuel processing, fabricating, or reprocessing, special nuclear material in a quantity exceeding 5,000 grams of contained uranium-235, uranium-233, or plutonium or any combination thereof pursuant to Part 70 of this chapter;

(4) Possess high-level radioactive waste at a geologic repository operations area pursuant to Part 60 of this chapter; or

(5) Possess spent fuel in an independent spent fuel storage installation (ISFSI) pursuant to Part 72 of this chapter; or

(6) Possess or use at any one time, for processing or manufacturing for distribution pursuant to Parts 30, 32, or 33 of this Chapter, byproduct material in quantities exceeding any one of the following quantities:

<sup>1</sup>A licensee whose license expires or terminates prior to, or on the last day of the calendar year, shall submit reports at the expiration or termination of the license, covering that part of the year during which the license was in effect.

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Radionuclide <sup>1</sup>	Quantity in curies
Cesium-137	1
Cobalt-60	1
Gold-198	100
Iodine-131	1
Iridium-192	10
Krypton-88	1,000
Promethium-147	10
Technetium-99m	1,000

<sup>1</sup>The Commission may require, as a license condition, or by rule, regulation or order pursuant to § 20.502, reports from licensees who are licensed to use radionuclides not on this list, in quantities sufficient to cause comparable radiation levels.

(7) Receive radioactive waste from other persons for disposal under Part 31 of this chapter.

(b) When an individual terminates employment with a licensee describe in paragraph (a) of this section, or an individual assigned to work in such a licensee's facility but not employed by the licensee, completes the work assignment in the licensee's facility, the licensee shall furnish to the Director of Management and Program Analysis, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, a report of the individual's exposures to radiation and radioactive material, incurred during the period of employment or work assignment in the licensee's facility, containing information recorded by the licensee pursuant to §§ 20.401(a) and 20.108. Such report shall be furnished within 30 days after the exposure of the individual has been determined by the licensee or 90 days after the date of termination of employment or work assignment, whichever is earlier.

<sup>1</sup>The Commission will evaluate the data obtained for 1978 and 1979 pursuant to this paragraph, and the benefits derived therefrom and may take action, including publication of notice of proposed rulemaking, to extend or otherwise modify this reporting requirement.

## § 20.409 Notifications and reports to individuals.

(a) Requirements for notifications and reports to individuals of exposure to radiation or radioactive material are specified in § 19.13 of this chapter.

(b) When a licensee is required pursuant to §§ 20.405 or 20.408 to report to the Commission any exposure of an individual to radiation or radioactive material, the licensee shall also notify the individual. Such notice shall be transmitted at a time not later than the transmittal to the Commission, and shall comply with the provisions of § 19.13(a) of this chapter.

## 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 Atomic Energy Act of 1954, as amended, or Title II of the Energy Reorganization Act of 1974, or any regulation or order issued thereunder. A court order may be obtained for the payment of a civil penalty imposed pursuant to section 234 of the Act for violation of section 53, 57, 62, 63, 81, 82, 101, 103, 104, 107, or 109 of the Act, or section 206 of the Energy Reorganization Act of 1974, or any rule, regulation, or order issued thereunder, or any term, condition, or limitation of any license issued thereunder, or for any violation for which a license may be revoked under section 186 of the Act. 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.

NOTE: The reporting and record keeping requirements contained in this part have been approved by the General Accounting Office under B-180225 (R0043), (R0044), and (R0084).

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## APPENDIX A.—PROTECTION FACTORS FOR RESPIRATORS \*

Description *	Modes *	Protection factors *		Tested and certified equipment—National Institute for Occupational Safety and Health (NIOSH) tests for permeability
		Particulates only	Particulates, gases and vapors *	
I. Air-purifying respirators †				
Facepiece, half-mask ‡	NP	10		30 CFR Part 11, Subpart K.
Facepiece, full	RP	80		
Facepiece, half-mask, full, or hood	PP	1,000		
II. Atmosphere-supplying respirators				
1. Air-line respirator				
Facepiece, half-mask	CF		1,000	
Facepiece, half-mask	D		5	
Facepiece, full	CF		5,000	
Facepiece, full	D		5	30 CFR Part 11, Subpart J.
Facepiece, full	PD		2,000	
Hood	CF		(1)	
Suit	CF		(1)	
2. Self-contained breathing apparatus (SCBA)				
Facepiece, full	D		80	
Facepiece, full	PD		10,000	30 CFR Part 11, Subpart H.
Facepiece, full	RD		80	
Facepiece, full	RP		1,000	
III. Combination respirator: Any combination of air-purifying and atmosphere-supplying respirators.				30 CFR Part 11, § 11.63(b).

\* For use in the selection of respiratory protective devices to be used only where the contaminants have been identified and the concentrations (or possible concentrations) are known.

† Only for shelter-in-place and where nothing interferes with the seal of tight-fitting facepieces against the skin. (Hoods and suits are exceptions.)

‡ The mode symbols are defined as follows: CF = continuous flow; D = demand; NP = negative pressure (s.e., negative phase during inhalation); PD = pressure demand (s.e., always positive pressure); PP = positive pressure, non-circulating (closed circuit); RP = positive pressure, non-circulating (closed circuit).

§ The protection factor is a measure of the degree of protection afforded by a respirator defined as the ratio of the concentration of airborne radioactive material outside the respiratory protective equipment to that inside the equipment (usually inside the facepiece) under conditions of use. It is applied to the ambient airborne concentration to estimate the concentrations inhaled by the wearer according to the following formula:

Concentration inhaled = Ambient airborne concentration / Protection factor

¶ The protection factors apply:

(a) Only for trained individuals wearing properly fitted respirators used and maintained under supervision in a well-planned respiratory protective program.

(b) For air-purifying respirators only when high efficiency particulate filters (above 99.97% removal efficiency by thermally generated 0.3 µm dioctyl phthalate (DOP) test) are used in atmospheres not deficient in oxygen and not containing radioactive gas or vapor respiratory hazards.

(c) No allowance is to be made for the use of sorbents against radioactive gases or vapors.

(d) For atmosphere-supplying respirators only when supplied with adequate respirable air. Respirable air shall be provided of the quality and quantity required in accordance with NIOSH/MSHA certification (described in 30 CFR Part 11). Oxygen and air shall not be used in the same apparatus.

§ Excluding radioactive contaminants that present an absorption or submersion hazard. For tritium oxide, approximately one half of the intake occurs by absorption through the skin so that an overall protection factor of less than 2 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. If the protection factor for a device is 5, the effective protection factor for tritium oxide is about 1.4; for devices with protection factors of 10 the effective factor for tritium oxide is about 1.7, and for devices with protection factors of 100 or more the effective factor for tritium oxide is about 1.8. Air-purifying respirators are not suitable for protection against tritium oxide. See also footnote 1 concerning supplied-air suits.

¶ Certain air and cartridge respirators shall not be used beyond service-life limitations.

Under other type only. This type of respirator is not satisfactory for use where it might be possible (e.g., if an accident or emergency were to occur) for the ambient airborne concentration to reach intermittent values greater than 10 times the pertinent values in Table 1, Column 1 of Appendix B of this part. This type of respirator is not suitable for protection against plutonium or other high-toxicity materials. The mask shall be tested for fit with irritant smoke, prior to use each time it is donned.

Equipment shall be operated in a manner that ensures that proper air flow-rates are maintained. A protection factor of no more than 1,000 may be used for tested and certified supplied-air hoods when a minimum air flow of 8 cubic feet per minute is maintained and calibrated airflow pressure gauges or flow measuring devices are used. A protection factor of up to 2,000 may be used for tested and certified supplied-air hoods when the air flow is maintained at the manufacturer's recommended minimum rate for the equipment, this rate is greater than 8 cubic feet per minute, and calibrated airflow pressure gauges or flow measuring devices are used.

The design of the supplied-air hood or helmet (with a minimum flow of 8 cfm of air) may determine its overall efficiency and the protection it provides. For example, some hoods expel air contaminated as into the breathing zone when the wearer works with hands-over-head. This expiration may be overcome if a short cape-like extension to the hood is worn under a cap or overalls. Other innovations specified by the approval agency shall be considered before using a hood in certain types of atmospheres, such as the design and its permeability to the contaminants under conditions of use.

Appropriate protection factors shall be determined (see 20.100(e)), taking into account the design of the suit and its permeability to the contaminant under conditions of use. There shall be a readily accessible person equipped with self-contained breathing apparatus and communications equipment whenever supplied-air suits are used.

No approval schedules are currently available for the equipment. Equipment shall be evaluated by testing or on the basis of reliable test information.

This type of respirator may provide greater protection and be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure such as skin absorption shall be taken into account in these circumstances.

Quantitative fit testing shall be performed on each individual and no more than 0.02% leakage is allowed with this type of apparatus. Permissible outward leakage of gas from this or any positive pressure self-contained breathing apparatus is unacceptable because service life will be reduced substantially. Special training in the use of this type of apparatus shall be provided to the wearer (see footnote 1).

Protection factor for type and mode of operation as listed above.

**Note 1.—Protection factors for respirators.** as may be approved by the U.S. Bureau of Mines/National Institute for Occupational Safety and Health (NIOSH) according to applicable approvals for respirators for type and mode of use to protect against airborne radionuclides, may be used to the extent that they do not exceed the protection factors listed in this table. The protection factors listed in this table may not be appropriate to circumstances where chemical or other respiratory hazards exist in addition to radiological hazards. The selection and use of respirators for these circumstances should take into account applicable approvals of the U.S. Bureau of Mines/NIOSH.

**Note 2.—Radioactive contaminants for which the concentration values in Table 1, column 1, Appendix B of this part are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.**

# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX B

### Concentrations in Air and Water Above Natural Background

[See notes at end of appendix]

Element (atomic number)	Isotope <sup>1</sup>	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Actinium (89).....	Ac 227	5	$2 \times 10^{-12}$	$6 \times 10^{-3}$	$8 \times 10^{-14}$
		I	$3 \times 10^{-11}$	$9 \times 10^{-3}$	$3 \times 10^{-13}$
	Ac 228	5	$8 \times 10^{-9}$	$3 \times 10^{-3}$	$9 \times 10^{-3}$
		I	$2 \times 10^{-8}$	$3 \times 10^{-3}$	$9 \times 10^{-3}$
Americium (95).....	Am 241	5	$6 \times 10^{-12}$	$1 \times 10^{-4}$	$2 \times 10^{-13}$
		★ I	$1 \times 10^{-10}$	$8 \times 10^{-4}$	$4 \times 10^{-13}$
	Am 242m	5	$6 \times 10^{-12}$	$1 \times 10^{-4}$	$2 \times 10^{-13}$
		I	$3 \times 10^{-10}$	$3 \times 10^{-3}$	$9 \times 10^{-13}$
	Am 242	5	$4 \times 10^{-8}$	$4 \times 10^{-3}$	$1 \times 10^{-9}$
		I	$5 \times 10^{-8}$	$4 \times 10^{-3}$	$2 \times 10^{-9}$
	Am 243	5	$6 \times 10^{-12}$	$1 \times 10^{-4}$	$2 \times 10^{-13}$
		I	$1 \times 10^{-10}$	$8 \times 10^{-4}$	$4 \times 10^{-13}$
	Am 244	5	$4 \times 10^{-8}$	$1 \times 10^{-1}$	$1 \times 10^{-7}$
		I	$2 \times 10^{-3}$	$1 \times 10^{-1}$	$3 \times 10^{-3}$
Antimony (51).....	Sb 122	5	$2 \times 10^{-7}$	$8 \times 10^{-4}$	$6 \times 10^{-9}$
		I	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$5 \times 10^{-9}$
	Sb 124	5	$2 \times 10^{-7}$	$7 \times 10^{-4}$	$5 \times 10^{-9}$
		I	$2 \times 10^{-8}$	$7 \times 10^{-10}$	$2 \times 10^{-3}$
	Sb 125	5	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$
		I	$3 \times 10^{-6}$	$3 \times 10^{-3}$	$9 \times 10^{-10}$
Argon (18).....	A 37	Sub <sup>2</sup>	$6 \times 10^{-3}$	$1 \times 10^{-4}$	
	A 41	Sub	$2 \times 10^{-6}$	$4 \times 10^{-6}$	
Arsenic (33).....	As 73	5	$2 \times 10^{-6}$	$1 \times 10^{-7}$	$7 \times 10^{-3}$
		I	$4 \times 10^{-7}$	$1 \times 10^{-7}$	$5 \times 10^{-4}$
	As 74	5	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$
		I	$1 \times 10^{-7}$	$2 \times 10^{-3}$	$4 \times 10^{-9}$
	As 76	5	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$4 \times 10^{-9}$
		I	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$3 \times 10^{-9}$
	As 77	5	$5 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$
		I	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$
Astatine (85).....	At 211	5	$7 \times 10^{-9}$	$5 \times 10^{-3}$	$2 \times 10^{-10}$
		I	$3 \times 10^{-8}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$
Barium (56).....	Ba 131	5	$1 \times 10^{-6}$	$5 \times 10^{-3}$	$4 \times 10^{-8}$
		I	$4 \times 10^{-7}$	$5 \times 10^{-3}$	$1 \times 10^{-8}$
	Ba 140	5	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$4 \times 10^{-9}$
		I	$4 \times 10^{-8}$	$7 \times 10^{-4}$	$1 \times 10^{-9}$
Berkelium (97).....	Bk 249	5	$9 \times 10^{-10}$	$2 \times 10^{-7}$	$3 \times 10^{-11}$
		I	$1 \times 10^{-7}$	$2 \times 10^{-3}$	$4 \times 10^{-9}$
	Bk 250	5	$1 \times 10^{-7}$	$6 \times 10^{-3}$	$5 \times 10^{-9}$
		I	$1 \times 10^{-8}$	$6 \times 10^{-3}$	$4 \times 10^{-8}$
Beryllium (4).....	Be 7	5	$6 \times 10^{-6}$	$5 \times 10^{-3}$	$2 \times 10^{-7}$
		I	$1 \times 10^{-6}$	$5 \times 10^{-3}$	$4 \times 10^{-8}$
Bismuth (83).....	Bi 206	5	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$
		I	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$5 \times 10^{-9}$
	Bi 207	5	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$6 \times 10^{-9}$
		I	$1 \times 10^{-8}$	$2 \times 10^{-3}$	$5 \times 10^{-10}$
	Bi 210	5	$6 \times 10^{-9}$	$1 \times 10^{-3}$	$2 \times 10^{-10}$
		I	$6 \times 10^{-9}$	$1 \times 10^{-3}$	$2 \times 10^{-10}$
	Bi 212	5	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$3 \times 10^{-9}$
		I	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$7 \times 10^{-9}$

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## APPENDIX B

## Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Bromine (35)	Br 82	S	$1 \times 10^{-6}$	$8 \times 10^{-3}$	$4 \times 10^{-8}$	$3 \times 10^{-4}$
	I		$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$	$4 \times 10^{-3}$
Cadmium (48)	Cd 109	S	$5 \times 10^{-8}$	$5 \times 10^{-3}$	$2 \times 10^{-9}$	$2 \times 10^{-4}$
	I		$7 \times 10^{-8}$	$5 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
	Cd 115m	S	$4 \times 10^{-8}$	$7 \times 10^{-4}$	$1 \times 10^{-9}$	$3 \times 10^{-3}$
	I		$4 \times 10^{-8}$	$7 \times 10^{-4}$	$1 \times 10^{-9}$	$3 \times 10^{-3}$
Calcium (20)	Cd 115	S	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$3 \times 10^{-3}$
	I		$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$	$4 \times 10^{-3}$
	Ca 45	S	$3 \times 10^{-8}$	$3 \times 10^{-4}$	$1 \times 10^{-9}$	$9 \times 10^{-4}$
	I		$1 \times 10^{-7}$	$5 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
Californium (98)	Ca 47	S	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$	$5 \times 10^{-3}$
	I		$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$	$3 \times 10^{-3}$
	Cf 249	S	$2 \times 10^{-12}$	$1 \times 10^{-4}$	$5 \times 10^{-14}$	$4 \times 10^{-4}$
	I		$1 \times 10^{-10}$	$7 \times 10^{-4}$	$3 \times 10^{-12}$	$2 \times 10^{-3}$
Carbon (6)	Cf 250	S	$5 \times 10^{-12}$	$4 \times 10^{-4}$	$2 \times 10^{-13}$	$1 \times 10^{-3}$
	I		$1 \times 10^{-10}$	$7 \times 10^{-4}$	$3 \times 10^{-12}$	$3 \times 10^{-3}$
	Cf 251	S	$2 \times 10^{-12}$	$1 \times 10^{-4}$	$6 \times 10^{-14}$	$4 \times 10^{-4}$
	I		$1 \times 10^{-10}$	$8 \times 10^{-4}$	$3 \times 10^{-12}$	$3 \times 10^{-3}$
	Cf 252	S	$6 \times 10^{-12}$	$2 \times 10^{-4}$	$2 \times 10^{-13}$	$7 \times 10^{-4}$
	I		$3 \times 10^{-11}$	$2 \times 10^{-4}$	$1 \times 10^{-12}$	$7 \times 10^{-4}$
	Cf 253	S	$8 \times 10^{-10}$	$4 \times 10^{-3}$	$3 \times 10^{-11}$	$1 \times 10^{-4}$
	I		$8 \times 10^{-10}$	$4 \times 10^{-3}$	$3 \times 10^{-11}$	$1 \times 10^{-4}$
	Cf 254	S	$5 \times 10^{-10}$	$4 \times 10^{-4}$	$2 \times 10^{-13}$	$1 \times 10^{-7}$
	I		$5 \times 10^{-12}$	$4 \times 10^{-4}$	$2 \times 10^{-13}$	$1 \times 10^{-7}$
Cerium (58)	C 14	S	$4 \times 10^{-4}$	$2 \times 10^{-3}$	$1 \times 10^{-5}$	$8 \times 10^{-4}$
	(CO <sub>2</sub> )	Sub	$5 \times 10^{-3}$		$1 \times 10^{-4}$	
Cesium (55)	Ce 141	S	$4 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$9 \times 10^{-3}$
	I		$2 \times 10^{-7}$	$3 \times 10^{-3}$	$5 \times 10^{-9}$	$9 \times 10^{-3}$
	Ce 143	S	$3 \times 10^{-7}$	$1 \times 10^{-3}$	$9 \times 10^{-9}$	$4 \times 10^{-3}$
	I		$2 \times 10^{-7}$	$1 \times 10^{-3}$	$7 \times 10^{-9}$	$4 \times 10^{-3}$
Chlorine (17)	Ce 144	S	$1 \times 10^{-8}$	$3 \times 10^{-4}$	$3 \times 10^{-10}$	$1 \times 10^{-3}$
	I		$6 \times 10^{-9}$	$3 \times 10^{-4}$	$2 \times 10^{-10}$	$1 \times 10^{-3}$
	Cs 131	S	$1 \times 10^{-3}$	$7 \times 10^{-3}$	$4 \times 10^{-7}$	$2 \times 10^{-3}$
	I		$3 \times 10^{-4}$	$3 \times 10^{-3}$	$1 \times 10^{-7}$	$9 \times 10^{-4}$
	Cs 134m	S	$4 \times 10^{-3}$	$2 \times 10^{-3}$	$1 \times 10^{-6}$	$6 \times 10^{-3}$
	I		$6 \times 10^{-4}$	$3 \times 10^{-3}$	$2 \times 10^{-7}$	$1 \times 10^{-3}$
	Cs 134	S	$4 \times 10^{-4}$	$3 \times 10^{-4}$	$1 \times 10^{-9}$	$9 \times 10^{-4}$
	I		$1 \times 10^{-4}$	$1 \times 10^{-3}$	$4 \times 10^{-10}$	$4 \times 10^{-3}$
	Cs 135	S	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-4}$
	I		$9 \times 10^{-8}$	$7 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
Chromium (24)	Cs 136	S	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$9 \times 10^{-3}$
	I		$2 \times 10^{-7}$	$2 \times 10^{-3}$	$6 \times 10^{-9}$	$6 \times 10^{-3}$
	Cs 137	S	$6 \times 10^{-4}$	$4 \times 10^{-4}$	$2 \times 10^{-9}$	$2 \times 10^{-3}$
	I		$1 \times 10^{-4}$	$1 \times 10^{-3}$	$5 \times 10^{-10}$	$4 \times 10^{-3}$
Chlorine (17)	Cl 36	S	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$8 \times 10^{-3}$
	I		$2 \times 10^{-7}$	$2 \times 10^{-3}$	$8 \times 10^{-10}$	$6 \times 10^{-3}$
Chromium (24)	Cl 38	S	$3 \times 10^{-4}$	$1 \times 10^{-3}$	$9 \times 10^{-9}$	$4 \times 10^{-4}$
	I		$2 \times 10^{-4}$	$1 \times 10^{-3}$	$7 \times 10^{-9}$	$4 \times 10^{-4}$
	Cr 51	S	$1 \times 10^{-3}$	$5 \times 10^{-3}$	$4 \times 10^{-7}$	$2 \times 10^{-3}$
	I		$2 \times 10^{-4}$	$3 \times 10^{-3}$	$8 \times 10^{-8}$	$2 \times 10^{-3}$

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## APPENDIX B

## Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope <sup>1</sup>	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Cesium (55)	Cs 137	3 × 10 <sup>-4</sup>	2 × 10 <sup>-2</sup>	1 × 10 <sup>-2</sup>	5 × 10 <sup>-4</sup>
	Cs 134m	2 × 10 <sup>-7</sup>	1 × 10 <sup>-2</sup>	6 × 10 <sup>-9</sup>	4 × 10 <sup>-4</sup>
	Cs 137	2 × 10 <sup>-3</sup>	8 × 10 <sup>-2</sup>	6 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>
	Cs 134	9 × 10 <sup>-4</sup>	6 × 10 <sup>-2</sup>	3 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>
	Cs 137	8 × 10 <sup>-7</sup>	4 × 10 <sup>-2</sup>	3 × 10 <sup>-9</sup>	1 × 10 <sup>-4</sup>
Copper (29)	Cu 64	5 × 10 <sup>-9</sup>	3 × 10 <sup>-2</sup>	2 × 10 <sup>-9</sup>	9 × 10 <sup>-3</sup>
	Cu 60	3 × 10 <sup>-7</sup>	1 × 10 <sup>-2</sup>	1 × 10 <sup>-9</sup>	5 × 10 <sup>-3</sup>
	Cu 64	9 × 10 <sup>-9</sup>	1 × 10 <sup>-2</sup>	3 × 10 <sup>-10</sup>	3 × 10 <sup>-3</sup>
	Cu 64	2 × 10 <sup>-6</sup>	1 × 10 <sup>-2</sup>	7 × 10 <sup>-6</sup>	3 × 10 <sup>-4</sup>
	Cu 64	1 × 10 <sup>-4</sup>	6 × 10 <sup>-2</sup>	4 × 10 <sup>-6</sup>	2 × 10 <sup>-4</sup>
Curium (96)	Cm 242	1 × 10 <sup>-10</sup>	7 × 10 <sup>-4</sup>	4 × 10 <sup>-12</sup>	2 × 10 <sup>-3</sup>
	Cm 243	2 × 10 <sup>-10</sup>	7 × 10 <sup>-4</sup>	6 × 10 <sup>-12</sup>	2 × 10 <sup>-3</sup>
	Cm 243	6 × 10 <sup>-12</sup>	1 × 10 <sup>-4</sup>	2 × 10 <sup>-12</sup>	5 × 10 <sup>-6</sup>
	Cm 244	1 × 10 <sup>-10</sup>	7 × 10 <sup>-4</sup>	3 × 10 <sup>-12</sup>	2 × 10 <sup>-3</sup>
	Cm 244	9 × 10 <sup>-12</sup>	2 × 10 <sup>-4</sup>	3 × 10 <sup>-12</sup>	7 × 10 <sup>-6</sup>
	Cm 244	1 × 10 <sup>-10</sup>	8 × 10 <sup>-4</sup>	3 × 10 <sup>-12</sup>	3 × 10 <sup>-3</sup>
	Cm 248	5 × 10 <sup>-12</sup>	1 × 10 <sup>-4</sup>	2 × 10 <sup>-12</sup>	4 × 10 <sup>-6</sup>
	Cm 248	1 × 10 <sup>-10</sup>	8 × 10 <sup>-4</sup>	4 × 10 <sup>-12</sup>	3 × 10 <sup>-3</sup>
	Cm 246	5 × 10 <sup>-12</sup>	1 × 10 <sup>-4</sup>	2 × 10 <sup>-12</sup>	4 × 10 <sup>-6</sup>
	Cm 246	1 × 10 <sup>-10</sup>	8 × 10 <sup>-4</sup>	4 × 10 <sup>-12</sup>	3 × 10 <sup>-3</sup>
	Cm 247	5 × 10 <sup>-12</sup>	1 × 10 <sup>-4</sup>	2 × 10 <sup>-12</sup>	4 × 10 <sup>-6</sup>
	Cm 247	1 × 10 <sup>-10</sup>	6 × 10 <sup>-4</sup>	4 × 10 <sup>-12</sup>	2 × 10 <sup>-3</sup>
Dysprosium (66)	Dy 165	3 × 10 <sup>-4</sup>	1 × 10 <sup>-2</sup>	9 × 10 <sup>-6</sup>	4 × 10 <sup>-4</sup>
	Dy 165	2 × 10 <sup>-4</sup>	1 × 10 <sup>-2</sup>	7 × 10 <sup>-6</sup>	4 × 10 <sup>-4</sup>
	Dy 166	2 × 10 <sup>-7</sup>	1 × 10 <sup>-2</sup>	8 × 10 <sup>-9</sup>	4 × 10 <sup>-3</sup>
	Dy 166	2 × 10 <sup>-7</sup>	1 × 10 <sup>-2</sup>	7 × 10 <sup>-9</sup>	4 × 10 <sup>-3</sup>
	Dy 166	8 × 10 <sup>-10</sup>	7 × 10 <sup>-4</sup>	3 × 10 <sup>-11</sup>	2 × 10 <sup>-3</sup>
Einsteinium (99)	Es 253	6 × 10 <sup>-10</sup>	7 × 10 <sup>-4</sup>	2 × 10 <sup>-11</sup>	2 × 10 <sup>-3</sup>
	Es 254m	5 × 10 <sup>-9</sup>	5 × 10 <sup>-4</sup>	2 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>
	Es 254m	6 × 10 <sup>-9</sup>	5 × 10 <sup>-4</sup>	2 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>
	Es 254	2 × 10 <sup>-11</sup>	4 × 10 <sup>-4</sup>	6 × 10 <sup>-12</sup>	1 × 10 <sup>-3</sup>
	Es 254	1 × 10 <sup>-10</sup>	4 × 10 <sup>-4</sup>	4 × 10 <sup>-12</sup>	1 × 10 <sup>-3</sup>
Erbium (68)	Er 169	5 × 10 <sup>-10</sup>	8 × 10 <sup>-4</sup>	2 × 10 <sup>-11</sup>	3 × 10 <sup>-3</sup>
	Er 169	4 × 10 <sup>-10</sup>	8 × 10 <sup>-4</sup>	1 × 10 <sup>-11</sup>	3 × 10 <sup>-3</sup>
	Er 169	6 × 10 <sup>-7</sup>	3 × 10 <sup>-2</sup>	2 × 10 <sup>-9</sup>	9 × 10 <sup>-3</sup>
	Er 169	4 × 10 <sup>-7</sup>	3 × 10 <sup>-2</sup>	1 × 10 <sup>-9</sup>	9 × 10 <sup>-3</sup>
	Er 171	7 × 10 <sup>-7</sup>	3 × 10 <sup>-2</sup>	2 × 10 <sup>-9</sup>	1 × 10 <sup>-4</sup>
Europium (63)	Eu 152	6 × 10 <sup>-7</sup>	3 × 10 <sup>-2</sup>	2 × 10 <sup>-9</sup>	1 × 10 <sup>-4</sup>
	Eu 152	4 × 10 <sup>-7</sup>	3 × 10 <sup>-2</sup>	2 × 10 <sup>-9</sup>	1 × 10 <sup>-4</sup>
	Eu 152 (T <sub>1/2</sub> = 9.2 hrs)	4 × 10 <sup>-7</sup>	3 × 10 <sup>-2</sup>	2 × 10 <sup>-9</sup>	1 × 10 <sup>-4</sup>
	Eu 152	3 × 10 <sup>-7</sup>	2 × 10 <sup>-2</sup>	1 × 10 <sup>-9</sup>	6 × 10 <sup>-3</sup>
	Eu 152 (T <sub>1/2</sub> = 13 yrs)	1 × 10 <sup>-9</sup>	2 × 10 <sup>-2</sup>	4 × 10 <sup>-10</sup>	8 × 10 <sup>-3</sup>
	Eu 154	2 × 10 <sup>-9</sup>	2 × 10 <sup>-2</sup>	6 × 10 <sup>-10</sup>	8 × 10 <sup>-3</sup>
	Eu 154	4 × 10 <sup>-9</sup>	6 × 10 <sup>-4</sup>	1 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>
	Eu 154	7 × 10 <sup>-9</sup>	6 × 10 <sup>-4</sup>	2 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>
Europium (63)	Eu 155	9 × 10 <sup>-9</sup>	6 × 10 <sup>-2</sup>	3 × 10 <sup>-9</sup>	2 × 10 <sup>-4</sup>
	Eu 155	7 × 10 <sup>-9</sup>	6 × 10 <sup>-2</sup>	3 × 10 <sup>-9</sup>	2 × 10 <sup>-4</sup>

# APPENDIX B

## Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope <sup>1</sup>		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air	Water	Air	Water
			+ (μCi/ml)	(μCi/ml)	(μCi/ml)	(μCi/ml)
Fermium (100)	Fm 254	S	$6 \times 10^{-8}$	$4 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-4}$
		I	$7 \times 10^{-8}$	$4 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-4}$
	Fm 255	S	$2 \times 10^{-8}$	$1 \times 10^{-3}$	$6 \times 10^{-10}$	$3 \times 10^{-5}$
		I	$1 \times 10^{-8}$	$1 \times 10^{-3}$	$4 \times 10^{-10}$	$3 \times 10^{-5}$
	Fm 256	S	$3 \times 10^{-9}$	$3 \times 10^{-3}$	$1 \times 10^{-10}$	$9 \times 10^{-7}$
Fluorine (9)		I	$2 \times 10^{-9}$	$3 \times 10^{-3}$	$6 \times 10^{-11}$	$9 \times 10^{-7}$
	F 18	S	$5 \times 10^{-9}$	$2 \times 10^{-3}$	$1 \times 10^{-7}$	$8 \times 10^{-4}$
Gadolinium (64)		I	$3 \times 10^{-9}$	$1 \times 10^{-3}$	$9 \times 10^{-9}$	$5 \times 10^{-4}$
	Gd 153	S	$2 \times 10^{-7}$	$6 \times 10^{-3}$	$8 \times 10^{-9}$	$2 \times 10^{-4}$
		I	$9 \times 10^{-8}$	$6 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
Gallium (31)	Gd 159	S	$5 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$8 \times 10^{-5}$
		I	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$8 \times 10^{-5}$
Germanium (32)	Ge 72	S	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$4 \times 10^{-5}$
		I	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$	$4 \times 10^{-5}$
Gold (79)	Ge 71	S	$1 \times 10^{-3}$	$5 \times 10^{-3}$	$4 \times 10^{-7}$	$2 \times 10^{-3}$
		I	$6 \times 10^{-8}$	$5 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$
	Au 196	S	$1 \times 10^{-4}$	$5 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
		I	$6 \times 10^{-7}$	$4 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-4}$
	Au 198	S	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$5 \times 10^{-5}$
Hafnium (72)		I	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$5 \times 10^{-5}$
		S	$1 \times 10^{-4}$	$5 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
	Hf 181	I	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
Helmium (67)		S	$4 \times 10^{-8}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$7 \times 10^{-5}$
		I	$7 \times 10^{-8}$	$2 \times 10^{-3}$	$3 \times 10^{-9}$	$7 \times 10^{-5}$
Hydrogen (1)	He 166	S	$2 \times 10^{-7}$	$9 \times 10^{-4}$	$7 \times 10^{-9}$	$3 \times 10^{-5}$
		I	$2 \times 10^{-7}$	$9 \times 10^{-4}$	$6 \times 10^{-9}$	$3 \times 10^{-5}$
Indium (49)	H3	S	$5 \times 10^{-4}$	$1 \times 10^{-1}$	$2 \times 10^{-7}$	$3 \times 10^{-3}$
		I	$5 \times 10^{-4}$	$1 \times 10^{-1}$	$2 \times 10^{-7}$	$3 \times 10^{-3}$
		Sub	$2 \times 10^{-3}$		$4 \times 10^{-3}$	
	In 113m	S	$8 \times 10^{-8}$	$4 \times 10^{-3}$	$3 \times 10^{-7}$	$1 \times 10^{-3}$
		I	$7 \times 10^{-8}$	$4 \times 10^{-3}$	$2 \times 10^{-7}$	$1 \times 10^{-3}$
Iodine (53)	In 114m	S	$1 \times 10^{-7}$	$5 \times 10^{-4}$	$4 \times 10^{-9}$	$2 \times 10^{-5}$
		I	$2 \times 10^{-8}$	$5 \times 10^{-4}$	$7 \times 10^{-10}$	$2 \times 10^{-5}$
	In 115m	S	$2 \times 10^{-4}$	$1 \times 10^{-2}$	$8 \times 10^{-9}$	$4 \times 10^{-4}$
		I	$2 \times 10^{-4}$	$1 \times 10^{-2}$	$6 \times 10^{-9}$	$4 \times 10^{-4}$
	In 115	S	$2 \times 10^{-7}$	$3 \times 10^{-3}$	$9 \times 10^{-9}$	$9 \times 10^{-5}$
Iodine (53)		I	$3 \times 10^{-8}$	$3 \times 10^{-3}$	$1 \times 10^{-9}$	$9 \times 10^{-5}$
	I 125	S	$5 \times 10^{-8}$	$4 \times 10^{-3}$	$8 \times 10^{-11}$	$2 \times 10^{-7}$
		I	$2 \times 10^{-7}$	$6 \times 10^{-3}$	$6 \times 10^{-9}$	$2 \times 10^{-4}$
	I 126	S	$8 \times 10^{-8}$	$5 \times 10^{-3}$	$9 \times 10^{-11}$	$3 \times 10^{-7}$
		I	$3 \times 10^{-7}$	$3 \times 10^{-3}$	$1 \times 10^{-9}$	$9 \times 10^{-5}$
	I 129	S	$2 \times 10^{-8}$	$1 \times 10^{-3}$	$2 \times 10^{-11}$	$6 \times 10^{-4}$
		I	$7 \times 10^{-8}$	$6 \times 10^{-3}$	$2 \times 10^{-9}$	$2 \times 10^{-4}$
	I 131	S	$9 \times 10^{-8}$	$6 \times 10^{-3}$	$1 \times 10^{-10}$	$3 \times 10^{-7}$
		I	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$6 \times 10^{-5}$
	I 132	S	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$3 \times 10^{-9}$	$8 \times 10^{-4}$
		I	$9 \times 10^{-7}$	$5 \times 10^{-3}$	$3 \times 10^{-9}$	$2 \times 10^{-4}$
	I 133	S	$3 \times 10^{-8}$	$2 \times 10^{-4}$	$4 \times 10^{-10}$	$1 \times 10^{-4}$
		I	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$7 \times 10^{-9}$	$4 \times 10^{-5}$
	I 134	S	$5 \times 10^{-7}$	$4 \times 10^{-3}$	$6 \times 10^{-9}$	$2 \times 10^{-5}$

# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope <sup>1</sup>		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Iodine (53)	I 134	I	3 × 10 <sup>-8</sup>	2 × 10 <sup>-7</sup>	1 × 10 <sup>-7</sup>	6 × 10 <sup>-4</sup>
	I 135	S	1 × 10 <sup>-7</sup>	7 × 10 <sup>-4</sup>	1 × 10 <sup>-9</sup>	4 × 10 <sup>-6</sup>
Iridium (77)	Ir 190	S	4 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	1 × 10 <sup>-8</sup>	7 × 10 <sup>-3</sup>
	Ir 192	S	1 × 10 <sup>-6</sup>	6 × 10 <sup>-3</sup>	4 × 10 <sup>-8</sup>	2 × 10 <sup>-4</sup>
	Ir 194	S	4 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	1 × 10 <sup>-8</sup>	2 × 10 <sup>-4</sup>
	Ir 192	I	1 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	4 × 10 <sup>-9</sup>	4 × 10 <sup>-3</sup>
	Ir 194	I	3 × 10 <sup>-8</sup>	1 × 10 <sup>-3</sup>	9 × 10 <sup>-10</sup>	4 × 10 <sup>-3</sup>
Iron (26)	Fe 55	S	2 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	8 × 10 <sup>-9</sup>	3 × 10 <sup>-3</sup>
	Fe 59	S	2 × 10 <sup>-7</sup>	9 × 10 <sup>-4</sup>	3 × 10 <sup>-9</sup>	3 × 10 <sup>-3</sup>
	Fe 55	I	9 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	3 × 10 <sup>-8</sup>	8 × 10 <sup>-4</sup>
	Fe 59	I	1 × 10 <sup>-6</sup>	7 × 10 <sup>-3</sup>	3 × 10 <sup>-8</sup>	2 × 10 <sup>-3</sup>
Krypton (36)	Kr 85	S	1 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	5 × 10 <sup>-9</sup>	6 × 10 <sup>-3</sup>
	Kr 85m	Sub	5 × 10 <sup>-8</sup>	2 × 10 <sup>-3</sup>	2 × 10 <sup>-9</sup>	5 × 10 <sup>-3</sup>
	Kr 85	Sub	6 × 10 <sup>-8</sup>	1 × 10 <sup>-7</sup>	1 × 10 <sup>-7</sup>	
	Kr 87	Sub	1 × 10 <sup>-8</sup>	3 × 10 <sup>-7</sup>	3 × 10 <sup>-7</sup>	
Lanthanum (57)	La 140	S	1 × 10 <sup>-6</sup>	2 × 10 <sup>-8</sup>	2 × 10 <sup>-8</sup>	
	La 140	I	2 × 10 <sup>-7</sup>	7 × 10 <sup>-4</sup>	5 × 10 <sup>-9</sup>	2 × 10 <sup>-3</sup>
Lead (82)	Pb 203	S	1 × 10 <sup>-7</sup>	7 × 10 <sup>-4</sup>	4 × 10 <sup>-9</sup>	2 × 10 <sup>-3</sup>
	Pb 210	S	3 × 10 <sup>-8</sup>	1 × 10 <sup>-3</sup>	9 × 10 <sup>-9</sup>	4 × 10 <sup>-4</sup>
	Pb 210	I	2 × 10 <sup>-8</sup>	1 × 10 <sup>-3</sup>	6 × 10 <sup>-9</sup>	4 × 10 <sup>-4</sup>
	Pb 212	S	1 × 10 <sup>-10</sup>	4 × 10 <sup>-4</sup>	4 × 10 <sup>-12</sup>	1 × 10 <sup>-7</sup>
	Pb 212	I	2 × 10 <sup>-10</sup>	5 × 10 <sup>-3</sup>	8 × 10 <sup>-12</sup>	2 × 10 <sup>-4</sup>
Lutetium (71)	Lu 177	S	2 × 10 <sup>-8</sup>	6 × 10 <sup>-4</sup>	6 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>
	Lu 177	I	2 × 10 <sup>-8</sup>	5 × 10 <sup>-4</sup>	7 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>
Manganese (25)	Mn 52	S	6 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	2 × 10 <sup>-8</sup>	1 × 10 <sup>-4</sup>
	Mn 52	I	5 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	2 × 10 <sup>-8</sup>	1 × 10 <sup>-4</sup>
	Mn 54	S	2 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	7 × 10 <sup>-9</sup>	3 × 10 <sup>-3</sup>
	Mn 54	I	1 × 10 <sup>-7</sup>	9 × 10 <sup>-4</sup>	3 × 10 <sup>-9</sup>	3 × 10 <sup>-3</sup>
Mercury (80)	Hg 197m	S	4 × 10 <sup>-7</sup>	4 × 10 <sup>-3</sup>	1 × 10 <sup>-8</sup>	1 × 10 <sup>-4</sup>
	Hg 197m	I	4 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	1 × 10 <sup>-9</sup>	1 × 10 <sup>-4</sup>
	Hg 197	S	8 × 10 <sup>-7</sup>	4 × 10 <sup>-3</sup>	3 × 10 <sup>-8</sup>	1 × 10 <sup>-4</sup>
	Hg 197	I	5 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	2 × 10 <sup>-8</sup>	1 × 10 <sup>-4</sup>
	Hg 203	S	7 × 10 <sup>-7</sup>	6 × 10 <sup>-3</sup>	3 × 10 <sup>-8</sup>	2 × 10 <sup>-4</sup>
Molybdenum (42)	Mo 99	S	8 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	3 × 10 <sup>-8</sup>	2 × 10 <sup>-4</sup>
	Mo 99	I	7 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	3 × 10 <sup>-8</sup>	2 × 10 <sup>-4</sup>
Neodymium (60)	Nd 144	S	2 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	7 × 10 <sup>-9</sup>	4 × 10 <sup>-3</sup>
	Nd 144	I	8 × 10 <sup>-11</sup>	2 × 10 <sup>-3</sup>	3 × 10 <sup>-12</sup>	7 × 10 <sup>-3</sup>
	Nd 147	S	3 × 10 <sup>-10</sup>	2 × 10 <sup>-3</sup>	1 × 10 <sup>-11</sup>	8 × 10 <sup>-3</sup>
	Nd 147	I	4 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	1 × 10 <sup>-8</sup>	6 × 10 <sup>-3</sup>
	Nd 149	S	2 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	8 × 10 <sup>-9</sup>	6 × 10 <sup>-3</sup>
	Nd 149	I	2 × 10 <sup>-8</sup>	8 × 10 <sup>-3</sup>	6 × 10 <sup>-9</sup>	3 × 10 <sup>-4</sup>
	Nd 149	I	1 × 10 <sup>-8</sup>	8 × 10 <sup>-3</sup>	5 × 10 <sup>-9</sup>	3 × 10 <sup>-4</sup>

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## APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope <sup>1</sup>		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Neptunium (93)	Np 237	S	$4 \times 10^{-12}$	$9 \times 10^{-3}$	$1 \times 10^{-13}$	$3 \times 10^{-3}$
	I		$1 \times 10^{-10}$	$9 \times 10^{-4}$	$4 \times 10^{-12}$	$3 \times 10^{-3}$
	Np 239	S	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$
Nickel (28)	I		$7 \times 10^{-7}$	$4 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Ni 59	S	$5 \times 10^{-7}$	$6 \times 10^{-3}$	$2 \times 10^{-8}$	$2 \times 10^{-4}$
	I		$8 \times 10^{-7}$	$6 \times 10^{-3}$	$3 \times 10^{-8}$	$2 \times 10^{-4}$
Niobium (Columbium) (41)	Ni 63	S	$6 \times 10^{-8}$	$8 \times 10^{-4}$	$2 \times 10^{-9}$	$3 \times 10^{-3}$
	I		$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$	$7 \times 10^{-4}$
	Ni 65	S	$9 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$
Niobium (Columbium) (41)	I		$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Nb 93m	S	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$4 \times 10^{-9}$	$4 \times 10^{-4}$
	I		$2 \times 10^{-7}$	$1 \times 10^{-3}$	$5 \times 10^{-9}$	$4 \times 10^{-4}$
Osmium (76)	Nb 95	S	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	I		$1 \times 10^{-7}$	$3 \times 10^{-3}$	$3 \times 10^{-9}$	$1 \times 10^{-4}$
	Nb 97	S	$6 \times 10^{-8}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$9 \times 10^{-4}$
Osmium (76)	I		$5 \times 10^{-8}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$9 \times 10^{-4}$
	Os 185	S	$5 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-8}$	$7 \times 10^{-3}$
	I		$5 \times 10^{-8}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$7 \times 10^{-3}$
Osmium (76)	Os 191m	S	$2 \times 10^{-3}$	$7 \times 10^{-3}$	$6 \times 10^{-7}$	$3 \times 10^{-3}$
	I		$9 \times 10^{-4}$	$7 \times 10^{-3}$	$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Os 191	S	$1 \times 10^{-8}$	$5 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
Osmium (76)	I		$4 \times 10^{-7}$	$5 \times 10^{-3}$	$1 \times 10^{-8}$	$2 \times 10^{-4}$
	Os 192	S	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$	$6 \times 10^{-3}$
	I		$3 \times 10^{-7}$	$2 \times 10^{-3}$	$9 \times 10^{-9}$	$5 \times 10^{-3}$
Palladium (46)	Pd 103	S	$1 \times 10^{-8}$	$1 \times 10^{-3}$	$5 \times 10^{-9}$	$3 \times 10^{-4}$
	I		$7 \times 10^{-7}$	$8 \times 10^{-3}$	$3 \times 10^{-8}$	$3 \times 10^{-4}$
	Pd 109	S	$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$9 \times 10^{-3}$
Phosphorus (15)	I		$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-8}$	$7 \times 10^{-3}$
	P 32	S	$7 \times 10^{-8}$	$5 \times 10^{-4}$	$2 \times 10^{-9}$	$2 \times 10^{-3}$
	I		$6 \times 10^{-8}$	$7 \times 10^{-4}$	$3 \times 10^{-9}$	$2 \times 10^{-3}$
Platinum (78)	Pt 191	S	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$
	I		$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Pt 193m	S	$7 \times 10^{-8}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-3}$
Platinum (78)	I		$5 \times 10^{-8}$	$5 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-3}$
	* Pt 193	S	$1 \times 10^{-7}$	$3 \times 10^{-3}$	$4 \times 10^{-8}$	$9 \times 10^{-4}$
	I		$3 \times 10^{-7}$	$5 \times 10^{-3}$	$1 \times 10^{-8}$	$2 \times 10^{-3}$
Platinum (78)	Pt 197m	S	$6 \times 10^{-8}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-3}$
	I		$5 \times 10^{-8}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-3}$
	Pt 197	S	$8 \times 10^{-7}$	$4 \times 10^{-3}$	$3 \times 10^{-8}$	$1 \times 10^{-4}$
Plutonium (94)	I		$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-8}$	$1 \times 10^{-4}$
	Pu 238	S	$2 \times 10^{-12}$	$1 \times 10^{-4}$	$7 \times 10^{-14}$	$5 \times 10^{-4}$
	I		$3 \times 10^{-11}$	$8 \times 10^{-4}$	$1 \times 10^{-12}$	$3 \times 10^{-3}$
Plutonium (94)	Pu 239	S	$2 \times 10^{-12}$	$1 \times 10^{-4}$	$6 \times 10^{-14}$	$5 \times 10^{-4}$
	I		$4 \times 10^{-11}$	$8 \times 10^{-4}$	$1 \times 10^{-12}$	$3 \times 10^{-3}$
	Pu 240	S	$2 \times 10^{-12}$	$1 \times 10^{-4}$	$6 \times 10^{-14}$	$5 \times 10^{-4}$
Plutonium (94)	I		$4 \times 10^{-11}$	$8 \times 10^{-4}$	$1 \times 10^{-12}$	$3 \times 10^{-3}$
	Pu 241	S	$9 \times 10^{-11}$	$7 \times 10^{-4}$	$3 \times 10^{-12}$	$2 \times 10^{-4}$
	I		$4 \times 10^{-10}$	$4 \times 10^{-4}$	$1 \times 10^{-11}$	$1 \times 10^{-3}$

# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air ( $\mu\text{Ci/ml}$ )	Water ( $\mu\text{Ci/ml}$ )	Air ( $\mu\text{Ci/ml}$ )	Water ( $\mu\text{Ci/ml}$ )
Plutonium (94)	Pu 242	S	$2 \times 10^{-12}$	$1 \times 10^{-14}$	$6 \times 10^{-14}$	$3 \times 10^{-14}$
		I	$4 \times 10^{-11}$	$9 \times 10^{-14}$	$1 \times 10^{-12}$	$3 \times 10^{-13}$
	Pu 243	S	$2 \times 10^{-9}$	$1 \times 10^{-11}$	$6 \times 10^{-9}$	$3 \times 10^{-9}$
		I	$2 \times 10^{-8}$	$1 \times 10^{-10}$	$8 \times 10^{-8}$	$3 \times 10^{-8}$
Polonium (84)	Po 210	S	$2 \times 10^{-12}$	$1 \times 10^{-14}$	$6 \times 10^{-14}$	$4 \times 10^{-14}$
		I	$3 \times 10^{-11}$	$3 \times 10^{-14}$	$1 \times 10^{-12}$	$1 \times 10^{-13}$
		S	$5 \times 10^{-10}$	$2 \times 10^{-12}$	$2 \times 10^{-11}$	$7 \times 10^{-12}$
		I	$2 \times 10^{-10}$	$8 \times 10^{-14}$	$7 \times 10^{-12}$	$3 \times 10^{-13}$
Potassium (19)	K 42	S	$2 \times 10^{-9}$	$9 \times 10^{-12}$	$7 \times 10^{-9}$	$3 \times 10^{-9}$
		I	$1 \times 10^{-7}$	$6 \times 10^{-10}$	$4 \times 10^{-9}$	$2 \times 10^{-9}$
Promethium (61)	Pm 142	S	$2 \times 10^{-7}$	$9 \times 10^{-10}$	$7 \times 10^{-9}$	$3 \times 10^{-9}$
		I	$2 \times 10^{-7}$	$9 \times 10^{-10}$	$5 \times 10^{-9}$	$3 \times 10^{-9}$
Praseodymium (59)	Pr 143	S	$3 \times 10^{-7}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$5 \times 10^{-9}$
		I	$2 \times 10^{-7}$	$1 \times 10^{-9}$	$6 \times 10^{-9}$	$5 \times 10^{-9}$
Promethium (61)	Pm 147	S	$6 \times 10^{-6}$	$6 \times 10^{-9}$	$2 \times 10^{-9}$	$2 \times 10^{-9}$
		I	$1 \times 10^{-7}$	$6 \times 10^{-9}$	$3 \times 10^{-9}$	$2 \times 10^{-9}$
Promethium (61)	Pm 149	S	$3 \times 10^{-7}$	$1 \times 10^{-9}$	$1 \times 10^{-9}$	$4 \times 10^{-9}$
		I	$2 \times 10^{-7}$	$1 \times 10^{-9}$	$8 \times 10^{-9}$	$4 \times 10^{-9}$
Protactinium (91)	Pa 230	S	$2 \times 10^{-9}$	$7 \times 10^{-11}$	$6 \times 10^{-11}$	$2 \times 10^{-11}$
		I	$8 \times 10^{-10}$	$7 \times 10^{-11}$	$3 \times 10^{-11}$	$2 \times 10^{-11}$
	Pa 231	S	$1 \times 10^{-12}$	$3 \times 10^{-13}$	$4 \times 10^{-14}$	$9 \times 10^{-14}$
		I	$1 \times 10^{-10}$	$8 \times 10^{-13}$	$4 \times 10^{-12}$	$2 \times 10^{-12}$
Radium (88)	Pa 233	S	$6 \times 10^{-7}$	$4 \times 10^{-12}$	$2 \times 10^{-9}$	$1 \times 10^{-9}$
		I	$2 \times 10^{-7}$	$3 \times 10^{-12}$	$4 \times 10^{-9}$	$1 \times 10^{-9}$
	Re 223	S	$2 \times 10^{-9}$	$2 \times 10^{-12}$	$6 \times 10^{-11}$	$7 \times 10^{-12}$
		I	$2 \times 10^{-10}$	$1 \times 10^{-12}$	$8 \times 10^{-12}$	$4 \times 10^{-12}$
Radium (88)	Re 224	S	$5 \times 10^{-9}$	$7 \times 10^{-12}$	$2 \times 10^{-10}$	$2 \times 10^{-10}$
		I	$7 \times 10^{-10}$	$2 \times 10^{-12}$	$2 \times 10^{-11}$	$5 \times 10^{-12}$
	Re 226	S	$3 \times 10^{-11}$	$4 \times 10^{-12}$	$3 \times 10^{-12}$	$3 \times 10^{-12}$
		I	$5 \times 10^{-11}$	$9 \times 10^{-12}$	$2 \times 10^{-12}$	$3 \times 10^{-12}$
Radium (88)	Re 228	S	$7 \times 10^{-11}$	$8 \times 10^{-12}$	$2 \times 10^{-12}$	$3 \times 10^{-12}$
		I	$4 \times 10^{-11}$	$7 \times 10^{-12}$	$1 \times 10^{-12}$	$3 \times 10^{-12}$
	Rn 220	S	$3 \times 10^{-7}$		$1 \times 10^{-9}$	
	Rn 222	S	$3 \times 10^{-8}$	$2 \times 10^{-12}$	$9 \times 10^{-12}$	$6 \times 10^{-12}$
Rhenium (75)	Re 183	S	$2 \times 10^{-7}$	$8 \times 10^{-12}$	$5 \times 10^{-9}$	$3 \times 10^{-9}$
		I	$6 \times 10^{-7}$	$3 \times 10^{-12}$	$2 \times 10^{-9}$	$9 \times 10^{-12}$
	Re 186	S	$2 \times 10^{-7}$	$1 \times 10^{-12}$	$8 \times 10^{-9}$	$5 \times 10^{-12}$
		I	$9 \times 10^{-8}$	$7 \times 10^{-12}$	$3 \times 10^{-9}$	$3 \times 10^{-12}$
Rhodium (45)	Rh 187	S	$5 \times 10^{-7}$	$4 \times 10^{-12}$	$2 \times 10^{-9}$	$2 \times 10^{-12}$
		I	$4 \times 10^{-7}$	$2 \times 10^{-12}$	$1 \times 10^{-9}$	$6 \times 10^{-12}$
	Rh 188	S	$2 \times 10^{-7}$	$9 \times 10^{-12}$	$6 \times 10^{-9}$	$3 \times 10^{-12}$
		I	$8 \times 10^{-8}$	$4 \times 10^{-12}$	$3 \times 10^{-9}$	$1 \times 10^{-12}$
Rhodium (45)	Rh 103m	S	$6 \times 10^{-12}$	$3 \times 10^{-11}$	$2 \times 10^{-12}$	$1 \times 10^{-12}$
		I	$8 \times 10^{-12}$	$4 \times 10^{-11}$	$3 \times 10^{-12}$	$1 \times 10^{-12}$
	Rh 105	S	$3 \times 10^{-7}$	$2 \times 10^{-12}$	$1 \times 10^{-9}$	$7 \times 10^{-12}$
		I	$7 \times 10^{-8}$	$7 \times 10^{-12}$	$2 \times 10^{-9}$	$2 \times 10^{-12}$
Rubidium (37)	Rb 86	S	$5 \times 10^{-7}$	$3 \times 10^{-12}$	$2 \times 10^{-9}$	$1 \times 10^{-12}$
	Rb 87	S	$7 \times 10^{-8}$	$5 \times 10^{-12}$	$2 \times 10^{-9}$	$2 \times 10^{-12}$

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## APPENDIX B

## Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air + ( $\mu\text{Ci/ml}$ )	Water ( $\mu\text{Ci/ml}$ )	Air ( $\mu\text{Ci/ml}$ )	Water ( $\mu\text{Ci/ml}$ )
Ruthenium (44)	Ru 97	S	$2 \times 10^{-4}$	$1 \times 10^{-2}$	$8 \times 10^{-4}$	$4 \times 10^{-4}$
		I	$2 \times 10^{-4}$	$1 \times 10^{-2}$	$6 \times 10^{-4}$	$3 \times 10^{-4}$
	Ru 103	S	$5 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-4}$	$8 \times 10^{-4}$
		I	$8 \times 10^{-9}$	$2 \times 10^{-3}$	$3 \times 10^{-9}$	$8 \times 10^{-3}$
	Ru 105	S	$7 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-4}$	$1 \times 10^{-4}$
		I	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-4}$	$1 \times 10^{-4}$
Samarium (62)	Ru 106	S	$8 \times 10^{-4}$	$4 \times 10^{-4}$	$3 \times 10^{-3}$	$1 \times 10^{-3}$
		I	$6 \times 10^{-4}$	$3 \times 10^{-4}$	$2 \times 10^{-10}$	$1 \times 10^{-3}$
	Sm 147	S	$7 \times 10^{-11}$	$2 \times 10^{-3}$	$2 \times 10^{-12}$	$6 \times 10^{-3}$
		I	$3 \times 10^{-10}$	$2 \times 10^{-3}$	$9 \times 10^{-13}$	$7 \times 10^{-3}$
	Sm 151	S	$6 \times 10^{-8}$	$1 \times 10^{-2}$	$2 \times 10^{-9}$	$4 \times 10^{-4}$
		I	$1 \times 10^{-7}$	$1 \times 10^{-2}$	$5 \times 10^{-9}$	$4 \times 10^{-4}$
Scandium (21)	Sm 153	S	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$8 \times 10^{-3}$
		I	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$8 \times 10^{-3}$
	Sc 46	S	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$4 \times 10^{-3}$
		I	$2 \times 10^{-8}$	$1 \times 10^{-3}$	$8 \times 10^{-10}$	$4 \times 10^{-3}$
Selenium (34)	Se 47	S	$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$9 \times 10^{-3}$
		I	$5 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$9 \times 10^{-3}$
	Se 48	S	$2 \times 10^{-7}$	$8 \times 10^{-4}$	$6 \times 10^{-9}$	$3 \times 10^{-3}$
Silicon (14)		I	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$5 \times 10^{-9}$	$3 \times 10^{-3}$
	Si 31	S	$1 \times 10^{-4}$	$6 \times 10^{-3}$	$4 \times 10^{-9}$	$3 \times 10^{-4}$
		I	$1 \times 10^{-7}$	$8 \times 10^{-3}$	$4 \times 10^{-9}$	$3 \times 10^{-4}$
Silver (47)	Ag 105	S	$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-4}$
		I	$8 \times 10^{-8}$	$3 \times 10^{-3}$	$3 \times 10^{-9}$	$1 \times 10^{-4}$
	Ag 110m	S	$2 \times 10^{-7}$	$9 \times 10^{-4}$	$7 \times 10^{-9}$	$2 \times 10^{-3}$
		I	$1 \times 10^{-6}$	$9 \times 10^{-4}$	$3 \times 10^{-10}$	$3 \times 10^{-3}$
Sodium (11)	Ag 111	S	$3 \times 10^{-7}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$4 \times 10^{-3}$
		I	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$4 \times 10^{-3}$
	Na 22	S	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$6 \times 10^{-9}$	$4 \times 10^{-3}$
Strontium (38)		I	$9 \times 10^{-8}$	$9 \times 10^{-4}$	$3 \times 10^{-10}$	$3 \times 10^{-3}$
	Na 24	S	$1 \times 10^{-6}$	$6 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
		I	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$5 \times 10^{-9}$	$3 \times 10^{-3}$
	Sr 85m	S	$4 \times 10^{-3}$	$2 \times 10^{-1}$	$1 \times 10^{-6}$	$7 \times 10^{-3}$
		I	$3 \times 10^{-3}$	$2 \times 10^{-1}$	$1 \times 10^{-6}$	$7 \times 10^{-3}$
	Sr 85	S	$2 \times 10^{-7}$	$3 \times 10^{-3}$	$8 \times 10^{-9}$	$1 \times 10^{-4}$
		I	$1 \times 10^{-7}$	$5 \times 10^{-3}$	$4 \times 10^{-9}$	$2 \times 10^{-4}$
	Sr 89	S	$3 \times 10^{-4}$	$2 \times 10^{-4}$	$3 \times 10^{-10}$	$3 \times 10^{-4}$
		I	$4 \times 10^{-8}$	$8 \times 10^{-4}$	$1 \times 10^{-9}$	$3 \times 10^{-3}$
	Sr 90	S	$1 \times 10^{-6}$	$1 \times 10^{-3}$	$3 \times 10^{-11}$	$3 \times 10^{-3}$
Sulfur (16)		I	$5 \times 10^{-8}$	$1 \times 10^{-3}$	$2 \times 10^{-10}$	$4 \times 10^{-3}$
	Sr 91	S	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$7 \times 10^{-3}$
		I	$3 \times 10^{-7}$	$1 \times 10^{-3}$	$9 \times 10^{-9}$	$5 \times 10^{-3}$
	Sr 92	S	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$7 \times 10^{-3}$
Tantalum (73)		I	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$6 \times 10^{-3}$
	S 35	S	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$9 \times 10^{-9}$	$6 \times 10^{-3}$
Tantalum (73)		I	$3 \times 10^{-7}$	$8 \times 10^{-3}$	$9 \times 10^{-9}$	$3 \times 10^{-4}$
	Ta 182	S	$4 \times 10^{-8}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$4 \times 10^{-3}$
		I	$2 \times 10^{-8}$	$1 \times 10^{-3}$	$7 \times 10^{-10}$	$4 \times 10^{-3}$

# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued  
(See notes at end of appendix)

Element (atomic number)	Isotope <sup>1</sup>	Table I		Table II	
		Column 1	Column 2	Column 1	Column 2
		Air † (μCi/ml)	Water (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)
Technetium (43)	Tc 94m	5	8 × 10 <sup>-3</sup>	3 × 10 <sup>-4</sup>	1 × 10 <sup>-2</sup>
	Tc 94	1	3 × 10 <sup>-3</sup>	1 × 10 <sup>-4</sup>	1 × 10 <sup>-2</sup>
	Tc 96	5	6 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	1 × 10 <sup>-4</sup>
	Tc 97m	1	2 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	5 × 10 <sup>-3</sup>
	Tc 97	5	2 × 10 <sup>-6</sup>	1 × 10 <sup>-3</sup>	4 × 10 <sup>-4</sup>
	Tc 97	1	2 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	2 × 10 <sup>-4</sup>
	Tc 97	5	1 × 10 <sup>-3</sup>	5 × 10 <sup>-3</sup>	2 × 10 <sup>-3</sup>
	Tc 97	1	3 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	8 × 10 <sup>-4</sup>
	Tc 99m	5	4 × 10 <sup>-3</sup>	2 × 10 <sup>-1</sup>	6 × 10 <sup>-3</sup>
	Tc 99	1	1 × 10 <sup>-3</sup>	8 × 10 <sup>-3</sup>	3 × 10 <sup>-3</sup>
Tellurium (52)	Tc 99	5	5 × 10 <sup>-6</sup>	1 × 10 <sup>-3</sup>	3 × 10 <sup>-4</sup>
	Tc 99	1	6 × 10 <sup>-6</sup>	5 × 10 <sup>-3</sup>	2 × 10 <sup>-4</sup>
	Te 125m	5	4 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	2 × 10 <sup>-4</sup>
	Te 125m	1	1 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	1 × 10 <sup>-4</sup>
	Te 127m	5	1 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	6 × 10 <sup>-4</sup>
	Te 127	1	4 × 10 <sup>-6</sup>	1 × 10 <sup>-3</sup>	5 × 10 <sup>-3</sup>
	Te 127	5	2 × 10 <sup>-6</sup>	8 × 10 <sup>-3</sup>	3 × 10 <sup>-4</sup>
	Te 129m	1	9 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	2 × 10 <sup>-4</sup>
	Te 129m	5	8 × 10 <sup>-6</sup>	1 × 10 <sup>-3</sup>	3 × 10 <sup>-3</sup>
	Te 129	1	3 × 10 <sup>-6</sup>	6 × 10 <sup>-4</sup>	2 × 10 <sup>-3</sup>
Terbium (65)	Te 129	5	5 × 10 <sup>-6</sup>	2 × 10 <sup>-3</sup>	8 × 10 <sup>-4</sup>
	Te 129	1	4 × 10 <sup>-6</sup>	2 × 10 <sup>-3</sup>	8 × 10 <sup>-4</sup>
	Te 131m	5	4 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	6 × 10 <sup>-3</sup>
	Te 131m	1	2 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	4 × 10 <sup>-3</sup>
	Te 132	5	2 × 10 <sup>-7</sup>	9 × 10 <sup>-4</sup>	3 × 10 <sup>-3</sup>
	Te 132	1	1 × 10 <sup>-7</sup>	6 × 10 <sup>-4</sup>	2 × 10 <sup>-3</sup>
	Tb 140	5	1 × 10 <sup>-7</sup>	1 × 10 <sup>-3</sup>	4 × 10 <sup>-3</sup>
	Tb 140	1	3 × 10 <sup>-6</sup>	1 × 10 <sup>-3</sup>	4 × 10 <sup>-3</sup>
	Thallium (81)	5	3 × 10 <sup>-6</sup>	1 × 10 <sup>-3</sup>	9 × 10 <sup>-4</sup>
	Thallium (81)	1	1 × 10 <sup>-6</sup>	7 × 10 <sup>-3</sup>	4 × 10 <sup>-4</sup>
Thorium (90)	Ti 200	5	2 × 10 <sup>-6</sup>	9 × 10 <sup>-3</sup>	7 × 10 <sup>-3</sup>
	Ti 201	1	9 × 10 <sup>-7</sup>	5 × 10 <sup>-3</sup>	3 × 10 <sup>-3</sup>
	Ti 202	5	8 × 10 <sup>-7</sup>	4 × 10 <sup>-3</sup>	3 × 10 <sup>-3</sup>
	Ti 202	1	2 × 10 <sup>-7</sup>	2 × 10 <sup>-3</sup>	8 × 10 <sup>-3</sup>
	Ti 204	5	6 × 10 <sup>-7</sup>	3 × 10 <sup>-3</sup>	2 × 10 <sup>-3</sup>
	Ti 204	1	3 × 10 <sup>-6</sup>	2 × 10 <sup>-3</sup>	9 × 10 <sup>-3</sup>
	Th 227	5	3 × 10 <sup>-10</sup>	5 × 10 <sup>-4</sup>	1 × 10 <sup>-11</sup>
	Th 228	5	2 × 10 <sup>-10</sup>	8 × 10 <sup>-4</sup>	6 × 10 <sup>-11</sup>
	Th 228	1	9 × 10 <sup>-11</sup>	2 × 10 <sup>-4</sup>	3 × 10 <sup>-11</sup>
	Th 230	5	6 × 10 <sup>-11</sup>	4 × 10 <sup>-4</sup>	2 × 10 <sup>-11</sup>
Thorium (90)	Th 230	1	2 × 10 <sup>-11</sup>	5 × 10 <sup>-4</sup>	8 × 10 <sup>-11</sup>
	Th 231	5	1 × 10 <sup>-11</sup>	9 × 10 <sup>-4</sup>	3 × 10 <sup>-11</sup>
	Th 231	1	1 × 10 <sup>-10</sup>	7 × 10 <sup>-3</sup>	5 × 10 <sup>-10</sup>
	Th 231	5	1 × 10 <sup>-10</sup>	7 × 10 <sup>-3</sup>	4 × 10 <sup>-10</sup>
	Th 232	5	3 × 10 <sup>-11</sup>	9 × 10 <sup>-4</sup>	1 × 10 <sup>-11</sup>
	Th 232	1	3 × 10 <sup>-11</sup>	1 × 10 <sup>-3</sup>	1 × 10 <sup>-11</sup>
	Th natural	5	4 × 10 <sup>-11</sup>	6 × 10 <sup>-3</sup>	2 × 10 <sup>-11</sup>
	Th natural	1	6 × 10 <sup>-11</sup>	6 × 10 <sup>-3</sup>	2 × 10 <sup>-11</sup>



# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX B

### Concentrations in Air and Water Above Natural Background—Continued

[See notes at end of appendix]

Element (atomic number)	Isotope <sup>1</sup>		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air † (μCi/ml)(μCi/ml)		Air † (μCi/ml)(μCi/ml)	
Thorium (90)	Th 234	S	$6 \times 10^{-9}$	$5 \times 10^{-4}$	$2 \times 10^{-9}$	$2 \times 10^{-3}$
	Th 230	I	$3 \times 10^{-9}$	$5 \times 10^{-4}$	$1 \times 10^{-9}$	$2 \times 10^{-3}$
Thallium (81)	Tm 170	S	$4 \times 10^{-8}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$5 \times 10^{-3}$
	Tm 171	I	$3 \times 10^{-8}$	$1 \times 10^{-3}$	$1 \times 10^{-9}$	$5 \times 10^{-3}$
Tin (50)	Sn 113	S	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$4 \times 10^{-9}$	$5 \times 10^{-3}$
	Sn 115	I	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$5 \times 10^{-3}$
Tungsten (Wolfram) (74)	W 181	S	$4 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$9 \times 10^{-3}$
	W 183	I	$5 \times 10^{-7}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$8 \times 10^{-3}$
	W 185	S	$1 \times 10^{-7}$	$5 \times 10^{-4}$	$4 \times 10^{-9}$	$2 \times 10^{-3}$
	W 187	I	$2 \times 10^{-7}$	$5 \times 10^{-4}$	$3 \times 10^{-9}$	$2 \times 10^{-3}$
Uranium (92)	U 230	S	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$8 \times 10^{-9}$	$4 \times 10^{-3}$
	U 232	I	$3 \times 10^{-7}$	$1 \times 10^{-3}$	$4 \times 10^{-9}$	$1 \times 10^{-3}$
	U 233	S	$3 \times 10^{-10}$	$2 \times 10^{-3}$	$2 \times 10^{-9}$	$7 \times 10^{-3}$
	U 234	I	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$1 \times 10^{-11}$	$6 \times 10^{-3}$
	U 235	S <sup>4</sup>	$1 \times 10^{-10}$	$1 \times 10^{-4}$	$4 \times 10^{-12}$	$5 \times 10^{-3}$
	U 236	I	$3 \times 10^{-11}$	$8 \times 10^{-4}$	$3 \times 10^{-12}$	$3 \times 10^{-3}$
	U 238	S <sup>4</sup>	$5 \times 10^{-10}$	$9 \times 10^{-4}$	$9 \times 10^{-12}$	$3 \times 10^{-3}$
	U 240	I	$1 \times 10^{-10}$	$9 \times 10^{-4}$	$4 \times 10^{-12}$	$3 \times 10^{-3}$
Vanadium (23)	U-natural	S <sup>4</sup>	$6 \times 10^{-10}$	$9 \times 10^{-4}$	$2 \times 10^{-11}$	$3 \times 10^{-3}$
	V 48	I	$1 \times 10^{-10}$	$9 \times 10^{-4}$	$4 \times 10^{-12}$	$3 \times 10^{-3}$
Xenon (54)	Xe 131m	Sub	$2 \times 10^{-7}$	$1 \times 10^{-3}$	$2 \times 10^{-11}$	$4 \times 10^{-3}$
	Xe 133	Sub	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$4 \times 10^{-12}$	$3 \times 10^{-3}$
	Xe 133m	Sub	$1 \times 10^{-7}$	$1 \times 10^{-3}$	$5 \times 10^{-12}$	$3 \times 10^{-3}$
	Xe 135	Sub	$2 \times 10^{-7}$	$9 \times 10^{-4}$	$6 \times 10^{-12}$	$3 \times 10^{-3}$
Ytterbium (70)	Yb 173	S	$6 \times 10^{-8}$	$8 \times 10^{-4}$	$2 \times 10^{-9}$	$3 \times 10^{-3}$
	Yb 175	I	$7 \times 10^{-7}$	$3 \times 10^{-3}$	$4 \times 10^{-9}$	$1 \times 10^{-3}$
Yttrium (39)	Y 90	S	$6 \times 10^{-7}$	$3 \times 10^{-3}$	$2 \times 10^{-9}$	$1 \times 10^{-3}$
	Y 91m	I	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$4 \times 10^{-9}$	$2 \times 10^{-3}$
	Y 91	S	$1 \times 10^{-7}$	$6 \times 10^{-4}$	$3 \times 10^{-9}$	$2 \times 10^{-3}$
	Y 92	I	$2 \times 10^{-7}$	$1 \times 10^{-1}$	$8 \times 10^{-9}$	$3 \times 10^{-3}$
	Y 93	S	$2 \times 10^{-7}$	$1 \times 10^{-1}$	$6 \times 10^{-9}$	$3 \times 10^{-3}$
	Y 93	I	$4 \times 10^{-7}$	$8 \times 10^{-4}$	$1 \times 10^{-9}$	$3 \times 10^{-3}$
	Y 93	S	$3 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$6 \times 10^{-3}$
	Y 93	I	$2 \times 10^{-7}$	$2 \times 10^{-3}$	$1 \times 10^{-9}$	$6 \times 10^{-3}$
	Y 93	S	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$5 \times 10^{-9}$	$3 \times 10^{-3}$
	Y 93	I	$1 \times 10^{-7}$	$8 \times 10^{-4}$	$5 \times 10^{-9}$	$3 \times 10^{-3}$

# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

Element (atomic number)	Isotope <sup>1</sup>		Table I		Table II	
			Column 1	Column 2	Column 1	Column 2
			Air ( $\mu\text{Ci/ml}$ )	Water ( $\mu\text{Ci/ml}$ )	Air ( $\mu\text{Ci/ml}$ )	Water ( $\mu\text{Ci/ml}$ )
Zinc (30)	Zn 65	S	$1 \times 10^{-7}$	$3 \times 10^{-3}$	$4 \times 10^{-9}$	$1 \times 10^{-4}$
		I	$6 \times 10^{-8}$	$5 \times 10^{-3}$	$2 \times 10^{-9}$	$2 \times 10^{-4}$
	Zn 69m	S	$4 \times 10^{-7}$	$2 \times 10^{-2}$	$1 \times 10^{-8}$	$7 \times 10^{-3}$
		I	$3 \times 10^{-7}$	$2 \times 10^{-2}$	$1 \times 10^{-8}$	$6 \times 10^{-3}$
	Zn 69	S	$7 \times 10^{-8}$	$5 \times 10^{-3}$	$2 \times 10^{-7}$	$2 \times 10^{-3}$
Zirconium (40)		I	$9 \times 10^{-8}$	$5 \times 10^{-3}$	$3 \times 10^{-7}$	$2 \times 10^{-3}$
	Zr 93	S	$1 \times 10^{-7}$	$2 \times 10^{-2}$	$4 \times 10^{-9}$	$8 \times 10^{-4}$
		I	$3 \times 10^{-7}$	$2 \times 10^{-2}$	$1 \times 10^{-8}$	$8 \times 10^{-4}$
	Zr 95	S	$1 \times 10^{-7}$	$2 \times 10^{-2}$	$4 \times 10^{-9}$	$6 \times 10^{-3}$
		I	$3 \times 10^{-8}$	$2 \times 10^{-2}$	$1 \times 10^{-8}$	$6 \times 10^{-3}$
	Zr 97	S	$1 \times 10^{-7}$	$5 \times 10^{-2}$	$4 \times 10^{-9}$	$2 \times 10^{-3}$
		I	$9 \times 10^{-8}$	$3 \times 10^{-2}$	$3 \times 10^{-9}$	$2 \times 10^{-3}$
		Sub	$1 \times 10^{-8}$		$3 \times 10^{-9}$	
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.						
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.			$3 \times 10^{-9}$	$9 \times 10^{-3}$	$1 \times 10^{-10}$	$3 \times 10^{-4}$
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.			$6 \times 10^{-12}$	$4 \times 10^{-7}$	$2 \times 10^{-14}$	$3 \times 10^{-9}$

<sup>1</sup>Soluble (S); Insoluble (I).

<sup>2</sup>"Sub" means that values given are for submersion in a semapherical infinite cloud of airborne material.

\* These radon concentrations are appropriate for protection from radon-222 combined with its short-lived daughters. Alternatively, the value in Table I may be replaced by one-third ( $\frac{1}{3}$ ) "working level." (A "working level" is defined as any combination of short-lived radon-222 daughters, polonium-218, lead-214, bismuth-214 and polonium-214, in one liter of air, without regard to the degree of equilibrium, that will result in the ultimate emission of  $1.3 \times 10^{-5}$  MeV of alpha particle energy.) The Table II value may be replaced by one-thirtieth ( $\frac{1}{30}$ ) of a "working level." The limit on radon-222 concentrations in restricted areas may be based on an annual average.

†4. For soluble mixtures of U-238, U-234 and U-235 in air chemical toxicity may be the limiting factor. If less than 5 percent by weight (enrichment) of U-235, the concentration value for a 40-hour workweek, Table I, is 0.3 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour workweek shall not exceed  $8 \times 10^{-2}$  SA  $\mu\text{Ci-hr/ml}$ , where SA is the specific activity of the uranium inhaled. The concentration value for Table II is 0.007 milligrams uranium per cubic meter of air. The specific activity for natural uranium is  $6.77 \times 10^{-4}$  curies per gram U. The specific activity for other mixtures of U-238, U-235 and U-234, if not known, shall be:  
 $SA = 8.6 \times 10^{-4}$  curies/gram U  $\frac{U-235}{U-238}$   
 $SA = (0.4 + 0.38 E + 0.0034 E^2) 10^{-4}$   $E \geq 0.75$   
 where E is the percentage by weight of U-235, expressed as percent.

\* Amended 37 FR 23319.

\*\* Amended 39 FR 23990; footnote redesignated 40 FR 50704.

\*\*\* Amended 40 FR 50704.

† Amended 38 FR 29314.

‡ Amended 39 FR 25463; redesignated 40 FR 50704.

## NOTE TO APPENDIX B

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 B 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  $MPC_A$ ,  $MPC_B$ , and  $MPC_C$  respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \frac{C_C}{MPC_C} \leq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting value for purposes of Appendix B shall be:

- a. For purposes of Table I, Col. 1— $6 \times 10^{-6}$
- b. For purposes of Table I, Col. 2— $4 \times 10^{-7}$
- c. For purposes of Table II, Col. 1— $2 \times 10^{-6}$
- d. For purposes of Table II, Col. 2— $3 \times 10^{-7}$

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 "B" 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 "B" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "B" for any radionuclide which is not known to be absent from the mixture; or

a. Element (atomic number) and isotope	Table I		Table II	
	Column 1 Air ( $\mu\text{Ci}/\text{ml}$ )	Column 2 Water ( $\mu\text{Ci}/\text{ml}$ )	Column 1 Air ( $\mu\text{Ci}/\text{ml}$ )	Column 2 Water ( $\mu\text{Ci}/\text{ml}$ )
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 234, Cm 244, Cf 254, and Fm 256 are not present.....		$9 \times 10^{-6}$		$3 \times 10^{-6}$
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 234, and Fm 256 are not present.....		$6 \times 10^{-6}$		$2 \times 10^{-6}$
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 244, and Cf 254 are not present.....		$2 \times 10^{-6}$		$6 \times 10^{-7}$
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present.....		$3 \times 10^{-6}$		$1 \times 10^{-6}$
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 246 are not present.....	$3 \times 10^{-6}$		$1 \times 10^{-6}$	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present.....	$3 \times 10^{-6}$		$1 \times 10^{-6}$	
If it is known that alpha-emitters and Ac 227 are not present.....	$3 \times 10^{-6}$		$1 \times 10^{-6}$	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 244, Cf 249 and Cf 251 are not present.....	$3 \times 10^{-6}$		$1 \times 10^{-6}$	

4. If a mixture of radionuclides consists of uranium and its daughters in ore dust prior to chemical separation of the uranium from the ore, the values specified below may be used for uranium and its daughters through radium-226, instead of those from paragraphs 1, 2, or 3 above.

a. For purposes of Table I, Col. 1— $1 \times 10^{-6}$   $\mu\text{Ci}/\text{ml}$  gross alpha activity; or  $5 \times 10^{-4}$   $\mu\text{Ci}/\text{ml}$  natural uranium; or 78 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1— $3 \times 10^{-6}$   $\mu\text{Ci}/\text{ml}$  gross alpha activity; or  $2 \times 10^{-4}$   $\mu\text{Ci}/\text{ml}$  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 B ( $MPC_A$ ) does not exceed  $\frac{1}{10}$

(i.e.  $\frac{C_A}{MPC_A} \leq \frac{1}{10}$ ) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed  $\frac{1}{10}$ .

$$\left( \text{i.e. } \frac{C_A}{MPC_A} + \frac{C_B}{MPC_B} + \dots \leq \frac{1}{10} \right)$$

# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX C

Material	Microcuries	Material	Microcuries
Americium-241	100	Osmium-191m <sup>1</sup>	100
Antimony-122	100	Osmium-191	100
Antimony-124	10	Osmium-193	100
Antimony-125	10	Palladium-103	100
Arsenic-73	100	Palladium-106	100
Arsenic-74	10	Phosphorus-32	10
Arsenic-75	10	Platinum-191	100
Arsenic-77	100	Platinum-193m	100
Barium-131	10	Platinum-193	100
Barium-133	10	Platinum-197m	100
Barium-140	10	Platinum-197	100
Bismuth-210	1	Plutonium-239	0.1
Bromine-82	10	Polonium-210	0.1
Cadmium-109	10	Potassium-42	10
Cadmium-115m	10	Praseodymium-142	100
Cadmium-115	100	Praseodymium-143	100
Calcium-45	10	Promethium-147	10
Calcium-47	10	Promethium-148	10
Carbon-14	100	Radium-226	0.1
Cerium-141	100	Rhenium-186	100
Cerium-143	100	Rhenium-188	100
Cerium-144	1	Rhodium-103m	100
Cesium-131	1,000	Rhodium-106	100
Cesium-134m	100	Rubidium-86	10
Cesium-134	1	Rubidium-87	10
Cesium-136	10	Ruthenium-97	100
Cesium-136	10	Ruthenium-103	10
Cesium-137	10	Ruthenium-106	10
Chlorine-36	10	Ruthenium-106	1
Chlorine-38	10	Samarium-151	10
Chromium-51	1,000	Samarium-153	100
Cobalt-58m	10	Scandium-46	10
Cobalt-58	10	Scandium-47	100
Cobalt-60	1	Scandium-48	10
Copper-64	100	Selenium-75	10
Dysprosium-165	10	Silicon-31	100
Dysprosium-166	100	Silver-105	10
Erbium-169	100	Silver-110m	1
Erbium-171	100	Silver-111	100
Europium-152 0.2 h	100	Sodium-24	10
Europium-152 13 yr	1	Strontium-85	10
Europium-154	1	Strontium-89	1
Europium-155	10	Strontium-90	0.1
Fluorine-18	1,000	Strontium-91	10
Gadolinium-153	10	Strontium-92	10
Gadolinium-156	100	Sulphur-35	100
Gallium-72	10	Tantalum-182	10
Germanium-71	100	Technetium-96	10
Gold-198	100	Technetium-97m	100
Gold-199	100	Technetium-97	100
Hafnium-181	10	Technetium-99m	100
Holmium-166	100	Technetium-99	10
Hydrogen-3	1,000	Tellurium-125m	10
Indium-113m	100	Tellurium-127m	10
Indium-114m	10	Tellurium-127	100
Indium-115m	100	Tellurium-129m	10
Indium-115	10	Tellurium-129	100
Iodine-125	1	Tellurium-131m	10
Iodine-126	1	Tellurium-132	10
Iodine-129	0.1	Terbium-160	10
Iodine-131	1	Thallium-200	100
Iodine-132	10	Thallium-201	100
Iodine-133	1	Thallium-202	100
Iodine-134	10	Thallium-204	10
Iodine-135	10	**Thorium (natural) <sup>1</sup>	100
Iridium-192	10	Thulium-170	10
Iridium-194	100	Thulium-171	10
Iron-55	100	Tin-113	10
Iron-59	10	Tin-125	10
Krypton-85	100	Tungsten-181	10
Krypton-87	10	Tungsten-185	10
Lanthanum-140	10	Tungsten-187	100
Lutetium-177	100	**Uranium (natural) <sup>2</sup>	100
Manganese-52	10	Uranium-233	0.1
Manganese-54	10	Uranium-234 Uranic 2-235	0.1
Manganese-56	10	Vanadium-48	10
Mercury-197m	100	Xenon-131m	1,000
Mercury-197	100	Xenon-133	100
Mercury-203	10	Xenon-136	100
Molybdenum-99	100	Ytterbium-175	100
Neodymium-147	100	Yttrium-90	10
Neodymium-149	100	Yttrium-91	10
Nickel-59	100	Yttrium-92	100
Nickel-63	10	Yttrium-93	100
Nickel-65	100	Zinc-65	10
Niobium-93m	10	Zinc-69m	100
Niobium-95	10	Zinc-69	1,000
Niobium-97	10	Zirconium-93	10
Osmium-185	10	Zirconium-95	10
		Zirconium-97	10

Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition .01  
Any radionuclide other than alpha emitting radionuclides, not listed above or mixtures of beta emitters of unknown composition .1

Note.—For purposes of § 20.303, 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").

<sup>1</sup> Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.

<sup>2</sup> Based on alpha disintegration rate of U-238, U-234, and U-235.

\* Amended 36 FR 16898.

\*\* Amended 39 FR 23990.



# PART 20 • STANDARDS FOR PROTECTION AGAINST RADIATION

## APPENDIX D.—UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICES

	Address	Telephone (24 hrs)
Region I: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	USNRC, 631 Park Ave., King of Prussia, PA 19406	(215) 337-5000 (FTS) 468-1000.
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia.	USNRC, 101 Marietta Street, Suite 3100, Atlanta, GA 30303	(404) 221-4503, (FTS) 242-4503.
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.	USNRC, 798 Roosevelt Road, Glen Ellyn, IL 60137	(312) 790-5500, (FTS) 384-2500.
Region IV: Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming.	USNRC, 611 Ryan Plaza Drive, Suite 1000, Arlington, TX 76011	(817) 860-8100, (FTS) 728-8100.
Region IV Field Office	USNRC, Region IV Uranium Recovery Field Office, 730 Semme Street, P.O. Box 25325, Denver, CO 80225.	(303) 234-7232, (FTS) 234-7232.
Region V: Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U.S. territories and possessions in the Pacific.	USNRC, 1450 Marin Lane, Suite 210, Walnut Creek, CA 94596	(415) 943-3700, (FTS) 463-3700.

# RULES and REGULATIONS

TITLE 10, CHAPTER 1, CODE OF FEDERAL REGULATIONS—ENERGY

## PART 34

### LICENSES FOR RADIOGRAPHY AND RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHIC OPERATIONS

- Sec.  
34.1 Purpose and scope.  
34.2 Definitions.  
34.3 Applications for specific licenses.

#### Subpart A—Specific Licensing Requirements

- 34.11 Issuance of specific licenses for use of sealed sources in radiography.

#### Subpart B—Radiation Safety Requirements

##### EQUIPMENT CONTROL

- 34.21 Limit on levels of radiation for radiographic exposure devices and storage containers.  
34.22 Locking of radiographic exposure devices and storage containers.  
34.23 Storage precautions.  
34.24 Radiation survey instruments.  
34.25 Leak testing, repair, tagging, opening, modification and replacement of sealed sources.  
34.26 Quarterly inventory.  
34.27 Utilization logs.  
34.28 Inspection and maintenance of radiographic exposure devices and storage containers.

- 34.29 Permanent radiographic installations.

#### PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANT

- 34.31 Training.  
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34.33 Personnel monitoring.

#### PRECAUTIONARY PROCEDURES IN RADIOGRAPHIC OPERATIONS

- 34.41 Security.  
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34.43 Radiation surveys and survey records  
34.44 Supervision of radiographers' assistants

##### EXEMPTIONS

- 34.51 Applications for exemptions.  
Appendix A.

#### § 34.1 Purpose and scope.

This part prescribes requirements for the issuance of licenses for the use of sealed sources containing byproduct material and radiation safety requirements for persons using such sealed sources in radiography. The provisions and requirements of this part are in addition to, and not in substitution for, other requirements of this chapter. In particular, the provisions of Part 30 of this chapter apply to applications and licenses subject to this part. Nothing in this part shall apply to uses of byproduct material for medical diagnosis or therapy.

#### § 34.2 Definitions.

As used in this part:

(a) "Radiography" means the examination of the structure of materials by nondestructive methods, utilizing sealed sources of byproduct materials;

(b) "Radiographer" means any individual who performs or who, in attendance at the site where the sealed source or sources are being used, personally supervises radiographic operations and who is responsible to the licensee for assuring compliance with the requirements of the Commission's regulations and the conditions of the license;

(c) "Radiographer's assistant" means any individual who, under the personal supervision of a radiographer, uses radiographic exposure devices, sealed sources or related handling tools, or radiation survey instruments in radiography;

(d) "Radiographic exposure device" means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded

position for purposes of making a radiographic exposure;

(e) "Sealed source" means any byproduct material that is encased in a capsule designed to prevent leakage or escape of the byproduct material;

(f) "Storage container" means a device in which sealed sources are transported or stored.

(g) "Source changer" means a device designed and used for replacement of sealed sources in radiographic exposure devices, including those also used for transporting and storage of sealed sources;

(h) "Permanent radiographic installatic~" means a shielded installation or structure designed or intended for radiography and in which radiography is regularly performed.

#### § 34.3 Applications for specific licenses.

Applications for specific licenses for use of sealed sources in radiography shall be filed on Form NRC-313R, "Application for Byproduct Material License—Use of Sealed Sources in Radiography."

#### Subpart A—Specific Licensing Requirements

#### § 34.11 Issuance of specific licenses for use of sealed sources in radiography.

An application for a specific license for use of sealed sources in radiography will be approved if:

(a) The applicant satisfies the general requirements specified in § 30.33 of this chapter;

(b) The applicant will have an adequate program for training radiographers and radiographers' assistants and submits to the Commission a schedule or de-

Authority: Secs. 81, 161, 182, 183, 68 Stat. 935, 945, 953, 954, as amended; 42 U.S.C. 2111, 2201, 2232, 2233. For the purposes of sec. 223, 68 Stat. 954, as amended, 42 U.S.C. 2273, §§ 34.11(d), 34.23(c), 34.25, 34.27, 34.28(b), 34.29(c), 34.31(c), 34.33(b), 34.33(e), and 34.43(c) issued under sec. 1610, 68 Stat. 950, as amended, 42 U.S.C. 2201(o), unless otherwise noted.

30 FR 8185  
description of such program which specifies the:

(1) Initial training;  
(2) Periodic training;  
(3) On-the-job training;  
(4) Means to be used by the licensee to determine the radiographer's knowledge and understanding of and ability to comply with Commission regulations and licensing requirements, and the operating and emergency procedures of the applicant; and

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

(c) The applicant has established and submits to the Commission satisfactory written operating and emergency procedures as described in § 34.32;

44 FR 30805  
(d) The applicant will have an internal inspection system adequate to assure that Commission regulations, Commission license provisions, and the applicant's operating and emergency procedures are followed by radiographers and radiographers' assistants; the inspection system shall include the performance of internal inspections at intervals not to exceed three months and the retention of records of such inspections for two years;

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

30 FR 8185  
(f) The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources, for possible leakage and contamination and submits to the Commission a description of such procedures including:

(1) Instrumentation to be used,  
(2) Method of performing test, 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.

## PART 34 • LICENSES FOR RADIOGRAPHY AND RADIATION SAFETY...

### Subpart B—Radiation Safety Requirements

#### EQUIPMENT CONTROL

§ 34.21 Limits on levels of radiation for radiographic exposure devices and storage containers.

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. 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 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.

§ 34.22 Locking of radiographic exposure devices, storage containers, and source changers.

(a) Each radiographic exposure device shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. The exposure device or its container shall be kept locked when not under the direct surveillance of a radiographer or a radiographer's assistant or as otherwise may be authorized in § 34.41. In addition, during radiographic operations the sealed source assembly shall be secured in the shielded position each time the source is returned to that position.

(b) Each sealed source storage container and source changer shall have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position. Storage containers and source changers shall be kept locked when containing sealed sources except when under the direct surveillance of a radiographer or a radiographer's assistant.

§ 34.23 Storage precautions.

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

§ 34.24 Radiation survey instruments.

The licensee shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this part and Part 20 of this chapter.

Each radiation survey instrument shall be calibrated at intervals not to exceed three months and after each instrument servicing and a record shall be maintained of the results of each instrument calibration and date thereof for two years after the 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.

§ 34.25 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 by the Commission to do so.

(b) Each sealed source shall be tested for leakage at intervals not to exceed 6 months. In the absence of a certificate

from a transferor that a test has been made within the 6 months prior to the transfer, the sealed source shall not be put into use until tested.

(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 licensee 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 pursuant to § 34.11(f).

Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Commission for six months after the next required leak test is performed or until the sealed source is transferred or disposed of.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this section 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 licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with Commission regulations. A report shall be filed, within 5 days of the test, with the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, describing the equipment involved, the test results, and the corrective action taken. A copy of such report shall be sent to the Director of the appropriate Nuclear Regulatory Commission's Inspection and Enforcement Regional Office listed in Appendix D of Part 20 of this chapter "Standards for Protection Against Radiation."

(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."



## PART 34 • LICENSES FOR RADIOGRAPHY AND RADIATION SAFETY...

### § 34.26 Quarterly inventory.

Each licensee shall conduct a quarterly physical inventory to account for all sealed sources received and possessed under his license. The records of the inventories shall be maintained for two years from the date of the inventory for inspection by the Commission, and shall include the quantities and kinds of by-product material, location of sealed sources, and the date of the inventory.

### § 34.27 Utilization logs.

Each licensee shall maintain current logs, which shall be kept available for two years from the date of the recorded event, for inspection by the Commission, at the address specified in the license, showing for each sealed source the following information:

- (a) A description (or make and model number) of the radiographic exposure device or storage container in which the sealed source is located;
- (b) The identity of the radiographer to whom assigned; and
- (c) The plant or site where used and dates of use.

### § 34.28 Inspection and maintenance of radiographic exposure devices, storage containers, and source changers.

- (a) The licensee shall check for obvious defects in radiographic exposure devices, storage containers, and source changers prior to use each day the equipment is used.
- (b) The licensee shall conduct a program for inspection and maintenance of radiographic exposure devices, storage containers, and source changers at intervals not to exceed three months or prior to the first use thereafter to assure proper functioning of components important to safety. Records of these inspections and maintenance shall be kept for two years.

### § 34.29 Permanent radiographic installations.

- (a) Permanent radiographic installations having high radiation area entrance controls of the types described in § 20.203(c) (2)(ii), (2)(iii), or (4) shall also meet the following special requirement.
- (b) Each entrance that is used for personnel access to the high radiation area in a permanent radiographic installation to which this section applies shall have both visible and audible warning signals to warn of the presence of radiation. The visible signal shall be actuated by radiation whenever the

source is exposed. The audible signal shall be actuated when an attempt is made to enter the installation while the source is exposed.

- (c) The alarm system shall be tested at intervals not to exceed three months or prior to the first use thereafter of the source in the installation. Records of the tests shall be kept for two years.

## PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHERS' ASSISTANTS

### § 34.31 Training.

- (a) The licensee shall not permit any individual to act as a radiographer until such individual:

- (1) Has been instructed in the subjects outlined in Appendix A of this part;
- (2) Has received copies of and instruction in NRC regulations contained in this part and in the applicable sections of Parts 19 and 20 of this chapter, NRC license(s) under which the radiographer will perform radiography, and the licensee's operating and emergency procedures;
- (3) Has demonstrated competence to use the licensee's radiographic exposure devices, sealed sources, related handling tools, and survey instruments; and
- (4) Has demonstrated understanding of the instructions in this paragraph (a) by successful completion of a written test and a field examination on the subjects covered.

- (b) The licensee shall not permit any individual to act as a radiographer's assistant until such individual:

- (1) Has received copies of and instruction in the licensee's operating and emergency procedures;
- (2) Has demonstrated competence to use, under the personal supervision of the radiographer, the radiographic exposure devices, sealed sources, related handling tools, and radiation survey instruments that the assistant will use; and
- (3) Has demonstrated understanding of the instructions in this paragraph (b) by successfully completing a written or oral test and a field examination on the subjects covered.

- (c) Records of the above training, including copies of written tests and dates of oral tests and field examinations, shall be maintained for three years.

### § 34.32 Operating and emergency procedures.

The licensee's operating and emergency procedures shall include instructions in at least the following:

- (a) The handling and use of licensed sealed sources and radiographic exposure devices to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Part 20 of this chapter "Standards for Protection Against Radiation";

- (b) Methods and occasions for conducting radiation surveys;

- (c) Methods for controlling access to radiographic areas;

- (d) Methods and occasions for locking and securing radiographic exposure devices, storage containers and sealed sources;

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

- (f) Transporting sealed sources to field locations, including packing of radiographic exposure devices and storage containers in the vehicles, posting of vehicles and control of the sealed sources during transportation;

- (g) Minimizing exposure of persons in the event of an accident;

- (h) The procedure for notifying proper persons in the event of an accident; and

- (i) Maintenance of records.

- (j) The inspection and maintenance of radiographic exposure devices and storage containers.

- (k) Steps that must be taken immediately by radiography personnel in the event a pocket dosimeter is found to be off-scale.

- (l) The procedure(s) for identifying and reporting defects and noncompliance, as required by Part 21 of this chapter.

### § 34.33 Personnel monitoring.

- (a) The licensee shall not permit any individual to act as a radiographer or a radiographer's assistant unless, at all times during radiographic operations, each such individual wears a direct reading pocket dosimeter and either a film badge or a thermoluminescent dosimeter (TLD). Pocket dosimeters shall have a range from zero to at least 200 milliroentgens and shall be recharged at the start of each shift. Each film badge and TLD shall be assigned to

\*Amended 42 FR 28891.

and worn by only one individual.

(b) Pocket dosimeters shall be read and exposures recorded daily.

(c) Pocket dosimeters shall be checked at periods not to exceed one year for correct response to radiation. Acceptable dosimeters shall read within plus or minus 30 percent of the true radiation exposure.

(d) If an individual's pocket dosimeter is discharged beyond its range, his film badge or TLD shall be immediately sent for processing.

(e) Reports received from the film badge or TLD processor shall be kept for inspection until the Commission authorizes their disposal. Records of daily pocket dosimeter readings shall be kept for two years.

#### PRECAUTIONARY PROCEDURES IN RADIOGRAPHIC OPERATIONS

##### § 34.41 Security.

During each radiographic operation the radiographer or radiographer's assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in Part 20 of this chapter, except (a) where the high radiation area is equipped with a control device or an alarm system as described in § 20.203(c)(2) of this chapter, or (b) where the high radiation area is locked to protect against unauthorized or accidental entry.

##### § 34.42 Posting.

Notwithstanding any provisions in § 20.204(c) of this chapter, areas in which radiography is being performed shall be conspicuously posted as required by § 20.203(b) and (c)(1) of this chapter.

##### § 34.43 Radiation surveys.

(a) At least one calibrated and operable radiation survey instrument shall be available at the location of radiographic operations whenever radiographic operations are being performed.

(b) A survey with a radiation survey instrument shall be made after each radiographic exposure to determine that the sealed source has been returned to its shielded position. The entire circumference of the radiographic exposure device shall be surveyed. If the radiographic exposure device has a source guide tube, the survey shall include the guide tube.

(c) A record of the survey required in paragraph (b) shall be maintained for two years when the survey is the last survey prior to locking the radiographic exposure device and ending direct surveillance of the operation.

##### § 34.44 Supervision of radiographers' assistants.

Whenever a radiographer's assistant uses radiographic exposure devices, uses sealed sources or related source handling tools, or conducts radiation surveys required by § 34.43(b) to determine that the sealed source has returned to the shielded position after an exposure, he shall be under the personal supervision of a radiographer. The personal supervision shall include (a) the radiographer's personal presence at the site where the sealed sources are being used, (b) the ability of the radiographer to give immediate assistance if required, and (c) the radiographer's watching the assistant's performance of the operations referred to in this section.

#### EXEMPTIONS

##### § 34.51 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.

#### Appendix A

##### I. Fundamentals of Radiation Safety

- A. Characteristics of gamma radiation.
- B. Units of radiation dose (mrem) and quantity of radioactivity (curie).
- C. Hazards of exposure to radiation.
- D. Levels of radiation from licensed material.

##### E. Methods of controlling radiation dose:

- 1. Working time.
- 2. Working distances.
- 3. Shielding.

##### II. Radiation Detection Instrumentation To Be Used

- A. Use of radiation survey instruments:
  - 1. Operation.
  - 2. Calibration.
  - 3. Limitations.
- B. Survey techniques.
- C. Use of personnel monitoring equipment:
  - 1. Film badges and thermoluminescent dosimeters (TLD's).
  - 2. Pocket dosimeters.

##### III. Radiographic Equipment To Be Used

- A. Remote handling equipment.
- B. Radiographic exposure devices.
- C. Storage containers.

##### IV. Inspection and Maintenance Performed by the Radiographers

##### V. Case Histories of Radiography Accidents

NOTE.—The reporting and record keeping requirements contained in this part have been approved by the General Accounting Office under B-180225 (R0052), (R0335).



UNITED STATES NUCLEAR REGULATORY COMMISSION  
Washington, D.C. 20555

## NOTICE TO EMPLOYEES

### YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to—

1. Apply these NRC regulations and the conditions of his NRC license to all work under the license.
2. Post or otherwise make available to you a copy of the NRC regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.
3. Post Notices of Violation involving radiological working conditions, proposed imposition of civil penalties and orders.
4. Refrain from discriminatory acts against employees who provide information to NRC.

### YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with those provisions of the NRC regulations, and the operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

### WHAT IS COVERED BY THESE NRC REGULATIONS

1. Limits on exposure to radiation and radioactive material in restricted and unrestricted areas.
2. Measures to be taken after accidental exposure.
3. Personnel monitoring, surveys and equipment.
4. Caution signs, labels, and safety interlock equipment.
5. Exposure records and reports.
6. Options for workers regarding NRC inspections.
7. Identifies "protected activities" that employees may engage in.
8. Prohibits discrimination against employees who engage in these protected activities.
9. Identifies the Department of Labor as a source of relief in the event of discrimination; and
10. Related matters.

### REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The NRC regulations require that your employer give you a written

report if you receive an exposure in excess of any applicable limit as set forth in the regulations or in the license. The basic limits for exposure to employees are set forth in Section 20.101, 20.103, and 20.104 of the Part 20 regulations. These Sections specify limits on exposure to radiation and exposure to concentrations of radioactive material in air.

2. If you work where personnel monitoring is required pursuant to Section 20.202:
  - (a) your employer must give you a written report of your radiation exposures upon the termination of your employment, if you request it, and
  - (b) your employer must advise you annually of your exposure to radiation, if you request it.

### INSPECTIONS

All activities under the license are subject to inspection by representatives of the NRC. In addition, any worker or representative of workers who believes that there is a violation of the Atomic Energy Act of 1954, the regula-

### STANDARDS FOR PROTECTION AGAINST RADIATION (PART 20); NOTICES, INSTRUCTIONS AND REPORTS TO WORKERS; INSPECTIONS (PART 19); EMPLOYEE PROTECTION

The Nuclear Regulatory Commission (NRC) in its Rules and Regulations: Part 20 has established standards for your protection against radiation hazards from radioactive material under license issued by the NRC; Part 19 has established certain provisions for the options of workers engaged in NRC licensed activities; Parts 30, 40, 50, and other parts containing provisions related to employee protection.

**POSTING REQUIREMENTS** Copies of this notice must be posted in a sufficient number of places in every establishment where activities licensed by the NRC are conducted, to permit employees to observe a copy on the way to or from their place of employment.

tions issued thereunder, or the terms of the employer's license with regard to radiological working conditions in which the worker is engaged, may request an inspection by sending a notice of the alleged violation to the appropriate United States Nuclear Regulatory Commission Regional Office (shown on map below). The request must set forth the specific grounds for the notice, and must be signed by the worker or the representative of the workers. During inspections, NRC inspectors may confer privately with workers, and any worker may bring to the attention of the inspectors any past or present condition which he believes contributed to or caused any violation as described above.

### EMPLOYEE PROTECTION

If an employee believes that discrimination has occurred due to engaging in the "protected activities" said employees may, within 30 days of the discriminatory act, file a complaint with the Department of Labor, Employment Standards Administration, Wage and Hour Division. The Department of Labor shall conduct an investigation

and shall, where discrimination has occurred, issue an order providing relief to the employee if relief is not provided by other means of settlement.

### PROTECTION OF INSPECTORS

The amended Atomic Energy Act, section 235, provides criminal penalties against any individual who kills, forcibly assaults, resists, opposes, impedes, intimidates or interferes with any person who performs any inspections which (1) are related to any activity or facility licensed by the Commission, and (2) are carried out to satisfy requirements under the Atomic Energy Act or under any other Federal law covering the safety of licensed facilities or the safety of radioactive materials. The acts described above are criminal not only if taken against inspection personnel who are engaged in the performance of such inspection duties, but also if taken against inspection personnel on account of such duties.

### SABOTAGE OF NUCLEAR FACILITIES OR FUEL

The amended Atomic Energy Act, section 236, provides criminal penalties against any individual who intentionally and willfully destroys or causes physical damage, or attempts to do so, to any production, utilization, or waste storage facility licensed under the act, or any nuclear fuel or spent fuel regardless of location.

### UNITED STATES NUCLEAR REGULATORY COMMISSION REGIONAL OFFICE LOCATIONS

A representative of the Nuclear Regulatory Commission can be contacted at the following addresses and telephone numbers. The Regional Office will accept collect telephone calls from employees who wish to register complaints or concerns about radiological working conditions or other matters regarding compliance with Commission rules and regulations.



#### Regional Offices

REGION	ADDRESS	TELEPHONE
I	U.S. Nuclear Regulatory Commission Region I 531 Park Avenue King of Prussia, PA 19406	215 337-5000
II	U.S. Nuclear Regulatory Commission Region II 101 Marietta St., N.W., Suite 3100 Atlanta, GA 30303	404 221-4503
III	U.S. Nuclear Regulatory Commission Region III 799 Roosevelt Road Glen Ellyn, IL 60137	312 932-2500
IV	U.S. Nuclear Regulatory Commission Region IV 611 Ryan Plaza Drive, Suite 1000 Arlington, TX 76012	817 465-8100
V	U.S. Nuclear Regulatory Commission Region V 1400 Marie Lane, Suite 210 Walnut Creek, CA 94596	415 943-3200

TITLE 25. RULES AND REGULATIONS  
PART I. DEPARTMENT OF ENVIRONMENTAL RESOURCES  
Subpart D. ENVIRONMENTAL HEALTH AND SAFETY  
ARTICLE V. RADIOLOGICAL HEALTH

CHAPTER 233. INDUSTRIAL RADIOGRAPHIC OPERATIONS

Authority

The provisions of this Chapter 233 issued under act of January 28, 1966, P.L. 1625 § 301 (73 P.S. § 1301).

Source

The provisions of this Chapter 233 adopted February 1, 1972, effective March 1, 1972, 2 Pa. B. 212.

GENERAL PROVISIONS

§ 233.1. Definitions.

The following words and terms, when used in this Chapter shall have the following meanings, unless the context clearly indicates otherwise:

(1) *Cabinet radiography* - Industrial radiography using radiation-producing 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 openings meet the requirements of § 227.63 of this Title (relating to high radiation areas), and which cabinet is so shielded that every location on the exterior meets conditions for an unrestricted area.

(2) *Industrial radiography* - The industrial examination of the macroscopic structure of materials by nondestructive methods utilizing radiation sources.

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

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

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

(6) *Shielded room radiography* - Industrial radiography which is conducted in an enclosed room, the interior of which is not occupied during radiographic operations, and which is so shielded that every location on the exterior meets conditions for an unrestricted area, 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 and meet the requirements of § 227.63 of this Title (relating to high radiation areas).

(7) *Storage container* - A device in which sealed radioactive sources are transported or stored.

§ 233.2. Scope.

The provisions of this Chapter shall establish radiation safety requirements for persons utilizing sources of radiation for industrial radiography. The requirements of this Chapter are in addition to, and not in substitution for, the other requirements of this Article.



## SEALED SOURCE REQUIREMENTS

### § 233.11. Radiation level limits.

(a) Radiographic exposure devices measuring less than four 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 inches from any exterior surface of the device.

(b) Radiographic exposure devices measuring a minimum of four 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 radiography exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten milliroentgens per hour at one meter from any exterior surface.

(c) The radiation levels specified are with the sealed source in the shielded ("OFF") position.

### § 233.12. Radiation source locks.

(a) Each radiation source shall be provided with a lock or outer-locked 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 § 233.51 of this Title (relating to security).

(b) Each storage container 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.

### § 233.13. Storage precautions.

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

### § 233.14. Repairs and testing.

(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 Department, the U.S. Atomic Energy Commission or any agreement state.

(b) Each sealed source shall be tested for leakage at intervals not to exceed six 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. 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 licensee would be to test at the nearest accessible point to the sealed source position or other appropriate measuring point. Records of leak test results shall be expressed in units of microcuries and maintained for inspection by the Department.

(c) Any test conducted pursuant to subsection (b) of this section 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 licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with § 225.22 of this Title (relating to transfer of materials) and §§ 227.81 - 227.85 of this Title (relating to waste disposal). Within 15 days after obtaining results of the test evidencing leakage, the licensee shall file a report with the Department describing the equipment involved, the test results and the corrective action taken.

(d) A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one inch square bearing

the prescribed radiation caution symbol in conventional colors, purple on a yellow background, and at least the instructions: "Danger - Radioactive Material - Do Not Handle - Notify Civil Authorities if Found."

§ 233.15. Quarterly inventory.

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

**RADIOGRAPHY AND RADIATION-PRODUCING MACHINES**

§ 233.21. Cabinet radiography.

Cabinet radiography using radiation-producing machines or equipment shall be exempt from other requirements of this Chapter. No registrant, however, 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.

§ 233.22. Shielded room radiography.

Shielded room radiography using radiation producing machines or equipment shall be exempt from other requirements of this Chapter. The following shall apply, however:

(1) No registrant shall permit any individual to operate a radiation-producing machine or equipment 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.

(2) 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-producing machine for shielded room radiography.

§ 233.23. Other radiography.

Other radiography using radiation machines or equipment shall be exempt from § 233.11 - 233.15 and § 233.53 (c) and (d) of this Title (relating to sealed source requirements, radiation surveys and records thereof). The following shall apply, however:

(1) 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.

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

**RADIATION SURVEY INSTRUMENTS AND LOGS**

§ 233.31. General requirements.

(a) The licensee or registrant shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this Chapter and Chapter 227 of this Title (relating to standards for control of radiation exposure).

(b) Each radiation survey instrument shall be calibrated at intervals not to exceed three months and after each instrument servicing and a record maintained of the latest date of calibration.

(c) Instrumentation required by this Chapter shall have a range such that two milliroentgens per hour through one roentgen per hour can be measured.

§ 233.32. Utilization logs.

Each licensee or registrant shall maintain current logs which shall be kept available for inspection by the Department, showing the following information for each source of radiation:

- (1) A description (or make and model number) of each radiation source or storage container in which a sealed source is located.
- (2) The identity of the radiographer to whom the source is assigned.
- (3) Locations where used and dates of use.
- (4) The voltage, current and exposure time for each radiographic exposure employing a radiation machine.

OPERATORS' PERSONAL SAFETY REQUIREMENTS

§ 233.41. Limitations.

(a) *Radiographer.* No licensee or registrant shall permit any person to act as a radiographer until that person has complied with the following requirements:

(1) Been instructed in and demonstrated understanding of the following subjects:

- (i) Fundamentals of radiation safety, including:
  - (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; and
  - (E) methods of controlling radiation dose, including working time, working distance and shielding.
- (ii) Radiation detection instrumentation to be used, including:
  - (A) use of radiation survey instruments, including operation, calibration and limitations;
  - (B) survey techniques; and
  - (C) use of personnel monitoring equipment, including film badges, pocket dosimeters and pocket chambers.
- (iii) Radiographic equipment to be used, including:
  - (A) remote handling equipment;
  - (B) radiographic exposure devices and sealed sources;
  - (C) storage containers; and
  - (D) operation and control of X-ray equipment.
- (iv) The requirements of pertinent federal and state regulations.
- (v) The licensee's or registrant's written operating and emergency procedures.

(2) Received copies of and instruction in the regulations contained in this Chapter and the applicable sections of Chapter 277 of this Title (relating to standards for control of radiation exposure), and the licensee's or registrant's operating and emergency procedures, and shall have demonstrated understanding thereof.

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

(b) *Radiographer's assistant.* No licensee or registrant shall permit any person to act as a radiographer's assistant until such person has complied with the following requirements:

(1) Received copies of and instructions in the licensee's or registrant's operating and emergency procedures, and shall have demonstrated understanding thereof.

(2) 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.

§ 233.42. Operating and emergency procedures.

The licensee's or registrant's operating and emergency procedures shall include instructions in at least the following:

- (1) The handling and use of radiation sources to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Chapter 227 of this Title (relating to standards for control of radiation exposure).
- (2) Methods and occasions for conducting radiation surveys.
- (3) Methods for controlling access to radiographic areas.
- (4) Methods and occasions for locking and securing sources of radiation.
- (5) Personnel monitoring and the use of personnel monitoring equipment.
- (6) Transportation to field locations, if appropriate, including packing of sources of radiation in the vehicles, posting of vehicles and control of sources of radiation during transportation.
- (7) Minimizing exposure of persons in the event of an accident.
- (8) The procedure for notifying proper persons in the event of an accident.
- (9) Maintenance of records.

§ 233.43. Personnel monitoring control.

(a) No licensee or 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 a pocket dosimeter, pocket chamber or other device which can be read immediately. Pocket dosimeters and pocket chambers shall be capable of indicating exposures as low as 50 milliroentgens (such as, ranges from zero to 200). A film badge shall be assigned to and worn by only one person.

(b) Pocket dosimeters, pocket chambers or other Department approved devices shall be read and doses recorded daily. A film badge shall be immediately processed if a pocket chamber or pocket dosimeter is discharged beyond its range. The film badge reports received from the film badge processor and records of pocket dosimeter and pocket chamber readings shall be maintained for inspection by the Department.

PRECAUTIONARY PROCEDURES

§ 233.51. Security.

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

- (1) where the high radiation area is equipped with a control device or an alarm system as described in § 227.63 of this Title (relating to high radiation areas); or
- (2) where the high radiation area is locked to protect against unauthorized or accidental entry.

§ 233.52. Posting.

Areas in which radiography is being performed shall be conspicuously posted as required by § § 227.62 and 227.63 of this Title (relating to posting).

§ 233.53. Radiation surveys and records.

(a) No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in § 233.31 of this Title (relating to radiation surveys) 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 § 223.12 of this Title (relating to locks).

(d) Records shall be kept of the surveys required by subsection (c) of this section and maintained for inspection by the Department.

COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF ENVIRONMENTAL RESOURCES

# NOTICE TO EMPLOYEES

## Standards for Protection Against Radiation

In Title 25 of its Rules and Regulations, The Pennsylvania Department of Environmental Resources has established standards for your protection against radiation hazards.

### YOUR EMPLOYER'S RESPONSIBILITY

Your employer is required to -

1. Apply these Department of Environmental Resources regulations and any conditions of his radioactive materials license to all work involving radiation sources.
2. Post or otherwise make available to you a copy of the regulations, licenses, and operating procedures which apply to work you are engaged in, and explain their provisions to you.

### YOUR RESPONSIBILITY AS A WORKER

You should familiarize yourself with these provisions of the regulations and operating procedures which apply to the work you are engaged in. You should observe their provisions for your own protection and protection of your co-workers.

### WHAT IS COVERED BY THESE REGULATIONS

1. Limits on exposure to radiation and radioactive materials in restricted and unrestricted areas;
2. Measures to be taken after accidental exposure;
3. Personnel monitoring, surveys and equipment;
4. Caution signs, labels, and safety interlock equipment;
5. Exposure records and reports; and
6. Related matters.

### REPORTS ON YOUR RADIATION EXPOSURE HISTORY

1. The Department of Environmental Resources regulations require that your employer give you a written report if you receive an exposure in excess of any applicable limit as set forth in the regulations or the license. The basic limits for exposure to employees are set forth in Chapter 227 of the regulations. This chapter specifies limits on exposure to radiation and exposure to concentrations of radioactive material in air.
2. If you work where personnel monitoring is required pursuant to Chapter 227;
  - (a) Your employer must give you a written report of your radiation exposure upon the termination of your employment if you request it, and
  - (b) Your employer must advise you annually of your exposure if you request it.

### INSPECTIONS

All activities involving radiation are subject to inspection by representatives of the Pennsylvania Department of Environmental Resources.

### INQUIRIES

Inquiries dealing with matters outlined above can be sent to the Bureau of Radiation Protection, Pennsylvania Department of Environmental Resources, P. O. Box 2063, Harrisburg, Pennsylvania 17120. Telephone 717-787-3720.

### POSTING REQUIREMENT

Copies of this notice must be posted in a sufficient number of places in every establishment where activities covered by the regulations are conducted to permit employees working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of employment.

## MATERIALS LICENSE

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 40 and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s); and to import such byproduct and source material. This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee		3. License number	37-23370-01
North American Inspection, Inc.		4. Expiration date	March 31, 1989
P. O. Box 88 Laurys Station, Pennsylvania 18059		5. Docket or Reference No.	
6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license	
A. Cobalt 60	A. Sealed sources (Technical Operations Model A-424-18)	A. Not to exceed 30 curies per source	
B. Cobalt 60	B. Sealed sources (Gamma Industries Model A-4-A)	B. Not to exceed 50 curies per source	
C. Cobalt 60	C. Sealed sources (Gamma Industries Model A-5-A)	C. Not to exceed 100 curies per source	
D. Cobalt 60	D. Sealed sources (Technical Operations Model A-424-14 or Gamma Industries T-8-T)	D. Not to exceed 100 curies per source	
E. Cobalt 60	E. Sealed sources (Gamma Industries Model A-5-A)	E. Not to exceed 100 curies per source	
F. Cobalt 60	F. Sealed sources (Technical Operations Model A-424-13)	F. Not to exceed 100 curies per source	
G. Cesium 137	G. Sealed sources (Gamma Industries Model VD(HP))	G. Not to exceed 125 milli- curies per source	
H. Cesium 137	H. Sealed sources (Gamma Industries Model VD(HP))	H. Not to exceed 225 milli- curies per source	
I. Iridium 192	I. Sealed sources (Gamma Industries Model A-2-A, Technical Operations Model 848, or Automation Industries Model G-2/G-3)	I. Not to exceed 100 curies per source	
J. Iridium 192	J. Sealed sources (Technical Operations Model A-424-9, Gamma Industries Model T-3-T, or Automation Industries Model T-3)	J. Not to exceed 100 curies per source	

MATERIALS LICENSE  
SUPPLEMENTARY SHEET

License number

37-23370-01

Docket or Reference number

6. Byproduct, source, and/or special nuclear material      7. Chemical and/or physical form      8. Maximum amount that licensee may possess at any one time under this license

K. Iridium 192

K. Sealed sources  
(Automation Industries  
Models N-2/N-3, Gamma  
Industries Model B-8-A,  
or Technical Operations  
Model 866)K. Not to exceed 100 curies  
per source

L. Iridium 192

L. Sealed sources (Gamma  
Industries Model GP)L. Not to exceed 100 curies  
per source

M. Iridium 192

M. Sealed sources (Gamma  
Industries Model PL-2)M. Not to exceed 200 curies  
per source

N. Iridium 192

N. Sealed sources (Gamma  
Industries Model TP or  
Technical Operations Model  
A-58101-8)N. Not to exceed 200 curies  
per source

## 9. Authorized use

- A. For use in Technical Operations Model 741 exposure devices for industrial radiography and in Technical Operations Model 771 source changers for storage and replacement of sources.
- B. For use in Gamma Industries Model Gammatron 50 exposure devices for industrial radiography and in Gamma Industries Model C-8 source changers for storage and replacement of sources.
- C. For use in Gamma Industries Model Gammatron 100 exposure devices for industrial radiography and in Gamma Industries Model C-8 source changers for storage and replacement of sources.
- D. For use in Technical Operations Model 680 exposure devices for industrial radiography and in Technical Operations Model 771 or Gamma Industries Model C-8 source changers for storage and replacement of sources.
- E. For use in Gamma Industries Model Gammatron 200 exposure devices for industrial radiography and in Gamma Industries Model C-8 source changers for storage and replacement of sources.
- F. For use in Technical Operations Model 676 exposure devices for industrial radiography and in Technical Operations Model 771 source changers for storage and replacement of sources.
- G. For use in Gamma Industries Model Tattle Tale exposure devices for industrial radiography.
- H. For use in Gamma Industries Model Master Minder 1 and 2 exposure devices for industrial radiography.



MATERIALS LICENSE  
SUPPLEMENTARY SHEET

License number 37-23370-01

Docket or Reference number

13. continued

- C. Sealed sources authorized for a use other than radiography shall be tested as radiography sources in accordance with Section 34.25 of 10 CFR 34.
14. The licensee is authorized to receive, possess, and use sealed sources of Iridium 192 or Cobalt 60 where the radioactivity exceeds the maximum amount of radioactivity specified in Item 8 of this license provided:
- A. Such possession does not exceed the quantity per source specified in Item 8 by more than 20% for Iridium 192 or 10% for Cobalt 60;
  - B. Records of the licensee show that no more than the maximum amount of radioactivity per source specified in Item 8 of the license was ordered from the supplier or transferor of the byproduct material; and
  - C. The levels of radiation for radiographic exposure devices and storage containers do not exceed those specified in Section 34.21, 10 CFR 34.
15. Pursuant to Title 10, Chapter I, Code of Federal Regulations, Part 40, "Domestic Licensing of Source Material," the licensee is authorized to possess, use, transfer, and import up to 999 kilograms of uranium contained as shielding material in the radiography exposure devices and source changers authorized by this license.
16. The licensee may transport licensed material or deliver licensed material to a carrier for transport in accordance with the provisions of Title 10, Code of Federal Regulations, Part 71, "Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions."
17. Except as specifically provided otherwise by this license, the licensee shall possess and use licensed material described in Items 6, 7, and 8 of this license in accordance with statements, representations, and procedures contained in application dated January 31, 1984; and letter dated March 22, 1984. The Nuclear Regulatory Commission's regulations shall govern the licensee's statements in applications or letters, unless the statements are more restrictive than the regulations.

FOR THE U. S. NUCLEAR REGULATORY COMMISSION

APR 05 1984

Date \_\_\_\_\_

By Joy C. Wey  
Material Licensing Branch  
Division of Fuel Cycle and Material  
Safety  
Washington, D. C. 20555



August 9, 1963

## AGREEMENT STATES

Became an  
Agreement State  
On-

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10/1/66

Alabama 205-832-5992

Mr. Aubrey Godwin, Chief  
Bureau of Radiological Health  
Environmental Health Adminis.  
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PROCEDURE  
IDENTIFICATION

RADIOGRAPHY OPERATING AND EMERGENCY PROCEDURES

"4.0"

4.0 RADIOGRAPHY OPERATING PROCEDURES

4.1 Personnel Monitoring:

- a. BADGE - Each employee at a job site must wear a current TLD or film badge. Badges will be worn until a replacement is received.
- b. POCKET DOSIMETERS - Each employee at a job site must wear an operable pocket dosimeter. The pocket dosimeter must be charged before each shift and the reading at the beginning and end of each shift recorded. Employees should frequently read their dosimeters during radiographic operations. Employees must first record their pocket dosimeter reading on the form prior to recharging their dosimeter at anytime throughout the shift. (See Form RS-4-1)
- c. LOCATION WORN - Badges and dosimeters may be worn at any convenient location between the shirt collar and front trouser pockets; such as, shirt pockets or at the waist on the belt or belt loops.
- d. DISCHARGE OF POCKET DOSIMETER - Should the pocket dosimeter be found discharged at anytime when in the vicinity of radioactive material, the employee must immediately stop work in the vicinity of radioactive material, notify the Radiation Safety Officer (RSO) and submit his badge for processing. He cannot return to work with radioactive material until a determination of his radiation exposure has been made.
- e. STORAGE OF BADGE - When not engaged in radiographic operations and not wearing your assigned badge, keep it away from sources of radiation such as in dark-rooms where cameras are stored, and in a cool and relatively dry area.

4.2 Check Out Of Equipment:

A. RADIOGRAPHY CAMERA

1. Utilization Log Entry - The radiographer must

PROCEDURE NO. RSO-4	ISSUE DATE 1-84	REV. DATE -0-	
PROCEDURE TYPE Radiation Safety	TEST METHOD Radiography		



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4.2 Check Out Of Equipment: (continued)

enter the following information in the Utilization Log:

- a. DATE CHECKED OUT
- b. RADIOGRAPHER
- c. CAMERA IDENTIFICATION BY MANUFACTURER, MODEL NUMBER AND SERIAL NUMBER
- d. RADIOISOTOPE, ACTIVITY, MANUFACTURER, MODEL NUMBER AND SERIAL NUMBER OF SOURCE
- e. PLANT LOCATION OF RADIOGRAPHY SITE OR DESTINATION (LOCATION OF JOB SITE)

(See Form RS-4-2)

2. Decay Curve - The radiographer should check the following information usually provided on the decay curve:

- a. ACTIVITY OF SOURCE ON GIVEN DATE
- b. SERIAL NUMBER OF SOURCE
- c. DATE OF LEAK TEST (IF THE SOURCE IS APPROACHING SIX (6) MONTHS SINCE IT WAS LEAK TESTED, THEN THE RADIATION SAFETY OFFICER (RSO) SHOULD BE NOTIFIED.)

1. DECAY CURVE CONTAINED IN CAMERA LOG BOOK.

3. Camera And Device Inspection - The radiographer must perform the following inspection daily prior to commencing operations: (See Form RS-4-3)

- a. LOCK OPERATES PROPERLY AND KEYS AVAILABLE
- b. PIG-TAIL CONNECTOR NOT WORN OR BENT
- c. PROTECTIVE PIG-TAIL SAFETY PLUG AND LOCK BOX CAP AVAILABLE
- d. CAUTION - RADIOACTIVE MATERIAL LABEL AND SYMBOL LEGIBLE
- e. VERIFY SOURCE AND CAMERA IDENTIFICATION





4.2 Check Out Of Equipment: (continued)

- f. MAXIMUM RADIATION LEVELS FOR IRIDIUM 192 CAMERAS DO NOT EXCEED 50 MR/HR AT SIX (6) INCHES FROM THE SURFACE, AND COBALT 60 CAMERAS DO NOT EXCEED 200 MR/HR AT THE SURFACE AND 10 MR/HR AT THREE (3) FEET FROM THE SURFACE
  - g. SOURCE INDICATOR PIN ON PIPELINE DEVICE OPERATES PROPERLY
  - h. TECH OPS 616 - CLEAN VACUUM PLUG AND PORT; AND CHECK SAFETY WIRING AND FASTENERS
- B. SOURCE TUBE AND CONTROLS - The radiographer must perform these inspections prior to leaving the shop and daily prior to commencing operations:
- 1. Source Tube Inspection
    - a. SOURCE TUBE IS FREE OF KINKS AND CRIMPS AND THE DISCONNECT COUPLING OPERATES PROPERLY
    - b. SOURCE TUBE END OR COLLIMATOR ATTACHES EASILY TO SOURCE TUBE AND IS NOT CLOGGED
  - 2. Controls Inspections
    - a. PIG-TAIL (SOURCE) CONNECTOR MATCHES WITH SOURCE IN CAMERA AND IS NOT WORN OR BENT
    - b. DRIVE CABLE IS FLEXIBLE, LUBRICATED AND NOT BENT OR CRIMPED
    - c. DRIVE CABLE CONDUIT IS FLEXIBLE, NOT CRIMPED AND CONNECTS EASILY TO CAMERA
    - d. CONTROL ASSEMBLY IS NOT LOSE OR WORN AND WILL DRIVE THE CABLE WITHOUT SLIPPING
    - e. TECH OPS 616 - CHECK VACUUM WITH CONTROL VALVE OFF; AND CHECK VACUUM WITH CAMERA LOCKED



4.2 Check Out Of Equipment: (continued)

C. Survey Meters (See Appendix 4-1)

1. Operation Verification - Check out one (1) and if possible, two (2) survey meters and check operation by surveying the camera with each meter. Record the reading at the source outlet nipple for your future reference.
2. Calibration - Check the calibration date on the sticker on the meter. Do not use any meter if the date is more than three (3) months old. If it is approaching three (3) months since it was calibrated, notify the Radiation Safety Officer (RSO).
3. Malfunction - On any job when the first meter fails to operate, notify the Radiation Safety Officer (RSO) "immediately" for a replacement. IF BOTH METERS DO NOT OPERATE AT ANY TIME, IMMEDIATELY CEASE OPERATIONS AND NOTIFY THE RADIATION SAFETY OFFICER (RSO).

D. Caution Signs And Warning Rope

1. CAUTION - RADIATION AREA (See Example 4-1)
2. CAUTION - HIGH RADIATION AREA (See Example 4-2)
3. CAUTION - RADIOACTIVE MATERIAL (See Example 4-3)
4. YELLOW WARNING ROPE OR TAPE

E. Miscellaneous (Some items may not be required)

1. Film
2. Developing Chemicals
3. Penetrameters
4. Lead Numbers and/or Letters

F. Documents And Forms

1. Operating and Emergency Procedures
2. U.S.N.R.C. Rules and Regulations - Parts 19, 20, and 34 (See RSO - Part 2)



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4.2 Check Out Of Equipment: (continued)

3. Radioactive Material License -
  - a. NUCLEAR REGULATORY COMMISSSION (See RSO - Part 3)
  - b. COPY OF AGREEMENT STATE NOTIFICATION  
(See RSO - Part 3)
4. Dosimeter and Survey Forms (See Form RS-4-4)
5. Nuclear Regulatory Commission Form - 3,  
"Notice To Employees" (See RSO - Part 2)
- G. Equipment Required For 120 Curies To 240 Curies Of  
Iridium 192
  1. Crank-Out Devices - Minimum forty (40) foot  
crank-outs and approximate 6 HVL collimators  
or thicker (approximate one (1) inch wall  
thickness of tungsten)
  2. Pipeline Devices - Minimum fifteen (15) foot  
control assemblies.
  3. NOTE: Use of high activity sources must be  
specifically authorized by the Radiation  
Safety Officer (RSO). High activity  
sources will not be used on lay barges  
or in crank-out devices on cross-country  
pipelines.

NOTE: See RSO - Part 6 - for manufacturers standard  
operating procedures (SOP) for projectors and  
source changers used by North American Inspection,  
Inc.

4.3 Transportation:

A. Placards And Signs

1. RADIOACTIVE - Vehicle or darkrooms in which  
radioactive material is transported will be  
identified with "RADIOACTIVE" placards as re-  
quired pursuant to 49-CFR 172.504.



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4.3 Transportation: (continued)

2. CAUTION - RADIOACTIVE MATERIAL sign with radiation symbol must be placed on darkroom whenever radioactive material is stored inside (although this is not required during transportation, it is best to place these signs on the darkroom whenever it contains radioactive material).  
(See Example 4-3)

B. Radiation Survey

1. Survey the outside of the vehicle to be certain that radiation levels do "not" exceed 2 MR/HR at any exterior surface.
2. Survey the cab of the truck, or driver and passenger positions in the vehicle and attempt to store the camera to achieve 2 MR/HR or less.  
(See Form RS-4-4 - line 16, 1.A & B)

- C. Security - Always keep the locked camera in a locked darkroom or a locked vehicle. Keys to the darkroom and vehicle must remain with the driver at all times. Prevent camera from moving and causing damage.

- D. Survey Meter - Keep at least one (1) survey meter with you in the cab or front seat.

- E. Accidents - If you are involved in a traffic accident and you are able, survey the camera. If the radiation levels in the vicinity of the camera are higher than normal or if it is likely the camera is damaged:

1. DO NOT ALLOW ANYONE IN THE AREA EXCEPT TO RESCUE AN INDIVIDUAL.
2. INFORM THE POLICE THAT THE VEHICLE MUST NOT BE MOVED.
3. NOTIFY IMMEDIATELY THE RADIATION SAFETY OFFICER (RSO) WHO WILL NOTIFY THE APPROPRIATE RADIATION REGULATORY AUTHORITIES. (See Form RS-4-5)





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4.4 Establishing Radiography Control Areas:

- A. Define general area in which radiographic shots are to be taken.
- B. Estimate the maximum exposure time that should occur in any one (1) hour.
- C. Using the above estimated exposure time in any one (1) hour, the activity of the source and type of camera, read the estimated distance from the Restricted Area Table. (See Table 4-A or 4-D)
- D. Using the above distance or knowledge of a similar prior setup, establish, if possible, a yellow warning rope or tape barricade and post along this barricade Caution - Radiation Area signs.
- E. If not possible to establish barricades at this distance, establish all barricades possible and, at such points where you cannot see people entering this area.
- F. If you have not been able to establish a continuous barricade above around the restricted area, then read from the Radiation Area Table (See Table 4-B or 4-E) the estimated distance and post Caution - Radiation Area signs at this distance. Establish all barricades possible at approximately this distance from the source.
- G. If you have not been able to establish a continuous barricade above, then read from the High Radiation Area Table (See Table 4-C or 4-F) the estimated distance and post Caution - High Radiation Area signs at this distance. Establish all barricades possible at this distance from the source.
- H. During the exposures you should adjust any barricades and posted signs. EXCEPT DO NOT CHECK THE HIGH RADIATION AREA SIGNS OR BARRICADE.
- I. Note: Whenever it is possible to establish a continuous barricade around a radiographic site which is appropriately posted, no additional signs or barricades will be established within that perimeter.
- J. Direct Surveillance - Radiographers must maintain direct surveillance over the radiographic area at



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4.4 Establishing Radiography Control Areas: (continued)

- J. all times during an exposure. Instruct unauthorized individuals entering the restricted area to leave. If they do not leave promptly, terminate the exposure. If any individual does not promptly leave the radiation area upon notice, immediately terminate the exposure and start again when the area is clear.
- K. When using Iridium 192 sources exceeding 120 curies, up to and including 250 curies, use Table 4-G for the distance to achieve for the 2 MR, 5 MR and 100 MR boundary levels.
- L. When using Cobalt 60 sources exceeding 120 curies, up to and including 200 curies, use Table 4-H for the distance to achieve the 2 MR, 5 MR and 100 MR boundary levels.

4.5 Making An Exposure:

- A. Authorized Operators - Only a radiographer or assistant radiographer under the personal supervision of a radiographer may operate the controls.
- B. Establish radiography control areas as above.
- C. Crank-Out Device
  - 1. Survey camera at source outlet nipple. Note reading for comparison at end of exposure.
  - 2. Remove safety plug and connect source tube to camera. Position source tube end or collimator in desired location, and whenever possible direct open beam down and away from possible occupied areas. Locate the camera such that source tube is in an approximate straight line without kinks. Place film.
  - 3. Crank out approximately six (6) inches on control cable and remove protector cap from lock box. Inspect control cable and pig-tail connectors to be certain they are not worn, bent or broken. Connect control cable to pig-tail and screw conduit male connecting thread into lock box.
  - 4. Hold hand crank back (counter-clockwise) to prevent source from moving and to enable lock to operate on some units. Unlock the pig-tail



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4.5 Making An Exposure: (continued)

4. and continue to hold the crank back.
  5. Stretch control cable away from camera in as straight a line as possible continuing to hold crank back.
  6. Crank source out as smoothly and rapidly as possible, but do not hit end of source tube hard.
- D. Pipeline Device (Less Than 120 Curies) - Hand Operated -
1. SURVEY CAMERA NEAR TOP. NOTE READING FOR COMPARISON AT END OF EXPOSURE.
  2. REMOVE DUST CAP AND SCREW ON KNURLED KNOB.
  3. POSITION CAMERA AND FILM.
  4. UNLOCK CAMERA.
  5. STRETCH AS FAR AS POSSIBLE MAINTAINING THE GREATEST DISTANCE BETWEEN THE TORSO OF THE BODY AND THE SOURCE. ROTATE THE KNURLED KNOB 180 DEGREES EXPOSING THE SOURCE AND REVEALING THE RED INDICATOR PIN.
  6. MOVE AS FAR AWAY AS EXPOSURE TIME PERMITS AND WHERE YOU CAN MAINTAIN DIRECT SURVEILLANCE.
- E. Pipeline Device (Greater Than 120 Curies) - Crank Operated -
1. SURVEY CAMERA NEAR TOP. NOTE READING FOR COMPARISON AT END OF EXPOSURE.
  2. REMOVE CAP AND ATTACH REMOTE CONTROL.
  3. POSITION FILM AND CAMERA.
  4. UNLOCK THE CAMERA.
  5. OPERATE CONTROL TO TURN SOURCE WHEEL 180 DEGREES EXPOSING THE SOURCE AND OBSERVE THE SOURCE POSITION INDICATOR.
  6. MOVE AS FAR AWAY AS EXPOSURE TIME PERMITS AND WHERE YOU CAN MAINTAIN DIRECT SURVEILLANCE.



4.5 Making An Exposure: (continued)

F. Vacuum Operated Self-Contained Camera -

1. SURVEY CAMERA NEAR TOP. NOTE READING FOR COMPARISON AT END OF EXPOSURE.
2. CONNECT VACUUM HOSE TO CONTROL UNIT, AND LAYOUT HOSE TO PREVENT KINKING.
3. POSITION FILM AND CAMERA.
4. UNLOCK CAMERA.
5. PUMP HANDLE TO OBTAIN FIFTEEN (15) INCH VACUUM. TURN CONTROL VALVE TO "ON" POSITION.
6. MOVE AS FAR AWAY AS EXPOSURE TIME PERMITS AND WHERE YOU CAN MAINTAIN DIRECT SURVEILLANCE.

4.6 X-Ray Machine Exposures:

- A. Authorized Operators - Radiographers using X-ray units must be trained and qualified as required for radiographers using isotope equipment. Only a radiographer or an assistant radiographer under the personal supervision of a radiographer may operate the X-ray unit.
- B. Establish RESTRICTED, RADIATION, and/or HIGH RADIATION AREAS as outlined above using Table 4-G for potential and current not less than the KV and MA employed.
- C. Exposure Procedure -
  1. POSITION X-RAY TUBE AND COLLIMATOR, WHEN IT CAN BE USED, IN DESIRED LOCATION. WHENEVER POSSIBLE DIRECT OPEN BEAM DOWN AND AWAY FROM OCCUPIABLE AREAS. PLACE FILM.
  2. POSITION CONTROL AS FAR AS POSSIBLE FROM THE X-RAY TUBE AND OUT OF THE DIRECT BEAM.
  3. ACTIVATE THE TUBE FROM THE CONTROL PANEL FOR THE DESIRED TIME AND OBSERVE THE INDICATOR LAMP.
  4. WHEN EXPOSURE IS TERMINATED OBSERVE THAT THE X-RAY INDICATOR LAMP IS OUT AND APPROACH THE X-RAY TUBE WITH AN OPERABLE SURVEY METER. SURVEY THE CLOSEST ACCESSIBLE POINT TO THE TUBE HEAD.





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4.6 X-Ray Machine Exposures: (continued)

4. IF THE SURVEY DOES NOT READ OVER BACKGROUND, THE X-RAY TUBE MAY BE HANDLED AND MOVED.

D. Crawler Operation -

1. SET X-RAY UNIT EXPOSURE CONTROLS AND SET CRAWLER INTO MOTION.
2. WALK ALONG THE PIPE WITH A SURVEY METER TO FOLLOW THE CRAWLER AND REMAIN OUT OF THE X-RAY BEAM TO THE GREATEST EXTENT POSSIBLE.
3. MAINTAIN A RESTRICTED AREA IN THE VICINITY OF THE CRAWLER BY HAVING PERSONNEL CARRYING CAUTION-RADIATION AREA SIGNS PRECEDE AND FOLLOW THE CRAWLER AT A SAFE DISTANCE WHILE MAINTAINING SURVEILLANCE OF THE AREA.
4. WHEN THE CRAWLER EXITS THE PIPE, SURVEY THE CLOSEST ACCESSIBLE POINT TO THE TUBE HEAD, AND TURN OFF EXPOSURE CONTROLS. IF THE SURVEY METER DOES NOT READ OVER BACKGROUND, THE CRAWLER AND/OR X-RAY TUBE MAY BE HANDLED AND MOVED.

4.7 Master Minder and Tattle-Tale Operations:

A. Master Minder

1. PLACE ON PIPE SO THAT DIRECT BEAM WILL BE AWAY FROM YOU AND THE BEAM PORT IS AGAINST THE PIPE.
2. UNLOCK SOURCE AND PULL IT OUT TO FULLEST EXTENT.
3. IF TIME PERMITS MOVE AWAY FROM UNIT.
4. AT END OF EXPOSURE APPROACH THE UNIT, REMAINING OUT OF THE DIRECT BEAM, PUSH IN THE SOURCE ROD AND LOCK IT.

B. Tattle-Tale

1. ATTACH THE UNIT TO THE CRAWLER SECURELY.
2. IMMEDIATELY BEFORE THE CRAWLER ENTERS THE PIPE, WHILE REMAINING OUT OF THE DIRECT BEAM, UNLOCK THE SOURCE ROD, PULL IT OUT TO ITS FULLEST EXTENT AND RELOCK IT IN THE EXPOSED POSITION.



4.7 Master Minder and Tattle-Tale Operations: (continued)

3. IMMEDIATELY AFTER THE CRAWLER EMERGES FROM THE PIPE, WHILE REMAINING OUT OF THE DIRECT BEAM, UNLOCK THE SOURCE ROD, PUSH IT IN AND RELOCK IT.

C. Surveys

1. AFTER EACH EXPOSURE MEASURE THE RADIATION LEVEL AT THE BEAM PORT TO MAKE SURE THAT IT HAS RETURNED TO ITS ORIGINAL LEVEL, INDICATING THAT THE SOURCE IS PROPERLY SHIELDED.
2. RECORD THE LAST RADIATION LEVEL MEASURED ABOVE PRIOR TO STORING THE DEVICE AND LEAVING IT UNATTENDED.

4.8 During An Exposure:

- A. Direct Surveillance - Maintain direct surveillance and allow only necessary radiographic personnel to enter the Restricted Area. If a person accidentally enters the Restricted Area and does not leave immediately upon notice, terminate the exposure and start over again.
- B. Radiation Area Surveys - During each exposure, check the radiation level at the operator position by observing the survey meter near you and time permitting survey the radiation levels at the perimeter of the Restricted Area and/or Radiation Area. Make adjustments in the barricade or location of signs. The radiation level may be determined from the appropriate table using the maximum estimated exposure time in one (1) hour.

4.9 At End Of Exposure:

A. Crank-Out Device -

1. Crank the source back into the camera as smoothly and rapidly as possible. Continue to hold the crank firmly to prevent the source from moving.
2. Approach the camera from the lock box side with a survey meter. Staying behind the camera, reach around and survey the camera at the outlet nipple and then survey the entire length of source tube. The reading at the outlet nipple should be the same noted just prior to making



4.9 At End Of Exposure: (continued)

2. the exposure. Lock the pig-tail in the camera. If at any time while approaching the camera, higher than normal readings are encountered, only attempt to crank in the source as above. If this fails to decrease the high reading, follow the emergency procedures below.
3. If you are going to make another exposure in the same general area or nearby pipe joint, then it is not necessary to disconnect the control cable and source tube. If the camera must be transported to another location or returned to storage, then disconnect control cable and source tube, and replace the lock box protector cap and safety plug.

B. Pipeline Device/Self-Contained Camera -

1. Without Remote Control - Approach the camera with a survey meter in the hand that you will not be using to operate the camera. Stretching as far as possible to maintain the greatest distance between the torso of the body and the source, rotate the knurled knob at 180 degrees shielding the source and retracting the red indicator pin.
2. With Remote Control - Operate the control to rotate the source wheel 180 degrees shielding the source, and observe that the source position indicator shows that the source is properly shielded.
3. Vacuum Operated - Turn control valve to the "OFF" position and approach the camera with a survey meter.
4. Immediately survey the camera at the same spot prior to the exposure. If you get the same reading, lock the camera. If you cannot immediately obtain the original reading by rotating the knob a few degrees then follow the emergency procedure below.



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4.9 At End Of Exposure: (continued)

- C. If the camera is to be left unattended, then it must be returned to the locked storage area, secured by placing it in a locked darkroom, locked storage vault or other locked room or area which is appropriately marked with Caution - Radioactive Material signs. Before storing the camera, measure the radiation level as above and record the reading on the survey form.

4.10 On-Site Records:

- A. Dosimeter Readings - Enter readings at beginning of shift and end of shift.
- B. Radiation Surveys
  - 1. DAILY AT BEGINNING OF EACH SHIFT.
  - 2. EACH TIME OPERATIONS COMMENCE IN A NEW LOCATION.
  - 3. EACH TIME THERE IS A MAJOR CHANGE IN AN EXISTING RADIATION AREA PERIMETER.
- C. Camera Surveys - Each time the camera is returned to locked storage preceding the absence of radiographic personnel, the radiation level, as measured above, will be recorded on the last survey form.  
(See Form RS-4-6)

4.11 Check-In Equipment:

- A. Radiography Camera
  - 1. UTILIZATION LOG ENTRY - THE RADIOGRAPHER MUST ENTER THE FOLLOWING INFORMATION IN THE UTILIZATION LOG: (See Form RS-4-6)
    - a. DATE CHECKED IN.
    - b. CAMERA SURVEY.
    - c. RADIOGRAPHER.
  - 2. CAMERA MAINTENANCE - INFORM RADIATION SAFETY OFFICER (RSO) OF ANY MAINTENANCE REQUIRED, AND ANY MALFUNCTION OR DEFECTS NOTED. (10CFR-Part 21)





4.11 Check-In Equipment: (continued)

- B. Controls and Survey Meters - Inform Radiation Safety Officer (RSO) of any maintenance required, and any malfunction or defects noted. (10CFR-Part 21)

4.12 Source Exchange Procedures:

- A. Authorized Personnel - Only radiographers may perform source exchanges.
- B. Outline of Procedures - The following is a generalized outline. The manufacturer's attached instructions for each model changer must be followed explicitly during the exchange.
  - 1. Check for proper operation of survey meter and survey the changer in its shipping configuration for any radiation levels in excess of 200 MR/HR at the surface and 10 MR/HR at one meter the surface.
  - 2. Establish and post restricted and radiation areas as described above, assuming a one (1) minute exposure time.
  - 3. Set up the exchange tube and follow the explicit instruction of the manufacturer for the changer being used.
  - 4. After the exchange is completed, survey the camera to determine if radiation levels for Iridium cameras exceed 50 MR/HR at six (6) inches from the surface; or if radiation levels for Cobalt cameras exceed 200 MR/HR on the surface or 10 MR/HR at one meter from the surface. The changer, in its shipping configuration, should not exceed 200 MR/HR on the surface or 10 MR/HR at one meter from the surface.
  - 5. Prepare the changer for shipment by applying the security seal, correct shipping labels, transport index, and shipping papers.

4.13 Emergency Procedures:

AT ANY TIME THE SOURCE CANNOT BE RETURNED TO ITS NORMAL SHIELDED POSITION AS SPECIFIED IN THE OPERATING PROCEDURE



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4.13 Emergency Procedures: (continued)

DURES, CLEAR THE DEFINED RESTRICTED AREA, ESTABLISH  
BARRICADES AT 2 MR/HR, MAINTAIN DIRECT SURVEILLANCE  
AND NOTIFY:

- a. ROBERT KEITH SHUMWAY.....215-262-1100  
(24 HOURS)  
OR
- b. RADIATION SAFETY OFFICER.....215-262-1111  
R.S.O. (NIGHTS, WEEKENDS,  
OR AND HOLIDAYS)
- c. ASST. RADIATION SAFETY OFFICER....215-262-1111  
(NIGHTS, WEEKENDS,  
OR AND HOLIDAYS)
- d. NUCLEAR REGULATORY COMMISSION.....215-338-5000  
U.S.N.R.C. (24 HOURS)



## 4.14

## INSTRUCTION FOR USE OF:

RESTRICTED AREA, RADIATION AREA  
AND HIGH RADIATION AREA TABLES.

1. Tables for Iridium 192 and Cobalt 60 are available. Each set contains a RESTRICTED AREA TABLE, A RADIATION AREA TABLE AND A HIGH RADIATION AREA TABLE.
2. The purpose of the tables are to provide the radiographer with initial distances to establish and/or define boundaries for Restricted, Radiation, and High Radiation Areas.

Since the tables are based on calculated radiation levels for an unshielded source, they provide safe and conservative distances. Attenuation and scatter or radiation by the specimen and other objects in the vicinity will produce radiation levels different from given in the tables, but the actual radiation levels will generally be lower.

3. During the first exposure, the Restricted Area boundary should be checked by performing an actual physical survey and adjusting the boundaries out where required, and in where permissible and only if there is a need to do so.
4. To use the tables, select the desired Restricted Area, Radiation Area, or High Radiation Area Table for the proper isotope being used.
5. Estimate the maximum number of radiography shots to be performed in the next hour and the maximum exposure time for each shot. From this information, determine the maximum exposure time in minutes to be performed in the next hour.

In the second line of the table labeled MIN/HR, select the column with the lowest MIN/HR which is not below the estimated work load (e.g. for an estimated maximum exposure time of 27 minutes in the next hour, select the 30 MIN/HR column). If desired, linear interpolation may be used.

6. From the Decay Chart supplied with the radiography source, determine the activity of the isotope. Then opposite the activity of the isotope in the selected work load column above, read the distance in feet from the source to define the desired boundary (e.g. if the work load is 30 MIN/HR



#### 4.14 (CONTINUED) USE OF RADIATION AREA TABLES:

6. for an 80 curie Iridium 192 source, then the distance from the source to establish the Restricted Area is 344 feet).

If a Collimator is used and the useful beam is directed downward, then the activity may be reduced by the attenuation of the collimator (e.g. if the collimator has three (3) half-value layers for the isotope being used, then the activity can be reduced by  $2^3$  or the 80 curie source would be considered a 10 curie source and the Restricted Area distance for a 30 MIN/HR work load would be 121 feet).

7. The first line labeled MR/HR gives the radiation level at the established boundary for each work load in the line below it (e.g. for a 30 MIN/HR work load using an Iridium 192 source, a survey meter would read 4.0 MR/HR at the boundary to achieve the desired 2.0 MR/HR in any one (1) hour required by the regulations).
8. ALWAYS perform a physical radiation survey with a survey meter to determine if the estimates provided by the tables are adequate.



# RESTRICTED AREA

Number of feet from unshielded Iridium 192 source for 2 MR in any one (1) hour as a function of total exposure time in one (1) hour and activity of Iridium.

Curies	2.0	2.2	2.4	2.7	3.0	3.4	4.0	4.8	6.0	8.0	12.0	24.0	120
RP/hr.	60	55	50	45	40	35	30	25	20	15	10	5	1
Min/hr.	54	52	50	47	44	41	38	35	31	27	22	16	7
1	121	116	111	105	99	93	86	78	70	61	50	35	16
5	172	164	157	149	140	131	121	111	99	86	70	50	22
10	210	201	192	182	172	161	149	146	121	105	86	61	27
15	243	233	222	210	198	184	172	157	140	124	99	70	31
20	272	260	248	235	222	207	192	175	157	136	111	78	35
25	297	285	272	258	243	227	210	195	172	149	121	86	38
30	321	308	294	278	262	245	227	207	186	161	131	93	41
35	344	329	314	297	280	262	243	222	199	172	140	99	44
40	364	349	333	316	297	278	258	235	210	182	149	105	47
45	384	368	351	333	314	293	272	248	222	192	157	111	50
50	408	386	368	349	329	308	285	260	233	201	164	116	53
55	421	403	384	364	344	321	297	272	243	210	172	121	54
60	438	419	400	379	358	334	310	283	253	219	179	126	57
65	454	435	415	394	371	348	321	293	262	227	186	131	59
70	470	450	429	407	384	359	333	304	272	235	192	136	61
75	486	465	443	421	397	371	344	314	280	243	198	140	63
80	501	479	457	434	409	382	354	323	289	250	204	145	65
85	515	493	470	446	421	394	364	333	297	258	210	149	67
90	528	506	483	458	432	404	374	342	306	265	216	153	68
95	543	520	496	470	443	415	384	351	314	272	222	157	70
100	556	533	500	482	454	425	394	359	321	276	227	161	72
105	570	545	520	493	465	435	403	368	329	284	233	164	74
110	583	558	532	504	475	445	412	376	336	291	238	168	75
115	595	570	543	515	486	454	421	384	344	297	243	172	77
120													

"TABLE 4-A"

# RADIATION AREA

Number of feet from unshielded Iridium 192 sources for 5 MR in any one (1) hour as a function of total exposure time in one (1) hour and activity of Iridium.



Curies	5.0	5.5	6.0	6.7	7.5	8.6	10	12	15	20	30	60	300
1	60	55	50	45	40	35	30	25	20	15	10	5	1
5	34	31	28	26	23	20	17	14	11	9	7	4	2
10	77	74	70	67	63	59	54	50	44	39	31	22	10
15	109	104	99	94	89	83	77	70	63	54	44	33	14
20	133	127	121	115	109	102	94	86	77	67	54	39	17
25	154	147	140	133	125	117	109	99	89	77	63	44	20
30	172	164	157	149	140	131	121	111	99	86	70	50	22
35	188	180	172	163	154	144	133	121	109	94	77	54	24
40	203	195	186	176	166	155	144	131	117	102	83	59	26
45	217	208	198	188	177	166	154	140	125	109	89	63	28
50	230	221	210	200	193	176	163	149	133	115	94	67	30
55	243	233	222	210	198	186	172	157	140	121	99	70	31
60	255	244	233	221	208	195	180	164	147	127	104	74	33
65	266	255	243	230	217	203	188	172	154	133	109	77	34
70	277	265	253	240	226	212	196	179	160	138	113	80	36
75	287	275	263	249	234	220	203	186	166	144	117	83	37
80	297	285	272	258	243	227	210	192	172	149	121	86	38
85	307	294	280	266	251	235	217	198	177	154	125	89	40
90	317	303	289	274	259	241	224	204	183	158	129	91	41
95	326	312	297	282	266	249	230	210	188	163	133	94	42
100	335	321	306	290	273	256	237	216	193	167	137	97	43
105	344	329	314	297	280	262	243	222	198	172	140	99	44
110	352	337	321	304	287	269	249	227	203	176	144	102	45
115	360	345	329	312	294	275	255	233	208	180	147	104	47
120	368	353	336	319	301	281	260	238	213	184	150	106	48
125	376	360	344	326	307	287	266	243	217	188	154	109	49

"TABLE 4-B"

# HIGH RADIATION AREA

Number of feet from unshielded Iridium 192 source for 100 MR in any one (1) hour as a function of total exposure time in one (1) hour and activity of Iridium.

MR/hr.	100	100	120	133	150	171	200	240	300	400	600	1200	6000
Mr. hr.	60	55	50	45	40	35	30	25	20	15	10	5	1
1	8	7	7	7	6	6	5	5	4	4	3	2	1
5	17	16	16	15	14	13	12	11	10	9	7	5	2
10	24	23	22	21	20	19	17	16	14	12	10	7	3
15	30	28	27	26	24	23	21	19	17	15	12	9	4
20	34	33	31	30	28	26	24	23	20	17	14	10	4
25	38	37	35	33	31	29	27	25	22	19	16	11	5
30	42	40	38	36	34	32	30	27	24	21	17	12	5
35	45	44	41	39	37	35	32	29	26	23	19	13	6
40	49	47	44	42	40	39	34	31	28	24	20	14	6
45	52	49	47	45	42	39	36	33	30	26	21	15	7
50	54	52	50	47	44	41	38	35	31	27	22	16	7
55	57	55	52	49	47	44	40	37	33	28	23	16	7
60	59	57	54	52	49	45	42	38	34	30	24	17	8
65	62	59	57	54	51	47	44	40	36	31	25	18	8
70	64	62	59	56	52	49	45	41	37	32	26	19	8
75	67	64	61	58	54	51	47	43	38	33	27	19	9
80	69	66	63	59	56	52	49	44	40	34	28	20	9
85	71	68	65	61	57	54	50	46	41	35	29	20	9
90	73	70	67	63	59	56	52	47	42	36	30	21	9
95	75	72	68	65	61	57	53	48	43	37	31	22	10
100	77	74	70	67	63	59	54	50	44	38	31	22	10
105	79	75	72	68	64	60	56	51	45	39	32	23	10
110	81	77	74	70	66	62	57	52	47	40	33	23	10
115	83	78	75	71	67	63	58	53	48	41	34	24	11
120	84	81	77	73	69	64	59	54	49	42	34	24	11

"TABLE 4-C"

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# RESTRICTED AREA

Number of feet from unshielded Cobalt 60 source for 2 MR in any one (1) hour as a function of total exposure time in one (1) hour and activity of Cobalt.



mR/hr.	2.0	2.2	2.4	2.7	3.0	3.4	4.0	4.8	6.0	8.0	12.0	24.0	120
min/hr.	60	55	50	45	40	35	30	25	20	15	10	5	1
1	85	81	77	73	69	65	60	55	49	42	35	24	11
5	190	182	173	164	155	145	134	122	110	95	77	55	24
10	268	267	245	232	219	205	190	173	155	134	110	77	35
15	324	315	300	285	268	251	232	212	190	164	134	95	42
20	379	363	346	329	310	290	268	245	219	190	155	110	49
25	425	406	387	367	346	324	300	274	245	212	173	122	55
30	465	445	424	402	379	355	329	300	268	232	190	134	60
35	502	481	458	435	410	383	355	325	290	251	205	145	65
40	537	514	490	465	438	410	379	346	310	268	219	155	69
45	569	545	520	493	465	435	402	367	329	285	232	164	73
50	600	574	548	520	490	458	424	387	346	300	245	173	77
55	629	602	574	545	514	481	445	406	363	315	257	182	81
60	657	629	600	569	537	502	465	424	379	329	268	190	85
65	684	655	624	592	559	522	484	442	395	342	279	197	88
70	710	680	648	615	580	542	502	458	410	355	290	205	92
75	735	704	671	636	600	561	520	477	424	367	300	212	95
80	759	727	693	669	620	580	537	490	438	379	310	219	98
85	782	749	714	677	639	597	553	505	452	391	319	226	101
90	805	770	735	697	657	615	569	520	465	402	329	232	104
95	827	792	755	716	675	632	585	534	477	414	338	239	107
100	849	812	775	735	693	648	600	548	490	424	346	245	110
105	869	832	794	753	710	664	615	561	502	435	355	251	112
110	890	852	812	771	727	680	629	574	514	445	363	257	115
115	910	871	831	788	743	695	643	587	525	455	373	263	117
120	930	890	849	805	759	710	657	600	537	465	379	268	120

"TABLE 4-D"

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# RADIATION AREA

Number of feet from unshielded Cobalt 60 source for 5 MR in any one (1) hour as a function of total exposure time in one (1) hour and activity of Cobalt.

mA/hr.	5.0	5.5	6.0	6.7	7.5	8.6	10	12	15	20	30	60	300
Min/hr.	60	55	50	45	40	35	30	25	20	15	10	5	1
1	54	51	49	46	44	41	38	35	31	27	22	15	7
5	120	115	110	98	92	85	77	69	60	49	35	35	15
10	170	162	155	147	139	130	120	110	98	85	69	49	22
15	208	199	190	180	170	159	147	134	120	104	85	60	27
20	240	230	219	208	196	183	170	155	139	120	98	69	31
25	268	257	245	232	219	205	193	177	155	135	110	77	35
30	294	281	268	255	240	224	208	190	170	147	120	85	38
35	317	304	290	275	259	242	224	205	183	159	130	92	41
40	339	325	310	294	277	259	240	219	196	170	139	98	44
45	360	345	329	312	294	275	255	232	208	180	147	104	46
50	379	363	346	329	310	290	268	245	219	190	155	110	49
55	398	381	363	345	325	304	281	257	230	199	162	115	51
60	416	398	379	360	339	317	294	269	240	208	170	120	54
65	433	414	395	375	353	330	306	279	250	216	177	125	56
70	449	430	410	389	367	343	317	290	259	224	183	130	58
75	465	445	424	402	379	355	329	300	268	232	190	134	60
80	480	460	438	416	392	366	339	310	277	240	196	139	62
85	495	474	452	428	404	378	350	319	286	247	202	143	64
90	509	487	465	441	416	389	360	329	294	255	208	147	66
95	523	501	477	453	425	399	370	338	302	262	214	151	68
100	537	514	490	465	438	410	379	346	310	268	219	155	69
105	550	526	502	476	449	420	389	355	317	275	224	159	71
110	563	539	514	487	460	430	398	363	325	281	230	162	73
115	575	551	525	498	470	440	407	371	332	288	235	166	74
120	588	563	537	509	480	449	416	379	339	294	240	170	76

"TABLE 4-E"

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# HIGH RADIATION AREA

Number of feet from unshielded Cobalt 60 source for 100 MR in any one (1) hour as a function of total exposure time in one (1) hour and activity of Cobalt.



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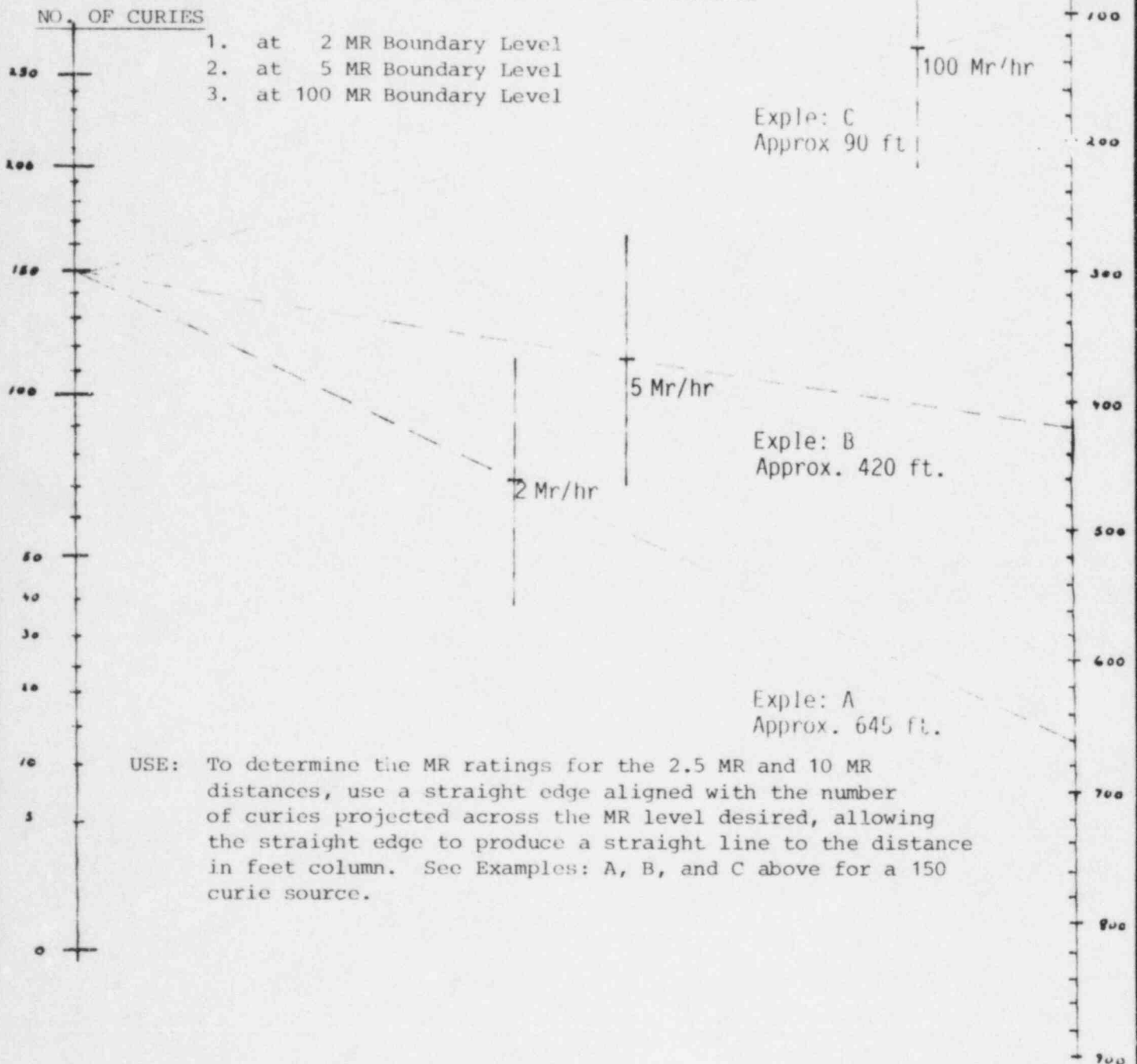
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"TABLE 4-F"

mR/hr.	100	109	120	133	150	171	200	240	300	400	600	1200	6000
Mln/hr.	60	55	50	45	40	35	30	25	20	15	10	5	1
1	12	11	11	10	10	9	8	8	7	6	5	3	2
5	27	26	24	23	22	20	19	17	15	13	11	8	3
10	38	36	35	33	31	29	27	24	22	19	15	11	5
15	46	44	42	40	38	35	33	30	27	23	19	13	6
20	54	51	49	46	44	41	38	35	31	27	22	15	7
25	60	57	55	51	49	46	42	39	35	30	24	17	8
30	66	63	60	57	54	50	46	42	38	33	27	19	8
35	71	68	65	61	58	54	50	46	41	35	29	20	9
40	76	73	69	66	62	58	54	49	44	38	31	22	10
45	80	77	73	70	66	61	57	52	46	40	33	23	10
50	83	81	77	73	69	65	60	55	49	42	35	24	11
55	89	85	81	77	73	68	63	57	51	44	36	26	11
60	93	89	85	80	76	71	66	60	54	46	38	27	12
65	97	93	88	84	79	74	68	62	56	48	39	28	12
70	100	96	92	87	82	77	71	65	58	50	41	29	13
75	104	99	95	90	85	79	73	67	60	52	42	30	13
80	107	103	98	93	88	82	76	69	62	54	44	31	14
85	111	106	101	96	90	84	78	71	64	55	45	32	14
90	114	109	104	99	93	87	80	73	66	57	46	33	15
95	117	112	107	101	95	89	83	75	68	58	48	34	15
100	120	115	110	104	98	92	85	77	69	60	49	35	15
105	123	118	112	106	100	94	87	79	71	61	50	35	16
110	126	120	115	109	103	96	89	82	73	63	51	36	16
115	129	123	117	111	105	98	91	83	74	64	53	37	17
120	131	126	120	114	107	100	93	85	76	66	54	38	17



"TABLE 4-G"

DISTANCE IN FEET FROM AN UNSHIELDED  
IR-192 SOURCE UP TO 250 CURIES

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"TABLE 4-H"Exple: A  
Approx. 150 ft.

100 Mr/hr

2 Mr/hr

5 Mr/hr

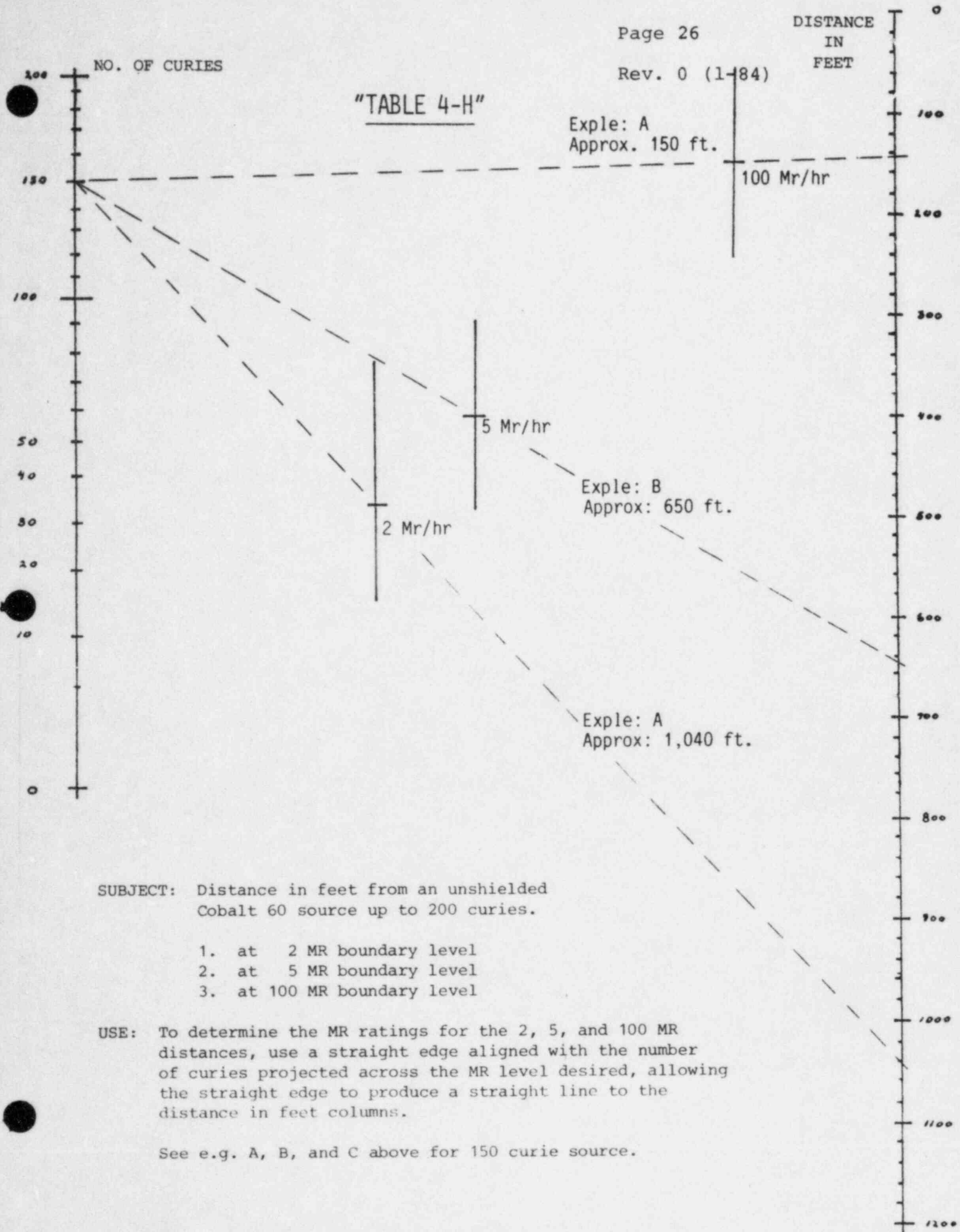
Exple: B  
Approx: 650 ft.Exple: A  
Approx: 1,040 ft.

SUBJECT: Distance in feet from an unshielded  
Cobalt 60 source up to 200 curies.

1. at 2 MR boundary level
2. at 5 MR boundary level
3. at 100 MR boundary level

USE: To determine the MR ratings for the 2, 5, and 100 MR distances, use a straight edge aligned with the number of curies projected across the MR level desired, allowing the straight edge to produce a straight line to the distance in feet columns.

See e.g. A, B, and C above for 150 curie source.



"TABLE 4-I"UNRESTRICTED, RADIATION AND HIGH RADIATION AREAS250 KV5 MAX-RAY UNITNUMBER OF FEET TO SPECIFIED BOUNDARY AS A FUNCTION  
OF TOTAL EXPOSURE TIME IN ONE HOUR.

WORK LOAD MINUTES/HOUR	UNRESTRICTED		RADIATION-HIGH		RADIATION	
	DIRECT	SCATTER	DIRECT	SCATTER	DIRECT	SCATTER
1	224	8	141	5	32	1
5	500	16	316	10	71	3
10	707	23	447	15	100	4
15	866	28	548	18	122	4
20	1,000	32	632	20	141	5
25	1,118	36	707	23	158	5
30	1,224	39	775	25	173	6
35	1,323	42	837	27	187	6
40	1,414	45	894	29	200	7
45	1,500	48	949	30	212	7
50	1,581	50	1,000	32	224	8
55	1,658	53	1,049	34	235	8
60	1,732	55	1,095	35	245	8

NOTE: FOR EVERY 0.25 INCH OF STEEL IN THE DIRECT BEAM THE DISTANCE TO THE SPECIFIED BOUNDARY IN THE DIRECT BEAM MAY BE CALCULATED BY REDUCING THE WORK LOAD BY ONE-HALF.

"TABLE 4-J"





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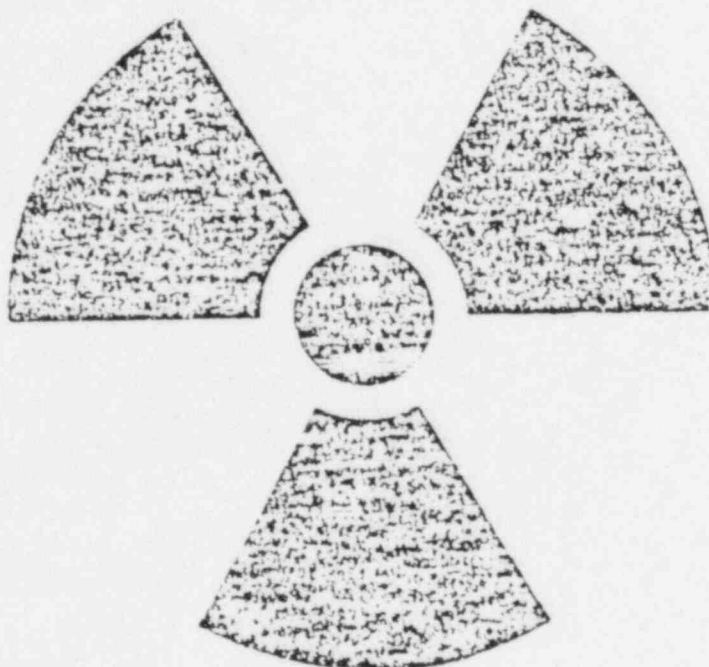
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"EXAMPLE 4-1"

USE THIS SIGN IN ANY AREA WHICH HAS A RADIATION LEVEL OF 2 MR  
IN ANY ONE HOUR.

**CAUTION**

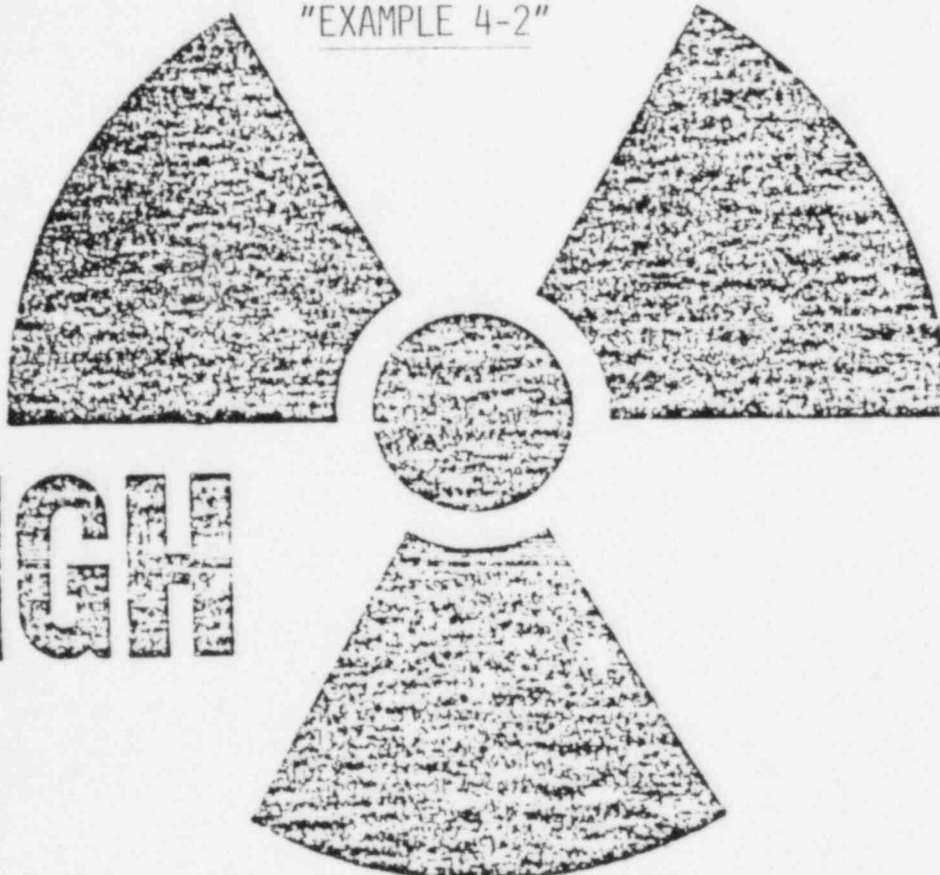


**RADIATION AREA**



# CAUTION

"EXAMPLE 4-2"



# HIGH

USE THIS SIGN IN ANY AREA WHICH HAS A RADIATION LEVEL OF 100 MR IN ANY 1 HF.

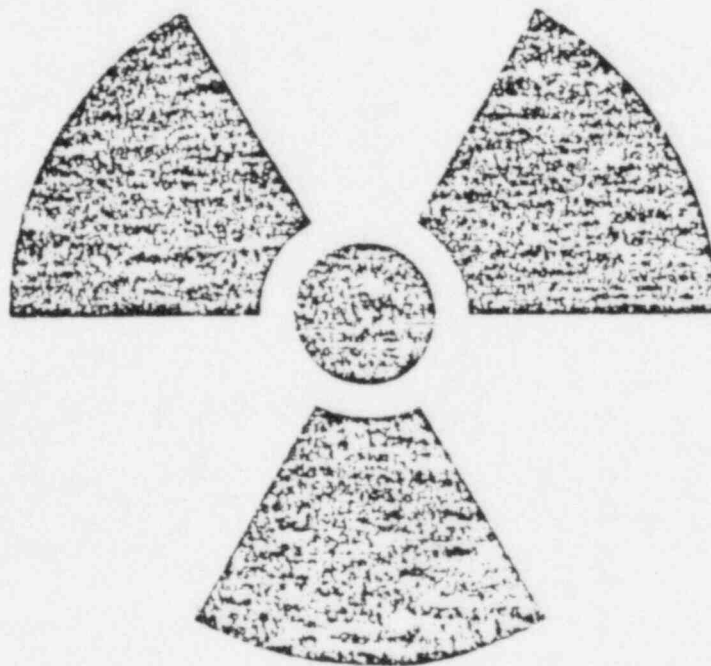
# RADIATION AREA



"EXAMPLE 4-3"

FOR STORAGE AREAS - STANDARD RADIATION CAUTION SIGN

**CAUTION**



**RADIOACTIVE  
MATERIALS**



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# DOSIMETER RADIATION RECORD

FOR OFFICE USE ONLY:

Total All MR \_\_\_\_\_

Period: From \_\_\_\_\_ To \_\_\_\_\_

NAME \_\_\_\_\_ SOCIAL SECURITY NO. \_\_\_\_\_ TOTAL MR X-RAY \_\_\_\_\_

MONTH \_\_\_\_\_ YEAR \_\_\_\_\_ JOB LOCATION \_\_\_\_\_ TOTAL MR GAMMA \_\_\_\_\_

Reading must be taken and recorded at the end of each work day. Reading should be recorded to the "high" (5) side of the scale indicator. Readings 1 through 4 MR will be recorded as 5 MR.

DOSIMETERS MUST BE RECHARGED AT THE BEGINNING OF EACH DAY/SHIFT PRIOR TO WORK.

Place N/A or draw a line in blanks when work was not performed  
& you were not around a source or radiation.

DATE	NAME (SIGNATURE)	DOSIMETER S/N	AMOUNT OF RADIATION RECEIVED		FILM BADGE NO.	VERIFIED
			X-RAY	GAMMA-RAY		
20			MR	MR		
21			MR	MR		
22			MR	MR		
23			MR	MR		
24			MR	MR		
25			MR	MR		
26			MR	MR		
27			MR	MR		
28			MR	MR		
29			MR	MR		
30			MR	MR		
31			MR	MR		
1			MR	MR		
2			MR	MR		
3			MR	MR		
4			MR	MR		
5			MR	MR		
6			MR	MR		
7			MR	MR		
8			MR	MR		
9			MR	MR		
10			MR	MR		
11			MR	MR		
12			MR	MR		
13			MR	MR		
14			MR	MR		
15			MR	MR		
16			MR	MR		
17			MR	MR		
18			MR	MR		
19			MR	MR		



## CHECK-OUT RECORD

FORM RS-4-2

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This Check-Out Utilization Log will be maintained for sealed sources and their exposure devices, X-ray machines and survey meter calibration devices removed from the permanent storage facility at N.A.I.I., Laurys Station, Pa. This Log will remain at the storage vault and the following information must be maintained.

[illegible]

This Utilization Log must be kept up-to-date and available for review by the Company R.S.O. at all times.





## DAILY EQUIPMENT INSPECTION CHECKLIST

(✓) denotes acceptability. "Area Checked"

### I. EXPOSURE DEVICE

- ( ) 1. Any abnormal surface readings.
- ( ) 2. Safety plug condition O.K.
- ( ) 3. Lock operating O.K.
- ( ) 4. Pigtail connector O.K.
- ( ) 5. Alignment of "S" tube with exit port O.K.
- ( ) 6. Strap/Handle O.K.
- ( ) 7. Camera labeled O.K.
- ( ) 8. Manufacturer checks O.K.

### II. SOURCE TUBE

- ( ) 1. Tube free of rust, dirt, and loose fittings.
- ( ) 2. Source tube threads/connectors O.K.
- ( ) 3. Source tube tip O.K.
- ( ) 4. Source tube free of kinks, damage or excess wear.
- ( ) 5. Interior clean and no flat spots.
- ( ) 6. Manufacturer checks O.K.

### III. CONTROL CABLES AND DRIVE MECHANISM

- ( ) 1. Unit operating O.K.
- ( ) 2. Connectors on drive cable O.K.
- ( ) 3. Drive cable hook-up free of wear/rust and is flexible.
- ( ) 4. Drive cable conduit O.K.
- ( ) 5. Cable moves free.
- ( ) 6. Hook-up O.K.
- ( ) 7. Manufacturer checks O.K.

### IV. X-RAY EQUIPMENT

- ( ) 1. Unit appears to be operating normal.
- ( ) 2. Electrical cables/connectors free of wear.
- ( ) 3. Control panel contains "warning label".
- ( ) 4. Control panel locks O.K.
- ( ) 5. Manufacturer checks O.K.

### V. VEHICLE STORAGE CONTAINER

- ( ) 1. Lock.
- ( ) 2. Labeling.
- ( ) 3. Bolting to floor.
- ( ) 4. Inside bracing.

NOTE: NOTIFY RADIATION SAFETY OFFICER (RSO) IF AN ITEM IS "NOT"  
SATISFACTORY PRIOR TO USING EQUIPMENT.



# "DAILY RADIATION SURVEY REPORT"

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Form RS-4-4 (Rev.0)  
(1-84)

RADIOGRAPHER \_\_\_\_\_ JOB LOCATION \_\_\_\_\_

DATE \_\_\_\_\_ TIME \_\_\_\_\_ PROJECT \_\_\_\_\_

1. SOURCE OF RADIATION: IR-192 \_\_\_\_\_ S/N \_\_\_\_\_, CO-60 \_\_\_\_\_ S/N \_\_\_\_\_, X-RAY \_\_\_\_\_ S/N \_\_\_\_\_
2. CURIES: \_\_\_\_\_ X-RAY KV-MA MAXIMUM: \_\_\_\_\_
3. SURVEY METER NO. \_\_\_\_\_ CALIBRATION DUE DATE \_\_\_\_\_
4. CAMERA MODEL NO. \_\_\_\_\_ MANUFACTURER \_\_\_\_\_ S/N \_\_\_\_\_
5. DAILY EQUIPMENT CHECK PERFORMED? (Form No. RS-4-3) EQUIPMENT ACCEPTABLE? YES \_\_\_\_\_ NO \_\_\_\_\_
6. RADIOGRAPHER DOSIMETER S/N \_\_\_\_\_ DATE CALIBRATION DUE \_\_\_\_\_
7. ASST. RADIOGRAPHER DOSIMETER S/N \_\_\_\_\_ DATE CALIBRATION DUE \_\_\_\_\_
8. RADIOGRAPHER FILM BADGE S/N \_\_\_\_\_ ASST. RADIOGRAPHER FILM BADGE NO. \_\_\_\_\_
9. SOURCE DECAY CURVE IN LOB BOOK? YES \_\_\_\_\_ NO \_\_\_\_\_  
SOURCE TRANSPORTATION DOCUMENTS IN LOG BOOK? YES \_\_\_\_\_ NO \_\_\_\_\_
10. RADIOGRAPHY MANUAL S/N \_\_\_\_\_, 3 OR MORE RADIATION SIGNS IN LAB/SITE? YES \_\_\_\_\_ NO \_\_\_\_\_
11. DOSIMETER RECORD RECEIVED: RADIOGRAPHER: (START 0 MR FINISH \_\_\_\_\_ MR)  
ASSISTANT RADIOGRAPHER: (START 0 MR FINISH \_\_\_\_\_ MR)

12. TOTAL EXPOSURE TIME FOR SHIFT/DAY: \_\_\_\_\_ HOURS, \_\_\_\_\_ MINUTES
13. PERSONNEL NOTIFIED OF RADIATION AREAS, WHERE APPLICABLE? YES \_\_\_\_\_ NO \_\_\_\_\_
14. CONSTANT SURVEILLANCE? YES \_\_\_\_\_ NO \_\_\_\_\_ DID YOU USE ROPES? YES \_\_\_\_\_ NO \_\_\_\_\_  
DID YOU USE SIGNS? YES \_\_\_\_\_ NO \_\_\_\_\_ WAS A COLLIMATOR USED? YES \_\_\_\_\_ NO \_\_\_\_\_
15. RECORD OF PHYSICAL SURVEY MADE TO DETERMINE SOURCE IS IN SHIELDED POSITION PRIOR TO SECURING EXPOSURE DEVICE \_\_\_\_\_

- a. IRIDIUM 192 \_\_\_\_\_ MR/HR AT 6 INCHES FROM SURFACE. ON CONTACT \_\_\_\_\_ MR/HR
- b. COBALT 60 \_\_\_\_\_ MR/HR AT SURFACE OF EXPOSURE DEVICE.

## 16. VEHICLE STORAGE SURVEY:

- 1a. LEAVE: \_\_\_\_\_ MR/HR AT DRIVER, \_\_\_\_\_ MR/HR AT OUTSIDE SURFACE, \_\_\_\_\_ MR/HR AT 1 FT. FROM SURFACE
- 1b. RETURN: \_\_\_\_\_ MR/HR AT DRIVER, \_\_\_\_\_ MR/HR AT OUTSIDE SURFACE, \_\_\_\_\_ MR/HR AT 1 FT. FROM SURFACE

EXPOSURE AREA A, B, OR C AS MAY BE APPLICABLE, WHERE MORE THAN ONE (1) EXPOSURE CONDITION EXISTS PER WORK SHIFT, RECORD IN EXPOSURE AREA A, B, OR C:

RESULT OF PHYSICAL SURVEY

BARRICADE EQUIPMENT

☐ SIGNS ☐ ROPE

☐ CONSTANT SURVEILLANCE

☐ \_\_\_\_\_

RESULT OF PHYSICAL SURVEY

BARRICADE EQUIPMENT

☐ SIGNS ☐ ROPE

☐ CONSTANT SURVEILLANCE

☐ \_\_\_\_\_

RESULT OF PHYSICAL SURVEY

BARRICADE EQUIPMENT

☐ SIGNS ☐ ROPE

☐ CONSTANT SURVEILLANCE

☐ \_\_\_\_\_

SIGNATURE OF RADIOGRAPHER \_\_\_\_\_

NAME OF ASST. RADIOGRAPHER (if applicable) \_\_\_\_\_



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FORM RS-4-5

Rev. 0 (1-84)

"NOTICE"

IN CASE OF ACCIDENT, WHEREIN THIS VEHICLE IS  
INVOLVED, EMERGENCY NOTIFICATION IS REQUIRED.

PLEASE CALL COLLECT:

NORTH AMERICAN INSPECTION, INC.

"DAY"

215-262-1100 - - - - - ALLENTOWN, PENNSYLVANIA

216-877-6231 - - - - - HARTVILLE, OHIO

412-324-5601 - - - - - WAYNESBURG, PENNSYLVANIA

"NIGHT AND HOLIDAYS"

215-262-1111 - - - - - ALLENTOWN, PENNSYLVANIA

412-324-5601 - - - - - WAYNESBURG, PENNSYLVANIA



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FORM RS-4-6

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## "UTILIZATION LOG"

1. NAME \_\_\_\_\_ S.S. NO. \_\_\_\_\_ DATE \_\_\_\_\_
2. TYPE SOURCE \_\_\_\_\_ CAMERA MODEL & S/N \_\_\_\_\_  
SOURCE S/N & CURIES \_\_\_\_\_
3. JOB SITES EXPOSURE LOCATION (CITY AND AREA) \_\_\_\_\_  
\_\_\_\_\_
4. MAXIMUM RADIATION LEVEL AT PERIMETER OF RESTRICTED AREA \_\_\_\_\_ MR/HR
5. RADIATION LEVEL AT 6 INCHES FROM SURFACE OF DEVICE \_\_\_\_\_ MR/HR  
(When securing prior to vehicle storage)
6. RADIATION LEVEL ON SURFACE OF VEHICLE STORAGE CONTAINER \_\_\_\_\_ MR/HR
7. RESULTS OF DAILY INSPECTION \_\_\_\_\_  
\_\_\_\_\_
8. SURVEY METER NO. \_\_\_\_\_ CALIBRATION DUE DATE \_\_\_\_\_
9. LEAK TEST DUE DATE \_\_\_\_\_ QUARTERLY INVENTORY DUE DATE \_\_\_\_\_
10. QUARTERLY INSPECTION DUE DATE \_\_\_\_\_ TOTAL EXPOSURE TIME \_\_\_\_\_
11. TOTAL NUMBER OF EXPOSURFS \_\_\_\_\_ FILM BADGE NUMBER \_\_\_\_\_
12. RADIATION REPORT COMPLETED (YES OR NO) \_\_\_\_\_ CAPS ON SOURCE TUBE \_\_\_\_\_
13. SUPPLEMENTAL LOG COMPLETED (YES OR NO) \_\_\_\_\_ VEHICLE SURVEYED \_\_\_\_\_
14. DOSIMETER REPORT COMPLETED (YES OR NO) \_\_\_\_\_
15. DOSIMETER SERIAL NUMBERS \_\_\_\_\_
16. FINAL STORAGE RESULTS (MR/HR) \_\_\_\_\_
17. COMMENTS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

RADIOGRAPHERS SIGNATURE

PROCEDURE  
IDENTIFICATION

## RADIOACTIVE MATERIAL TRANSPORTATION/SHIPMENT(S)

## 1.0 SCOPE:

"5.0"

- 1.1 This procedure describes the packaging and labeling requirements for transportation of radioactive material via NORTH AMERICAN INSPECTION, INC.'S vehicle and common carrier and is supported by NORTH AMERICAN INSPECTION, INC.'S Quality Assurance Program for Radioactive Material Packages - approval #0514. (See appendix RS-5-1.)
- 1.2 This procedure conforms to the requirements of U.S.N.R.C. Title 10-CFR Part 71, The Department of Transportation, Title 49 - Parts 171 through 177.
- 1.3 This procedure shall be used in conjunction with Part 4 - captioned Operating Procedures of this manual.

## 2.0 PACKAGING:

- 2.1 Projectors and Source Changers shall be packaged as described below:

PACKAGING REQUIREMENTS

EXPOSURE DEVICE OR SOURCE CHANGER	MAXIMUM ACTIVITY AND SOURCE TYPE	MINIMUM TYPE OF OVER- PACK OR CONTAINER
T/O 741 PROJECTOR	30 CURIES CO-60	NONE REQUIRED
G/I 50 PROJECTOR	50 CURIES CO-60	NONE REQUIRED
G/I 100 PROJECTOR	100 CURIES CO-60	NONE REQUIRED
T/O 680 PROJECTOR	100 CURIES CO-60	NONE REQUIRED
G/I 200 PROJECTOR	200 CURIES CO-60	NONE REQUIRED
T/O 676 PROJECTOR	250 CURIES CO-60	NONE REQUIRED
G/I TATTLETALE	125 MCI CS-137	A-7 METAL SHIP. CONT./6717 S.B.*
G/I MASTER MINDER 1 & 2	225 MCI CS-137	A-7 METAL SHIP. CONT./6717 S.B.*
G/I CENTURY S & SA	100 CURIES IR-192	6717 SHIPPING BARREL
T/O 660 PROJECTOR	100 CURIES IR-192	METAL STORAGE BOX/WOODEN OVERPACK
A/I 520 PROJECTOR	100 CURIES IR-192	METAL STORAGE BOX/WOODEN OVERPACK
G/I PIPELINER 1 PROJECTOR	100 CURIES IR-192	6717 SHIPPING BARREL
G/I PIPELINER 201 PROJ.	200 CURIES IR-192	6717 SHIPPING BARREL
T/O 616 PROJECTOR	200 CURIES IR-192	715 SHIPPING BARREL

\*S.B. = SHIPPING BARREL

PROCEDURE NO.

RSC-5

ISSUE DATE

1-84

REV. DATE

-0-

PROCEDURE TYPE

Radiation Safety

TEST METHOD

Radiography



2.0 PACKAGING: (continued)PACKAGING REQUIREMENTS

EXPOSURE DEVICE OR SOURCE CHANGER	MAXIMUM ACTIVITY AND SOURCE TYPE	MINIMUM TYPE OF OVER- PACK OR CONTAINER
T/O 771 SOURCE CHANGER	250 CURIES CO-60	NONE REQUIRED
G/I C-8 SOURCE CHANGER	200 CURIES CO-60	NONE REQUIRED
G/I C-10 SOURCE CHANGER	200 CURIES IR-192	6717 SHIPPING BARREL
T/O 650 SOURCE CHANGER	100 CURIES IR-192	NONE REQUIRED

2.2 When shipping an exposure device or source changer containing a radioactive source, assure that the source is in the properly stored position with the use of a calibrated survey instrument.

2.3 The exposure device or source changer shall be prepared for shipment as follows:

2.3.1 EXPOSURE DEVICE: Assure that the shipping plug is securely in place and sealed and the device is locked.

2.3.2 SOURCE CHANGER: Assure that the source hold down and cover are properly bolted and sealed.

3.0 MARKING:

3.1 Each package of radioactive material prepared for transport shall contain the following information marked on the exterior surface of the package.

## 3.1.1 PROPER SHIPPING NAME:

<u>Source Changer or Package Containing Exposure Device</u>	<u>Proper Shipping Name</u>
a. Containing Source	Radioactive Material Special Form N.O.S.
b. Empty (except lead shielded devices)	Radioactive Material L.S.A., N.O.S.

3.1.2 The name and address of NORTH AMERICAN INSPECTION, INC.

3.1.3 The U.S.N.R.C. Compliance Number or Type of Package.  
(See form RS-5-2)



## 4.0 LABELING:

4.1 Survey the package to determine the proper shipping label as described in the following:

<u>REQUIRED LABEL</u>	<u>RADIATION LEVEL AT SURFACE IN MR/HR</u>	<u>RADIATION LEVEL AT 3 FT. IN MR/HR</u>
RADIOACTIVE WHITE I (See Example RS-5-2, Figure "A")	0 - 0.5 MAX.	N/A
*RADIOACTIVE YELLOW II (See Example RS-5-2, Figure "B")	0.5 - 50.0 MAX. (and) 0.1 - 1.0 MAX.	
*RADIOACTIVE YELLOW III (See Example RS-5-2, Figure "C")	50.0 - 100.0 MAX. (and/or)	1.1 - 10.0 MAX.

\*NOTE: The transport index is the highest radiation level in millirem per hour at three (3) feet from any accessible external surface of the package. This number shall be expressed in the next highest tenth and written in the transport index box on RADIOACTIVE YELLOW II AND III LABELS. e.g. 1.01 millirem = 1.1 millirem. Enter 1.1 in the transport index, or 0.0 millirem = 0.1 millirem. Enter 0.1 in transport index.

4.2 Complete two (2) appropriate labels indicating the contents, Iridium 192 or Cobalt 60 and the number of curies. For RADIOACTIVE II AND III LABELS, record the transport index in the box. (See note above.) The label shall be attached to opposite sides of the package - one being placed near the shipping label.

4.3 Empty exposure devices or source changers "DO NOT" require labeling if the following conditions exist:

- 4.3.1 THE RADIATION LEVEL AT THE SURFACE IS LESS THAN .5 MR/HR.
- 4.3.2 THERE IS NO MEASURABLE RADIATION LEVEL AT THREE (3) FEET FROM THE SURFACE.
- 4.3.3 IF THE ABOVE CONDITIONS EXIST, THE PACKAGE SHALL BE MARKED WITH THE FOLLOWING STATEMENT:

EXEMPT FROM THE SPECIFICATION, PACKAGING, MARKING,  
LABELING AND EXEMPT FROM THE PROVISIONS OF 49-CFR -  
173.393 PER 49-CFR 173.391.



5.0 SHIPPING PAPERS:

5.1 Shipments via commercial carrier:

5.1.1 A separate bill of lading or air bill shall be completed for "each package" of radioactive material.

5.1.2 The proper shipping name as described below shall be entered on the bill of lading or air bill:

PACKAGE CONTAINING EXPOSURE  
DEVICE OR SOURCE CHANGER

PROPER SHIPPING  
NAME

a. Containing A Source

RADIOACTIVE MATERIAL  
Special Form N.O.S.

b. Empty Device

RADIOACTIVE MATERIAL  
L.S.A., N.O.S.

5.1.3 When shipping a package of Radioactive Material that requires a RADIOACTIVE YELLOW II LABEL by Motor Freight, the bill of lading shall also contain the statement, "RADIOACTIVE PLACARDS SUPPLIED".

5.1.4 The bill of lading or air bill shall contain two (2) copies of the shipping and certification documents described in paragraph 6.

6.0 SHIPPING/CERTIFICATION DOCUMENT:

6.1 As a minimum, three (3) copies of the Shipper/Certification Document shown in Form RS-5-1 shall be completed for each package of Radioactive Material. Distribution of the Shipper/Certification Document shall be as follows:

1. Two (2) copies shall be attached to the bill of lading or air bill.
2. One (1) copy forwarded to the Radiation Safety Officer.

7.0 TRANSPORTING RADIOISOTOPES VIA NORTH AMERICAN INSPECTION, INC.'S  
AUTHORIZED VEHICLE:

7.1 The requirements of paragraphs 1, 2, 3, and 4 shall apply with additional requirements as follows:

7.1.1 A calibrated, operable Survey Meter shall be located in the vehicle near the driver.



7.0 TRANSPORTING RADIOISOTOPES VIA NORTH AMERICAN INSPECTION, INC'S  
AUTHORIZED VEHICLE: (continued)

- 7.1.2 A radiation survey shall be conducted to insure that the radiation level at the external surface of the vehicle and at the driver is 2 MR/HR or less.
- 7.1.3 Each vehicle, while transporting a radioisotope requiring a RADIOACTIVE YELLOW III LABEL, (see Example RS-5-2 - figure "C") shall display on the front, rear, and both sides of the vehicle, placards consisting of a diamond shaped sign containing the word "RADIOACTIVE".
  - 7.1.3.1 These PLACARDS shall be removed or covered when the vehicle does not contain the article for which such marking is required. (D.O.T. - 49 Part 177.823, D)
- 7.1.4 Each vehicle requiring placarding as specified in paragraph 7.1.3 above shall have posted in a conspicuous place as shown in Example RS-5-3 notifying authorities who to call in the event of an accident.
- 7.1.5 D.O.T. Shipping Certificate (see form RS-5-2) shall be completed for each movement via NORTH AMERICAN INSPECTION, INC. vehicle.

8.0 SHIPMENT BY CARGO AIRCRAFT:

- 8.1 In addition to the requirements of paragraphs 1 through 6, the following requirements shall also apply for shipment of Radioactive Material via Cargo Aircraft.
  - 8.1.1 The package shall have a "CARGO AIRCRAFT ONLY" label as shown in Example RS-5-4 affixed to the exterior surface.

9.0 SHIPMENT BY MOTOR FREIGHT:

- 9.1 In addition to the requirements of paragraphs 1 through 6, when shipping via Motor Freight, four (4) PLACARDS bearing the work "RADIOACTIVE" shall be supplied to the driver.



# SHIPPER'S CERTIFICATION FOR RADIOACTIVE MATERIALS

Page 6

Two completed and signed copies of this certification shall be handed to the carrier.

(Use block letters)

"EXAMPLE" RS-5-1

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**WARNING:** Failure to comply in all respects with the applicable regulations of the Department of Transportation, 49-CFR, CAB 82 and, for international shipments, the IATA Restricted Articles Regulations may be a breach of the applicable law, subject to legal penalties. This certification shall in no circumstance be signed by a consolidator, a forwarder, or an IATA Cargo Agent.

This shipment is within the limitations prescribed for: (mark one)

☐ passenger aircraft And contains radioactive material intended for use in, or incident to, research, or medical diagnosis or treatment

☒ cargo-only aircraft

NATURE AND QUANTITY OF CONTENT					PACKAGE			
PROPER SHIPPING NAME	RADIOISOTOPE	GROUP	FORM	ACTIVITY		CATEGORY	TRANSPORT INDEX	TYPE
FOR U.S. SHIPMENTS, SEE SECTION 2, CAB 82, TARIFF 6-D	NAME OR SYMBOL OF PRINCIPAL RADIOACTIVE CONTENT	GROUP NUMBER OF GROUPS I TO VII	CHEMICAL FORM AND PHYSICAL STATE (GAS/LIQUID/SOLID), or SPECIAL FORM, or SPECIAL ENCAPSULATION	NUMBER OF CURIES, or MILLI-CURIES	Number of Packages	I—WHITE or II—YELLOW or III—YELLOW LABEL	FOR YELLOW LABEL CATEGORIES ONLY	INDUSTRIAL or TYPE A, or TYPE B
RADIOACTIVE MATERIAL SPECIAL FORM N.O.S.	Ir-192	N/A	SPECIAL FORM	101Ci.	1	YELLOW-III	1.1	"B"
UN 2974								
CARGO AIRCRAFT ONLY								

## ADDITIONAL INFORMATION REQUIRED FOR FISSILE MATERIALS ONLY

EXEMPTED FROM THE ADDITIONAL REQUIREMENTS FOR FISSILE MATERIALS SPECIFIED IN 7.1. OF PART 2 OF THE IATA RESTRICTED ARTICLES REGULATIONS ☐  
 NAMES, PLUS QUANTITY IN GRAMS, OR CONCENTRATION OR ENRICHMENT IN U235:

NOT EXEMPTED: FISSILE CLASS I ☐ FISSILE CLASS II ☐ FISSILE CLASS III ☐

Additional certificates obtained by the Shipper when necessary:

Special Form Encapsulation Certificate(s) ☐  
 Type "B" Packaging Certificate(s) ☐  
 Certificate(s) for Fissile Material ☐

NOT REQUIRED FOR DOMESTIC SHIPMENT

Certificate(s) for Large Radioactive Source ☐  
 Government Approvals/Permits ☐

USA/6717/B(U) TYPE B PACKAGE

Special Handling Information

I hereby certify that the contents of this consignment are fully and accurately described above by Proper Shipping Name and are classified, packed, marked, labelled and in proper condition for carriage by air according to applicable national governmental regulations, and for International Shipments, the current IATA Restricted Articles Regulations.

Name and full address of Shipper GAMMA INDUSTRIES	Name and title of person signing Certification JAMES DAVID DUPRE	
2255 TED DUNAUM AVENUE	SHIPPING AGENT	
BATON ROUGE, LA. 70802		
Date 8.26.83	Signature of the Shipper (see WARNING above) <i>James David Dupre</i>	
Air Waybill No. 485 124 065	Airport of Departure BTR	Airport of Destination





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"EXAMPLE" RS-5-2

Figure "A"



MORE THAN 0.5 MREM/HR ON CONTACT AND IS NOT A "LARGE QUANTITY"



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"EXAMPLE" RS-5-2

Figure "B"



VEHICLE PLACARD NOT REQUIRED: FOR USE ON SOURCE CHANGER IF:  
MORE THAN .05 BUT NOT MORE THAN 50 MREM/HR AT CONTACT  
AND NOT EXCEEDING I.I. OF 1.



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"EXAMPLE" RS-5-2

Figure "C"



VEHICLE PLACARD REQUIRED: FOR USE ON SOURCE CHANGER IF:  
MORE THAN 50 MREM/HR AT CONTACT T.I. IS MORE THAN 1



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Example RS-5-3

"NOTICE"

IN CASE OF ACCIDENT, WHEREIN THIS VEHICLE IS  
INVOLVED, EMERGENCY NOTIFICATION IS REQUIRED.

PLEASE CALL COLLECT:

NORTH AMERICAN INSPECTION, INC.

"DAY"

215-262-1100 - - - - - ALLENTOWN, PENNSYLVANIA

216-877-6231 - - - - - HARTVILLE, OHIO

412-324-5601 - - - - - WAYNESBURG, PENNSYLVANIA

"NIGHT AND HOLIDAYS"

215-262-1111 - - - - - ALLENTOWN, PENNSYLVANIA

412-324-5601 - - - - - WAYNESBURG, PENNSYLVANIA



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EXAMPLE RS-5-4



AFFIXED ADJACENT TO RAM LABELS ON ALL "CARGO ONLY AIR SHIPMENTS"





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FORM RS-5-1

"SHIPPING/CERTIFICATION DOCUMENT FOR RADIOACTIVE MATERIAL"

SHIPPED TO: \_\_\_\_\_

CARRIER: \_\_\_\_\_

WEIGHT: \_\_\_\_\_

PROPER SHIPPING NAME



RADIOACTIVE MATERIAL  
SPECIAL FORM N.O.S.



RADIOACTIVE MATERIAL  
L.S.A., N.O.S.

42974 "EXPOSURE DEVICE AND MATERIAL IDENTIFICATION" 4/29/11

EXPOSURE DEVICE	SERIAL NO.	SOURCE NO.	NRC CERT. OF COMP.	TYPE OF PACKAGE
G/I TATTLETALE			USA-6717-B(U)	DOT 7-A Type A Overpack
G/I PIPELINER 1			USA-6717-B(U)	TYPE B Overpack
G/I PIPELINER 201			USA-6717-B(U)	TYPE B Overpack
G/I CENTURY S, SA(old)			USA-6717-B(U)	TYPE B Overpack
G/I 35 S, SA (old)			USA-6717-B	DOT 7-A Overpack
CENTURY S, SA (new)			USA-9135-B(U)	TYPE B
CENTURY UNIV. S, SA(new)			USA-9135-B(U)	TYPE B
GAMMATRON 50			USA-9126-B(U)	TYPE B
GAMMATRON 100			USA-9127-B(U)	TYPE B
GAMMATRON 200			USA-9127-B(U)	TYPE B
STERMINDER 1&2			USA-6717-B(U)	TYPE B (Overpack)
T/O 616			USA-9039-B(U)	TYPE B (Overpack)
T/O 660			USA-9033-B(U)	TYPE B
T/O 676			USA-9027-B(U)	TYPE B
T/O 741			USA-9027-B(U)	TYPE B
T/O 680			USA-9035-B(U)	TYPE B
SOURCE CHANGERS	SERIAL NO.	SOURCE NO.	NRC CERT. OF COMP.	TYPE OF PACKAGE
T/O 650			USA-9032-B(U)	TYPE B
T/O 771			USA-9107	TYPE B
G/I C-8			USA-9128-B(U)	TYPE B
G/I C-10			USA-6717-B	TYPE B Overpack

NATURE AND QUANTITY OF CONTENTS

LABELING

RADIONUCLIDE	FORM	ACTIVITY IN CURIES
IRIDIUM 192	SPECIAL FORM	
COBALT 60	SPECIAL FORM	
CESIUM 137	SPECIAL FORM	
DEPLETED U238	NORMAL FORM	
LB. AT .15 MCI/LB		

SHIPPING LABEL	TRANSPORT INDEX
RADIOACTIVE WHITE I	
RADIOACTIVE YELLOW II	
RADIOACTIVE YELLOW III	

SHIPPERS CERTIFICATION

This is to certify that the above named materials are properly classified, described, packaged, labeled, and labeled; and are in proper condition for transportation according to the applicable regulations of the DEPARTMENT OF TRANSPORTATION (D.O.T.)

TRANSPORTATION BY AIR

This shipment is within the limitations prescribed for cargo - only aircraft.(EX. RS-5-1)



NORTH AMERICAN INSPECTION, INC.  
P. O. BOX 88  
LAURYS STATION, PA. 18058

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Rev. 0 (1-84)

FORM RS-5-2

DEPARTMENT OF TRANSPORTATION (D.O.T.) SHIPPING CERTIFICATE

1. N.R.C. PACKAGE APPROVAL NO. \_\_\_\_\_ (N.A.I.I. Form RS-5-1)
2. TRUCK/VEHICLE NO. \_\_\_\_\_ DRIVER \_\_\_\_\_
3. a. RADIATION SURVEY READING @ SURFACE OF TRANSPORT CONTAINER \_\_\_\_\_ MR  
b. TRANSPORT INDEX (0.1 to 10.0) \_\_\_\_\_ MR  
c. LABEL: CLASS I \_\_\_\_\_ CLASS II \_\_\_\_\_ CLASS III \_\_\_\_\_
4. ( ) MOBILE LAB ( ) PRIVATE VEHICLE ( ) COMPANY CAR
5. MR LEVEL AT DRIVER \_\_\_\_\_ MR; MR LEVEL AT PASSENGER \_\_\_\_\_ MR
6. a. TYPE OF RADIOACTIVE MATERIAL: ( ) IR-192; ( ) CO-60; ( ) OTHER  
b. NO. OF CURIES \_\_\_\_\_ TYPE PROJECTOR/SOURCE CHANGER \_\_\_\_\_

NOTE A: The radioactive material and vehicle covered in this certificate is considered "sole use" for NORTH AMERICAN INSPECTION, INC.

NOTE B: It is the responsibility of the Radiographer to complete this form for each shipment of radioactive material used in "sole use" vehicles for NORTH AMERICAN INSPECTION, INC.

\_\_\_\_\_  
RADIOGRAPHER

\_\_\_\_\_  
DATE

QUALITY ASSURANCE PROGRAM APPROVAL  
FOR RADIOACTIVE MATERIAL PACKAGES

REVISION NUMBER

0

Rev. 0 (1-84) "Page 14"

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and Title 10, Code of Federal Regulations, Chapter 1, Part 71, and in reliance on statements and representations heretofore made in Item 5 by the person named in Item 2, the Quality Assurance Program identified in Item 5 is hereby approved. This approval is issued to satisfy the requirements of Section 71.101 of 10 CFR Part 71. This approval is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

2. NAME North American Inspection Inc.			3. EXPIRATION DATE 2-28-89
STREET ADDRESS P.O. Box 88			4. DOCKET NUMBER 71-0514
CITY Laurys Station	STATE PA	ZIP CODE 18059	
5. QUALITY ASSURANCE PROGRAM APPLICATION DATE(S) January 31, 1984			

## 6. CONDITIONS

Activities authorized by this approval: procurement, maintenance, repair and use to be executed with regard to transportation packages in special form. All other activities (i.e., design, fabrication, assembly, testing, and modification) shall be satisfied by obtaining certifications from package suppliers that these activities were conducted in accordance with an NRC-approved QA program. It shall remain the responsibility of the licensee-user that all transportation activities meet the requirements of 10 CFR §71.101.



FOR THE U.S. NUCLEAR REGULATORY COMMISSION

*Charles E. MacDonald*  
Charles E. MacDonald

FEB 24 1984

CHIEF, TRANSPORTATION CERTIFICATION BRANCH  
DIVISION OF FUEL CYCLE AND MATERIAL SAFETY  
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

DATE

"APPENDIX RS-5-1"10.0 DESCRIPTION OF QUALITY ASSURANCE PROGRAM FOR TYPE "B"  
QUALITY SHIPMENTS OF RADIOACTIVE MATERIAL:10.1 ORGANIZATION:

- a. NORTH AMERICAN INSPECTION, INC. pursuant to 10-CFR 71.12 and 10-CFR 71.51 (a) is responsible for a Quality Assurance Program for Type "B" quality shipments and transportation of radioactive material. Fabrication and design of Type "B" packages are not included.
- b. The organizational structure in Section 7.0 is applicable.
  1. The Radiation Safety Officer (RSO), is responsible for administration of the program, training of personnel, procurement of manufacturer's certifications, maintaining packaging and shipping documents, retention of records and program audits.
  2. Radiographers are responsible for handling, storage, shipping and transporting radioactive packages in accordance with the procedures in Section 4.0; and they are responsible for inspecting, surveying and maintenance reports in accordance with the procedures in Section 4.0.

10.2 QUALITY ASSURANCE PROGRAM:

- a. Radiographers are trained in their responsibilities above according to Section 5.0.
- b. The Quality Assurance Program will be viable, requiring management approval, and the program encompasses specific requirements stated in the package approval for use, and general radiation safety and shipping requirements.
- c. Manufacturer's certifications will be requested and maintained on all N.R.C. Type "B" packages manufactured and procured after January 1, 1979.

10.3 DOCUMENT CONTROL:

- a. Packaging, shipping, inspection and handling instru-

"APPENDIX RS-5-1"10.3 DOCUMENT CONTROL: (continued)

ctions from the manufacturers shall be maintained for each model Type "B" package.

- b. The Radiation Safety Officer (RSO) shall insure that the shipment and transportation of Type "B" packages is conducted in accordance with the above documents.

10.4 HANDLING, SHIPPING, TRANSPORTATION AND STORAGE:

- a. Radiography personnel will handle, ship, transport and store radioactive packages in accordance with the procedures in Section 4.0.
- b. Radiography personnel will determine the completeness of package inspections and presence of manufacturer's certificates before shipment.

10.5 INSPECTION, SURVEYS AND MAINTENANCE REPORTS:

- a. Inspection, surveys and maintenance reports on Type "B" packages will be made in accordance with Section 4.0 procedures.
- b. Quarterly inspection and maintenance of Type "B" packages will be performed by the Radiation Safety Officer (RSO) as outlined in Section 7.0.

10.6 QUALITY ASSURANCE RECORDS:

- a. Utilization logs, shipment records, package surveys, and quarterly inspection records will be maintained as specified in Sections 4.0 and 7.0.
- b. Training records are maintained in accordance with Section 5.0.
- c. Equipment and package, procedures and instructions are maintained by the R.S.O.

10.7 AUDITS:

- a. Quarterly audits of the entire Radiation Safety Program are performed in accordance with Section 6.0.





"APPENDIX RS-5-1"

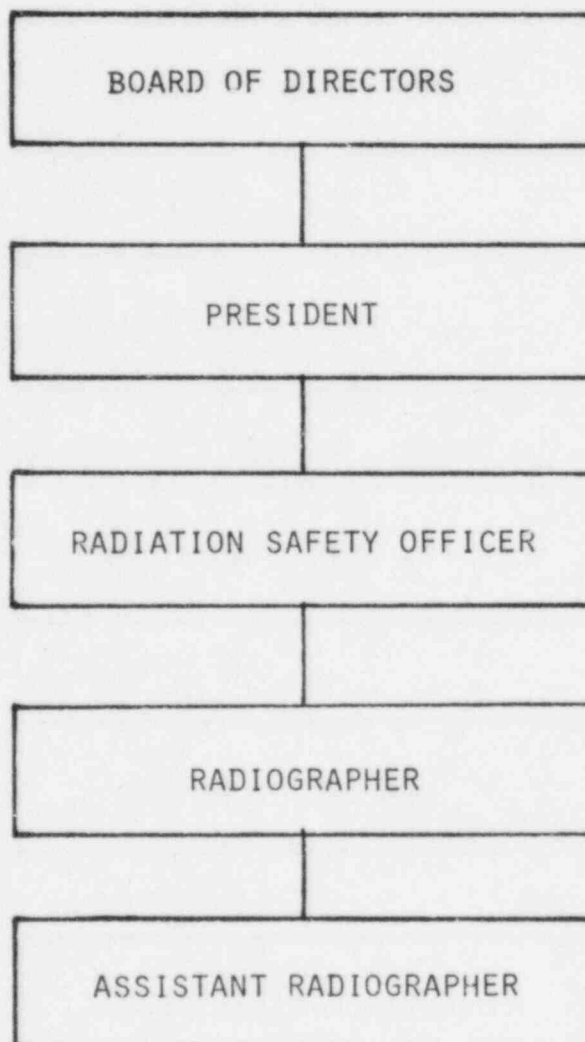
10.7 AUDITS: (continued)

- b. The quarterly audits include the necessary checks on the Quality Assurance Program as outlined in Section 7.0.
- c. Any deficiencies revealed by the audits are corrected in accordance with Section 7.0.



"APPENDIX RS-5-1"

"ORGANIZATIONAL CHART"





NORTH AMERICAN INSPECTION, INC.

P.O. BOX 88

LAURYS STATION, PA. 18059

"RADIATION SAFETY RELATED INCIDENT DATA REPORT"

THIS REPORT IS TO BE COMPLETED WITHIN 24 HOURS IN THE EVENT THAT:

- A. YOUR DOSIMETER IS DISCHARGED BEYOND 200 MR DUE TO UNKNOWN CIRCUMSTANCES IN WHICH THE POSSIBILITY OF AN EXCESSIVE EXPOSURE TO RADIATION EXISTS.
- B. YOUR FILM BADGE BECOMES WET? MUTILATED OR LOST.
- C. YOU HAVE REASON TO BELIEVE THAT YOUR FILM BADGE MAY INDICATE AN EXCESSIVE EXPOSURE THAT YOU MAY NOT HAVE RECEIVED.
- D. OTHER. (Explain on reverse side of this sheet)

FORWARD THIS REPORT TO YOUR R.S.O. IMMEDIATELY AFTER COMPLETION.

SECTION 1 (COMPLETE ALL ITEMS)

1. NAME (PRINT) \_\_\_\_\_ SIGNATURE \_\_\_\_\_
2. WORK LOCATION \_\_\_\_\_  
Lab - Customer - Site - City - State
3. DID YOU STOP RADIOGRAPHIC OPERATIONS IMMEDIATELY? YES \_\_\_\_\_ NO \_\_\_\_\_
4. DID YOU NOTIFY YOUR RADIATION SAFETY OFFICER (R.S.O.)? YES \_\_\_\_\_ NO \_\_\_\_\_
5. WHEN? DATE: \_\_\_\_\_ TIME: \_\_\_\_\_
6. WHICH OF THE ITEMS OCCURRED? A. \_\_\_\_\_ (COMPLETE SECTION 2) B. \_\_\_\_\_ (COMPLETE SECTION 3)  
C. \_\_\_\_\_ (COMPLETE SECTION 4) D. \_\_\_\_\_ (USE REVERSE SIDE)

SECTION 2 (TO BE COMPLETED IN THE EVENT THAT "A" ABOVE OCCURRED)

1. WHEN WERE YOU AWARE THAT YOUR DOSIMETER WENT OFF SCALE: DATE \_\_\_\_\_ TIME \_\_\_\_\_
2. DID A POSSIBLE OVER EXPOSURE OCCUR? YES \_\_\_\_\_ NO \_\_\_\_\_ AT WHAT DISTANCE WHERE YOU  
FROM THE SOURCE: \_\_\_\_\_ FEET FOR WHAT LENGTH OF TIME: \_\_\_\_\_ MINUTES/HOURS
3. PROJECTOR DEVICE USED - MAKE AND MODEL \_\_\_\_\_ SERIAL NO. \_\_\_\_\_
4. SOURCE TYPE: IR-192 \_\_\_\_\_ CO-60 \_\_\_\_\_ SOURCE S/N \_\_\_\_\_ NO. OF CURIES \_\_\_\_\_
5. SURVEY METER: MODEL \_\_\_\_\_ SERIAL NO. \_\_\_\_\_ DATE CALIBRATED \_\_\_\_\_
6. EXPLAIN IN DETAIL EXACTLY EVERYTHING THAT OCCURRED. (USE REVERSE SIDE OF SHEET)

SECTION 3 (TO BE COMPLETED IN THE EVENT THAT "B" ABOVE OCCURRED)

1. EXPLAIN IN DETAIL HOW YOUR FILM BADGE BECAME WET, LOST, ETC. (USE REVERSE SIDE)

SECTION 4 (TO BE COMPLETED IN THE EVENT THAT "C" ABOVE OCCURRED)

1. WHERE WAS YOUR FILM BADGE LOCATED WHEN YOU BELIEVE IT WAS EXPOSED TO RADIATION? \_\_\_\_\_
2. HOW MUCH RADIATION DO YOU CALCULATE YOUR FILM BADGE RECEIVED? \_\_\_\_\_ MR UNKNOWN \_\_\_\_\_
3. WERE YOU WEARING YOUR FILM BADGE? YES \_\_\_\_\_ NO \_\_\_\_\_ IF NO, EXPLAIN: \_\_\_\_\_
4. EXPLAIN EXACTLY EVERYTHING THAT OCCURRED. (USE REVERSE SIDE OF SHEET)
5. ON THE REVERSE SIDE INCLUDE ANY OTHER INFORMATION WHICH YOU FEEL IS PERTINENT.

SECTION 5 (TO BE COMPLETED IN THE EVENT THAT "D" ABOVE OCCURRED)

1. EXPLAIN IN DETAIL EXACTLY EVERYTHING THAT OCCURRED. (USE REVERSE SIDE OF SHEET)



## NORTH AMERICAN INSPECTION, INC.

P.O. Box 88

LAURYS STATION, PA. 18059

MADE IN TRIPLICATE

## "RADIOGRAPHER'S PERFORMANCE REVIEW"

ANNOUNCED ( )

UNANNOUNCED ( )

RADIOGRAPHER \_\_\_\_\_ S.S. NO. \_\_\_\_\_ DATE \_\_\_\_\_

JOB LOCATION \_\_\_\_\_

U.S.N.R.C. REGION: I II III IV V STATE: \_\_\_\_\_

RSO OR JOB RADIOGRAPHER \_\_\_\_\_ ASST. RADIOGRAPHER \_\_\_\_\_

PROJECTOR SERIAL NUMBER \_\_\_\_\_ RADIOACTIVE CONTENT \_\_\_\_\_

PROJECTOR SERIAL NUMBER \_\_\_\_\_ RADIOACTIVE CONTENT \_\_\_\_\_

## "SURVEY COMMENTS"

1. DOSIMETERS CHARGED DAILY AND READINGS RECORDED S/N \_\_\_\_\_ COMMENT \_\_\_\_\_  
S/N \_\_\_\_\_
2. RADIATION SURVEY METER IN PROPER WORKING ORDER INCLUDING CALIBRATION DATE S/N \_\_\_\_\_ COMMENT \_\_\_\_\_  
AND PROPERLY USED.
3. FILM BADGES PROPERLY WORN AND STORED. COMMENT \_\_\_\_\_
4. COPY OF RADIOGRAPHIC OPERATIONS MANUAL AVAILABLE - COPY OF U.S.N.R.C. OR APPLICABLE STATE LICENSE. COMMENT \_\_\_\_\_
5. COPY OF THE APPLICABLE U.S.N.R.C./OR STATE RULES AND REGULATIONS AVAILABLE COMMENT \_\_\_\_\_
6. COPIES OF U.S.N.R.C. FORM #3 OR APPLICABLE STATE FORM PROPERLY POSTED. COMMENT \_\_\_\_\_
7. PROJECTORS POSTED TO INDICATE CONTENTS. COMMENT \_\_\_\_\_
8. RADIOISOTOPE STORAGE BUILDING OR MOBILE LAB PROPERLY POSTED TO INDICATE RADIOACTIVE MATERIAL. COMMENT \_\_\_\_\_
9. RECORDS OF SOURCE STORAGE, EQUIPMENT MAINTENANCE AND UTILIZATION. COMMENT \_\_\_\_\_
10. RECORDS OF VEHICLE SURVEY (when appl.) COMMENT \_\_\_\_\_
11. RADIATION AREA POSTING. COMMENT \_\_\_\_\_

REMARKS \_\_\_\_\_

N.A.I.I. RADIATION SAFETY OFFICER

RADIOGRAPHERS ACKNOWLEDGEMENT



NORTH AMERICAN INSPECTION, INC.  
P.O. BOX 88  
LAURYS STATION, PA. 18059

## 8.1 "LEAK TEST RECORD"

"PLACE N/A IN ALL BLANKS NOT APPLICABLE"

1. SOURCE NO. \_\_\_\_\_ CURIES \_\_\_\_\_ MATERIAL \_\_\_\_\_
2. DATE RECEIVED \_\_\_\_\_ RECEIVED FROM \_\_\_\_\_
3. RECEIVED IN CONTAINER S/N \_\_\_\_\_ MODEL \_\_\_\_\_ TYPE \_\_\_\_\_
4. DATE MANUFACTURER PERFORMED "LEAK TEST" \_\_\_\_\_  
(SEE DECAY CURVE)
5. NEXT "LEAK TEST" DUE DATE \_\_\_\_\_ DATE OF DISPOSAL \_\_\_\_\_
6. CURIES ON DATE OF DISPOSAL \_\_\_\_\_ WIPE TEST DATE \_\_\_\_\_  
WIPE SURVEY RESULTS \_\_\_\_\_  
\_\_\_\_\_
7. RESULTS OF "LEAK TEST" \_\_\_\_\_  
\_\_\_\_\_  
(OR WAS SOURCE RETURNED PRIOR TO "LEAK TEST" DUE DATE) \_\_\_\_YES \_\_\_\_NO
8. "LEAK TEST" PERFORMED BY \_\_\_\_\_
9. PROCEDURE NAME OR NUMBER USED \_\_\_\_\_
10. SOURCE SHIPPED TO \_\_\_\_\_  
IN CONTAINER NO. \_\_\_\_\_
11. COMMENTS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

SIGNATURE OF R.S.O. \_\_\_\_\_

DATE \_\_\_\_\_





NORTH AMERICAN INSPECTION, INC.  
P.O. BOX 88  
LAURYS STATION, PA. 18059

"FILM BADGE TRANSMITTAL/RECEIPT FORM"

ATTACHED HERewith IS YOUR PERSONAL DOSIMETERY REPORT FOR  
THE MONTH BEGINNING THE 20TH DAY OF \_\_\_\_\_  
TO AND INCLUDING THE 19TH DAY OF \_\_\_\_\_.

ATTACHED IS YOUR MONTHLY FILM BADGE NO. \_\_\_\_\_  
COINCIDING WITH THE ABOVE DATE.

PLEASE ACKNOWLEDGE RECEIPT OF THIS TRANSMITTAL BY YOUR  
SIGNATURE AND DATE OF RECEIPT. RETURN YOUR PREVIOUS  
DOSIMETRY REPORT AND FILM BADGE ATTACHED TO THIS FORM -  
WITHIN 2 DAYS AFTER YOU ARE IN RECEIPT OF THIS FORM.

DATE RECEIVED \_\_\_\_\_ RETURN DATE \_\_\_\_\_

RECEIVED BY \_\_\_\_\_  
SIGNATURE

COMMENTS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



NORTH AMERICAN INSPECTION, INC.  
P.O. BOX 88  
LAURYS STATION, PA. 18059

"RADIOACTIVE SOURCE CHANGE QUALIFICATION"

THIS IS TO CERTIFY THAT:

NAME: \_\_\_\_\_ POSITION: \_\_\_\_\_

WAS GIVEN A DEMONSTRATION OF SOURCE CHANGES USING THE FOLLOWING AUTHORIZED  
SOURCE CHANGERS:

- ( ) T/O 771, capacity 250 curies of COBALT 60
- ( ) T/O 650, capacity 100 curies of IRIDIUM 192
- ( ) GAMMA INDUSTRIES C-8, capacity 200 curies of  
COBALT 60
- ( ) GAMMA INDUSTRIES C-10, capacity 100 curies of  
IRIDIUM 192

THE ABOVE RADIOGRAPHER HAS DEMONSTRATED COMPETENCE IN CHANGING OF  
THE SOURCE(S) USING THE MANUFACTURERS SOURCE CHANGE PROCEDURE(S)  
NUMBER \_\_\_\_\_.

THIS CHANGE WAS DEMONSTRATED AND SUPERVISED BY THE COMPANY'S  
RADIATION SAFETY OFFICER AND/OR MANUFACTURER'S QUALIFIED  
REPRESENTATIVE.

WITNESSED BY R.S.O. (N.A.I.I.) \_\_\_\_\_

APPROVED BY TECHNICAL DIRECTOR (N.A.I.I.) \_\_\_\_\_

DATE: \_\_\_\_\_

COPY OF CERTIFICATION TO THE EMPLOYEES RADIATION SAFETY QUALIFICATION FILE.



NORTH AMERICAN INSPECTION, INC.

P.O. BOX 88

LAURYS STATION, PA. 18059

"RADIOACTIVE LEAK TEST PROCEDURE QUALIFICATIONS"

THIS IS TO CERTIFY THAT:

NAME: \_\_\_\_\_ POSITION: \_\_\_\_\_

WAS GIVEN A DEMONSTRATION TO PERFORM A LEAK TEST USING:

- ( ) HP-C2 LEAK TEST KIT, HEALTH PHYSICS ASSOCIATES
- ( ) T/O 518 LEAK TEST KIT, TECHNICAL OPERATIONS
- ( ) KOWIPE LEAK TEST KIT, GAMMA INDUSTRIES

THIS TEST IS TO BE PERFORMED USING THE INSTRUCTIONS SUPPLIED BY THE MANUFACTURER WITH THE LEAK TEST KIT AND SHALL COMPLY WITH THE PROVISIONS OF NORTH AMERICAN INSPECTION, INC.'S (N.A.I.I.) LICENSE.

THE ABOVE TEST HAS BEEN DEMONSTRATED TO THE SATISFACTION OF THE RADIATION SAFETY OFFICER (R.S.O.).

WITNESSED BY R.S.O. (N.A.I.I.) \_\_\_\_\_

APPROVED BY TECHNICAL DIRECTOR (N.A.I.I.) \_\_\_\_\_

DATE: \_\_\_\_\_

COPY OF CERTIFICATION TO THE EMPLOYEES RADIATION SAFETY QUALIFICATION FILE.

**TECH/OPS, INC.**  
**LEAK TEST KIT MODEL 518**

**INSTRUCTIONS FOR USE**

This kit is designed for use on Tech/Ops Gamma Ray Projectors. It provides a convenient and safe method of performing leak tests of radiographic sources in accordance with NRC regulations, which require such tests at intervals of not more than 6 months.

**CONTENTS**

Flexible swab holder with swab  
Vial of EDTA solution  
Plastic Envelope  
Mailing Box  
Identification Sheet

**PROCEED IN THIS MANNER:**

1. Be sure source is fully retracted and secured in the projector. (Use a survey meter to be sure that radiation levels are normal.)
2. Remove source guide tube from front of projector or remove shipping plug.
3. Wet the swab with EDTA solution. Shake off excess and insert the swab into the hole in the shield. Wipe the interior of the hole thoroughly by rotating swab holder.
4. Withdraw swab and place in plastic envelope.
5. The swab should now be monitored by turning the survey meter to its most sensitive range. Place the meter in a low background area and move the swab in its plastic envelope to the meter, not the meter to the swab.
6. If there is no indication on the meter, or if the indication is no more than 0.2 mR per hour above background, put the plastic envelope with the swab in the mailing box and mail to Tech/Ops, Incorporated, 40 North Ave., Burlington, Massachusetts 01803. Be sure to fill out and return the identification sheet.
7. If the swab should show more than 0.2 mR per hour, do not mail. Contact Tech/Ops, Inc., for specific instructions.

NOTE: If the survey meter available does not have the capability of detecting as little as 0.2 mR per hour, ship the wipe-test swab to Tech/Ops, Inc., via express. Do not ship if the radiation from the swab exceeds 2 mR per hour and contact Tech/Ops, Inc., for specific instructions. The wipe-test swab will be subjected to a precise radio-assay when received by Tech/Ops, and a leak-test certificate will be mailed promptly. The NRC requires that this certificate be kept with your records and that it be available for inspection (10 CFR 34.25(c)).

**NOTICE**

In order to use this Model 518 Leak Test Kit, the user must be specifically licensed to do so in accordance with Title 10, Code of Federal Regulations, Part 34, Paragraph 34.11 (f). If your license does not authorize the use of this leak test kit, an application for a license amendment should be filed on Form NRC-313R with the Materials Licensing Branch, Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety and Safeguards, U. S. Nuclear Regulatory Commission, Washington, DC 20555.

Use of this kit without specific authorization constitutes a violation of U. S. Nuclear Regulatory Commission regulations.

**Tech/Ops, Inc.**  
Burlington, MA

**Tech/Ops**

40 NORTH AVENUE  
BURLINGTON, MA. 01803  
(617) 272-2000

**518**  
**LEAK TEST**

Co. Name \_\_\_\_\_ P.O. No. \_\_\_\_\_  
Street \_\_\_\_\_ NRC or \_\_\_\_\_  
City, State \_\_\_\_\_ State License No. \_\_\_\_\_  
Projector \_\_\_\_\_ Serial No. \_\_\_\_\_  
Model No. \_\_\_\_\_  
Source \_\_\_\_\_ Serial No. \_\_\_\_\_ Curies \_\_\_\_\_  
Model No. \_\_\_\_\_  
IR-192 \_\_\_\_\_ CO-60 \_\_\_\_\_ CS-137 \_\_\_\_\_ Other \_\_\_\_\_

Wipe  
Performed By \_\_\_\_\_

Date \_\_\_\_\_

The United States Nuclear Regulatory Commission requires that radiographic sources be tested for evidence of leaking at the time of manufacture and thereafter at not more than six-month intervals. The amount of removable contamination must not exceed 0.005 microcuries. If the test shows more than 0.005 microcurie of removable contamination, the source and equipment must be immediately taken out of service and be repaired or be disposed of. Please note that this source must be tested again on or before \_\_\_\_\_

FOR TECH-OPS USE ONLY

ORIGINAL



# GAMMA INDUSTRIES

A Division of Nuclear Systems, Inc.

HOME OFFICE  
2255 Ted Dunham Avenue  
Baton Rouge, Louisiana 70821  
(504) 383-7791 - Telex 586473

9320 Tavenor Drive  
Houston, Texas 77034  
(713) 944-7676  
Telex 775677

## KOWIPE LEAK TEST KIT

BKGD	TOTAL CPM	EFF %	DPM	MICROCURIE CONTAMINATION

### GAMMA INDUSTRIES LEAK TEST KIT SERVICE

**NOTICE:** Control of sealed Radioisotope sources by The U.S. Nuclear Regulatory Commission and The Agreement States require leak tests at defined intervals — six months for Beta-Gamma Sources, or three months for Alpha Sources, or as required by specific licenses. Licensee's performing their own leak tests must be licensed to do this and procedures for performing the tests must be approved by the NRC or Agreement State. Licensees may choose to have required leak tests performed by some other entity which has been approved by the NRC or Agreement State.

Gamma Industries has been approved to perform leak tests on radioisotope sealed sources. This is accomplished using the KOWIPE Leak Test Kit.

#### INSTRUCTIONS FOR USING THE KOWIPE LEAK TEST KIT

1. Completely identify the source being leak tested by providing information on KOWIPE Leak Test Kit.
2. **DO NOT** attempt to test the sealed source capsule because of the possible excessive personnel radiation exposure. The test shall be performed by swabbing an area most accessible to the source.
3. Using a survey meter, ascertain that the source is in a safe, shielded position.
4. Instructions:
  - a) Dissolve the contents of attached packet in a small volume of water.
  - b) Remove swab in packet on left. Dip cotton tip in the solution and proceed with the wipe test by swabbing areas nearest and most accessible to the source.

- COMPANY: \_\_\_\_\_
- ADDRESS: \_\_\_\_\_
- SOURCE MANUFACTURER: \_\_\_\_\_
- DATE OF TEST: \_\_\_\_\_
- ISOTOPE: \_\_\_\_\_
- SOURCE STRENGTH (ci): \_\_\_\_\_
- SOURCE SERIAL NO. \_\_\_\_\_
- REMARKS: \_\_\_\_\_
- a) Replace the swab in the same container from which it was removed.
  - b) Remove the second swab and perform the wipe test with the swab dry.
  - c) Return the swab to the container.
  - d) It is important that the swabs be placed in the proper container.
  - e) Be sure the requested information is completed to properly identify the source.
  - f) Return the KOWIPE Leak Test Kit to Gamma Industries for analysis.



NORTH AMERICAN INSPECTION, INC.

P.O. BOX 88  
LAURYS STATION, PA. 18059

OPERATING INSTRUCTIONS

LUDLUM MEASUREMENTS, INC.

MODEL 6 GEIGER COUNTER

1. REMOVE BATTERY LID AND INSTALL TWO "D" SIZE BATTERIES. NOTE (+) (-) MARKS ON INSIDE OF LID. MATCH BATTERY POLARITY TO THESE MARKS.

NOTE: CENTER POST OF FLASHLIGHT BATTERY IS POSITIVE.  
REPLACE BATTERY LID.

2. TURN INSTRUMENT RANGE SWITCH TO "BAT." THE METER SHOULD DEFLECT TO THE BATTERY CHECK PORTION OF THE METER SCALE. IF METER DOES NOT RESPOND, RECHECK THAT BATTERIES HAVE PROPER POLARITY.
3. TURN THE RANGE SWITCH TO X1. EXPOSE THE INSTRUMENT TO A RADIATION CHECK SOURCE. THE METER SHOULD RESPOND.
4. CHECK CALIBRATION AND PROCEED TO USE THE INSTRUMENT.



NORTH AMERICAN INSPECTION, INC.

P.O. BOX 88  
LAURYS STATION, PA. 18059

## OPERATING INSTRUCTIONS

GAMMA INDUSTRIES

MODEL 250B & 252B SURVEY METERS

### A. OPERATING THE INSTRUMENT:

1. INSPECTION: THE INSTRUMENT SHOULD BE VISUALLY CHECKED FOR PHYSICAL DAMAGE. NOTE CALIBRATION DATE.
2. FUNCTIONAL TEST: TURN SWITCH TO X1 POSITION MOMENTARILY AND THEN RETURN TO TEST POSITION. THE METER SHOULD INDICATE ABOVE THE BAT./CKT. POSITION.

THIS TEST INDICATES THAT SWITCH, BATTERIES, POWER SUPPLIES, GM TUBE, INTEGRATED CIRCUIT AND METER MOVEMENT ARE IN "GOOD WORKING ORDER".

3. OPERATION CHECK: SELECT THE DESIRED RANGE. IF AVAILABLE, USE A CHECK SOURCE TO INSURE INSTRUMENT IS OPERATING CORRECTLY.

### B. READING SCALES:

THE SCALES ARE MARKED 0-10 DIV/HR WITH A MULTIPLIER AS SELECTED BY THE SELECTOR SWITCH. SIMPLY READ THE MEASUREMENT INDICATED ON THE LINEAR SCALE AND MULTIPLY BY SELECTED NUMBER.

THE GEIGER-MUELLER TUBE IS POSITIONED WITHIN THE UNIT AT THE POSITION INDICATED BELOW. FOR MOST ACCURATE RESULTS, HOLD THE INSTRUMENT LEVEL AND PERPENDICULAR TO THE SOURCE OF RADIATION.

