U.S. Department of Energy
Washington, D.C.

PAGE CHANGE

DOE 5480.1 Chg 2

4-29-81

SUBJECT: ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION PROGRAM FOR DOE OPERATIONS

1. PURPOSE. This Page Change transmits a revised Attachment 1, a table of contents, and one chapter of DOE 5480.1, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION PROGRAM FOR DOE OPERATIONS, OF 5-5-80.

2. EXPLANATION OF CHANGE.

   a. Chapter XI, REQUIREMENTS FOR RADIATION PROTECTION, is added.

   b. The Table of Contents has been revised to incorporate the added chapter, and to delete Chapters XIV and XV.

   c. Attachment 1 has been revised to delete ERDAM 0524 and ERDAM 0545, which are replaced by the issuance of the attached chapter, and to delete ERDAM 0502, ERDAM 0513, and ERDAM 0525, which are replaced by the issuance of DOE 5484.1, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION INFORMATION REPORTING REQUIREMENTS, OF 2-24-81.

3. FILING INSTRUCTIONS.

   a.

Remove Page	Dated	Insert Page	Dated
Atch 1, page 1 (and 2)	12-18-80	Atch 1, page 1 (and 2)	4-29-81
iii and iv	12-18-80	iii and iv	4-29-81
		XI-1 thru XI-19	4-29-81
		Atch XI-1, pages 1-16	4-29-81

   b. After filing the attached pages, this transmittal may be discarded.

BY ORDER OF THE SECRETARY OF ENERGY:

William S. Heffelfinger
Director of Administration

DISTRIBUTION:
All Departmental Elements
Federal Energy Regulatory Commission (info)

INITIATED BY:
Operational and Environmental Safety Division

REFERENCES

Pending the issuances of additional supplementary chapters to this Order, the following may be used as guideline procedures and standards in the discharge of the Department's environmental protection, safety, and health protection program.

1. ERDAM 0511, RADIOACTIVE WASTE MANAGEMENT, of 9-19-73, which provides for minimizing radioactive exposure and associated risk to man and environment.

2. ERDAM 0527, RESPONSE TO ACCIDENTS INVOLVING NUCLEAR WEAPONS IN THE CUSTODY OF THE DOD, of 2-15-72, which provides for compliance with the AEC-DOD Memorandum of Understanding, of 6-10-70.

3. ERDAM 0528, CONTRACTOR OCCUPATIONAL MEDICAL PROGRAM, of 8-21-75, which establishes a program to protect contractor employees against health hazards in their work environment.

4. ERDAM 0529, SAFETY STANDARDS FOR THE PACKAGING OF FISSILE AND OTHER RADIOACTIVE MATERIALS, of 12-21-76, which provides for assurance of the protection of the public health and safety during transportation of such materials.

5. ERDAM 0550, OPERATIONAL SAFETY STANDARDS, of 3-26-73, which provides for assurance that all aspects of operations are conducted in accordance with specifically identified operational safety standards.

Vertical line denotes change

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CHAPTER XI

REQUIREMENTS FOR RADIATION PROTECTION

1. PURPOSE. This chapter establishes radiation protection standards and requirements for Department of Energy and Department of Energy contractor operations based upon the recommendations of the Environmental Protection Agency and the National Council on Radiation Protection and Measurement.

2. DEFINITIONS.

   a. Controlled Area. Any area to which access is controlled in order to protect individuals from exposure to radiation and radioactive materials.

   b. Dose Commitment. The dose equivalent (rem) received by specific organs during a period of one calendar year, that was the result of an uptake of a radionuclide by a person occupationally exposed.

   c. First Collision Dose. A measure of radiation dose at a certain point, based on the incident energy transferred to secondary charged particles, per gram of absorbing materials, by primary particles that suffer only one collision in the medium.

   d. Neutron Spectrum. A description of a neutron radiation field in terms of the number of neutrons per unit energy interval.

   e. Primary Unit. A nuclear accident dosimeter unit placed in a position near a potential accident site.

   f. Screening. A method for rapidly selecting those individuals involved in a nuclear accident and subjected to acutely serious radiation exposure.

3. RESPONSIBILITIES AND AUTHORITIES.

   a. Heads of Field Organizations shall:

      (1) Review and approve emergency plans for rescue and recovery operations.

      (2) Act, where immediate decisions and actions are required, on requests for exemptions from the requirements of this chapter and immediately report and justify such action to the Operational and Environmental Safety Division. Contractors may be authorized to take all appropriate measures in emergency situations. See paragraph 4e, "Guidance for Emergency Exposure During Rescue and Recovery Activities."

(3) Assure that Department employees, Department contractor personnel, and the general public are protected against unnecessary radiation exposure and comply with the provisions of this chapter.

b. The Deputy Assistant Secretary for Naval Reactors shall assume the same responsibilities as Heads of Field Organizations for Naval Reactors activities.

4. REQUIREMENTS.

a. Occupationally-Related Exposure of Individuals in Controlled Areas. Radiation exposures shall be limited to levels reasonably achievable within the standards prescribed below.

(1) Radiation Protection Standards for External and Internal Exposures. See Figure XI-1.

(2) Procedural Requirements.

(a) Restrictions.

1 An individual under age 18 shall neither be employed in, nor allowed to enter, controlled areas in such a manner that he or she will receive doses of radiation in amounts exceeding one-tenth the standards in paragraph a(1) above.

2 Students under age 18 exposed to radiation during educational activities shall not exceed 0.1 rem/year. This exposure shall be considered a part of the 0.5 rem/year limit for workers under age 18 and not supplemental to it.

(b) Combining Internal and External Dose. Current year whole-body internal dose commitment from radionuclides for which the whole body is the critical organ must be combined with the external whole-body dose. Where both the external penetrating dose and internal dose to critical organ are known, they shall be combined for that organ.

(c) Emergency or Accidental Exposure. Radiation doses received in emergency or accidental situations will be chargeable to the radiation exposure records of the exposed individuals. However, the decision as to whether an exposed individual will continue to work in a radiation area will be made on a case-by-case basis by operating contractor management in accordance with the advice of the contractor's health physics and occupational medical departments and subject to the approval of the head of the field organization. The operating contractor shall assure the head of the responsible field office that the unsafe conditions

Type of Exposure	Exposure Period	Dose Equivalent (Dose or Dose Commitment[1/] rem)
Whole body, head and trunk, gonads, lens of the eye[2/], red bone marrow, active blood-forming organs.	Year Calendar Quarter	5[3/] 3
Unlimited areas of the skin (except hands and forearms). Other organs, tissues, and organ systems (except bone).	Year Calendar Quarter	15 5
Bone.	Year Calendar Quarter	30 10
Forearms.[4/]	Year Calendar Quarter	30 10
Hands[4/] and feet.	Year Calendar Quarter	75 25

1/ To meet the above dose commitment standards, operations must be conducted in such a manner that it would be unlikely that an individual would assimilate in a critical organ, by inhalation, ingestion, or absorption, a quantity of a radionuclide or mixture of radionuclides that would commit the individual to an organ dose that exceeds the limits specified in the above table.

2/ A beta exposure below a maximum energy of 700 KeV will not penetrate the lens of the eye; therefore, the applicable limit for these energies would be that for the skin (15 rem/year).

3/ In special cases, with the approval of the Director, Division of Operational and Environmental Safety, a worker may exceed 5 rem/year, provided his or her average exposure per year since age 18 will not exceed 5 rem per year. This does not apply to emergency situations.

4/ All reasonable effort shall be made to keep exposures of forearms and hands to the general limit for the skin.

FIGURE XI-1
RADIATION PROTECTION STANDARDS FOR
OCCUPATIONALLY-RELATED EXTERNAL AND INTERNAL EXPOSURE

under which the emergency or accidental exposures were received have been eliminated. The decision to resume operations following an emergency or accidental radiation exposure shall be subject to the approval of the head of the responsible field office.

(d) Monitoring Requirements. Monitoring is required where the potential exists for the individual to receive a dose or dose commitment in any calendar quarter in excess of 10 percent of the quarterly or annual standards stated in paragraphs (1) and (2)(a)2 above. Monitoring requirements as specified for the following conditions shall include:

1 External Radiation. Personnel monitoring equipment for each individual.

2 Internal Radiation. Periodic (monthly, quarterly, annually, etc.) bioassay analysis or in vivo counting or evaluation of air concentration to which the individual is exposed, or a combination of all methods.

(e) Methods of Estimating Dose Commitment. Methods of estimating dose commitment to the organ of interest should be suitable to the existing conditions and consistent with assumptions and recommendations of the Environmental Protection Agency, the National Council on Radiation Protection, and the International Commission on Radiological Protection.

(3) Concentration Guides.

(a) Air. Concentration Guides in Attachment 1, Table I, Column 1, were derived for the most part from the yearly standards in paragraph a(1) above (assume a 40 hour workweek). They should be used in evaluating the adequacy of health protection measures against airborne radioactivity in occupied areas.

(b) Water. The Concentration Guides in Attachment 1, Table I, Column 2, are applicable to the discharge of liquid effluents to sanitary sewage systems (see paragraph 3b(5) on page XI-6). Drinking water concentrations in controlled areas shall be maintained within the concentration guides specified in Table II, Column 2.

b. Exposure of Individuals and Population Groups in Controlled Areas. Exposures to members of the public shall be as low as reasonably achievable levels within the standards prescribed below.

(1) Radiation Protection Standards for External and Internal Exposure. See Figure XI-2.

Type of Exposure	Annual Dose Equivalent or Dose Commitment (rem) 1/ Based on dose to individuals at points of maximum probable exposure (rem)	Based on average dose to a suitable sample of the exposed population 2/ (rem)
Whole body, gonads, or bone marrow	0.5	0.17
Other organs	1.5	0.5

1/ In keeping with Department of Energy policy on lowest practicable exposures, exposures to the public shall be limited to as small a fraction of the respective annual dose limits as is reasonably achievable.

2/ See Paragraph 5.4, Federal Radiation Council Report No. 1, for discussion on concept of suitable sample of exposed population.

FIGURE XI-2
RADIATION PROTECTION STANDARDS FOR EXTERNAL AND INTERNAL EXPOSURE OF MEMBERS OF THE PUBLIC

(2) Monitoring Requirements. To assure that doses to the public are maintained as low as reasonably achievable consistent with dose standards set forth in paragraph b(1) above, effluents the environment, and other parameters shall be monitored and documented in accordance with DOE 5484.1, of 2-24-81.

(3) Concentration Guides.

(a) Concentration Guides in Attachment 1, Table II, were derived for the most part from the dose standards for individuals in paragraph 4b(1) above (assume 168 hours of exposure per week). These guides shall be reduced by a factor of three when applied to a suitable sample of the population. Where transient exposures can be calculated, the concentration guides other than those in Attachment 1, Table II, may be used to evaluate compliance with the dose commitment standard.

(b) There may be situations where it is not feasible or desirable to evaluate the exposure of individuals and samples of exposed populations to effluents to assure compliance with standards in paragraph 4b(1) above. In those cases, effluent releases to uncontrolled areas shall be such that average concentrations of radioactivity at the point of release are as low as reasonably achievable. The point of release shall be considered to be the point at which the effluents pass beyond the site boundary. Radioactivity concentrations may be averaged over periods up to 1 year.

(4) Further Limitations on Effluent Discharges. In any situation in which the effluents discharged by one or more activities of the Department, Department contractors, or others cause exposure to approach the standards specified in paragraph b(1) above, appropriate effluent discharge limits may be set for these operations. In such cases, the manager of the field organization may take the necessary corrective action if all activities concerned are within his or her area of responsibility. Otherwise, each case will be referred to the Director, Operational and Environmental Safety Division for appropriate action including, where appropriate, coordination with actions taken by the Nuclear Regulatory Commission under the Code of Federal Regulations, Title 10, Part 20.106(e).

(5) Discharge to Sanitary Sewage Systems.

(a) Effluents may be discharged to public sanitary sewage systems provided:

1 The quantity of radioactivity released in any one month, if diluted by the average monthly quantity of water released by the installation, will not result in an average concentration exceeding the concentration guide in Attachment 1, Table I, Column 2.

2 The radiation protection standards in paragraph (1), above, are not exceeded.

(b) Concentrations or quantities of radioactive materials greater than those specified in paragraphs 4(b) and (5)(a)1 and 2, above, may be released to chemical or sanitary sewage systems owned by the Federal Government provided the standards in paragraph 4b(1) above are not exceeded in uncontrolled areas.

c. Nuclear Accident Dosimetry. These requirements are applicable to Department of Energy contractor installations possessing sufficient quantities and kinds of fissile material to potentially constitute a critical mass and where a nuclear accident is possible and may result in the excessive exposure of personnel to radiation.

(1) Basic Elements.

(a) A method for initial "screening" of personnel involved in nuclear accidents.

(b) A system of fixed units (primary unit) capable of yielding first collision radiation dose and the approximate neutron spectrum at the locations.

(c) Personnel dosimeters capable of furnishing data sufficient to normalize data derived from the fixed system.

(d) Methods for analysis of biological materials (including sodium 24 activity, and phosphorous 32 activity in hair).

(2) Nuclear Accident Dosimeter Units.

(a) The fixed unit should be capable of determining first collision fission neutron dose at its location within 25 percent.

(b) The gamma ray components for all units should permit measuring fission gamma radiation in the presence of neutrons at the location of the unit within approximately 20 percent.

(c) The exposure range of the gamma components should extend from 10 Roentgen to about 10^4 Roentgen.

(d) The unit should measure the approximate neutron spectrum to permit converting rad to rem dose.

(e) A system for counting to provide the dose data within the time necessary to achieve accuracy required by the above criteria (paragraphs 4c(2)(a) and (b)) should be available.

(f) The units should be assembled in such a manner as to permit easy recovery.

(g) Units using foils containing radioactive material shall be placed in fire-resistant containers.

(h) Units should be shock resistant and they should also be protected against contamination to avoid false measurements.

(3) Number and Placement of Dosimeter Units. The number of units needed and the placement of units will depend on the nature of the operation, structural design of the facility, and accessibility of areas to personnel. The following placement criteria are acceptable.

(a) The number and distribution of units should be chosen such that each unit will be sufficiently near a work location as to permit increased accuracy in the extrapolation of dose to personnel.

(b) The fixed units should be placed such that there is as little extraneous intervening shielding and obstruction as possible between the units and the potential accident area.

(c) If there are unusual shielding situations affecting work areas near a potential accident location, additional fixed units should be provided. Care should be exercised to assure that these units are distributed in close proximity to actual work locations.

(d) Personnel dosimeters should be worn and should be capable of providing spectrum and flux information to aid in extrapolating dose from fixed units to location of personnel.

(e) Ease of recovery after a nuclear accident should be considered in placement of the fixed units. Careful consideration should be given to the need for remote retrieval mechanisms.

(f) Consideration should be given to the type and number of units procured in order to achieve economic and efficient use of the unit.

d. Quality Factors to be Applied in Determining Rem Exposure. The exposure standards specified in this chapter are expressed in terms of rem, which implies that the absorbed dose (expressed in rads) should be multiplied by an appropriate weight factor (quality factor). The quality factors to be used for determining neutron exposures from known energies are provided in Figures XI-3 and XI-4.

e. Guidance for Emergency Exposure During Rescue and Recovery Activities.

(1) Purpose. The emergency action guidance promulgated in this part provides instructions and background information for use in determining appropriate actions concerning the rescue and recovery of persons and the protection of health and property during periods of emergency.

(2) General Considerations.

(a) The problem of controlling exposure to radiation during rescue and recovery actions is extremely complex. Performing rescue and recovery operations requires the exercise of prompt judgment to take into account multiple hazards and alternate methods of accomplishment. Sound judgment and flexibility of action are crucial to the success of any type of emergency actions. Although the guiding principle is to minimize the risk of injury to those persons involved in the rescue and recovery activities, the control of radiation exposures should be consistent with the immediate objective of saving human life, the recovery of a deceased victim, and the protecting of health and saving of property.

(b) To preclude the possibility of unnecessarily restricting action that may be necessary to save lives, these instructions do not establish a rigid upper limit of exposure but rather leave judgment up to persons in charge of emergency operations to determine the amount of exposure that should be permitted to perform the emergency mission.

(c) The official in charge must carefully examine any proposed action involving further radiation exposure by weighing the risks of radiation insults, actual or potential, against the benefits to be gained. Exposure probability, biological consequences related to dose, and the number of people involved are the essential elements to be evaluated in making a risk determination.

Neutron Energy	$\overline{QF}$	Neutron Flux Density
MeV		cm^{-2} s^{-1}
2.5×10^{-8} (thermal)	2	680
1×10^{-7}	2	680
1×10^{-6}	2	560
1×10^{-5}	2	560
1×10^{-4}	2	580
1×10^{-3}	2	680
1×10^{-2}	2.5	700
1×10^{-1}	7.5	115
5×10^{-1}	11	27
1	11	19
2.5	9	20
5	8	16
7	7	17
10	6.5	17
14	7.5	12
20	8	11
40	7	10
60	5.5	11
1×10^{2}	4	14
2×10^{2}	3.5	13
3×10^{2}	3.5	11
4×10^{2}	3.5	10

FIGURE XI-3

Mean quality factors, $\overline{QF}$*, and values of neutron flux density which in a period of 40 hours results in a maximum dose equivalent of 100 mrem.

*Maximum value of QF in a 30-cm phantom.

Radiation Type	Rounded QF
X rays, gamma rays, electrons or positrons, Energy >0.03 MeV	1
Electrons or positrons, Energy <0.03 MeV	1
Neutrons, Energy <10keV	3
Neutrons, Energy >10keV	10
Protons	1-10*
Alpha particles	1-20
Fission fragments, recoil nuclei	20

*Use the higher value for round-off or calculate by the methods of ICRP Publication 4.

FIGURE XI-4
PRACTICAL QUALITY FACTORS

(d) These instructions recognize that accident situations involving the saving of lives will require separate criteria from those of actions required to recover deceased victims or to save property. In the latter instances, the amount of exposure expected to be received by persons should be controlled as much as possible within occupational limits.

(3) Emergency Situations. Specific dose criteria and judgment factors are set forth for the three categories of risk-benefit considerations, i.e., actions involving the saving of human life, the recovery of deceased victims, and the protection of health and property.

(a) Saving of Human Life.

1 Attempts to rescue victims of a nuclear incident should be regarded in the same context as any other emergency action involving the rescue of victims, regardless of the type of hazard involved.

2 If it is determined that an individual may be alive within the affected area, the course of action to be pursued should be determined by the person onsite having the emergency action responsibility.

3 Exposure projections shall be determined by the person onsite having the emergency action responsibility. Exposure guidance should be based on an immediate evaluation of the situation. The decision making process should consider:

a Evaluation of the inherent risks:

i The reliability of the prediction of radiation injury cannot be greater than the reliability of the estimation dose. Therefore, consideration should be given to limits of error associated with the specific instruments and techniques used to estimate the dose rate. This is especially crucial when the estimated dose approximates 100 rems or more.

ii The exposure expected in performing the action shall be weighed in terms of the effects of acute whole-body exposure and entry of radioactive material into the body.

iii Current assessment of the degree and nature of the hazard, and the capability of reducing inherent risk from that hazard through appropriate mechanism such as the use of protective equipment, remote manipulation equipment, or similar means.

4 In the course of making a decision to perform the action, the risk to rescue personnel should be weighed against the probability of success of the rescue action.

5 Any rescue action that may involve substantial personal risk should be performed by volunteers, and each emergency worker shall be advised of the known or estimated extent of such risk prior to participation.

(b) Recovery of Deceased Victims.

1 Accident situations involving recovery of deceased victims require criteria separate from those for saving lives. Since the element of time is no longer a critical factor, the recovery of deceased victims should be well planned. The amount of radiation exposure received by persons in recovery operations shall be controlled within existing occupational exposure guides.

2 In those situations where victims are located in areas inaccessible because of high direct radiation fields, and where the recovery mission would result in exposure in excess of occupational exposure standards, special remote recovery devices should be used to retrieve the bodies.

3 In special circumstances where it is impossible to recover bodies without the entry of emergency workers into the area, the occupation exposure standards contained in this chapter may be exceeded. However, the planned exposures of an individual participating in the recovery should not exceed 12 rem total for the year or 5 (N-18), whichever is the more limiting.

(c) Protection of Health and Property. Where the risk of the radiation hazard either bears significantly on the state of health of people or may result in loss of property, and immediate remedial action is required, the following criteria apply:

1 When the person in charge of emergency action onsite deems it essential to reduce a hazard potential to acceptable levels or to prevent a substantial loss of property, a planned exposure up to, but not to exceed, 12 rem for the year may be received by the individuals participating in the operation. The person in charge of emergency action under special circumstances could waive these limits and permit volunteers to receive an exposure up to, but not to exceed, 25 rem.

2 Where the potential risk of radiation hazard is such that life would be in jeopardy, or that there would be severe effects on health of the public or loss of property inimical to the public safety, the criteria for saving human life shall apply.

f. Guidance on Maintaining Exposures to As Low As Reasonably Achievable.

(1) Introduction. Exposures to radiation shall be maintained as low as reasonably achievable and within the guidelines provided in paragraphs 4 a and b. Assurance that worker and public exposures do not exceed the exposure guidelines (e.g., 3 rem per quarter, 5 rem per year for radiation workers) is, in itself, insufficient in that Department policy is that operations shall be conducted in a manner to assure that radiation exposure to individuals and population groups is limited to the lowest levels reasonably achievable. The guidelines contained herein suggest several factors to consider in each operation to assure compliance with Department policy. They are by no means exhaustive. Other criteria should be added as particular situations dictate. Basic to following these guidelines is the premise that exposures can be maintained as low as reasonably achievable through considerations in the design or modification to a facility and equipment, reducing the errors in radiation exposure assessments through the application of state-of-the-art instrumentation maintenance and calibration, and by the institution of appropriate procedures and training.

(2) Considerations Toward Maintaining Radiation Exposures As Low As Reasonably Achievable. When applying the following guidelines, changes in processes or modifications to existing facilities should be considered on the merits of the specific case.

(a) Facility Considerations.

1 Design.

a Exposure rates in work areas should be reduced as low as reasonably achievable by proper facility design and equipment layout. Design factors to consider are: occupancy time, source terms, spacing, processes, equipment, and shielding. Onsite personnel exposure levels less than one-fifth of the permissible dose equivalent limits prescribed in this chapter should be used as a design objective.

b Primary means for assuring protection should be through physical safeguards, e.g., remote handling, equipment, shielding, etc. Administrative controls should be regarded as secondary means.

c The general concept in the design facility for purposes of high level contamination confinement should be primary, secondary, and tertiary confinement. Primary confinement would be the process enclosures and their ventilation and air cleaning systems, secondary confinement would be the operating area compartments and their ventilation and air cleaning systems, and the tertiary confinement would be the structure and its ventilation and air cleaning systems.

d Compartmentalization should be provided to isolate high risk areas.

e Decommissioning requirements should be considered in the design of a facility. The avoidance of rough surfaces, cracks, and crevices in potential contamination areas should be considered in this context.

f The use of protective coating in radiation areas should comply with the specifications contained in American National Standards Institute Standard N512-1974, "Protective Coating for Nuclear Industry."

g Interior surfaces, as well as layout of ducts and pipes, should be designed to minimize buildup of contamination and exposure to personnel, and to facilitate cleanup.

h Equipment and components requiring frequent servicing should be located in areas free of radiation or in the lowest practicable radiation field.

i Ventilation systems should be designed to assure control of air contaminants. Redundant equipment should be provided in all exhaust systems servicing contaminated and potentially contaminated areas. The system should permit easy safe access for servicing.

j Air cleaning systems should be designed to reduce plant releases and minimize vulnerability to adverse conditions such as fire or explosion. The design should also permit in-place testing of both online and standby filter installations. These tests should be performed as recommended in American National Standards Institute Standard N510-1980, "Testing of Nuclear Air Cleaning Systems."

k Liquid waste systems should be designed to confine or reduce releases to the environment offsite and onsite.

l Personnel and equipment traffic patterns should be well defined so as to minimize the potential spread of contamination. Entrances and exits should be designed, posted, and controlled to minimize transient or casual exposure.

2 Operating Equipment.

a All operating equipment including enclosures, glove boxes, conveyors, hoods, ventilation, and air cleaning systems should be routinely inspected to assure optimum performance from the safety viewpoint.

b For those facilities involving glove box operations, the following guidance applies:

i Double ring ports should be required for all glove box gloves.

ii Equipment located in glove boxes should be designed for in-place maintenance.

iii The inner surface of a glove box should be designed to permit easy, efficient decontamination. Since contamination buildup in a glove box is a large contributor to worker exposure, a routine schedule for inspection and decontamination of glove boxes should be established.

iv Air cleaning should be provided at the glove box exhaust port.

c Valve packing and gaskets should be selected on the basis of achieving optimum performance in order to minimize leakage and spillage of radioactive materials.

3 Monitoring and Protective Equipment.

a Ambient air and exhaust monitoring systems including readout and preset alarms should be located to permit rapid monitoring of airborne releases. Monitors should be selected, tested, and calibrated in accordance with the general guidance contained in American National Standards Institute Standard N13.1, "Guide to Sampling Airborne Radioactive Materials in a Nuclear Facility."

b Portable instrumentation should be available as appropriate. Scheduled tests and calibration should comply with the specifications contained in American National Standards Institute Standard N13/42 WG4, "Radiation Protection Instrumentation and Calibration-Final."

c Inhalation and ingestion should be minimized by proper use of state-of-the-art respiratory protection. The respiratory program shall comply with guidance contained in American National Standards Institute Standard Z88.2, "Respiratory Protection."

d To achieve optimum accuracy, personnel dosimeters should comply with the performance parameters contained in American National Standards Institute Standard N13.5, "Performance Specifications for Direct Reading and Indirect Reading Pocket Dosimeters for X and Gamma Radiation," American National Standards Institute Standard N13.7, "Film Badge Performance, " and

American National Standards Institute Standard N13/42 WG 1 Final Draft 1979, "TLD - A Standard for Performance."

e Radiation monitoring systems (e.g., area monitors, effluent monitors, etc.) should be appropriately selected, installed, tested, and calibrated following the recommendations contained in American National Standards Institute Standard N13.10-1974, "Specification and Performance of Onsite Instrumentation for Continuously Monitoring Radioactivity in Effluents."

f Protection systems should be reliable and capable of being tested in situ. The design of critical systems such as alarm systems shall provide for redundancy and independence to assure (1) that no single failure results in the loss of the protection function, and (2) that removal from service of any component does not result in loss of the redundancy.

g The emergency warning systems should be designed to comply with the performance specifications contained in American National Standards Institute Standard N16.2, "Criticality Accident Alarm," and American National Standards Institute Standard N2.3, "Immediate Evacuation Signal for Use in Industrial Facilities Where Radiation Exposure May Occur."

4 Procedures.

a Records of exposure data, contamination surveys, airborne and internal exposure data should be evaluated to determine whether exposures are being maintained as low as reasonably achievable. Where appropriate, procedures should be used to maintain exposures as low as reasonably achievable.

b Total man-rems should be estimated for large tasks and a total man-rem dose established before initiating the job.

c Approximate radiation levels should be posted in work areas.

d Contamination control procedures should be established for all jobs where contamination may be present. Supervision should assure that workers follow proper procedures in order to maintain their exposures as low as reasonably achievable.

e Special tools and temporary shielding should be used where practicable to reduce radiation exposures.

f Tasks should be completed with the fewest people in the radiation field consistent with safe operations. Procedures should be established to assure there is effective use of personnel and that personnel are not idle in the radiation area.

g Where appropriate, time and motion studies should be conducted to assure that workers in radiation fields complete assigned tasks with the minimum time consistent with safe operations.

h Objectives should include reducing exposure rates in worker locations rather than instituting a system of worker rotation to minimize exposure to individuals. Emphasis should be placed on worker efficiency.

i Worker locations should be properly evaluated on a routine basis to determine whether sufficient effort has been expended to assure that exposures are maintained as low as reasonably achievable. In the case of glove box operations, this would include a determination that box contamination buildup is minimized, shielding is optimum, and workers complete their tasks within a reasonable time.

j Buffer area control points should be clearly established and contain appropriate equipment and clothing to permit proper contamination control. Maintaining proper supervision in the area is essential to maintaining exposure as low as reasonably achievable.

k Procedures should be instituted to review periodically the potential for and actual release of radioactivity to the environment in gaseous and liquid effluents.

(b) Radiation Safety Management.

1 Training.

a Worker safety training programs should be established and conducted at a sufficient frequency to familiarize the worker with the fundamentals of health physics and the proper procedures for maintaining exposures and plant releases as low as reasonably achievable. Training programs should be on a continuing basis to enable training of replacement personnel as well as retraining to assure that personnel remain proficient and should include a means to determine that the trainee has attained the necessary qualification status. A radiation safety training program should include but not be limited to:

i Principles of design operation and maintenance of the plant, project equipment, or experiment.

ii Potential problem areas from the radiological viewpoint.

iii Basic characteristics of radiation and contamination.

iv Methods (procedures-equipment) for exposure and contamination control.

v Basic understanding of biological dose and methods of assessment.

vi Emergency procedures and systems.

b Operations supervision should have a good understanding of the radiological characteristics and potential safety problem areas associated with their program including all the training elements covered under paragraph a above. This would permit a proper assessment of the adequacy of controls instituted to maintain exposures as low as reasonably achievable.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See notes at end of attachment)

Element (atomic number)	Isotope,* soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area† Column 1 Air (uCi/ml)	Table II Uncontrolled Area† Column 2 Water (uCi/ml)
Actinium (89)	Ac	227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
			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^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
			I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
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	3×10^{-3}		1×10^{-4}	
	A	41	Sub	2×10^{-6}		4×10^{-8}	
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}	1×10^{-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	4×10^{-9}	2×10^{-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}

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

†These values apply to individuals in uncontrolled areas. One-third of these values will be used for a suitable sample of the population.

NOTE: $\mu Ci/ml \times 10^{12} = pCi/m^3$; $\mu Ci/ml \times 10^3 = Ci/l$.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Berkelium (97)	Bk	249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
			I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	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^{-8}	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^{-2}	3×10^{-9}	4×10^{-4}
			I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
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^{-5}
			I	3×10^{-11}	2×10^{-4}	1×10^{-12}	7×10^{-5}
	Cf	253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
			I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf	254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
			I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C	14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)		Sub	5×10^{-5}		1×10^{-6}	
Cerium (58)	Ce	141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)		Table I Controlled Area: Column 1 Air (uCi/ml)	Table I Controlled Area: Column 2 Water (uCi/ml)	Table II Uncontrolled Area: Column 1 Air (uCi/ml)	Table II Uncontrolled Area: Column 2 Water (uCi/ml)
Cerium (58) Cont'd.	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}
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}
	Co 58	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
		I	5×10^{-8}	3×10^{-3}	2×10^{-9}	9×10^{-5}
	Co 60	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
		I	9×10^{-9}	1×10^{-3}	3×10^{-10}	3×10^{-5}
Copper (29)	Cu 64	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	3×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Curium (96)	Cm 242	S	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
		I	2×10^{-10}	7×10^{-4}	6×10^{-12}	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 244a	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}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Curium (96) Cont'd.	Cm	247	S	5×10^{-12}	1×10^{-4}	2×10^{-13}	$4 \times 10^{-[illegible]}$
			I	1×10^{-10}	6×10^{-4}	4×10^{-12}	2×10^{-5}
	Cm	248	S	6×10^{-13}	1×10^{-5}	2×10^{-14}	4×10^{-7}
			I	1×10^{-11}	4×10^{-5}	4×10^{-13}	1×10^{-6}
	Cm	249	S	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
			I	1×10^{-5}	6×10^{-2}	4×10^{-7}	2×10^{-3}
Dysprosium (66)	Dy	165	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-6}
	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}	8×10^{-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}	5×10^{-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	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	(T/2=9.2 hrs)		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Eu	152	S	1×10^{-8}	2×10^{-3}	4×10^{-10}	8×10^{-5}
	(T/2=13 yrs)		I	2×10^{-8}	2×10^{-3}	6×10^{-10}	8×10^{-5}
	Eu	154	S	4×10^{-9}	6×10^{-4}	1×10^{-10}	2×10^{-5}
			I	7×10^{-9}	6×10^{-4}	2×10^{-10}	2×10^{-5}
	Eu	155	S	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
			I	7×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
Fermium (100)	Fm	254	S	6×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
			I	7×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Fm	255	S	2×10^{-8}	1×10^{-3}	6×10^{-10}	3×10^{-5}
			I	1×10^{-8}	1×10^{-3}	4×10^{-10}	3×10^{-5}
	Fm	256	S	3×10^{-9}	3×10^{-5}	1×10^{-10}	9×10^{-7}
			I	2×10^{-9}	3×10^{-5}	6×10^{-11}	9×10^{-7}
Fluorine (9)	F	18	S	5×10^{-6}	2×10^{-2}	2×10^{-7}	8×10^{-4}
			I	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
Gadolinium (64)	Gd	153	S	2×10^{-7}	6×10^{-3}	8×10^{-9}	2×10^{-4}
			I	9×10^{-8}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Gd	159	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Gallium (31)	Ga	72	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Germanium (32)	Ge	71	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
			I	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
Gold (79)	Au	196	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
	Au	198	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Au	199	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	8×10^{-7}	4×10^{-3}	3×10^{-8}	2×10^{-4}
Hafnium (72)	Hf	181	S	4×10^{-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)	H	3	S	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			I	5×10^{-6}	1×10^{-1}	2×10^{-7}	3×10^{-3}
			Sub	2×10^{-3}		4×10^{-5}	
Indium (49)	In	113m	S	8×10^{-6}	4×10^{-2}	3×10^{-7}	1×10^{-3}
			I	7×10^{-6}	4×10^{-2}	2×10^{-7}	1×10^{-3}
	In	114m	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
			I	2×10^{-8}	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^{-8}	3×10^{-3}	1×10^{-9}	9×10^{-5}
Iodine (53)*	I	125	S	3×10^{-9}	2×10^{-5}	8×10^{-11}	2×10^{-7}
			I	2×10^{-7}	6×10^{-3}	6×10^{-9}	2×10^{-4}
	I	126	S	4×10^{-9}	3×10^{-5}	9×10^{-11}	3×10^{-7}
			I	3×10^{-7}	3×10^{-3}	1×10^{-8}	9×10^{-5}
	I	129	S	8×10^{-10}	5×10^{-6}	2×10^{-11}	6×10^{-8}
			I	7×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
	I	131	S	4×10^{-9}	3×10^{-5}	1×10^{-10}	3×10^{-7}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	I	132	S	1×10^{-7}	8×10^{-4}	3×10^{-9}	8×10^{-6}
			I	9×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
	I	133	S	2×10^{-8}	1×10^{-4}	4×10^{-10}	1×10^{-6}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

*In the derivation of the concentration guides for soluble forms of iodine in Table II, a 2 gram thyroid (infants) and daily intakes of 3×10^{6} ml of air and 1×10^{3} ml of water (fluid water plus water contents of foods) assumed.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Iodine (53) Cont'd.	I	134	S	3×10^{-7}	2×10^{-3}	6×10^{-9}	2×10^{-5}
			I	3×10^{-6}	2×10^{-2}	1×10^{-7}	6×10^{-4}
	I	135	S	5×10^{-8}	4×10^{-4}	1×10^{-9}	4×10^{-6}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Iridium (77)	Ir	190	S	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ir	192	S	1×10^{-7}	1×10^{-3}	4×10^{-9}	4×10^{-5}
			I	3×10^{-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^{-2}	3×10^{-8}	2×10^{-3}
	Fe	59	S	1×10^{-7}	2×10^{-3}	5×10^{-9}	6×10^{-5}
			I	5×10^{-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^{-2}	9×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	4×10^{-4}
	Pb	210	S	1×10^{-10}	4×10^{-6}	4×10^{-12}	1×10^{-7}
			I	2×10^{-10}	5×10^{-3}	8×10^{-12}	2×10^{-4}
	Pb	212	S	2×10^{-8}	6×10^{-4}	6×10^{-10}	2×10^{-5}
			I	2×10^{-8}	5×10^{-4}	7×10^{-10}	2×10^{-5}
Lutetium (71)	Lu	177	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Manganese (25)	Mn	52	S	2×10^{-7}	1×10^{-3}	7×10^{-9}	3×10^{-5}
			I	1×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Mn	54	S	4×10^{-7}	4×10^{-3}	1×10^{-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	3×10^{-6}	1×10^{-2}	9×10^{-8}	5×10^{-4}
	Hg	203	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
Molybdenum (42)	Mo	99	S	7×10^{-7}	5×10^{-3}	3×10^{-8}	2×10^{-4}
			I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Neodymium (60)	Nd	144	S	8×10^{-11}	2×10^{-3}	3×10^{-12}	7×10^{-5}
			I	3×10^{-10}	2×10^{-3}	1×10^{-11}	8×10^{-5}
	Nd	147	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	2×10^{-3}	8×10^{-9}	6×10^{-5}
	Nd	149	S	2×10^{-6}	8×10^{-3}	6×10^{-8}	3×10^{-4}
			I	1×10^{-6}	8×10^{-3}	5×10^{-8}	3×10^{-4}
Neptunium (93)	Np	237	S	4×10^{-12}	9×10^{-5}	1×10^{-13}	3×10^{-6}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	Np	239	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	7×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
Nickel (28)	Ni	59	S	5×10^{-7}	6×10^{-3}	2×10^{-8}	2×10^{-4}
			I	8×10^{-7}	6×10^{-2}	3×10^{-8}	2×10^{-3}
	Ni	63	S	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
			I	3×10^{-7}	2×10^{-2}	1×10^{-8}	7×10^{-4}
	Ni	65	S	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Niobium (Columbium) (41)	Nb	93m	S	1×10^{-7}	1×10^{-2}	4×10^{-9}	4×10^{-4}
			I	2×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Nb	95	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	1×10^{-7}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Nb	97	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
			I	5×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
Osmium (76)	Os	185	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	5×10^{-8}	2×10^{-3}	2×10^{-9}	7×10^{-5}
	Os	191m	S	2×10^{-5}	7×10^{-2}	6×10^{-7}	3×10^{-3}
			I	9×10^{-6}	7×10^{-2}	3×10^{-7}	2×10^{-3}
	Os	191	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
			I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Os	193	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	3×10^{-7}	2×10^{-3}	9×10^{-9}	5×10^{-5}
Palladium (46)	Pd	103	S	1×10^{-6}	1×10^{-2}	5×10^{-8}	3×10^{-4}
			I	7×10^{-7}	8×10^{-3}	3×10^{-8}	3×10^{-4}
	Pd	109	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
Phosphorus (15)	P	32	S	7×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
			I	8×10^{-8}	7×10^{-4}	3×10^{-9}	2×10^{-5}
Platinum (78)	Pt	191	S	8×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
			I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Pt	193	S	1×10^{-4}	3×10^{-2}	9×10^{-3}	9×10^{-4}
			I	3×10^{-7}	5×10^{-2}	1×10^{-3}	2×10^{-3}
	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}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Platinum (78) Cont'd.	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^{-12}	1×10^{-4}	7×10^{-14}	5×10^{-6}
			I	3×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	239	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	240	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	8×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	241	S	9×10^{-11}	7×10^{-3}	3×10^{-12}	2×10^{-4}
			I	4×10^{-8}	4×10^{-2}	1×10^{-9}	1×10^{-3}
	Pu	242	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
			I	4×10^{-11}	9×10^{-4}	1×10^{-12}	3×10^{-5}
	Pu	243	S	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
			I	2×10^{-6}	1×10^{-2}	8×10^{-8}	3×10^{-4}
	Pu	244	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
			I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
Polonium (84)	Po	210	S	5×10^{-10}	2×10^{-5}	2×10^{-11}	7×10^{-7}
			I	2×10^{-10}	8×10^{-4}	7×10^{-12}	3×10^{-5}
Potassium (19)	K	42	S	2×10^{-6}	9×10^{-3}	7×10^{-8}	3×10^{-4}
			I	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
Praseodymium (59)	Pr	142	S	2×10^{-7}	9×10^{-4}	7×10^{-9}	3×10^{-5}
			I	2×10^{-7}	9×10^{-4}	5×10^{-9}	3×10^{-5}
	Pr	143	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
			I	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
Promethium (61)	Pm	147	S	6×10^{-8}	6×10^{-3}	2×10^{-9}	2×10^{-4}
			I	1×10^{-7}	6×10^{-3}	3×10^{-9}	2×10^{-4}
	Pm	149	S	3×10^{-7}	1×10^{-3}	1×10^{-8}	4×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
Protactinium (91)	Pa	230	S	2×10^{-9}	7×10^{-3}	6×10^{-11}	2×10^{-4}
			I	8×10^{-10}	7×10^{-3}	3×10^{-11}	2×10^{-4}
	Pa	231	S	1×10^{-12}	3×10^{-5}	4×10^{-14}	9×10^{-7}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Pa	233	S	6×10^{-7}	4×10^{-3}	2×10^{-8}	1×10^{-4}
			I	2×10^{-7}	3×10^{-3}	6×10^{-9}	1×10^{-4}
Radium (88)	Ra	223	S	2×10^{-9}	2×10^{-5}	6×10^{-11}	7×10^{-7}
			I	2×10^{-10}	1×10^{-4}	8×10^{-12}	4×10^{-6}
	Ra	224	S	5×10^{-9}	7×10^{-5}	2×10^{-10}	2×10^{-6}
			I	7×10^{-10}	2×10^{-4}	2×10^{-11}	5×10^{-6}
	Ra	226	S	3×10^{-11}	4×10^{-7}	3×10^{-12}	3×10^{-8}
			I	5×10^{-11}	9×10^{-4}	2×10^{-12}	3×10^{-5}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Radium (88) Cont'd.	Ra	228	S	7×10^{-11}	8×10^{-7}	2×10^{-12}	3×10^{-8}
			I	4×10^{-11}	7×10^{-4}	1×10^{-12}	3×10^{-5}
Radon (86)	Rn	220	S	3×10^{-7}		1×10^{-8}	
	Rn	222	S	1×10^{-7}		3×10^{-9}	
Rhenium (75)	Re	183	S	3×10^{-6}	2×10^{-2}	9×10^{-8}	6×10^{-4}
			I	2×10^{-7}	8×10^{-3}	5×10^{-9}	3×10^{-4}
	Re	186	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	2×10^{-7}	1×10^{-3}	8×10^{-9}	5×10^{-5}
	Re	187	S	4×10^{-6}	4×10^{-2}	3×10^{-7}	3×10^{-3}
			I	5×10^{-7}	4×10^{-2}	2×10^{-8}	2×10^{-3}
	Re	188	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
			I	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
Rhodium (45)	Rh	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^{-8}	7×10^{-4}	2×10^{-9}	2×10^{-5}
	Rb	87	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	7×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
Ruthenium (44)	Ru	97	S	2×10^{-6}	1×10^{-2}	8×10^{-8}	4×10^{-4}
			I	2×10^{-6}	1×10^{-2}	6×10^{-8}	3×10^{-4}
	Ru	103	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	8×10^{-8}	2×10^{-3}	3×10^{-9}	8×10^{-5}
	Ru	105	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
	Ru	106	S	8×10^{-8}	4×10^{-4}	3×10^{-9}	1×10^{-5}
			I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Samarium (62)	Sm	147	S	7×10^{-11}	2×10^{-3}	2×10^{-12}	6×10^{-5}
			I	3×10^{-10}	2×10^{-3}	9×10^{-12}	7×10^{-5}
	Sm	151	S	6×10^{-8}	1×10^{-2}	2×10^{-9}	4×10^{-4}
			I	1×10^{-7}	1×10^{-2}	5×10^{-9}	4×10^{-4}
	Sm	153	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
			I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Scandium (21)	Sc	46	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	4×10^{-5}
			I	2×10^{-8}	1×10^{-3}	8×10^{-10}	4×10^{-5}
	Sc	47	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
			I	5×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
	Sc	48	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
			I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Selenium (34)	Se	75	S	1×10^{-6}	9×10^{-3}	4×10^{-8}	3×10^{-4}
			I	1×10^{-7}	8×10^{-3}	4×10^{-9}	3×10^{-4}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

				Table I Controlled Area		Table II Uncontrolled Area	
Element (atomic number)	Isotope, soluble (S); insoluble (I)			Column 1 Air (uCi/ml)	Column 2 Water (uCi/ml)	Column 1 Air (uCi/ml)	Column 2 Water (uCi/ml)
Silicon (14)	Si	31	S	6×10^{-6}	3×10^{-2}	2×10^{-7}	9×10^{-4}
			I	1×10^{-6}	6×10^{-3}	3×10^{-8}	2×10^{-4}
Silver (47)	Ag	105	S	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
			I	8×10^{-8}	3×10^{-3}	3×10^{-9}	1×10^{-4}
	Ag	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^{-5}	3×10^{-11}	3×10^{-7}
			I	5×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Sr	91	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	1×10^{-3}	9×10^{-9}	5×10^{-5}
	Sr	92	S	4×10^{-7}	2×10^{-3}	2×10^{-8}	7×10^{-5}
			I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
Sulfur (16)	S	35	S	3×10^{-7}	2×10^{-3}	9×10^{-9}	6×10^{-5}
			I	3×10^{-7}	8×10^{-3}	9×10^{-9}	3×10^{-4}
Tantalum (73)	Ta	182	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	4×10^{-5}
			I	2×10^{-8}	1×10^{-3}	7×10^{-10}	4×10^{-5}
Technetium (43)	Tc	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}

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)		Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Tellurium (52) Cont'd.	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	3×10^{-11}	3×10^{-5}	1×10^{-12}	1×10^{-6}
		I	3×10^{-11}	3×10^{-4}	1×10^{-12}	1×10^{-5}
	Th 234	S	6×10^{-8}	5×10^{-4}	2×10^{-9}	2×10^{-5}
		I	3×10^{-8}	5×10^{-4}	1×10^{-9}	2×10^{-5}
Thulium (69)	Tm 170	S	4×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}
		I	3×10^{-8}	1×10^{-3}	1×10^{-9}	5×10^{-5}

*A curie of natural thorium means the sum of 3.7×10^{10} dis/sec from Th 232 plus 3.7×10^{10} dis/sec from Th 228. One curie of natural thorium is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND—Continued

(See notes at end of attachment)

Element (atomic number)	Isotope, soluble (S); insoluble (I)			Table I Controlled Area Column 1 Air (uCi/ml)	Table I Controlled Area Column 2 Water (uCi/ml)	Table II Uncontrolled Area Column 1 Air (uCi/ml)	Table II Uncontrolled Area Column 2 Water (uCi/ml)
Thulium (69) Cont'd.	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}	1×10^{-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}	7×10^{-5}	1×10^{-11}	2×10^{-6}
			I	1×10^{-10}	1×10^{-4}	4×10^{-12}	5×10^{-6}
	U	232	S	1×10^{-10}	2×10^{-5}	3×10^{-12}	8×10^{-7}
			I	3×10^{-11}	8×10^{-4}	9×10^{-13}	3×10^{-5}
	U	233	S	5×10^{-10}	1×10^{-4}	2×10^{-11}	4×10^{-6}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	234	S	6×10^{-10}	1×10^{-4}	2×10^{-11}	4×10^{-6}
			I	1×10^{-10}	9×10^{-4}	4×10^{-12}	3×10^{-5}
	U	235	S	5×10^{-10}	1×10^{-4}	2×10^{-11}	4×10^{-6}
			I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	U	236	S	6×10^{-10}	1×10^{-4}	2×10^{-11}	5×10^{-6}
			I	1×10^{-10}	1×10^{-3}	4×10^{-12}	3×10^{-5}
	U	238	S	7×10^{-11}	2×10^{-5}	3×10^{-11}	6×10^{-7}
			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	7×10^{-11}	2×10^{-5}	3×10^{-12}	6×10^{-7}
			I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)	V	48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
			I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54)	Xe	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}

*A curie of natural uranium means the sum of 3.7×10^{10} disintegrations per second from U 238 plus 3.7×10^{10} dis/sec from U 234 plus 1.7×10^{9} dis/sec from U 235. One curie of natural uranium is equivalent to 3,000 kilograms or 6,615 pounds of natural uranium.

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND —Continued

(See notes at end of attachment)

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

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the guide values, for purposes of this attachment, 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 guide otherwise established in this attachment for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture will 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 CGs are CG_A, CG_B, and CG_C, respectively, then the concentrations should be limited so that the following relationship exists:

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \frac{C_C}{CG_C} \leq 1$$

2. If either the identiy or the concentration of any radionuclide in the mixture is not known, the guide values for purposes of this attachment will be:

   a. For purposes of Table I, Col. 1, 6×10^{-13}

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

   c. For purposes of Table II, Col. 1, 2×10^{-14}

   d. For purposes of Table II, Col. 2, 3×10^{-8}

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in 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 guide for the mixture is the guide specified in this attachment for the radionuclide in the mixture having the lowest concentration guide, or

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

Element (atomic number) and isotope	Table I Controlled Area Column 1 Air (μCi/ml)	Table I Controlled Area Column 2 Water (μCi/ml)	Table II Uncontrolled Area Column 1 Air (μCi/ml)	Table II Uncontrolled Area 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^{-5}		3×10^{-6}
If it is known that Sr 90, I 125, I 126, I 129 (I 131, I 133, Table II only) Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present		6×10^{-5}		2×10^{-6}
If it is known that Sr 90, I 129 (I 125, I 126, I 131, Table II only) Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present		2×10^{-5}		6×10^{-7}
If it is known that (I 129, Table II only) Ra 226 and Ra 228 are not present		3×10^{-6}		1×10^{-7}
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	3×10^{-9}		1×10^{-10}	
If it is known that alpha-emitters and Pb-210, Ac 227, Ra 228, and Pu 241 are not present	3×10^{-10}		1×10^{-11}	
If it is known that alpha-emitters and Ac 227 are not present	3×10^{-11}		1×10^{-12}	
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, Pu 244, Cm 248, Cf 249, and Cf 251 are not present	3×10^{-12}		1×10^{-13}	

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

   a. For purposes of Table I, Col. 1, 1×10^{-10} μCi/ml gross alpha activity; or 2.5×10^{-11} μCi/ml natural uranium; or 75 micrograms per cubic meter of natural uranium in air.

   b. For purposes of Table II, Col. 1, 3×10^{-12} μCi/ml gross alpha activity; or 8×10^{-13} μCi/ml natural uranium; or 3 micrograms per cubic meter of natural uranium in air.

5. For purposes of this note, a radionuclide may be considered as not present in a mixure if (a) the ratio of the concentration of that radionuclide in the mixture (C_A) to the concentration guide for that radionuclide specified in Table II of this annex (CG_A) does not exceed 1/10, i.e.,

$$\frac{C_A}{CG_A} \leq \frac{1}{10}$$

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.,

$$\frac{C_A}{CG_A} + \frac{C_B}{CG_B} + \ldots \leq \frac{1}{4}$$

6. Conversion from μCi/cc to pCi/m^3 for air and pCi/l for water are as follows:

   a. Air-μCi/cc x 10^{12} = pCi/m^3

   b. Water-μCi/cc x 10^9 = pCi/l

7. Concentrations may be derived for unlisted radionuclides provided yearly dose limits in paragraph 6b(1) of this chapter and paragraph 6a(1) are used and the methods are consistent with those recommended by the Federal Radiation Council, National Council on Radiological Protection, and International Commission on Radiological Protection.