ITEM 14

MALLINCKRODT, INC.

MALLINCKRODT NUCLEAR

HEALTH PHYSICS DEPARTMENT

RADIATION PROTECTION PROGRAM

DATE: SEPTEMBER 26, 1977

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D. W. Soldan, Chairman

MALLINCKRODT, INC.
St. Louis, Missouri

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SECTION 1

1. RADIATION PROTECTION PROGRAM

1.1 Scope

To comply with regulations promulgated by the United States Nuclear Regulatory Commission for controlling licensed byproduct material and to conform with its standards for protection against radiation, Mallinckrodt has developed a comprehensive program for controlling exposure to and handling of radioactive materials.

The program is supported by Divisional Management to assure the participation and cooperation of all personnel. It includes routine sampling and measurement procedures to evaluate the presence of radiation in the environment as well as the exposure of personnel to radiation. It incorporates administrative controls and procedures to ensure confinement of byproduct materials to designated areas, to restrict access of personnel to these materials, and to permit use of these materials by authorized personnel only.

The program, under the administration of the Corporate Radiation Protection Officer, is the primary means by which up-to-date standards or practices for radiation control are defined and enforced for Mallinckrodt, Inc. Except where a definite procedure or technique is specified by regulations, the program specifies the application of those methods of radiation measurement or control that are the best available for a given situation. In no instance does the program specify standards or practices less stringent than the minimum standards for radiation control set forth by the United States Nuclear Regulatory Commission in Title 10, Code of Federal Regulations. Further, the program incorporates the current issue of the subject Federal Regulations and provides for incorporation of future revisions in Title 10, Code of Federal Regulations.

The program is the basic reference for providing radiation safety for Mallinckrodt, Inc. The program is the basic guide for every supervisor associated with activities involving the handling and use of licensed materials. Such supervisory personnel are responsible for the continuous application of the program. A detailed description of the program comprises Sections 2-11 of Item 14 of this submission.

SECTION 2

2. DEFINITIONS and ACRONYMS

2.1 Definitions

1) Unrestricted area - any area access to which is not controlled for radiation protection purposes.

2) General restricted area - any area access to which is controlled for radiation protection purposes. The entrances to these areas are posted with signs worded - RESTRICTED AREA, MALLINCKRODT/NUCLEAR EMPLOYEES OR ESCORTED VISITORS ONLY.

3) Specific restricted area - any areas within general restricted areas which are posted with caution signs as specified in Subparagraph 4.1.2.3. The entrances to these areas are posted with signs worded - RESTRICTED AREA, AUTHORIZED PERSONNEL OR ESCORTED VISITORS ONLY.

4) Shall, must - these words are used to denote a requirement.

5) Should, may - these words are used to denote permission or a recommendation.

6) Committee - the Radiation Safety Committee for a particular license.

7) Commission, the Nuclear Regulatory Commission or its duly authorized representatives.

8) Individual - Any human being.

2.2 Acronyms

1) ALARA - as low as is reasonably achievable

2) CFR - Code of Federal Regulations

3) DOT - Department of Transportation

4) ICRP - International Commission on Radiological Protection

5) MPC - Maximum permissible concentration

6) NRC - Nuclear Regulatory Commission

7) RAM - Radioactive material

8) SOP - Standard operating procedures

9) TLD - Thermoluminescence dosimeter

10) LED - Local Emergency Director

11) RPS - Radiation Protection Staff

SECTION 3

3. RADIATION PROTECTION ORGANIZATION

3.1 Director of Operations

3.1.1 Responsibility

The Director of Operations is administratively responsible to Director of Radiopharmaceutical R&D.

3.1.2 Duties

The Director of Operations ensures that a well supervised Radiation Protection Organization is established with well defined responsibilities.

3.2 Radiation Safety Committee

3.2.1 Function

The Radiation Safety Committee administers the Radiation Radiation Protection Program to assure control of the procurement, use and disposition of radioactive materials.

3.2.2 Composition

The Committee is composed of a Radiological Safety Officer, a representative of management, and other individuals trained and experienced in the safe use of radioactive materials. A quorum consists of half the membership (or a simple majority if there is an odd number of members), one of whom must be the Chairman or Vice Chairman, or, in their absence, the Secretary. In general, the members are chosen to represent departments which handle or use licensed materials.

3.2.2 Responsibility

The Radiation Safety Committee is administratively responsible to the Director of Operations.

3.2.4 Duties

3.2.4.1 Safety Evaluations

The Radiation Safety Committee makes safety evaluations of new uses of radioactive materials in excess of those specified in 33.100 Subsection 11.2 Item 1 Schedule A, Column I, or if the proposed processing or experimentation is of a sufficiently hazardous nature, prior to use of the RAM. Verbal approval with stipulations may be given, after which the safety evaluations are documented within seven days by the Secretary and incorporated in the

3.2.4.1 minutes of the meeting. Safety evaluations include but are not necessarily limited to, the following considerations.

1) The experience and qualifications of the individuals who will use the RAMs.
2) The adequacy of the facilities including the containment systems, shielding and apparatus.
3) The methodology to be used.
4) The quantity of radioactivity involved.
5) The chemical and physical form of the radionuclide.
6) The decay scheme and halflife of the radionuclide.
7) The biological fate of the radionuclide in the body.

3.2.4.2 Personnel Classifications

The Committee reviews the qualifications and experience of all individuals and groups them in one of the following classifications:

1) Individuals who may use or directly supervise the use of radioactive materials within their area of responsibility.
2) Individuals who may use radioactive materials only under direct supervision. Untrained and inexperienced individuals automatically fall in a Class 2 Category.

The Radiation Safety Committee, upon petition by a departmental manager will consider raising the classification of individuals providing they have at least 40 hours of training and experience in the safe use of radioactive materials.

Mallinckrodt drivers in Class 2 are exempt from direct supervision when picking up or delivering radioactive materials packaged in accordance with DOT regulations.

3.2.4.3 Administrative Controls

The Committee requires the establishment of a Radiation Protection Program by the Radiation Protection Staff commensurate with current Federal or State regulations.

The Radiation Safety Committee requires and reviews quarterly summary reports of exposures, levels and concentrations and takes appropriate action in the form of recommendations to the Director of Operations, or directives to departmental managers or the Radiation Protection Staff. Such action is

3.2.4.3 taken when changes in procedures or modification of facilities would substantially improve the Radiation Protection Program at a reasonable cost.

3.2.4.4 Committee Limits

The Radiation Safety Committee establishes limits to minimize the internal and external exposure of individuals in restricted areas and the release of radioactive materials to unrestricted areas. These limits, which may be more restrictive than applicable Federal or State regulatory limits, are reviewed on a quarterly basis and reduced where possible to achieve the commitment stated in Paragraph 3.2.6.

3.2.4.5 Work Restrictions

The Radiation Safety Committee restricts individuals from additional exposure when Committee limits are reached or upon their projected date of restriction, whichever occurs first. The authority to impose work restrictions is delegated to the Chief Radiological Safety Officer or Resident Radiological Safety Officers.

A departmental manager may petition the Committee for a waiver of thw work restriction. The Radiation Safety Committee may approve the petition providing:

1) Conditions are established to minimize additional exposure (e.g., permitting an individual to use hotcell manipulators when restricted because of extremities exposure).
2) A new committee limit is established for the individual for the duration of the quarter.
3) Corrective actions have been taken or proposed to prevent a recurrence of the conditions resulting in the work restriction.

3.2.4.6 Reports or Responses to the Commission:

The Committee reviews the circumstances causing exposures or levels of radiation or concentrations which require a report to the Commission and any items of non-compliance noted during an inspection for joint determination of corrective actions.

3.2.5 Meeting Frequency

A meeting of the Radiation Safety Committee is held under any of the following circumstances:

3.2.5 1) To fulfill the duties listed in Paragraph 3.2.4.
2) Whenever any Committee member requests the Chairman or his alternate to call a meeting at any time for any reason.
3) Whenever the Secretary, on a monthly basis, determines by inquiry of the members that a particular situation should be brought to the attention of the Committee.

3.2.6 ALARA Commitment

The Committee issues periodic notices or directives to make plant personnel aware of management's commitment to keep occupational exposures and exposures to the general populace as low as is reasonably achieveable.

3.2.7 Enforcement Actions

The Radiation Safety Committee has the authority and responsiblity to enforce safe plant operation. Any operation which threatens the radiation safety of personnel, the general populace or the plant is subject to curtailment. This enforcement authority and responsibility is delegated by the Committee to each Radiation Safety Committee member and each Radiation Protection Staff member. The Committee recommends appropriate disciplinary action when warranted.

3.3 Radiation Protection Staff

3.3.1 Function

The Radiation Protection Staff functions as the working body of the Radiation Safety Committee by monitoring daily operations to achieve the goals of the Radiation Protection Program.

3.3.2 Composition

The Radiation Protection Staff consists of the Chief Radiological Safety Officer, the Resident Radiological Safety Officers and all other Class 1 individuals supervising the use of RAMs. This is in conformity with corporate policy that safety, including radiation safety, is the direct responsibility of line supervision. The Radiation Safety Committee may select, approve and designate certain supervisory individuals as Staff Radiological Safety Officers, depending upon the diversification and complexity of the operation. This formal organization minimizes the Radiation Protection Staff permitting more direct inter-action among members.

3.3.2 The selection of Staff Radiological Safety Officers does not relieve other line supervisors of their responsibility for the radiation safety of personnel reporting to them, although the dominant authority and responsibility in a specific area is that of the Radiological Staff Officer.

3.3.3 Responsibilities

1) The Chief Radiological Safety Officer is administratively responsible to the Maryland Heights Radiation Safety Committee.
2) The Resident Radiological Safety Officers are administratively directly responsible to the Chief Radiological Safety Officer.
3) The Staff Radiological Safety Officers are administratively responsible to the Resident Radiological Safety Officer for operations within their respective departments.
4) Class 1 Line Supervisors are administratively responsible to the Staff Radiological Safety Officers for their area. If the Radiation Safety Committee has not designated Staff Radiological Safety Officers, Line Supervisors are administratively responsible to the Resident Radiological Safety Officer.

3.3.4 Duties

3.3.4.1 Chief Radiological Safety Officer

1) Prescribes, develops, and implements a Radiation Protection Program commensurate with applicable Federal and State regulations and the provisions and conditions of the licenses.
2) Makes safety evaluations of proposed new uses of radioactive materials in quantities in excess of those specified in Paragraph 11.2.1, 33.100 Schedule A, Column II considering the items listed in Subparagraph 3.2.4.1. Verbal approval with stipulations may be given, after which the safety evaluations are documented by the Chief Radiological Safety Officer for distribution to the Radiation Safety Committee members for their review and comments. The original or amended safety evaluations are incorporated into the minutes of the next Radiation Safety Committee meeting.

3.3.4.1 3) Prepares end of the quarter listings for Staff Radiological Safety Officers and Class 1 Line Supervisors identifying the "Top Ten" individuals heading the lists for external and internal exposures.

4) Compiles quarterly reports to the Radiation Safety Committee specifying the primary sources of exposure to radiation or to RAMs with recommendations for exposure reduction as per Subparagraph 3.2.4.3.

5) Issues directives to respective Staff Radiological Safety Officers when work restrictions are necessary as per Subparagraph 3.2.4.5.

6) Gathers information and data needed by the Radiation Safety Committee to determine corrective actions to be taken for reports or responses to the NRC as per Subparagraph 3.2.4.6.

7) Prepares applications for new NRC licenses and license amendments.

8) Ensures that plant personnel receive sufficient radiation safety indoctrination and training for their respective jobs.

9) Provides technical advice and services to the Resident and Staff Radiological Safety Officers and other individuals on all levels.

10) Curtails any operation involving RAMs which threatens the safety of personnel, the general populace or the plant as per Paragraph 3.2.7.

11) Supervises the overall Radiation Protection Program to assure compliance with established standards and procedures.

3.3.4.2 Resident Radiological Safety Officers

The duties of the Resident Radiological Safety Officers parallel those of the Chief Radiological Safety Officer for their respective areas of responsibility. In addition, the Resident Radiological Safety Officer shall perform, or cause to be performed, all operations prescribed in SECTION 7.

3.3.4.3 Staff Radiological Safety Officers

1) Assure that personnel under their supervision are aware of, practice, and apply good radiation safety practices, standards, and procedures.

2) Make safety evaluations of proposed new uses of RAMs in quantities less than those specified in Subsection 11.2 Item 1, 33.100 Schedule A, Column II, considering the items listed in Subparagraph 3.2.4.1. The safety evaluations are documented and submitted to the Chief Radiological Safety Officer within seven days

3.3.4.3 2) for review and comments. The original or amended evaluations are incorporated in the minutes of the next Radiation Safety Committee meeting.

3) Submit quarterly reports to the Chief Radiological Safety Officer specifying the primary sources of internal and external exposures to any personnel under their supervision whose names appear on the "Top Ten" lists with recommendations for exposure reductions as per Subparagraph 3.3.4.1, Item 4.

4) Implement and enforce work restriction directives issued by the Chief Radiological Safety Officer.

5) Submit a written report to the Chief Radiological Safety Officer describing the circumstances resulting in work restrictions and the corrective actions taken or proposed.

6) Interrogate personnel under their supervision to determine the circumstances causing exposures or levels of radiation or concentrations which require a report to the Commission and determine the causes for any items of noncompliance noted by the NRC during inspections of their areas. The information obtained is documented and submitted to the Chief Radiological Safety Officer.

7) Submit a written request to the Chief Radiological Safety Officer for any increase in the quantity of a radionuclide to be ordered for verification of possession limits prior to the order change.

8) Provide continuing on the job radiation safety training of personnel under their supervision.

9) Provide technical advice and services to personnel working under their supervision.

10) Curtail any operation under their supervision which threatens the safety of personnel, the general populace or the plant as per Paragraph 3.2.7.

11) Supervise the Radiation Protection Program in their area of responsibility to assure compliance with established standards and procedures.

3.3.4.4 Class 1 Line Supervisors

The duties of Class 1 Line Supervisors parallel those of the Staff Radiological Safety Officers for their respective areas.

3.4 Health Physics and Health/Safety and Maintenance Departments

3.4.1 Functions

These departments are principally a service and advisory group organized to protect the health and provide for the safety of plant personnel and the general populace and for maintenance of equipment and facilities. Although physically located at the facility 2703 Wagner Place, Maryland Heights, Missouri 63043, the services and advice of these departments are available to all Corporate licensees.

3.4.2 Composition

The group is composed of highly specialized individuals trained and experienced in the areas of radiation safety, occupational safety, industrial hygiene, first aid, nuclear instrumentation calibration and repair, equipment and facilities maintenance and plant security.

3.4.3 Responsibility

The department heads are responsible to the Director of Operations.

SECTION 4

4. RADIATION SAFETY COMMITTEE STANDARDS

4.1 Regulatory Standards

4.1.1 Permissible Doses, Levels and Concentrations

4.1.1.1 Exposure of Individuals to Radiation in Restricted Areas

The maximum permissible external exposure to an individual during any one quarter is limited as follows:

1) 1.25 Rems to the whole body, head and trunk, active blood forming organs, lens of eyes, or gonads.
2) 3.0 Rems to the whole body, head and trunk, active blood forming organs, lens of eyes, or gonads, providing a determination of the individual's accumulated occupational exposure has been made and is less than 5 (N-18) Rems where N is the age in years at the last birthday.
3) 18.75 Rems to the hands and forearms, feet and ankles.
4) 7.5 Rems to the skin of the whole body.

4.1.1.2 Determination of Accumulated Dose

Form NRC-4 must be completed and retained in an individual's radiation history file before the option in Subparagraph 4.1.1.1 Item 2) may be exercised. Reasonable efforts should be made to obtain copies of the individual's previous occupational radiation exposure history. Alternatively, the following exposures may be assumed for lack of information.

1) 3.75 Rems per quarter prior to January 1, 1961.
2) 1.25 Rems per quarter on or after January 1, 1961.
3) The accumulated dose as determined above shall be carried forward and entered on Form NRC-5, or an equivalent form having all the required information.

4.1.1.3 Exposure of Individuals to Concentrations of Radioactive Materials in Restricted Areas

The airborne concentrations of RAMs shall be controlled such that during any one calendar quarter an individual would not inhale a quantity of RAMs which when averaged over a 13 week period would be in excess of the limits specified in Subsection 11.3

4.1.1.3 Item 1), 10 CFR 20 Appendix B, Table I, Column 1. The following shall be considered when making the exposure evaluation.

1) The maximum permissible concentrations in air are based upon a 40 hour work week. The tabulated MPCs may be increased or decreased by multiplying the MPC by 40 hours per week divided by the hours of exposure to an individual during the week.
2) When more than one radionuclide is present, the summation of the concentration of each radionuclide divided by its respective MPC should be less than or equal to unity.

$$\frac{C_1}{MPC_1} + \frac{C_2}{MPC_2} + \ldots\ldots + \frac{C_n}{MPC_n} \leq 1$$

4.1.1.4 Exposure of Minors

The exposure to radiation or to air concentrations of RAMs shall be controlled to limit the exposures to individuals under age 18 to the following:

1) Ten percent of the limits specified in Subparagraph 4.1.1.1 Items 1), 3), and 4).
2) The appropriate concentrations as specified in Subsection 11.3, Item 1) 10 CFR-20 Appendix B, Table II, Column 1, when averaged over periods not greater than one week.

4.1.1.5 Permissive Levels of Radiation in Unrestricted Areas

Radiation levels at the boundaries between restricted and unrestricted areas shall be controlled such that the following conditions are established.

1) Any individual is not likely to receive a dose to the whole body in any period of one calendar year in escess of 500 millirem.
2) Any individual would not receive an exposure of 2 millirem in any one hour, independent of occupancy time.
3) Any individual would not receive an exposure of 100 millirem in any seven consecutive days, independent of occupancy time. This reduces to approximately 0.6 millirem per hour as a guideline.

4.1.1.6 Radioactivity in Effluents to Unrestricted Areas

The yearly average effluent airborne concentrations of RAMs shall be controlled such that the limits specified in Subsection 11.3 Item 1) 10CFR-20 Appendix B, Table II, Column 1 are not exceeded. The following shall be considered when making this determination.

1) The concentrations must be determined at the boundaries between the restricted and unrestricted areas. Alternatively, the concentrations may be determined at the points of discharge to the atmosphere.
2) When more than one radionuclide is present, the summation of the concentration of each radionuclide divided by its respective MPC should be less than or equal to unity.

$$\frac{C_1}{MPC_1} + \frac{C_2}{MPC_2} + \ldots + \frac{C_n}{MPC_n} \leq 1$$

4.1.1.7 Medical Diagnosis and Therapy

Exposures to radiation or to RAMs as a result of medical diagnosis or therapy are not included in an individual's occupational radiation history file.

4.1.1.8 Orders Requiring Furnishing of Bioassay Services

The NRC may direct a licensee to provide bioassay services for an individual and to furnish a copy of the results to the Commission.

4.1.2 Precautionary Procedures

4.1.2.1 Surveys

Evaluations of the hazards, resulting from operations with RAMs, including appropriate physical measurements, shall be performed and recorded.

4.1.2.2 Personnel Monitoring

Appropriate dosimetry devices such as filmbadges, pocket dosimeters or TLDs shall be issued to and required to be worn by individuals entering restricted areas under the following circumstances:

4.1.2.2 1) When an individual is likely to receive an exposure in excess of 25 percent of the limits specified in Subparagraph 4.1.1.1 Items 1), 3) and 4).

2) When an individual under 18 years is likely to receive an exposure in excess of 5 percent of the limits in Subparagraph 4.1.1.1 Items 1, 3) and 4).

3) When an individual enters an area within which a major portion of the body could receive an exposure of 100 millirems in any one hour.

4.1.2.3 Caution Signs, Labels, Signals and Controls

All areas, rooms, enclosures and containers for RAMs within restricted areas shall be conspicuously posted with signs or with labels bearing the conventional radiation warning symbol in magenta or purple on a yellow background with appropriate precautionary wording.

1) CAUTION RADIATION AREA signs shall be posted to define all areas within which a major portion of the body could receive an exposure of 5 millirems in any one hour or 100 millirems in any 5 consecutive days.

2) CAUTION HIGH RADIATION AREA signs shall be posted to define all areas within which a major portion of the body could receive an exposure of 100 millirems in any one hour. Access to such areas must be controlled for radiation protection purposes. Control devices activated upon entry of an individual may be used to either reduce the radiation levels below 100 millirems in any one hour, or warn the individual and the area supervisor by means of conspicuous audible or visible alarms. Alternatively, the area may be maintained locked with positive control over each entry by means such as limited issuance of keys to authorized individuals and occupancy logbooks. Direct surveillance of the area may be substituted only for high radiation areas which exist for periods less than 30 days. Under all circumstances, an individual must not be prevented from leaving a high radiation area.

3) CAUTION AIRBORNE RADIOACTIVITY AREA signs shall be posted to define all areas within which air concentration of RAMs exist either in excess of the limits specified in Subsection 11.3 Item 1) 10CFR-20 Appendix B, Table 1, Column 1, or in excess of 25 percent of the value as determined by Subparagraph 4.1.1.3 Items 1) and 2).

4.1.2.3 4) CAUTION RADIOACTIVE MATERIALS signs shall be posted to define all areas within which RAMs are used or stored in an amount exceeding 10 times the applicable quantity specified in Subsection 11.3 Item 2), 10CFR-20 Appendix C.

5) CAUTION RADIOACTIVE MATERIALS labels shall be affixed to all containers within which an amount of RAM is present either in excess of the applicable quantity specified in Subsection 11.3 Item 2) 10CFR-20 Appendix C, or in concentrations in excess of the applicable concentrations listed in Subsection 11.3 Item 1) 10CFR-20 Appendix B, Table 1, Column 2. These labels shall have sufficient additional information to permit individuals who are working with or around the RAMs to take precautions to minimize exposures (e.g., radionuclide, activity, calibration date). Caution RAMs labels are not required when the materials are constantly attended; when the RAMs are packaged and labeled in accordance with the DOT regulations; or when the containers are accessible only to authorized individuals (e.g. within hot cells or gloveboxes) providing written records are available identifying the RAMs.

4.1.2.4 Exceptions to 4.1.2.3

1) Rooms or areas within a restricted area need not be posted with caution signs because of the presence of a sealed source providing the radiation level at a distance of 12 inches from the source container does not exceed 5 millirem per hour.
2) Rooms or areas within a restricted area need not be posted with caution signs because of the presence of RAMs for periods of less than 8 hours providing the materials are constantly attended and necessary radiation protection precautions are taken.
3) Rooms or areas need not be posted with caution signs because of the presence of RAMs packaged and labeled in accordance with the regulations of the DOT.

4.1.2.5 Procedures for Picking Up, Receiving and Opening Packages

1) Mutual arrangements shall be made between the licensee and carrier to receive incoming packages of RAMs upon delivery.

4.1.2.5 2) Incoming packages of RAMs shall be promptly surveyed and monitored to assure that no leakage has occurred in transit.

3) Such surveys and monitoring shall be performed within 3 hours after receipt of the package during normal working hours, or within 18 hours if received after normal working hours.

4) Removable contamination in excess of 22,000 disintegrations per minute per 100 square centimeters; or radiation levels at the surface of the package in excess of 200 millirem per hour; or radiation levels in excess of 10 millirem per hour at 3 feet from the surface of the package are indications of leakage.

5) If leakage is indicated, immediate notification shall be made by telephone and telegraph to the director of the appropriate NRC Regional Office listed in Subsection 11.3 Item 3) 10CFR-20 Appendix D and to the final delivering carrier.

6) Shipments received in exclusive use vehicles and Mo-99/Tc-99m generators returned by customers are exempt from the survey and monitoring requirements specified in Items 2) and 3) of this Subparagraph.

7) Procedures shall be established, maintained, and followed for safely opening all packages containing RAMs.

4.1.2.6 Instruction of Personnel

Instructions for individuals working in or frequenting restricted areas as specified in the NRC Rules and Regulations 10CFR-19 are available for review upon request. Refer to Subsection 11.1 Item 1) FORM NRC-3 and to SECTION 6 GOOD RADIATION SAFETY PRACTICES for relevant information. Forms NRC-3 shall be prominently posted.

4.1.2.7 Storage and Control of RAMs in Unrestricted Areas

1) RAMs shall not be stored in unrestricted areas unless secured from unauthorized removal.

2) RAMs temporarily placed in unrestricted areas shall be maintained under constant surveillance and control.

4.1.3 Waste Disposal

4.1.3.1 Transfer to Another Licensee

Radioactive waste shall be disposed of by transfer to an authorized recipient licensed to receive RAMs in the form of waste.

4.1.3.2 Disposal by Release into Sanitary Sewage Systems

1) Radioactive waste which is readily soluble or dispersible in water may be discharged into a sanitary sewage system.
2) The maximum quantity of any one radionuclide divided by the average daily total facility water consumption must be less than or equal to the applicable MPC specified in Subsection 11.3 Item 1) 10CFR-20 Appendix B, Table 1, Column 2.

$$\frac{A_1}{V} \leq \frac{MPC_1}{} \quad \text{and} \quad \frac{A_1}{V} = C_1$$

3) When more than one radionuclide is present, the summation of the concentration of each radionuclide, as determined in Item 2 of this Subparagraph, divided by its respective MPC shall be less than or equal to unity.

$$\frac{C_1}{MPC_1} + \frac{C_2}{MPC_2} + \ldots + \frac{C_n}{MPC_n} \leq 1$$

4) A similar calculation using the average monthly total facility water consumption shall be made to determine the maximum quantities of radionuclides which may be released in any one month.
5) The summation of all quantities of RAMs released shall not exceed one Curie per year.

4.1.3.3 Burial in Soil

Radioactive waste may be disposed of by burial in soil providing:

1) The total quantity of RAMs buried at one location and one time does not exceed 1,000 times the amount specified in Subsection 11.3 Item 2) 10 CFR-20 Appendix C.
2) Burial is at a minimum depth of 4 feet.
3) Not more than 12 burials are made yearly separated by at least 6 feet.

4.1.4 Records, Reports and Notification

4.1.4.1 Records of Surveys, Radiation Motitoring and Disposal

In general, all records relating to exposure of personnel to radiation or RAMs and releases of RAMs to the environment must be maintained for an indefinite time period.

4.1.4.1 1) Records of all personnel monitoring required pursuant to Subparagraph 4.1.2.2 must be maintained indefinitely on Form NRC-5 or on forms having all the requisite information for periods of time not exceeding one calendar quarter.
2) All records pursuant to the following Subparagraphs must also be maintained indefinitely: 4.1.1.3; 4.1.1.6; 4.1.3.2; and 4.1.3.3.
3) Records pursuant to Subparagraph 4.1.2.5 must be maintained for a period of two years.
4) Other records must be maintained from one NRC Inspection to the next pursuant to Subparagraph 4.1.2.1.
5) Although not required pursuant to 10CFR-20.108, it is the policy of Mallinckrodt, Inc. to maintain records of bioassay results.

4.1.4.2 Reports of Theft or Loss of RAMs

Any loss or theft of RAMs in such quantities or under such circumstances as to pose a substantial hazard to individuals in unrestricted areas shall be reported immediately by telephone and telegraph to the Director of the appropriate NRC Regional Office listed in Subsection 11.3 Item 3) 10CFR-20 Appendix D. A written report shall be sent to the Director of Inspection and Enforcement including the following information:

1) A complete description of the RAMs.
2) The circumstances causing the loss or theft.
3) The disposition or probable disposition of the RAMs.
4) The exposure or potential exposure to individuals in unrestricted areas.
5) Actions taken or planned to recover the RAMs.
6) Corrective actions taken or planned to prevent a recurrence.

Any additional pertinent information which becomes available after filing the initial written report shall be submitted within a period of 30 days. The names of any individuals who may have received an exposure shall be stated on a separate page of the report.

4.1.4.3 Notification of Incidents

The Director of the appropriate NRC Regional Office listed in Subsection 11.3 Item 3) 10CFR-20 Appendix D shall be informed by telephone and telegraph of any incident which may have caused or threatens to cause:

4.1.4.3 Notification Interval

	Immediate	24 Hours
Exposure to the whole body of any individual	25 Rems or more	5 Rems or more
Exposure to the skin of the whole body	150 Rems more	30 Rems or more
Exposure to the feet, ankles, hands or forearms	375 Rems or more	75 Rems or more
Concentrations of RAMs greater than the limits in Subsection 11.3 Item 1) Table II, Column 1 averaged over 24 hours	5000 x MPCa or more	500 x MPCa or more
Operational loss of any facilities	1 work week or more	1 day or more
Damage to property	$100,000 or more	$1,000 or more

The names of any individuals who may have received an exposure shall be stated on a separate page of any report.

4.1.4.4 Reports of Overexposures and Excessive Levels and Concentrations

A written report shall be submitted to the Director of the appropriate NRC Regional Office listed in Subsection 11.3 Item 3) 10CFR-20 Appendix D with copies to the Director of Inspection and Enforcement on the following items:

1) Exposure of an individual to radiation or concentrations of RAMs in excess of any limits applicable to the license.
2) Any incident reported pursuant to Subparagraph 4.1.4.3.
3) Levels of radiation or concentrations of RAMs in an unrestricted area in excess of the limits specified in Subparagraphs 4.1.1.5 and 4.1.1.6 not involving exposure to an individual.

These reports shall include relevant information including the cause of the exposure, the extent of the exposure and actions taken or planned to prevent a recurrence. The name of any exposed individuals shall be made a separate part of the report.

4.1.4.5 Personnel Exposure and Monitoring Reports

A report shall be submitted to the Director of Inspection and Enforcement within the first quarter of each year summarizing the exposures to personnel for the previous calendar year. This statistical summary report shall have the following format:

Estimated Whole Body Exposure Range (Rems)	Number of Individuals In Each Range
No measurable exposure	---
Exposure less than 0.1	---
0.1 to 0.25	---
0.25 to 0.5	---
0.5 to 0.75	---
0.75 to 1	---
1.0 to 2.0	---
...	---
...	---
...	---
11 to 12	---
12 +	---

4.1.4.6 Reports of Personnel Exposure on Termination of Employment or Work

Upon termination of employment or work, the exposure of an individual issued dosimetry devices pursuant to Subparagraph 4.1.2.2 shall be reported to the Director of Inspection and Enforcement. Such reports shall be furnished within 30 days after the exposure has been determined or within 90 days of termination, whichever is earlier.

4.1.4.7 Notifications and Reports to Individuals

A copy of any report involving exposure to an individual submitted to the NRC pursuant to Subparagraph 4.1.4.4 shall be sent concurrently to the exposed individual. The report shall include the following information:

1) Radiation exposure data
2) The results of determinations of RAMs deposited in the body or critical organ
3) Pertinent data and survey results
4) The name of the licensee
5) The name of the individual
6) The individual's social security number
7) The individual's date of birth
8) The individual's exposure information
9) The following statement:

4.1.4.7 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.

4.2 Committee Standards

4.2.1 Permissible Doses, Levels and Concentrations

4.2.1.1 Exposures to Individuals in Restricted Areas

The maximum permissible external exposure to an individual in any one quarter is established by the Committee in the minutes of the Radiation Safety quarterly meetings. As dosimetry data becomes available during the quarter, the projected date of reaching Committee Limits is calculated upon which date an individual is restricted from further exposure as per Subparagraph 3.2.5 In general, the Committee Limits are one half of the Regulatory Limits specified in Subparagraph 4.1.1.1 Items 1), 2), 3) and 4). Under adverse conditions, the Committee Limits may exceed one half of the Regulatory Limits. However, as actions are taken to improve operational procedures, facilities and equipment to reduce exposures, the Committee Limits shall be reduced accordingly. The purpose of establishing such Committee Limits is twofold.

1) To prevent an individual from exceeding Regulatory Limits.
2) To minimize the exposure of an individual to achieve the ALARA commitment stated in Paragraph 3.2.6.

4.2.1.2 Exposure of Individuals to Concentrations of Radioactive Material in Restricted Areas

The average airborne concentrations of RAMs should be controlled such that 25 percent of the limits specified in Subparagraph 4.1.1.3 are not exceeded. Concentrations in excess of 25 percent of these limits shall be investigated to determine the possible cause and corrective actions to be taken.

4.2.1.3 Radioactivity in Effluents to Unrestricted Areas

The yearly average effluent airborne concentrations of RAMs should be controlled such that 25 percent of the limits specified in Subparagraph 4.1.1.6 are not exceeded at the boundaries between the restricted and unrestricted areas. Reference should be made to the airborne RAM's removal efficiency studies of effluent air treatment systems to determine appropriate corrective actions.

4.2.1.4 Internal Exposures to Individuals to RAM's

The maximum permissible critical organ burdens of an individual may be based upon the chronic uptake model of ICRP Publication 2. The burdens for 4 particular radionuclides of interest are tabulated below:

Radionuclide	Critical Organ	$_{q}f_{2}$ microcuries
Iodine-131	Thyroid	0.14
Iodine-125	Thyroid	0.5*
Mercury-203	Kidneys	1.9**
Mercury-197	Kidneys	7.6**

*Calculated value from ICRP-2
**Divide values by two if measuring one kidney

A direct thyroid burden measurement for Iodine-131 and Iodine-125 using an external gamma probe is required under the following conditions:

1) If prescribed on a Master Batch Sheet or SOP immediately before processing and upon completion.
2) At least weekly of all individuals who work routinely in areas wherein Iodine products are processed, handled or stored.
3) Of all individuals working in an area within which elevated air concentrations of Iodine are measured.
4) Of all individuals working in an area within which an uncontained spill of Iodine occurs.
5) Whenever external personal contamination identified as Iodine is detected upon an individual.

A direct kidney burden measurement for Mercury-203 and Mercury-197 using an external gamma probe is required under the following conditions.

1) If prescribed on a Master Batch Sheet or SOP immediately before processing and upon completion.
2) Of all individuals working in an area within which elevated air concentrations of Mercury are measured.
3) Of all individuals working in an area within which an uncontained spill of Mercury occurs.
4) Whenever external personal contamination identified as Mercury is detected upon an individual.

4.2.1.4 A urinalysis is required for all radionuclides under the following conditions:

1) At least monthly of all individuals who work routinely in areas within which radionuclides are processed, handled or stored.
2) Of all individuals working in an area within which elevated air concentrations of RAM's are measured.
3) Of all individuals working in an area within which an uncontained spill of RAM's occurs.
4) Whenever external personal contamination by RAM's is detected upon an individual.

The derived investigation levels (DILS) established in ICRP Publication 10 shall be used as action points for evaluating urinalysis data.

4.2.1.5 Permissible Levels of Surface Contamination

Any surface on which is detected readily removable contamination in excess of permissible levels shall be decontaminated until reduced below the following specified levels:

1) The permissible level of readily removable contamination within restricted areas on surfaces exterior to ventilated enclosures is 2000 dpm/100 cm^2 on the average, or 10,000 dpm/100 cm^2 maximum at any one location.
2) The permissible level of readily removable contamination on surfaces in unrestricted areas is 200 dpm/100 cm^2.
3) The maximum permissible level of readily removable contamination on packages or containers of RAM's is 2,200 dpm/100 cm^2.

4.2.2 Precautionary Procedures

4.2.2.1 Requirements for Protective Outer Garments

Appropriate protective outer garments shall be worn over uniforms or personal clothing (e.g. shoecovers, gowns, gloves, caps or disposable labcoats) under the following conditions:

1) If surfaces you may contact have levels of readily removable contamination in excess of the permissible limits specifed in Subparagraph 4.2.1.5 Item 2).
2) If involved in decontamination operations.

4.2.2.2 Requirements for Limiting Internal Exposures to Individuals to RAM's

An individual shall be restricted from further internal exposure to a particular radionuclide or radionuclides if it is determined by bioassay measurements that the individual has a significant whole body or critical organ burden.

1) Greater than 50 percent burden - the individual is restricted from further work which caused or may have caused the increased burden.
2) Greater than 100 percent burden - the individual is restricted from work with any significant quantities of the radionuclide or radionuclides and from any area wherein air concentrations of the RAM's exist in excess of 10 percent of the applicable limits specified in Subsection 11.3 Item 1) 10CFR-20 Appendix B, Table 1, Column 1.

The individual shall remain restricted until the burden as averaged over any 7 consecutive days is below the applicable action points as specified in this Subparagraph Items 1) and 2).

4.2.2.3 Requirements for Issuance and Assignment of Personnel Dosimetry Devices

1) All individuals working in or frequenting general restricted areas shall be issued and assigned a TLD affixed to or contained within an identification badge. These combination TLD/ID badges shall be worn during all working hours. The normal wearing frequency is quarterly.
2) All individuals working in specific restricted areas within the general restricted areas which require posting as radiation or high radiation areas shall be issued and assigned additional dosimetry devices (e.g. whole body and extremity filmbadges, TLD's and self reading pocket chambers) appropriate to the work being performed. These devices shall be worn during all working hours. The normal wearing frequency is weekly.

4.2.3 Records, Reports and Notification

4.2.3.1 Notification and Reports to Individuals

Written reports shall be sent to any individuals pursuant to Subparagraph 4.1.4.4 and 4.1.4.7 if the critical organ burden of any individual as averaged over a calendar quarter exceeds the limits specified in Subparagraph 4.2.1.4.

SECTION 5

5. RADIATION SAFETY INDOCTRINATION

5.1 Requirement

All untrained and inexperienced individuals shall receive a radiation safety indoctrination before beginning work with RAMs. Any individuals will be given a review indoctrination upon request of their departmental manager.

5.2 Lecture Outline

5.2.1 Ionizing Radiation

1) Beta, Gamma, X-ray
2) Interaction with Matter

5.2.2 Units of Measure

5.2.2.1 Radioactivity

1) Curie, Millicurie, Microcurie
2) Concentration
3) Specific Activity

5.2.2.2 Radiation and Dose

1) Roentgen
2) Rad
3) Rem

5.2.3 Personnel Exposure

5.2.3.1 External Exposure

1) Dosimeters, Filmbadges, TLDs
2) Regulatory Limits, Committee Limits

5.2.3.2 Internal Exposure

1) Whole Body, Critical Organ
2) Uptake Measurements, Urinalyses
3) Regulatory Limits, Committee Limits

5.2.4 Protection Against Radiation

5.2.4.1 External Radiation

1) Time--Rate
2) Distance--Inverse Square Law
3) Shielding--Half Value Layers

5.2.4.2 Internal Radiation

1) Ventilated Hoods, Gloveboxes, Hotcells
2) Uniforms, Gloves, Shoecovers

5.2.4.3 Monitoring and Surveys

1) Loose Contamination Levels
2) Personal Contamination Levels
3) Airborne Radioactivity Levels
4) Survey Meters, Radiation Monitors

5.2.4.4 Technique--SECTION 6

5.3 Training Fascicles for Distribution

1) Transportation of Radioactive Materials
2) Philosophy of Radiation Protection
3) Control of Internal Protection Hazards
4) Basic Principles of Radiation Protection
5) Radiation Protection Guides
6) Minimum Shielding Required for Laboratory Areas

5.4 Documents Available for Review

1) Applicable NRC License
2) ICRP Publications
3) NRC Rules and Regulations--Title 10
4) DOT Regulations--Title 49
5) Mallinckrodt, Inc., Radiation Protection Program

SECTION 6

6. GOOD RADIATION SAFETY PRACTICES

6.1 Preface

Perhaps as much as 90% of Good Radiation Safety Practices fall in the categories of common sense and good housekeeping in the strict dictionary sense of the words. "Common sense 1: sound and prudent but often unsophisticated judgement." "Good housekeeping 3: the routine tasks that have to be done for a system to function." The remaining 10% is the application of knowledge, training and experience in the use of RAMS gained only over a period of time. The following practices are by no means comprehensive, but include those most pertinent to over-all operations.

6.2 Practices in Restricted Areas

6.2.1 Personal Habits

1) Individuals should be conscious of and avoid such habits as chewing of gum, biting their fingernails or placing objects such as pencils or eyeglass temples in the mouth.
2) The application of cosmetics is prohibited.
3) Mouth pipetting is prohibited.
4) Habits such as nose rubbing and head scratching should be curbed.

6.2.2 Precautions

1) Smoking, eating and drinking (except from drinking fountains) is prohibited in areas so posted.
2) Individuals shall report to their supervisor any break in the skin, such as a cut or abrasion, regardless of whether sustained on the job or not. The supervisor will consult with a RPS member for appropriate measures to be taken.
3) Individuals must wash their hands each time upon leaving posted areas.
4) Individuals should wash their hands each time after handling potentially contaminated items.
5) Individuals must survey all items being removed from restricted areas to prevent the inadvertent transfer of contamination to unrestricted areas.

6.2.3 Personal Contamination Surveys

Any contamination detectible above background is indicative of excessive loose contamination levels and should be reported to the individual's supervisor.

1) Individuals should survey their hands and shoes each time upon leaving a restricted area so posted.
2) All other exposed body surfaces including the face and hair should be surveyed.
3) Clothing to be worn upon leaving a restricted area should be surveyed including in particular the sleeves, pockets and waistband area.
4) Personal belongings including pens, self reading dosimeters and filmbadges should be surveyed.

6.2.4 Personal Dosimetry

1) Each individual shall wear all assigned and issued dosimetry devices, including TLDs, filmbadges and self reading dosimeters, during all working hours.
2) The dose accumulated on self reading dosimeters should be observed frequently when working with RAMs and the reading recorded as specified by specific procedures and on the individuals record at the end of each working day.
3) Self reading dosimeters and filmbadges shall be stored in designated low background areas with control badges at the end of each working day.

6.2.5 Protective Clothing

1) Lightweight disposable gloves should be worn as a precautionary measure when handling items which are unlikely to be contaminated.
2) Heavy duty rubber gloves shall be worn when handling items which are known or likely to be contaminated.
3) Lightweight gloves may be worn inside heavy duty gloves as an additional precautionary measure.
4) Shoecovers shall be worn in all areas designated as shoecover areas and in any areas temporarily established as shoecover areas as a result of a spill of RAMs.
5) Gloves and shoecovers shall be removed before leaving a restricted area.
6) Care should be exercised when removing gloves or shoecovers to prevent the possible spread of contamination.
7) Outer protective clothing such as labcoats, gowns, aprons or caps may be required to be worn over laboratory uniforms or personal clothing for certain operations. Such clothing must be removed before leaving the particular area.

6.2.6 Work Area Surveys

1) Each individual is responsible for knowing the radiation fields in which he is working by personally measuring the radiation levels with a survey meter. The individual shall periodically record the radiation levels if so required by written procedures.
2) Each individual shall check his work area for gross contamination by wiping large areas with paper towels or similar disposable materials which are subsequently held in close proximity to a radiation monitor detector.
3) Individuals shall report any high survey results to their supervisor for corrective action.

6.2.7 Handling RAMs

1) Any operation involving volatile forms of RAMs shall be performed in a ventilated hood, glovebox or hotcell under negative pressure.
2) RAMs shall be handled over disposable material placed upon work surfaces to prevent possible contamination of the permanent surfaces.
3) Perform all work with RAMs over a benchtop or cart to minimize the consequences of spills.
4) RAMs shall be placed within lead safes or behind lead shields of sufficient thickness to minimize external exposure. Refer to written procedures or consult with your supervisor for appropriate wall thickness for the activity and radionuclide being handled.

6.2.8 Transport of RAMs

1) Activity being transferred from location to location shall be placed within uncontaminated lead safes provided for this purpose.
2) Safes containing activity shall be transported from location to location on carts, skids or other means of conveyance having sides to prevent the lead safes from falling off.

6.2.9 Radioactive Waste Handling

The mishandling of radioactive waste can easily cause elevated radiation levels, or elevated airborne concentrations of RAMs, or the spread of RAMs as contamination.

1) Never intermix dry, solid radioactive waste with glass bottles containing liquid radioactive waste. The dry waste is reduced in volume by compaction. Glass bottles are placed in a glass crusher so the liquid may be siphoned off. Intermixing would cause processing problems with possibly serious consequences.

6.2.9 2) Always replace needle guards on disposable syringes.
3) Always replace screwcap or crimpcap closures on bottles before disposal, including so called "empty" bottles.
4) Never place radioactive waste in containers for nonradioactive waste.
5) Never dispose of radioactive waste by means of nonradioactive sinks or drains.
6) Never dispose of more than submillicurie quantities of liquid waste with a halflife greater than one week by means of radioactive sinks or drains.
7) Always dispose of high level radioactive waste in shielded containers within ventilated enclosures.

6.2.10 Accidents

Refer to and familiarize yourself with the EMERGENCY PROCEDURES as prescribed in SECTION 8. Inform your LED, supervisor, or member of the RPS of any incident which threatens your personal safety, the safety of any other individual, or the facility. The most common accidents and actions to be taken are as follows:

1) Any wound such as a needle puncture of the skin or cuts from sharp objects containing or contaminated with RAMs should be reported immediately, allowed to bleed and washed thoroughly.
2) Report any spills of RAMs immediately and request assistance. Avoid spreading the spilled material by staying in the general vicinity long enough to make other individuals aware of the spill and its location.

6.3 Conclusion

There is some degree of risk involved in any occupation. Work in the nuclear field entails exposure to radiation or RAMs and is not an exception. It is generally accepted that the risk to an individual is neglibible when continuous occupational exposures are maintained within the limits established by the NRC. There is also general agreement that any unnecessary exposure is an undesirable exposure. Radiation workers must accept this fundamental principle and vigilantly perform all operations involving RAMs in such a manner as to mimimize exposure to themselves and to all other individuals.

SECTION 7

7. STANDARD OPERATING PROCEDURES

7.1 Health Physics

1) Calibration of Survey Meters
2) Calibration of Equipment Air Samples
3) Calibration of Uptake Machine for Thyroid Burden Measurements
4) Air Sample Cartridge Changing
5) Radiation Level Survey
6) Thyroid Burden Measurements
7) Film Badge Dosimetry
8) Urinalysis Program
9) Contaminated Uniforms
10) Survey of Laundry for Radioactive Material
11) Loose Contamination Level Survey
12) Contamination Check of Shipping Containers
13) Liquid Waste Analysis
14) High Level Solid and Liquid Radioactive Waste Handling
15) Low Level Solid and Liquid Radioactive Waste Handling
16) Packaging and Shipment of Radioactive Waste
17) Environmental Fence Line Survey
18) Environmental Air Sampling Survey
19) Filtration Media Efficiency Testing
20) Fume Hood Face Velocity Testing
21) Glove Box Pressure Differential Checks
22) Building Air Flow Pattern Check

7.2 Maintenance

7.2.1 Periodic Maintenance of Hot Labs

1) Exhaust Systems
2) Benches and Floors

7.2.2 Care and Cleaning of Animal Rooms

SECTION 8

8. EMERGENCY PROCEDURES PROGRAM

8.1 Emergency Organization

8.1.1 Plant Emergency Director

8.1.1.1 Responsibility

The Plant Manager is the Plant Emergency Director and is administratively responsible to the Director of Operations who is responsible to the Director of Radiopharmaceutical R&D. The Director of Operations is the Plant Emergency Director in the absence of a Plant Manager.

8.1.1.2 Duties

The Plant Emergency Director ensures that a well supervised Emergency Organization is established with well defined responsibilities. The Plant Emergency Director shall provide overall direction for emergency situations, including:

1) Maintain contact with and coordinate the efforts of Local Emergency Directors.
2) Respond to requests for assistance from Local Emergency Directors.
3) Assume direct control of any emergency affecting more than one operations area or building.
4) Control the release of information to the public media.
5) Assure that loss reports and necessary notifications are made to insurance and regulatory agencies.
6) Assure that the necessary number of emergency drills are performed.

8.1.2 Technical Advisors

8.1.2.1 Responsibility

The Technical Advisors are selected on the basis of their qualifications and experience in handling emergencies and are administratively responsible to the Plant Emergency Director.

8.1.2.2 Duties

The Technical Advisory Group shall respond to emergencies and provide the Plant Emergency Director or Local Emergency Directors advice regarding the following services:

8.1.2.2 1) Safety or Industrial Hygiene
2) Health/Physics and Decontamination
3) First Aid
4) Plant Engineering and Maintenance
5) Fire Fighting Speciality Assistance

8.1.3 Local Emergency Directors

8.1.3.1 Responsibility

The Local Emergency Directors are selected and trained by the Technical Advisory Group to cope with emergency situations in their respective areas and in this respect are administratively responsible to the Plant Emergency Director.

8.1.3.2 Duties

The Local Emergency Directors shall direct all emergency activities in their respective areas. Such duties will be assumed by their alternates until relieved by the Local Emergency Director or as directed by the Plant Emergency Director. Actions taken during emergency situations include:

1) Take necessary initial steps to control the emergency as required.
2) Notify the Plant Emergency Director if required.
3) Arrange for proper shutdown of operations or equipment if required.
4) Assure that personnel in their area are properly trained.
5) Establish and maintain emergency procedures and evacuation plans.
6) Determine that all individuals have been evacuated from a danger area and prepare a list of the individuals to the Plant Emergency Director.
7) Provide guidance and assistance to the Fire Department as they arrive, after which the Fire Marshall or Captain shall have total authority while directing fire control.
8) Establish a safe and orderly return to work procedure.

8.2 Emergency Procedures Manual

The Emergency Procedures Manual is a separate document subject to change as facilities, operations and procedures change. The contents of this 61 page document include:

8.2 Introduction
Emergency Organizational Chart
Objective and Policy
Local Emergency Director
Plant Emergency Director
Technical Advisory Group
Operating Procedures
Emergency Announcements and Requests for Assistance
Actions of Responding Groups
Fire and Explosion
Emergency Evacuation Routes and Assembly Area Graphs
Second Shift Emergency Plan
Radiological Spills and Contamination
Chemical Spills or Releases
Methods to Secure
Significant Injury
Information for Handling Emergencies
Severe Weather Procedures
Medical or Hospital Assistance
Plant Emergency Call List
Emergency Locker Contents and Locations

8.3 Outside Emergency Services

8.3.1 Hospitals and Medical Offices

Provisions have been made for treatment of occupational injuries by appropriately trained physicians in the Greater Metropolitan St. Louis area. These injuries may be placed in two main categories.

8.3.1.1 Ordinary occupational injuries such as lacerations, contusions, fractures, burns, eye injuries, exposure to chemicals or other injuries not involving RAMs.

The control of internal or external exposure to individuals as may result from

1) An accidental high thyroid uptake of Iodine-131 or Iodine-125, or

2) The treatment of individuals who sustain injuries involving gross contamination with RAMs resulting from unlikely events such as an explosion, fire or other destruction of the facilities or equipment. A program to handle such emergencies was established in 1968. This program is currently under review by a committee established by the hospital under the chairmanship of Dr. David Kipnis, M.D., Chief of Medicine at Washington University, to update the procedures and protocol.

8.3.2 Ambulance or Taxi Transportation

Provisions are incorporated in the Emergency Procedures Manual, including telephone listings, for transportation of individuals to specified hospitals or medical offices.

8.3.3 Fire Fighting and Auxillary Services

Provisions are incorporated in the Emergency Procedures Manual, for the local fire department, police department and utilities companies, including telephone listings. In addition, the police or fire department are summoned by our security service upon automatic alarm signals at the service center.

SECTION 9

9. PLANT SECURITY

9.1 Building Security

9.1.1 Electronic Systems

All doors and windows through which unauthorized entry can be made are equipped with devices to signal a central service center located off site which initiates appropriate action. These systems are activated during non-routine working hours. In addition, our water sprinkler system automatically activates an alarm signal upon drop of water pressure. Manual fire alarm boxes are also strategically located throughout the facility.

9.1.2 Armed Guard Service

Provisions have been made for armed guard duty during specified night hours. An extension of this service is under consideration by Management to include daytime hours.

9.2 Security Badges

9.2.1 Personnel Identification Badges

All permanent and temporary employees, including outside contractors and their employees, are issued identification badges which are required to be worn on site.

9.2.2 Temporary Visitors Badges

Visitors are issued temporary badges by the receptionists who require that they sign a logbook upon entering and leaving the facility.

SECTION 10

10. RADIATION SAFETY TRAINING SESSIONS

10.1 Attendance

All individuals who use or supervise the use of RAMs shall attend periodic Radiation Safety Training Sessions specific to their respective duties and responsibilities. This training shall be provided by the Chief RSO or Resident RSOs commencing during the first quarter of 1978.

10.2 Testing

All individuals attending such training sessions shall be given written tests to determine their level of competency. The results of these tests shall be maintained for review.

SECTION 11

11. ADDENDUM

11.1 Forms

11.2 Schedules

11.3 Appendices

Form NRC-3
(4-75)
10 CFR 19
10 CFR 20

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

NOTICE TO EMPLOYEES

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

In Part 20 of its Rules and Regulations, the Nuclear Regulatory Commission has established standards for your protection against radiation hazards from radioactive material under license issued by the Nuclear Regulatory Commission. In Part 19 of its Rules and Regulations, the Nuclear Regulatory Commission has established certain provisions for the options of workers engaged in NRC licensed activities.

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.

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; and
7. 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 Sections 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 regulations 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 Inspection and Enforcement Regional Office (shown on map at right). 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.

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 working in or frequenting any portion of a restricted area to observe a copy on the way to or from their place of

UNITED STATES NUCLEAR REGULATORY COMMISSION

Regional Offices

REGION	ADDRESS	TELEPHONE	
		DAYTIME	NIGHTS AND HOLIDAYS
I	Region I, Office of Inspection and Enforcement, USNRC 631 Park Avenue King of Prussia, Pennsylvania 19406	215 337-1150	215 337-1150
II	Region II, Office of Inspection and Enforcement, USNRC 230 Peachtree Street, N.W., Suite 818 Atlanta, Georgia 30303	404 [illegible] 4503	404 [illegible] 4503
III	Region III, Office of Inspection and Enforcement, USNRC 799 Roosevelt Road Glen Ellyn, Illinois 60137	312 858 2660	312 858 2660
IV	Region IV, Office of Inspection and Enforcement, USNRC 611 Ryan Plaza Drive, Suite 1000 Arlington, Texas 76012	817 334 2841	817 334 2841
V	Region V, Office of Inspection and Enforcement, USNRC 1990 N. California Boulevard, Suite 202, Walnut Creek Plaza Walnut Creek, California 94596	415 486 3141	415 486 3141

FORM AEC-4
(9-48)

Form Approved
Bureau of Budget No. 58-R118.
Expiration Date: June 30, 1961.

U.S. ATOMIC ENERGY COMMISSION

OCCUPATIONAL EXTERNAL RADIATION EXPOSURE HISTORY

See Instructions on the Back

IDENTIFICATION

1. NAME (PRINT—LAST, FIRST, AND MIDDLE)	2. SOCIAL SECURITY NO.
3. DATE OF BIRTH (MONTH, DAY, YEAR)	4. AGE IN FULL YEARS (R)

OCCUPATIONAL EXPOSURE—PREVIOUS HISTORY

5. PREVIOUS EMPLOYMENTS INVOLVING RADIATION EXPOSURE—LIST NAME AND ADDRESS OF EMPLOYER	6. DATES OF EMPLOYMENT (FROM—TO)	7. PERIODS OF EXPOSURE	PREVIOUS DOSE HISTORY	
			8. WHOLE BODY (REM)	9. INSERT ONE RECORD OR CALCULATED

10. REMARKS	11. ACCUMULATED OCCUPATIONAL DOSE—TOTAL	

13. CALCULATIONS—PERMISSIBLE DOSE

WHOLE BODY

(A) PERMISSIBLE ACCUMULATED DOSE = 5(N−18) = _____ REM

(B) TOTAL EXPOSURE TO DATE (FROM ITEM 11) = _____ REM

(C) PERMISSIBLE DOSE = _____ REM

12. CERTIFICATION I CERTIFY THAT THE EXPOSURE HISTORY LISTED IN COLUMNS 5, 6, AND 7 IS CORRECT AND COMPLETE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

EMPLOYEE'S SIGNATURE DATE

14. NAME OF LICENSEE

FORM AEC
9 60

Form approved
Bureau of Budget No. 38-R120
Expiration date June 30, 1961

U.S. ATOMIC ENERGY COMMISSION

CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

IDENTIFICATION

1 NAME PRINT Last first and middle	2 SOCIAL SECURITY NO.
3 DATE OF BIRTH (Month, day, year)	4 AGE IN FULL YEARS

OCCUPATIONAL EXPOSURE

5 DOSE RECORDED FOR (Specify Whole body, Skin of whole body, or hands and forearms, feet and ankles)	6 PERMISSIBLE DOSE AT BEGINNING OF PERIOD COVERED BY THIS SHEET rem	7 METHOD OF MONITORING (e.g. Film Badge, FB Packet, Chamber, PC, Calculations, Etc.) GAMMA _____ NEUTRONS _____ BETA _____

8 PERIOD OF EXPOSURE From to	DOSE FOR THE PERIOD rem				13 RUNNING TOTAL FOR CALENDAR QUARTER rem
	9 GAMMA	10 BETA	11 NEUTRON	12 TOTAL	

LIFETIME ACCUMULATED DOSE

14 PREVIOUS TOTAL rem	15 TOTAL DOSE RECORDED ON THIS SHEET rem	16 TOTAL ACCUMULATED DOSE rem	17 PERM. ACC. DOSE 5(N-18) rem	18 PERMISSIBLE DOSE rem

12 NAME OF LICENSEE

MALLINCKRODT INC.
MALLINCKRODT NUCLEAR
2703 WAGNER PLACE
MARYLAND HEIGHTS, MO 63043

33 FR 14579

33 FR 14579

SCHEDULES

§ 33.100 Schedule A.

Byproduct material	Col. I curies	Col. II curies
Antimony-122	1	0.01
Antimony-124	1	.01
Antimony-125	1	.01
Arsenic-73	10	.1
Arsenic-74	1	.01
Arsenic-76	1	.01
Arsenic-77	10	.1
Barium-131	10	.1
Barium-140	1	.01
Bismuth-210	.1	.001
Bromine-82	10	.1
Cadmium-109	1	.01
Cadmium-115m	1	.01
Cadmium-115	10	.1
Calcium-45	1	.01
Calcium-47	10	.1
Carbon-14	100	1.
Cerium-141	10	.1
Cerium-143	10	.1
Cerium-144	1	.001
Cesium-131	100	1.
Cesium-134m	100	1.
Cesium-134	1	.001
Cesium-135	1	.01
Cesium-136	10	.1
Cesium-137	1	.001
Chlorine-36	1	.01
Chlorine-38	10	.1
Chromium-51	100	1.
Cobalt-58m	100	1.
Cobalt-58	1	.01
Cobalt-60	1	.001
Copper-64	10	.1
Dysprosium-165	100	1.
Dysprosium-166	10	.1
Erbium-169	10	.1
Erbium-171	10	.1
Europium-152 9.2 h	10	.1
Europium-152 13 y	.1	.001
Europium-154	1	.001
Europium-155	1	.01
Fluorine-18	100	1.
Gadolinium-153	1	.01
Gadolinium-159	10	.1
Gallium-72	10	.1
Germanium-71	100	1.
Gold-196	10	.1
Gold-198	10	.1
Iridium-191	1	.01
Iridium-192	10	.1
Iridium-194	100	1.
Iridium-190	100	1.
Iridium-192m	1	.01
Iridium-192n	100	1.
Iridium-194	1	.01
Iodine-125	.1	.001
Iodine-126	.1	.001
Iodine-129	.1	.001
Iodine-131	1	.001
Iodine-132	10	.1
Iodine-133	1	.01
Iodine-134	10	.1
Iodine-135	1	.01
Iridium-192	1	.01
Iridium-194	10	.1
Iron-55	10	.1
Iron-59	1	.01
Krypton-85	100	1.
Krypton-87	10	.1
Lanthanum-140	1	.01
Lutetium-177	10	.1
Manganese-51	1	.01

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Byproduct material	Col. I curies	Col. II curies
Mercury-197m	10	.1
Mercury-197	10	.1
Mercury-203	1	.01
Molybdenum-99	10	.1
Neodymium-147	10	.1
Neodymium-149	10	.1
Nickel-59	10	.1
Nickel-63	1	.01
Nickel-65	10	.1
Niobium-93m	1	.01
Niobium-95	1	.01
Niobium-97	100	1.
Osmium-185	1	.01
Osmium-191m	100	1.
Osmium-191	10	.1
Osmium-193	10	.1
Palladium-103	10	.1
Palladium-109	10	.1
Phosphorus-32	1	.01
Platinum-191	10	.1
Platinum-193m	100	1.
Platinum-197m	10	.1
Platinum-197	100	1.
Polonium-210	.01	.0001
Potassium-42	1	.01
Praseodymium-142	10	.1
Praseodymium-143	10	.1
Promethium-147	1	.01
Promethium-149	10	.1
Rhenium-186	10	.1
Rhenium-188	10	.1
Rhodium-105m	1,000	10.
Rubidium-83	10	.1
Rubidium-86	1	.01
Rubidium-87	1	.01
Rubidium-87	100	1.
Ruthenium-97	1	.01
Ruthenium-103	10	.1
Ruthenium-105	10	.1
Ruthenium-106	.1	.001
Samarium-151	10	.1
Samarium-153	10	.1
Scandium-46	1	.01
Scandium-47	10	.1
Scandium-48	1	.01
Selenium-75	1	.01
Silicon-31	10	.1
Silver-105	1	.01
Silver-110m	.1	.001
Silver-111	10	.1
Sodium-24	1	.01
Strontium-85m	1,000	10.
Strontium-85	1	.01
Strontium-89	1	.01
Strontium-90	.01	.0001
Strontium-91	10	.1
Strontium-92	10	.1
Sulphur-35	10	.1
Tantalum-182	1	.01
Technetium-96	1	.01
Technetium-97m	10	.1
Technetium-97	10	.1
Technetium-99m	100	1.
Technetium-99	1	.01
Tellurium-125m	10	.1
Tellurium-127m	10	.1
Tellurium-127	100	1.
Tellurium-129m	10	.1
Tellurium-129	100	1.
Tellurium-131m	10	.1
Tellurium-132	10	.1
Terbium-160	10	.1
Thallium-200	10	.1
Thallium-201	10	.1
Thallium-202	10	.1
Thallium-204	10	.1
Thulium-170	10	.1
Thulium-171	10	.1
Tin-113	1	.01
Tin-123	1	.01
Tungsten-181	10	.1
Tungsten-185	1	.01
Tungsten-187	10	.1
Vanadium-48	1	.01
Xenon-131m	1,000	10.
Xenon-133	100	1.
Xenon-135	100	1.
Ytterbium-175	10	.1
Yttrium-87	1	.01
Yttrium-90	1	.01
Yttrium-91	1	.01
Yttrium-92	10	.1
Yttrium-93	10	.1
Zinc-65	1	.01
Zinc-69m	10	.1
Zinc-69	100	1.
Zirconium-93	1	.01
Zirconium-95	1	.01
Zirconium-97	1	.01
Any byproduct material other than alpha emitting byproduct material not listed above	.1	.001

» Note—The reporting and record keeping requirements contained in this part have been approved by the General Accounting Office under B-180225 (R0085) «

APPENDIX B

Concentrations in Air and Water Above Natural Background

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]		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	S	2×10^{-12}	6×10^{-3}	8×10^{-14}	2×10^{-4}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		* I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 242m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am 242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 244	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	5×10^{-5}
Antimony (51)	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub[2]	6×10^{-3}		1×10^{-4}	
	A 41	Sub	2×10^{-8}		4×10^{-9}	
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As 77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-6}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]		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	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	* S	6×10^{-12}	2×10^{-4}	2×10^{-13}	7×10^{-6}
		* I	3×10^{-11}	2×10^{-4}	1×10^{-12}	7×10^{-6}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-3}	1×10^{-7}	8×10^{-5}
	(CO_2)	Sub	5×10^{-5}		1×10^{-6}	
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}

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Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-3}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-3}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-3}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-6}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-6}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		* I	2×10^{-10}	7×10^{-4}	6×10^{-12}	2×10^{-5}
	Cm 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	5×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cm 244	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cm 245	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 246	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Cm 247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm 248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
		I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm 249	S	1×10^{-5}	6×10^{-3}	4×10^{-7}	2×10^{-3}
		I	1×10^{-5}	6×10^{-3}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy 165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
	Dy 166	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Einsteinium (99)	Es 253	S	8×10^{-10}	7×10^{-4}	3×10^{-11}	2×10^{-5}
		I	6×10^{-10}	7×10^{-4}	2×10^{-11}	2×10^{-5}
	Es 254m	S	5×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
		I	6×10^{-9}	5×10^{-4}	2×10^{-10}	2×10^{-5}
	Es 254	S	2×10^{-11}	4×10^{-4}	6×10^{-13}	1×10^{-5}
		I	1×10^{-10}	4×10^{-4}	4×10^{-12}	1×10^{-5}
	Es 255	S	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	4×10^{-10}	8×10^{-4}	1×10^{-11}	3×10^{-5}
Erbium (68)	Er 169	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	4×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	Er 171	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Europium (63)	Eu 152 (T/2 = 9.2 hrs)	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu 152 (T/2 = 13 yrs)	S	1×10^{-6}	2×10^{-3}	4×10^{-10}	8×10^{-5}
		I	2×10^{-6}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu 154	S	4×10^{-6}	6×10^{-4}	1×10^{-10}	2×10^{-5}
		I	7×10^{-6}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu 155	S	9×10^{-6}	6×10^{-3}	3×10^{-9}	2×10^{-4}
		I	7×10^{-6}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm 254	S	6×10^{-6}	4×10^{-3}	2×10^{-9}	1×10^{-4}
		I	7×10^{-6}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm 255	S	2×10^{-6}	1×10^{-3}	6×10^{-10}	3×10^{-5}
		I	1×10^{-6}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm 256	S	3×10^{-9}	3×10^{-3}	1×10^{-10}	9×10^{-7}
		I	2×10^{-9}	3×10^{-3}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F 18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd 153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
		I	9×10^{-6}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd 159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Gallium (31)	Ga 72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge 71	S	1×10^{-5}	5×10^{-3}	4×10^{-7}	2×10^{-3}
		I	6×10^{-6}	5×10^{-3}	2×10^{-7}	2×10^{-3}
Gold (79)	Au 196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au 198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au 199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf 181	S	4×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
		I	7×10^{-8}	2×10^{-3}	3×10^{-9}	7×10^{-5}
Holmium (67)	Ho 166	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Hydrogen (1)	H3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
		Sub	2×10^{-3}	.....	4×10^{-3}	.....
Indium (49)	In 113m	S	8×10^{-6}	4×10^{-3}	3×10^{-7}	1×10^{-3}
		I	7×10^{-6}	4×10^{-3}	2×10^{-7}	1×10^{-3}
	In 114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	2×10^{-6}	5×10^{-4}	7×10^{-10}	2×10^{-5}
	In 115m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	In 115	S	2×10^{-7}	3×10^{-3}	9×10^{-9}	9×10^{-5}
		I	3×10^{-6}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)	I 125	S	5×10^{-9}	4×10^{-3}	8×10^{-11}	2×10^{-7}
		I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I 126	S	8×10^{-9}	5×10^{-3}	9×10^{-11}	3×10^{-7}
		I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I 129	S	2×10^{-9}	1×10^{-3}	2×10^{-11}	6×10^{-8}
		I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I 131	S	9×10^{-9}	6×10^{-3}	1×10^{-10}	3×10^{-7}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I 132	S	2×10^{-7}	2×10^{-3}	3×10^{-9}	8×10^{-6}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I 133	S	3×10^{-8}	2×10^{-4}	4×10^{-10}	1×10^{-6}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	I 134	S	5×10^{-7}	4×10^{-3}	6×10^{-9}	2×10^{-4}

25 FR 10914, Oct. 31, 1960, as amended at 38 FR 1975, Jan. 19, 1973

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Iodine (53)	I 134	I	3×10^{-6}	2×10^{-3}	1×10^{-7}	6×10^{-4}
	I 135	S	1×10^{-7}	7×10^{-4}	1×10^{-8}	4×10^{-4}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-4}
Iridium (77)	Ir 190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir 192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	9×10^{-10}	4×10^{-5}
	Ir 194	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
Iron (26)	Fe 55	S	9×10^{-7}	2×10^{-2}	3×10^{-8}	8×10^{-4}
		I	1×10^{-6}	7×10^{-3}	3×10^{-8}	2×10^{-3}
	Fe 59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	5×10^{-5}
Krypton (36)	Kr 85m	Sub	6×10^{-6}		1×10^{-7}	
	Kr 85	Sub	1×10^{-5}		3×10^{-7}	
	Kr 87	Sub	1×10^{-6}		2×10^{-8}	
	Kr 88	Sub	1×10^{-6}		2×10^{-8}	
Lanthanum (57)	La 140	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	1×10^{-7}	7×10^{-4}	4×10^{-9}	2×10^{-5}
Lead (82)	Pb 203	S	3×10^{-6}	1×10^{-3}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-3}	6×10^{-8}	4×10^{-4}
	Pb 210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
		I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb 212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
		I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu 177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn 52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn 54	* S	4×10^{-7}	4×10^{-3}	1×10^{-8}	1×10^{-4}
		I	4×10^{-8}	3×10^{-3}	1×10^{-9}	1×10^{-4}
	Mn 56	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Mercury (80)	Hg 197m	S	7×10^{-7}	6×10^{-3}	3×10^{-8}	2×10^{-4}
		I	8×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Hg 197	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg 203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo 99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
Neodymium (60)	Nd 144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
		I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd 147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd 149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}

APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

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

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(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Plutonium (94)	Pu 242	S	2×10^{-13}	1×10^{-6}	6×10^{-14}	5×10^{-6}
		I	4×10^{-11}	9×10^{-4}	1×10^{-13}	3×10^{-5}
	Pu 243	S	2×10^{-6}	1×10^{-3}	6×10^{-8}	3×10^{-4}
		I	2×10^{-6}	1×10^{-3}	8×10^{-9}	3×10^{-4}
	Pu 244	S	2×10^{-13}	1×10^{-6}	6×10^{-14}	4×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-13}	1×10^{-5}
Polonium (84)	Po 210	S	5×10^{-10}	2×10^{-3}	2×10^{-11}	7×10^{-7}
		I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K 42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr 142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr 143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm 147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
		I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm 149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protoactinium (91)	Pa 230	S	2×10^{-8}	7×10^{-5}	6×10^{-11}	2×10^{-6}
		I	8×10^{-10}	7×10^{-5}	3×10^{-11}	2×10^{-6}
	Pa 231	S	1×10^{-12}	3×10^{-3}	4×10^{-14}	9×10^{-7}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa 233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra 223	S	2×10^{-9}	2×10^{-3}	6×10^{-11}	7×10^{-7}
		I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra 224	S	5×10^{-9}	7×10^{-3}	2×10^{-10}	2×10^{-6}
		I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra 226	S	3×10^{-11}	4×10^{-7}	3×10^{-13}	3×10^{-8}
		I	5×10^{-11}	9×10^{-4}	2×10^{-13}	3×10^{-5}
	Ra 228	S	7×10^{-13}	8×10^{-7}	2×10^{-13}	3×10^{-8}
		I	4×10^{-12}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn 220	S	3×10^{-7}		1×10^{-8}	
	Rn 222 [3]	***	3×10^{-8}		3×10^{-9}	
Rhenium (75)	Re 183	S	3×10^{-6}	2×10^{-3}	9×10^{-8}	6×10^{-5}
		I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re 186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re 187	S	9×10^{-6}	7×10^{-3}	3×10^{-7}	3×10^{-3}
		I	5×10^{-7}	4×10^{-3}	2×10^{-8}	2×10^{-3}
	Re 188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh 103m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	6×10^{-5}	3×10^{-1}	2×10^{-6}	1×10^{-2}
	Rh 105	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Rubidium (37)	Rb 86	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	7×10^{-6}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb 87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	7×10^{-6}	5×10^{-3}	2×10^{-9}	2×10^{-5}

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Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Ruthenium (44)	Ru 97	S	2×10^{-6}	1×10^{-3}	8×10^{-8}	4×10^{-5}
		I	2×10^{-6}	1×10^{-3}	6×10^{-8}	3×10^{-5}
	Ru 103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	8×10^{-6}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru 105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru 106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-3}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-3}
Samarium (62)	Sm 147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
		I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm 151	S	6×10^{-8}	1×10^{-3}	2×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Sm 153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc 46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc 47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc 48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se 75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
		I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}
Silicon (14)	Si 31	S	6×10^{-6}	3×10^{-3}	2×10^{-7}	9×10^{-5}
		I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag 105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag 110m	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-8}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Ag 111	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Sodium (11)	Na 22	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	9×10^{-9}	9×10^{-4}	3×10^{-10}	3×10^{-5}
	Na 24	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Strontium (38)	Sr 85m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
		I	3×10^{-5}	2×10^{-1}	1×10^{-6}	7×10^{-3}
	Sr 85	S	2×10^{-7}	3×10^{-3}	8×10^{-9}	1×10^{-4}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Sr 89	S	3×10^{-8}	3×10^{-4}	3×10^{-10}	3×10^{-6}
		I	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Sr 90	S	1×10^{-9}	1×10^{-3}	3×10^{-11}	3×10^{-7}
		I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr 91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr 92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S 35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
		I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta 182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
		I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Technetium (43)	Tc 96m	S	8×10^{-5}	4×10^{-1}	3×10^{-6}	1×10^{-2}
		I	3×10^{-5}	3×10^{-1}	1×10^{-6}	1×10^{-2}
	Tc 96	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Tc 97m	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	2×10^{-7}	5×10^{-3}	5×10^{-9}	2×10^{-4}
	Tc 97	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Tc 99m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	1×10^{-5}	8×10^{-2}	5×10^{-7}	3×10^{-3}
	Tc 99	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Tellurium (52)	Te 125m	S	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	Te 127m	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
		I	4×10^{-8}	2×10^{-3}	1×10^{-9}	5×10^{-5}
	Te 127	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Te 129m	S	8×10^{-8}	1×10^{-3}	3×10^{-9}	3×10^{-5}
		I	3×10^{-8}	6×10^{-4}	1×10^{-9}	2×10^{-5}
	Te 129	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
		I	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	Te 131m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
	Te 132	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
		I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Terbium (65)	Tb 160	S	1×10^{-7}	1×10^{-3}	3×10^{-9}	4×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
Thallium (81)	Tl 200	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Tl 201	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
		I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	Tl 202	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	2×10^{-7}	2×10^{-3}	8×10^{-9}	7×10^{-5}
	Tl 204	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	2×10^{-3}	9×10^{-10}	6×10^{-5}
Thorium (90)	* Th 227	S	3×10^{-10}	5×10^{-4}	1×10^{-11}	2×10^{-5}
		I	2×10^{-10}	5×10^{-4}	6×10^{-12}	2×10^{-5}
	Th 228	S	9×10^{-12}	2×10^{-4}	3×10^{-13}	7×10^{-6}
		I	6×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
	Th 230	S	2×10^{-12}	5×10^{-5}	8×10^{-14}	2×10^{-6}
		I	1×10^{-11}	9×10^{-4}	3×10^{-13}	3×10^{-5}
	* Th 231	S	1×10^{-6}	7×10^{-3}	5×10^{-8}	2×10^{-4}
		I	1×10^{-6}	7×10^{-3}	4×10^{-8}	2×10^{-4}
	Th 232	S	3×10^{-11}	5×10^{-5}	1×10^{-12}	2×10^{-6}
		I	3×10^{-11}	1×10^{-3}	1×10^{-12}	4×10^{-5}
	** Th natural	S	6×10^{-11}	6×10^{-5}	2×10^{-12}	2×10^{-6}
		I	6×10^{-11}	6×10^{-4}	2×10^{-12}	2×10^{-5}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]	†	Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Thorium (90)	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
	Tm 171	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	8×10^{-9}	5×10^{-4}
Tin (50)	Sn 113	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	5×10^{-8}	2×10^{-3}	2×10^{-9}	8×10^{-5}
	Sn 125	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	8×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Tungsten (Wolfram) (74)	W 181	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
		I	1×10^{-7}	1×10^{-2}	4×10^{-9}	3×10^{-4}
	W 185	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
	W 187	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Uranium (92)	U 230	S	3×10^{-10}	1×10^{-4}	1×10^{-11}	5×10^{-6}
		I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U 232	S	1×10^{-11}	8×10^{-4}	3×10^{-13}	3×10^{-5}
		I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U 233	S	5×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	** U 234	S[4]	6×10^{-10}	9×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	** U 235	S[4]	5×10^{-10}	8×10^{-4}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U 236	S	6×10^{-10}	1×10^{-3}	2×10^{-11}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	** U 238	S[4]	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	** U-natural	S[4]	1×10^{-10}	1×10^{-3}	5×10^{-12}	3×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	3×10^{-5}
Vanadium (23)	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe 131m	Sub	2×10^{-5}		4×10^{-7}	
	Xe 133	Sub	1×10^{-5}		3×10^{-7}	
	Xe 133m	Sub	1×10^{-5}		3×10^{-7}	
	Xe 135	Sub	4×10^{-6}		1×10^{-7}	
Ytterbium (70)	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39)	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}

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APPENDIX B

Concentrations in Air and Water Above Natural Background—Continued

(See footnotes on page 20-15)

Element (atomic number)	Isotope [1]		Table I Column 1 Air (μCi/ml)	Table I Column 2 Water (μCi/ml)	Table II Column 1 Air (μCi/ml)	Table II Column 2 Water (μCi/ml)
Zinc (30)	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-3}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-3}
	Zn 69	S	7×10^{-6}	5×10^{-3}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-3}	3×10^{-7}	2×10^{-3}
Zirconium (40)	Zr 93	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-3}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-3}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-3}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-3}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub	1×10^{-6}		3×10^{-8}	
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours.			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.			6×10^{-13}	4×10^{-7}	2×10^{-14}	3×10^{-8}

[1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in a semispherical infinite cloud of airborne material.

[3] 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 (⅓) "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 x 10 MeV of alpha particle energy.) The Table II value may be replaced by one-thirtieth (1/30) of a "working level." The limit on radon-222 concentrations in restricted areas may be based on an annual average.

40 FR 50704

[4] For soluble mixtures of U-238, U-234 and U-235 in air chemical toxicity may be the limiting factor. If the percent by weight (enrichment) of U-235 is less than 5, the concentration value for a 40-hour workweek, Table I, is 0.2 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 8×10^{-9} SA μCi-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 6.77×10^{-7} curies per gram U. The specific activity for other mixtures of U-238, U-235 and U-234, if not known, shall be:

39 FR 23990

$SA = 3.6 \times 10^{-7}$ curies/gram U (U-depleted $E \geq 0.72$)

$SA = (0.4 + 0.38\,E + 0.0034\,E^2)\ 10^{-6}$

where E is the percentage by weight of U-235, expressed as percent.

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* Amended 37 FR 23319.

** Amended 39 FR 23990; footnote re designated 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, and MPC_B, and MPC_C, respectively, then the concentrations shall be limited so that the following relationship exists:

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

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

a. For purposes of Table I, Col. 1—6×10^{-14}

b. For purposes of Table I, Col. 2—4×10^{-7}

c. For purposes of Table II, Col. 1—2×10^{-11}

d. For purposes of Table II, Col. 2—3×10^{-6}

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

c. Element (atomic number) and isotope	Table I		Table II	
	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)	Column 1 Air (μCi/ml)	Column 2 Water (μCi/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		9×10^{-8}		3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, table II only), Pb 210, Po 210, Ra 223, Ra 224, Ra 226, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		6×10^{-8}		2×10^{-6}
If it is known that Sr 90, I 129, (I 125, I 126, I 131, table II only), Pu 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present		2×10^{-8}		6×10^{-7}
If it is known that (I 129, table II only), Ra 226, and Ra 228 are not present		3×10^{-8}		1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	3×10^{-14}		1×10^{-10}	
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-13}		1×10^{-11}	
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-12}		1×10^{-10}	
If it is known that Ac 227, Th 230, Pa 231, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249 and Cf 254 are not present	3×10^{-12}		1×10^{-10}	

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—1×10^{-12} μCi/ml gross alpha activity; or 5×10^{-12} μCi/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Col. 1—3×10^{-11} μCi/ml gross alpha activity; or 2×10^{-10} μCi/ml natural uranium; or 8 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 1/10 (i.e. $\frac{C_A}{MPC_A}\leq\frac{1}{10}$) and (b) the sum of such ratios for all the radionuclides considered as not present in the mixture does not exceed 1/4 (i.e. $\frac{C_A}{MPC_A}+\frac{C_B}{MPC_B}+\cdots\leq 1/4$).

APPENDIX C

Material	Microcuries
Americium-241	.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
*Barium-133	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1
Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.2 h	100
Europium-152 13 yr	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10
Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10

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Material	Microcuries
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100
Plutonium-239	.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1
Silver-111	100
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulphur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
**Thorium (natural)[1]	100
Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
**Uranium (natural)[2]	100
Uranium-233	.01
Uranium-234—Uranium-235	.01
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10

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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 §§ 20.203 and 20.304, where there is involved a combination of isotopes in known amounts the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity"). Example: For purposes of § 20.304, if a particular batch contains 20,000 μCi† of Au^{198} and 50,000 μCi† of C^{14}, it may also include not more than 300 μCi† of I^{131}. This limit was determined as follows:

$$\frac{20{,}000\ \mu Ci\ Au^{198}}{100{,}000\ \mu Ci} + \frac{50{,}000\ \mu Ci\ C^{14}}{100{,}000\ \mu Ci} + \frac{300\ \mu Ci\ I^{131}}{1{,}000\ \mu Ci} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in § 20.304.

[1] Based on alpha disintegration rate of Th-232, Th-230 and their daughter products.

[2] Based on alpha disintegration rate of U-238, U-234, and U-235.

* Amended 36 FR 16898.

** Amended 39 FR 23990.

† Amended 38 FR 29314.

Appendix D

UNITED STATES NUCLEAR REGULATORY COMMISSION

INSPECTION AND ENFORCEMENT REGIONAL OFFICES

Region	Address	Telephone	
		Daytime	Nights and Holidays
I Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont	Region I, USNRC Office of Inspection and Enforcement 631 Park Avenue King of Prussia, Pa. 19406	(215) 337-1150	(215) 337-1159
II Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Panama Canal Zone, Puerto Rico, South Carolina, Tennessee, Virginia, Virgin Islands, and West Virginia	Region II, USNRC Office of Inspection and Enforcement 230 Peachtree St., N.W. Suite 1217 * Atlanta, Ga. 30303	(404) 221-4503	(404) 221-4503
III Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin	Region III, USNRC Office of Inspection and Enforcement 799 Roosevelt Road Glen Ellyn, Ill. 60137	(312) 858-2660	(312) 858-2660
IV Arkansas, Colorado, Idaho, Kansas, Louisiana, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, and Wyoming	Region IV, USNRC Office of Inspection and Enforcement 611 Ryan Plaza Drive Suite 1000 Arlington, Texas 76012	(817) 334-2841	(817) 334-2841
V Alaska, Arizona, California, Hawaii, Nevada, Oregon, Washington, and U.S. territories and possessions in the Pacific	Region V, USNRC Office of Inspection and Enforcement 1990 N. California Blvd. Suite 202 Walnut Creek, Calif. 94596	(415) 486-3141	(415) 486-3141

40 FR 42557

* Amended 41 FR 55851.