NEBRASKA DEPARTMENT OF HEALTH AND HUMAN SERVICES
NOTICE OF PUBLIC HEARING

December 2, 2019
1:00 p.m. Central Time
Nebraska State Office Building – Lower Level B
301 Centennial Mall South, Lincoln, Nebraska

The purpose of this hearing is to receive comments on proposed changes to Title 180, Chapter 4 of the Nebraska Administrative Code (NAC) – *Standards for Protection Against Radiation.* The chapter governs radiation safety standards for entities that use radioactive material and x-ray machines; radiation protection programs; and occupational dose limits for individuals. The proposed changes update formatting and correct any typographical errors.

Authority for these regulations is found in Neb. Rev. Stat. § 81-3117(7).

Interested persons may attend the hearing and provide verbal or written comments or mail, fax or email written comments, no later than the day of the hearing to: DHHS Legal Services, PO Box 95026, Lincoln, NE 68509-5026, (402) 742-2382 or dhhs.regulations@nebraska.gov, respectively.

A copy of the proposed changes is available online at http://www.sos.ne.gov, or by contacting DHHS at the mailing address or email above, or by phone at (402) 471-8417. The fiscal impact statement for these proposed changes may be obtained at the office of the Secretary of State, Regulations Division, 1201 N Street, Suite 120, Lincoln, NE 68508, or by calling (402) 471-2385.

Auxiliary aids or reasonable accommodations needed to participate in a hearing can be requested by calling (402) 471-8417. Individuals with hearing impairments may call DHHS at (402) 471-9570 (voice and TDD) or the Nebraska Relay System at 711 or (800) 833-7352 TDD at least 2 weeks prior to the hearing.

FISCAL IMPACT STATEMENT

Agency: **Department of Health and Human Services**	
Title: 180	Prepared by: Julia Schmitt
Chapter: 4	Date prepared: 06/12/2019
Subject: Standards For Protection Against Radiation	Telephone: 402/471-0528

Type of Fiscal Impact:

	State Agency	Political Sub.	Regulated Public
No Fiscal Impact	(☒)	(☒)	(☒)
Increased Costs	(☐)	(☐)	(☐)
Decreased Costs	(☐)	(☐)	(☐)
Increased Revenue	(☐)	(☐)	(☐)
Decreased Revenue	(☐)	(☐)	(☐)
Indeterminable	(☐)	(☐)	(☐)

Provide an Estimated Cost & Description of Impact:

State Agency:

Political Subdivision:

Regulated Public:

If indeterminable, explain why:

PROPOSED REGULATION QUESTIONNAIRE

Title 180 NAC 4

1) Is the regulation essential to the health, safety, or welfare of Nebraskans?

Yes. The purpose of the regulations are to institute and maintain a program to permit development and utilization of sources of radiation for peaceful purposes consistent with the protection of occupational and public health and safety and the environment. The regulated entities use radioactive materials and x-ray radiation generating machines. This chapter sets out basic radiation safety requirements like dose limits for individuals working with radiation. It also sets out limits on the dose the public can be exposed to as a result of the use of radiation.

2) Do the costs of the regulation outweigh the benefits? Provide specific data and reasoning.

Radioactive materials provide benefits to the public in a number of medical and industrial settings. Misuse of radioactive materials and ionizing radiation can be life-threatening and have catastrophic environmental consequences. The regulations provide safeguards that allow the benefits while minimizing risks. Without regulation by the state, individuals would be required to meet the same standards under federal licensure at significantly great cost to the licensees. As an Agreement State, the Annual Fees levied by Nebraska for licensure and regulation are much less than those levied by the U.S. Nuclear Regulatory Commission (NRC).
Examples:

Material Type	NRC	Nebraska
Medical Use	$11,100 – 18,500	$3,900
Panoramic Irradiator	$62,000	$11,500
Irradiator, self-shielded	$6,500	$2,600
Broad Scope (Educational or Medical)	$29,700	$18,000
Industrial Radiography	$10,600	$6,500

3) Does a process exist to measure the effectiveness of the regulation? If so, explain.

Yes. Licensees and registrants are inspected for compliance with the radiation safety regulations. The performance of the Office of Radiological Health is evaluated by the Nuclear Regulatory Commission during the Integrated Materials Performance Evaluation Program (IMPEP). Performance is assessed in the following areas: technical staffing and training; status of materials inspection program; technical quality of inspections; technical quality of licensing actions; technical quality of incident and allegation activities, and; compatibility of regulations.

4) Has a less restrictive alternative been considered?

The least restrictive alternative has been chosen. Because the Agreement requires that Nebraska's regulatory program be compatible with that of the NRC, rather than always identical, there are some areas of the regulations that we are allowed more flexibility in crafting regulations that more directly

meet the needs of our licensees while still being protective. Each regulation of the NRC is assigned a compatibility designation. Compatibility A regulations are basic radiation protection standard or related definitions, signs, labels or terms necessary for a common understanding of radiation protection principles. The State regulations must be essentially identical to those of the NRC. Compatibility B regulations have significant direct trans-boundary implications. The State regulations must be essentially identical to those of the NRC. For Compatibility C regulations, the essential objectives must be adopted by the State to avoid conflicts, duplications or gaps. The manner in which the essential objectives are addressed need not be the same as NRC, provided the essential objectives are met. For any Compatibility C regulations, the least restrictive regulatory alternative has been chosen.

5) Was the regulation solely promulgated due a state statutory requirement? If so, provide citations.

Yes, Neb. Rev. Stat. § 71-3505 (1) and § 71-3507 (1) requires regulations. However, even if the statute were to be changed to "may", regulations would still be needed to ensure public safety and safe radiation use by the regulated entities.

6) Was the regulation promulgated as the result of a federal mandate? If so, include copies of the applicable federal statutes and regulations.

No. However, Section 274 of the Atomic Energy Act provides a statutory basis under which the U. S. Nuclear Regulatory Commission (NRC) relinquishes to the States portions of its regulatory authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials to States that meet certain requirements. The mechanism for the transfer of NRC's authority to a State is an agreement signed by the Governor of the State and the Chairman of the Commission, in accordance with section 274b of the Act. The NRC relinquished their authority to the State of Nebraska in 1966 when Governor Morrison signed the Agreement with the NRC. The Agreement requires that Nebraska maintain a regulatory program that is adequate to protect public health and safety and the environment and that our regulations be compatible with those of the NRC. The NRC periodically reviews the program for adequacy and compatibility with that of the NRC. As an Agreement State, if the Nebraska Regulations for Control of Radiation are not found to be compatible, the NRC can terminate the Agreement and resume regulatory authority over radioactive materials within the State. Currently, there are 38 states that have agreements with the NRC with several more states in process.

PROPOSED REGULATION
POLICY PRE-REVIEW CHECKLIST

Agency: DHHS – Division of Public Health
Title, Chapter of Regulation: Title 180 NAC 4
Subject: Standards For Protection Against Radiation
Prepared by: Julia Schmitt
Telephone: 402-471-0528

A. Policy Changes and Impacts

1. What does the regulation do and whom does it impact? Provide a brief description of the proposed rule or regulation and its impacts on state agencies, political subdivisions, and regulated persons or entities.

   The regulated entities use radioactive materials and x-ray machines. This chapter sets out basic radiation safety standards, such as occupational dose limits for users of radiation. This revision re-promulgates Title 180 NAC 4 to update formatting.

2. Describe changes being proposed to current policy and briefly provide rationale.

   The regulations were reformatted and typographical errors were corrected.

B. Why is the rule necessary? Explain and provide an identification of authorizing statute(s) or legislative bill(s).

1. Update of regulation (repeal of obsolete statutes, reflect current policy, editing or technical language changes, etc.)

   This revision re-promulgates Title 180 NAC 4 to update formatting and correct typographical errors.

2. Annual changes – cost of living, hunting season schedules, etc.

   No.

3. Law was changed – federal ___ or state ___ [Cite authorizing statute(s) or legislative bill(s)]

   N/A

4. Extension of established policy or program, new initiatives or changes in policy (within statutory authority) No

5. Constituent initiated No

6. Financial needs – increases/decreases in fees No

7. Litigation requires changes in rules No

8. Addresses legal or constitutional concerns of Attorney General's office No

9. Implements federal or court mandate No

10. Other (explain)

C. What happens if these rules are not adopted?

Typographical errors would remain in the regulation.

D. Policy Checklist

1. Is this an update or editorial change reflecting essentially no change in policy? Yes

2. Does the policy in the proposed regulation reflect legislative intent? Yes.

3. Is the policy proposed in the regulation a state mandate on local government? Yes Is it funded? Yes

4. Is the policy proposed in the regulation a federal mandate on local government? No Is it funded? N/A

E. Fiscal Impact. In addition to completing the required Fiscal Impact Statement (a copy must be attached to this document), the agency must address the following:

No fiscal impact.

1. Will the proposed regulation reduce, increase, or have no change in resources – funds, personnel or FTE? No change.

2. Have initial contacts been made with citizens or organizations that may be impacted by the proposed regulation? No, because the changes are formatting and editorial. We will solicit public comment before a public hearing.

3. Does the proposed regulation impact another agency? No Explain the impact.

4. Will the proposed regulation reduce, increase, or have no change on reporting requirements of businesses? No Change

5. What is the agency's best estimate of the additional or reduced spending? If there is none, please note. If receipt of federal funds is contingent upon approval of the proposed regulation, then indicate the amount and nature of the federal funds affected, and enclose laws or correspondence from federal officials substantiating the information.

No change in spending.

6. Include a description of the impact that the proposed regulation will have on the number of state employees and how the agency intends to address proposed increases or decreases in FTE.

No Impact.

F. Unique problems or issues and recommendations.

No known problems or issues.

G. Who is expected to be affected, or to oppose or support the proposed regulation? Explain what initial informal contacts have been made with organizations or citizens who may be affected by the regulation prior to the public hearing.

No known supporters or opponents.

DHHS will solicit public comment on the proposed regulations before the public hearing.

H. Are these proposed rules a likely candidate for negotiated rulemaking? Explain. Has the process been completed? If so, explain how the issues were addressed.

No.

TITLE 180 CONTROL OF RADIATION

CHAPTER 4 STANDARDS FOR PROTECTION AGAINST RADIATION

001. SCOPE AND AUTHORITY. 180 Nebraska Administrative Code (NAC) 4 establishes standards for protection against ionizing radiation resulting from activities conducted according to licenses or registrations issued by the Department. The regulations are authorized by and implement the Nebraska Radiation Control Act, Nebraska Revised Statute (Neb. Rev. Stat.) §§ 71-3501 to 71-3520.

001.01 SOURCE CONTROL. The requirements of 180 NAC 4 are designed to control the receipt, possession, use, transfer, and disposal of sources of radiation by any licensee or registrant so the total dose to an individual, including doses resulting from all sources of radiation other than background radiation, does not exceed the standards for protection against radiation prescribed in 180 NAC 4. However, nothing in 180 NAC 4 will be construed as limiting actions that may be necessary to protect health and safety.

001.02 EXCEPTIONS. Except as specifically provided in other Chapters of Title 180, 180 NAC 4 applies to persons licensed or registered by the Department to receive, possess, use, transfer, or dispose of sources of radiation. The limits in 180 NAC 4 do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of medical diagnosis or therapy, to exposure from individuals administered radioactive material and released in accordance with 180 NAC 7-037 or to voluntary participation in medical research programs.

001.03 CODE OF FEDERAL REGULATIONS. 40 Code of Federal Regulations (CFR) as published on July 1, 2013 and 49 CFR as published October 1, 2013 and referred throughout this Chapter are herein incorporated by reference and available for viewing at the Nebraska Department of Health and Human Services, Radiological Health, 301 Centennial Mall South, 3rd Floor, Lincoln, Nebraska 68509.

001.04 INCORPORATION BY REFERENCE. National Council on Radiation Protection and Measurement (NRCP) 116, International Commission on Radiological Protection (ICRP) 23 and Compressed Gas Association Publication G7.1 as referred to in this Chapter are herein incorporated by reference and available for viewing at the Nebraska Department of Health and Human Services, Radiological Health, 301 Centennial Mall South, 3rd Floor, Lincoln, Nebraska 68509.

002. DEFINITIONS. The following definitions apply:

002.01 AIR-PURIFYING RESPIRATOR. An air-purifying respirator is a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

002.02 ANNUAL LIMIT ON INTAKE (ALI). The annual limit on intake (ALI) is the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. Annual limit on intake (ALI) is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 0.05 Sievert (Sv) (5 roentgen equivalent man (rem)) or a committed dose equivalent of 0.5 Sv (50 rem) to any individual organ or tissue. Annual limit on intake (ALI) values for intake by ingestion and by inhalation of selected radionuclides are given in Table I, Columns 1 and 2, of Appendix 4-B of 180 NAC 4.

002.03 ASSIGNED PROTECTION FACTOR (APF). The assigned protection factor (APF) is the expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the assigned protection factor (APF).

002.04 ATMOSPHERE-SUPPLYING RESPIRATOR. An atmosphere-supplying respirator is a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

002.05 CLASS. Class is the classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days. For purposes of these regulations, "lung class" and "inhalation class" are equivalent terms.

002.06 DECLARED PREGNANT WOMAN. A declared pregnant woman is a woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

002.07 DEMAND RESPIRATOR. A demand respirator is an atmosphere-supplying respirator that admits breathing air to the face piece only when a negative pressure is created inside the face piece by inhalation.

002.08 DERIVED AIR CONCENTRATION (DAC). The derived air concentration (DAC) is the concentration of a given radionuclide in air which, if breathed by the reference man for working year of 2,000 hours under conditions of light work, (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one annual limit on intake (ALI). Derived air concentration (DAC) values are given in Table I, Column 3, of Appendix 4-B of 180 NAC 4.

002.09 DERIVED AIR CONCENTRATION-HOUR (DAC-HOUR). A derived air concentration-hour (DAC-hour is the product of the concentration of radioactive material in air, expressed as a fraction or multiple of the derived air concentration for each radionuclide,

and the time of exposure to that radionuclide, in hours. A licensee or registrant may take 2,000 derived air concentration (DAC)-hours to represent one annual limit on intake (ALI), equivalent to a committed effective dose equivalent of 0.05 Sv (5 rem).

002.10 DISPOSABLE RESPIRATOR. A disposable respirator is a respirator for which maintenance is not intended and that is designed to be discarded after excessive breathing resistance, sorbent exhaustion, physical damage, or end-of-service-life renders it unsuitable for use. Examples of this type of respirator are a disposable half-mask respirator or a disposable escape-only self-contained breathing apparatus (SCBA).

002.11 DOSE OR RADIATION DOSE. Dose or radiation dose is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

002.12 DOSIMETRY PROCESSOR. A dosimetry processor is an individual or an organization that processes and evaluates individual monitoring devices in order to determine the radiation dose delivered to the monitoring devices.

002.13 FILTERING FACEPIECE. A filtering facepiece is a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps. Dust mask is another term for filtering facepiece.

002.14 FIT FACTOR. The fit factor is the quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

002.15 FIT TEST. A fit test is the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

002.16 HELMET. A helmet is a rigid respiratory inlet covering that also provides head protection against impact and penetration.

002.17 HOOD. A hood is a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

002.19 INHALATION CLASS. Inhalation class has the same meaning as class.

002.20 LOOSE-FITTING FACEPIECE. A loose-fitting facepiece is a respiratory inlet covering that is designed to form a partial seal with the face.

002.21 LUNG CLASS. Lung class has the same meaning as class.

002.22 NEGATIVE PRESSURE RESPIRATOR. A negative pressure respirator is a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator. A tight fitting respirator is another term for a negative pressure respirator.

002.23 NONSTOCHASTIC EFFECT. A nonstochastic effect is a health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is a nonstochastic effect. For purposes of Title 180, a deterministic effect is an equivalent term.

002.24 PLANNED SPECIAL EXPOSURE. A planned special exposure is an infrequent exposure to radiation, separate from and in addition to the annual occupational dose limits.

002.25 POSITIVE PRESSURE RESPIRATOR. A positive pressure respirator is a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

002.26 POWERED AIR-PURIFYING RESPIRATOR (PAPR). A powered air-purifying respirator (PAPR) is an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

002.27 PRESSURE DEMAND RESPIRATOR. A pressure demand respirator is a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

002.28 QUALITATIVE FIT TEST (QLFT). A qualitative fit test (QLFT) is a pass or fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

002.29 QUANTITATIVE FIT TEST (QNFT). A quantitative fit test (QNFT) is an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

002.29 QUARTER. A quarter is the period of time equal to one-fourth of the year observed by the licensee or registrant, approximately 13 consecutive weeks, providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

002.30 REFERENCE MAN. Reference man is the hypothetical aggregation of human physical and physiological characteristics determined by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base. A description of the reference man is contained in the International Commission on Radiological Protection Report, ICRP Publication 23, "Report of the Task Group on Reference Man."

002.31 RESPIRATORY PROTECTIVE EQUIPMENT. Respiratory protective equipment is an apparatus, such as a respirator, used to reduce an individual's intake of airborne radioactive materials.

002.32 SANITARY SEWERAGE. Sanitary sewerage is a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

002.33 SELF-CONTAINED BREATHING APPARATUS (SCBA). Self-contained breathing apparatus (SCBA) is an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

002.34 STOCHASTIC EFFECT. A stochastic effect is a health effect that occurs randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are stochastic effects.

002.35 SUPPLIED-AIR RESPIRATOR (SAR). A supplied-air respirator (SAR) is an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user. Airline respirator is another term for a supplied-air respirator.

002.36 TIGHT-FITTING FACEPIECE. A tight-fitting facepiece is a respiratory inlet covering that forms a complete seal with the face.

002.37 USER SEAL CHECK. A user seal check is an action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check. Fit check is another term for user seal check.

002.38 VERY HIGH RADIATION AREA. A very high radiation area is an area accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a radiation source or 1 meter from any surface that the radiation penetrates. Note: For the very high doses received at high dose rates, the units of absorbed dose, gray and rad, are appropriate, rather than units of dose equivalent, sieverts and rem.

002.39 WEIGHTING FACTOR (W_T). The weighting factor (W_T) for an organ or tissue (T) means the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of W_T are:

ORGAN DOSE WEIGHTING FACTORS	
Organ or Tissue	W_T
Gonads	0.25
Breast	0.15
Red Bone Marrow	0.12
Lung	0.12
Thyroid	0.03

Bone Surfaces	0.03
Remainder	0.30[a]
Whole Body	1.00[b]

[a] 0.30 results from 0.06 for each of 5 "remainder" organs, excluding the skin and the lens of the eye, that receive the highest doses.

[b] For the purpose of weighting the external whole body dose, for adding it to the internal dose, a single weighting factor, w_T = 1.0, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

003. IMPLEMENTATION. Conditions on licenses are implemented as follows.

003.01 MORE RESTRICTIVE. Any existing license condition that is more restrictive than 180 NAC 4 remains in force until there is an amendment or renewal of the license.

003.02 EXEMPTIONS. If a license condition exempts a licensee from a provision of 180 NAC 4 in effect on or before May 30, 1994, it also exempts the licensee from the corresponding provision of 180 NAC 4.

003.03 PRIOR REGULATIONS. If a license condition cites provisions of 180 NAC 4 in effect prior to May 30, 1994, which do not correspond to any provisions of 180 NAC 4, the license condition remains in force until there is an amendment or renewal of the license that modifies or removes this condition.

004. RADIATION PROTECTION PROGRAMS. Each licensee or registrant must have and follow a radiation protection program as follows.

004.01 RADIATION PROTECTION PROGRAM COMPLIANCE. Each licensee or registrant must develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of 180 NAC 4. See 180 NAC 4-047 for recordkeeping requirements relating to these programs.

004.02 AS LOW AS REASONABLY ACHIEVABLE (ALARA). The licensee or registrant must use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and public doses that are as low as reasonably achievable (ALARA).

004.03 RADIATION PROTECTION PROGRAM REVIEW. The licensee or registrant must, at intervals not to exceed 12 months, review the radiation protection program content and implementation.

004.04 CONSTRAINT ON AIR EMISSIONS. To implement the as low as reasonably

achievable (ALARA) requirements of 180 NAC 4-004.02 and despite of the requirements in 180 NAC 4-013, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its daughters must be established by licensees, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 0.1 mSv (10 mrem) per year from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee must report the exceedance as provided in 180 NAC 4-059 and promptly take appropriate corrective action to ensure against a recurrence.

005. OCCUPATIONAL DOSE LIMITS FOR ADULTS. Occupational dose limits for adults are as follows.

005.01 OCCUPATIONAL DOSE CONTROL. The licensee or registrant must control the occupational dose to individual adults, except for planned special exposures according to 180 NAC 4-010, to the following dose limits:

(A) An annual limit, which is the more limiting of:
  (i) The total effective dose equivalent being equal to 0.05 Sv (5 rem); or
  (ii) The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv (50 rem).

(B) The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:
  (i) A lens dose equivalent of 0.15 Sv (15 rem), and
  (ii) A shallow dose equivalent of 0.5 Sv (50 rem) to the skin of the whole body or to the skin of any extremity.

005.02 DOSES RECEIVED IN EXCESS OF THE ANNUAL LIMITS. Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year and during the individual's lifetime. See 180 NAC 4-010(E)(i) and (ii).

005.03 EXTERNAL EXPOSURE. Licensees and registrants must determine external exposure so that:

(A) When the external exposure is determined by measurement with an external personal monitoring device, the deep-dose equivalent must be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the U.S. Nuclear Regulatory Commission (NRC). The assigned deep-dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow-dose equivalent must be the dose averaged over the contiguous 10 square centimeters of skin receiving the highest exposure. The deep-dose equivalent, lens dose equivalent, and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

(B) If an individual is required to be monitored by 180 NAC 4-022, when a protective apron is worn while working with medical fluoroscopic equipment and monitoring is

conducted as specified in 180 NAC 4-022.01(E), the effective dose equivalent for external radiation must be determined as follows:

(i) When only one individual monitoring device is used and it is located at the neck (collar) outside the protective apron, the reported deep dose equivalent must be the effective dose equivalent for external radiation; or

(ii) When only one individual monitoring device is used and it is located at the neck (collar) outside the protective apron, and the reported dose exceeds 25% of the limit specified in 180 NAC 4-005.01, the reported deep dose equivalent value multiplied by 0.3 must be the effective dose equivalent for external radiation; or

(iii) When individual monitoring devices are worn, both under the protective apron at the waist and outside the protective apron at the neck, the effective dose equivalent for external radiation must be assigned the value of the sum of the deep dose equivalent reported for the individual monitoring device located at the waist under the protective apron multiplied by 1.5 and the deep dose equivalent reported for the individual monitoring device located at the neck outside the protective apron multiplied by 0.04.

005.04 DERIVED AIR CONCENTRATION (DAC) AND ANNUAL LIMIT ON INTAKE (ALI) VALUES. Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in Table I of Appendix 4-B of 180 NAC 4 and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits. See 180 NAC 4-052.

005.05 SOLUBLE URANIUM INTAKE. In addition to the annual dose limits, the licensee must limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity. See Appendix 4-B of 180 NAC 4.

005.06 DOSE REDUCTION. The licensee or registrant must reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person.

006. COMPLIANCE WITH REQUIREMENTS FOR SUMMATION OF EXTERNAL AND INTERNAL DOSES. Requirements for addressing external and internal doses are as follows.

006.01 SUMMING EXTERNAL AND INTERNAL DOSES. If the licensee is required to monitor according to both 180 NAC 4-022.01 and 4-022.02, the licensee must demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only according to 180 NAC 4-022.01 or only according to 180 NAC 4-022.02 then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses according to 180 NAC 4-006.02 through 4-006.04. The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

006.02 INTAKE BY INHALATION. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

(A) The sum of the fractions of the inhalation annual limit on intake (ALI) for each

radionuclide;

(B) The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000; or

(C) The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, W_T, and the committed dose equivalent, H_T,50, per unit intake is greater than 10% of the maximum weighted value of $H_{T,50}$ ($W_T H_{T,50}$) per unit intake for any organ or tissue.

006.03 INTAKE BY ORAL INGESTION. If the occupationally exposed individual also receives an intake of radionuclides by oral ingestion greater than 10% of the applicable oral annual limit on intake (ALI), the licensee or registrant must account for this intake and include it in demonstrating compliance with the limits.

006.04 INTAKE THROUGH WOUNDS OR ABSORPTION THROUGH SKIN. The licensee or registrant must evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of derived air concentration (DAC) for hydrogen-3 and does not need to be evaluated or accounted for according to 180 NAC 4-006.04.

007. DETERMINATION OF EXTERNAL DOSE FROM AIRBORNE RADIOACTIVE MATERIAL. Licensees must determine dose from airborne radioactive material as follows.

007.01 DEEP DOSE EQUIVALENT, LENS DOSE EQUIVALENT AND SHALLOW DOSE EQUIVALENT. Licensees must, when determining the dose from airborne radioactive material, include the contribution to the deep dose equivalent, lens dose equivalent, and shallow dose equivalent from external exposure to the radioactive cloud. See Appendix 4-B of 180 NAC 4.

007.02 RADIONUCLIDES OTHER THAN NOBLE GASES OR NONUNIFORM DISTRIBUTION. Airborne radioactivity measurements and derived air concentration (DAC) values must not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep dose equivalent to an individual must be based upon measurements using instruments or individual monitoring devices.

008. DETERMINATION OF INTERNAL DOSE. Licensees must determine the internal dose as follows.

008.01 TIMELY MEASUREMENTS. For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee must, when required under 180 NAC 4-022 take suitable and timely measurements of:

(A) Concentrations of radioactive materials in air in work areas; or

(B) Quantities of radionuclides in the body; or

(C) Quantities of radionuclides excreted from the body; or

(D) Combinations of these measurements.

008.02 INHALATION CONCENTRATION. Unless respiratory protective equipment is used, as provided in 180 NAC 4-028 or the assessment of intake is based on bioassays, the licensee must assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

008.03 ADDITIONAL CONSIDERATIONS. When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior or the material in an individual is known, the licensee may:

(A) Use that information to calculate the committed effective dose equivalent, and, if used, the licensee must document that information in the individual's record; and

(B) Upon prior approval of the Department, adjust the derived air concentration (DAC) or annual limit on intake (ALI) values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and

(C) Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See Appendix 4-B of 180 NAC 4.

008.04 CLASS Y MATERIAL INTAKE ASSESSMENT. If the licensee chooses to assess intakes of Class Y material using the measurements given in 180 NAC 4-008.01(B) or (C), the licensee may delay the recording and reporting of the assessments for periods up to seven months, unless otherwise required by 180 NAC 4-058 or 4-059. This delay permits the licensee to make additional measurements basic to the assessments.

008.05 KNOWN NUCLIDES AND CONCENTRATION. If the identity and concentration of each radionuclide in a mixture are known, the fraction of the derived air concentration (DAC) applicable to the mixture for use in calculating derived air concentration (DAC)-hours must be either:

(A) The sum of the ratios of the concentration to the appropriate derived air concentration (DAC) value, D, W, or Y, from Appendix 4-B of 180 NAC 4 for each radionuclide in the mixture; or

(B) The ratio of the total concentration for all radionuclides in the mixture to the most restrictive derived air concentration (DAC) value for any radionuclide in the mixture.

008.06 KNOWN NUCLIDES. If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the derived air concentration (DAC) for the mixture must be the most restrictive derived air concentration (DAC) of any radionuclide in the mixture.

008.07 MIXTURE OF NUCLIDES. When a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

(A) The licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in 180 NAC 4-005 and in complying with the monitoring requirements in 180 NAC 4-022;

(B) The concentration of any radionuclide disregarded is less than 10% of its derived air concentration (DAC); and

(C) The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30%.

008.08 DETERMINING COMMITTED EFFECTIVE DOSE EQUIVALENT. Committed effective dose equivalent must be determined as follows:

(A) In order to calculate the committed effective dose equivalent, the licensee may assume that the inhalation of one annual limit on intake (ALI), or an exposure of 2,000 derived air concentration (DAC)-hours, results in a committed effective dose equivalent of 0.05 Sv (5 rem) for radionuclides that have their annual limit on intake (ALI)s or derived air concentration (DAC)s based on the committed effective dose equivalent; and

(B) For an annual limit on intake (ALI), and the associated derived air concentration (DAC) determined by the nonstochastic organ dose limit of 0.5 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), the stochastic annual limit on intake (ALI) is listed in parentheses in Table I of Appendix 4-B of 180 NAC 4. The licensee may, as a simplifying assumption, use the stochastic annual limit on intake (ALI) to determine committed effective dose equivalent. However, if the licensee uses the stochastic annual limit on intake (ALI), the licensee must also demonstrate that the limit in 180 NAC 4-005.01(A)(ii) is met.

009. DETERMINATION OF PRIOR OCCUPATIONAL DOSE. Prior occupational dose must be determined as follows.

009.01 PRIOR OCCUPATIONAL DOSE. For each individual who may enter the licensee's or registrant's restricted area and is likely to receive, in a year, an occupational dose requiring monitoring according to 180 NAC 4-022, the licensee or registrant must:

(A) Determine the occupational radiation dose received during the current year; and

(B) Attempt to obtain the records of cumulative occupational radiation dose.

009.02 PRIOR PLANNED SPECIAL EXPOSURE AND DOSES IN EXCESS OF THE LIMITS. Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant must determine:

(A) The internal and external doses from all previous planned special exposures; and

(B) All doses in excess of the limits, including doses received during accidents and emergencies, received during the lifetime of the individual.

009.03 RECORDS OF PRIOR OCCUPATIONAL DOSE. In complying with the requirements of 180 NAC 4-009.01, a licensee or registrant may:

(A) Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual received during the current year;

(B) Accept, as the record of cumulative radiation dose, an up-to-date Department Form NRH-1, or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee or registrant; or

(C) Obtain reports of the individual's dose equivalent from the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee or registrant, by telephone, telegram, electronic media, or letter. The licensee or registrant must request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

009.04 EXPOSURE HISTORY. The licensee or registrant must record the exposure history, as required by 180 NAC 4-009.01, on Department Form NRH-1, or other clear and legible record, including all of the information required on that form.

(A) The form or record must show each period in which the individual received occupational exposure to radiation or radioactive material and must be signed by the individual who received the exposure. For each period for which the licensee or registrant obtains reports, the licensee or registrant must use the dose shown in the report in preparing Department Form NRH-1 or equivalent. For any period in which the licensee or registrant does not obtain a report, the licensee or registrant must place a notation on Department Form NRH-1 indicating the periods of time for which data are not available.

(B) Licensees or registrants are not required to partition historical dose between external dose equivalent(s) and internal committed dose equivalent(s). Further, occupational exposure histories obtained and recorded on Department Form NRH-1 before the May 30, 1994, might not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

009.05 ASSUMPTIONS. If the licensee or registrant is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee or registrant must assume:

(A) In establishing administrative controls under 180 NAC 4-005.06 for the current year, that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

(B) That the individual is not available for planned special exposures.

009.06 RECORDS RETENTION. The licensee or registrant must retain the records on Department Form NRH-1 or equivalent until the Department terminates each pertinent license or registration requiring this record. The licensee or registrant must retain records used in preparing Department Form NRH-1 or equivalent for three years after the record is made. This includes records required under the standards for protection against radiation in effect prior to May 30, 1994.

010. PLANNED SPECIAL EXPOSURES. A licensee or registrant may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in 180 NAC 4-005 provided that each of the following conditions is satisfied:

(A) The licensee or registrant authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the dose estimated to result from the planned special exposure are unavailable or impractical;

(B) The licensee or registrant, and employer if the employer is not the licensee or registrant, specifically authorizes the planned special exposure, in writing, before the exposure occurs.

(C) Before a planned special exposure, the licensee or registrant ensures that each individual involved is:
  (i) Informed of the purpose of the planned operation; and
  (ii) Informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and
  (iii) Instructed in the measures to be taken to keep the dose as low as reasonably achievable (ALARA) considering other risks that may be present;

(D) Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant ascertains prior doses as required by 180 NAC 4-009.02 during the lifetime of the individual for each individual involved;

(E) Subject to 180 NAC 4-005.02, the licensee or registrant must not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses in excess of the limits to exceed:
  (i) The numerical values of any of the dose limits in 180 NAC 4-005.01 in any year; and
  (ii) Five times the annual dose limits in 180 NAC 4-005.01 during the individual's lifetime;

(F) The licensee or registrant maintains records of the conduct of a planned special exposure in accordance with 180 NAC 4-051 and submits a written report in accordance with 180 NAC 4-060; and

(G) The licensee or registrant records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposures must not be considered in controlling future occupational dose of the individual according to 180 NAC 4-005.01 but must be included in evaluations required by 180 NAC 4-010.04 and 4-010.05.

011. OCCUPATIONAL DOSE LIMITS FOR MINORS. The annual occupational dose limits for minors are 10% of the annual occupational dose limits specified for adult workers in 180 NAC 4-005.

012. DOSE EQUIVALENT TO AN EMBRYO/FETUS. Licensees and registrants must control doses to embryo/fetus as follows.

012.01 DOSE LIMIT. The licensee or registrant must ensure that the dose equivalent to an embryo/ fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 5 mSv (0.5 rem). See 180 NAC 4-052 for record keeping requirements.

012.02 UNIFORM EXPOSURE RATE. The licensee or registrant must make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in 180 NAC 4-012.01.

012.03 DOSE EQUIVALENT. The dose equivalent to an embryo/fetus is the sum of:
(A) The deep dose equivalent to the declared pregnant woman; and
(B) The equivalent dose to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

012.04 REMAINDER OF PREGNANCY. If the dose equivalent to the embryo/fetus is found to have exceeded 5 mSv (0.5 rem), or is within 0.5 mSv (0.05 rem) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee or registrant must be deemed to be in compliance with 180 NAC 4-012.01 if the additional dose to the embryo/fetus does not exceed 0.5 mSv (0.05 rem) during the remainder of the pregnancy.

013. DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC. Licensees and registrants must control doses to individual members of the public as follows.

013.01 DOSE LIMITS. Each licensee or registrant must conduct operations so that:

(A) The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed 1 mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 180 NAC 7-037, from voluntary participation in medical research programs, and from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with 180 NAC 4-04; and

(B) The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with 180 NAC 7-037, does not exceed 0.02 mSv (0.002 rem) in any one hour.

013.02 MEMBERS OF THE PUBLIC IN RESTRICTED AREAS. If the licensee or registrant permits members of the public to have access to restricted areas, the limits for members of the public continue to apply to those individuals.

013.03 VISITORS. Despite the requirements of 180 NAC 4-013.01(A), a licensee may permit visitors to an individual who cannot be released, under 180 NAC 7-037, to receive a radiation dose greater than 1 mSv (0.1 rem) if:

(A) The radiation dose received does not exceed 5 mSv (0.5 rem); and

(B) The authorized user, as defined in 180 NAC 7, has determined before the visit that it is appropriate.

013.04 PRIOR AUTHORIZATION. A licensee, registrant, or an applicant for a license or registration may apply for prior Department authorization to operate up to an annual dose limit for an individual member of the public of 5 mSv (0.5 rem). This application must include the following information:

(A) Demonstration of the need for and the expected duration of operations in excess of the limit in 180 NAC 4-013.01; and

(B) The licensee's or registrant's program to assess and control dose within the 5 mSv (0.5 rem) annual limit; and

(C) The procedures to be followed to maintain the dose as low as reasonably achievable (ALARA).

013.05 ADDITIONAL REQUIREMENTS. In addition to the requirements of 180 NAC 4, a licensee or registrant subject to the provisions of the U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190 must comply with those standards.

013.06 ADDITIONAL RESTRICTIONS. In order to restrict the collective dose, licensees and registrants may be required to further restrict radiation levels in unrestricted areas or on the total quantity of radionuclides that may be released in effluents.

014. COMPLIANCE WITH DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC. Licensees and registrants must demonstrate compliance with dose limits for individual members of the public as follows.

014.01 SURVEYS. The licensee or registrant must make or cause to be made surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas to demonstrate compliance with the dose limits for individual members of the public in 180 NAC 4-013.

014.02 DEMONSTRATING COMPLIANCE. A licensee or registrant must show compliance with the annual dose limit in 180 NAC 4-013 by:

(A) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed or registered operation does not exceed the annual dose limit; or

(B) Demonstrating that:

(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table II of Appendix 4-B of 180 NAC 4; and

(ii) If an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv (0.002 rem) in an hour and 0.5 mSv (0.05 rem) in a year.

014.03 ADJUSTMENT OF EFFLUENT CONCENTRATION VALUES. Upon approval from the Department, the licensee or registrant may adjust the effluent concentration values in Appendix 4-B, Table II, of 180 NAC 4 for members of the public, to take into account the actual physical and chemical characteristics of the effluents, such as, aerosol size distribution, solubility, density, radioactive decay equilibrium, and chemical form.

015. RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION. The radiological criteria for termination of a license are as follows.

015.01 GENERAL PROVISIONS AND SCOPE. The criteria in 180 NAC 4 apply to the decommissioning of facilities licensed under 180 NAC 3. The criteria do not apply to uranium and thorium recovery facilities or to uranium solution extraction facilities.

015.02 LIMITATIONS. The criteria in 180 NAC 4 do not apply to sites which:

(A) Were decommissioned prior to May 27, 2000 in accordance criteria identified in the Site Decommissioning Management Plan Action Plan of April 16, 1992 (57 FR 13389); or

(B) Previously submitted and received Department approval on a decommissioning plan that is compatible with the Site Decommissioning Management Plan Action Plan criteria.

015.03 ADDITIONAL CLEANUP. After a site has been decommissioned and the license

terminated in accordance with the criteria in 180 NAC 4, a former licensee must conduct additional cleanup only if, based on new information, the Department determines that the criteria of 180 NAC 4 were not met and residual radioactivity remaining at the site could result in significant threat to public health and safety.

015.04 PEAK TOTAL EFFECTIVE DOSE EQUIVALENT. When calculating total effective dose equivalent (TEDE) to the average member of the critical group the license must determine the peak annual total effective dose equivalent (TEDE) dose expected within the first 1000 years after decommissioning.

016. RADIOLOGICAL CRITERIA FOR UNRESTRICTED USE. A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 0.25 mSv (25 mrem) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are as low as reasonably achievable (ALARA) must take into account consideration of any detriments expected to potentially result from decontamination and waste disposal.

017. CRITERIA FOR LICENSE TERMINATION UNDER RESTRICTED CONDITIONS. The criteria for license termination under restricted conditions are as follows.

017.01 CRITERIA. A site will be considered acceptable for license termination under restricted conditions if:

(A) The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of 180 NAC 4-016 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are as low as reasonably achievable (ALARA). Determination of the levels which are as low as reasonably achievable (ALARA) must take into account consideration of any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal;

(B) The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the total effective dose equivalent (TEDE) from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 0.25 mSv (25 mrem) per year;

(C) The licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site. Acceptable financial assurance mechanisms are:

(i) Funds placed into an account segregated from the licensee's assets and outside the licensee's administrative control, and in which the adequacy of the trust funds is to be assessed based on an assumed annual one percent real rate of return on investment.

(ii) A statement of intent in the case of Federal, State or local Government licensees, as described in 180 NAC 3-018.06, (D); or

(iii) When a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by such governmental entity.

(D) The licensee has submitted a decommissioning plan to the Department indicating the

licensee's intent to decommission in accordance with 180 NAC 3-018.01, and specifying that the licensee intends to decommission by restricting use of the site. The licensee must document in the decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.

(i) Licensees proposing to decommission by restricting use of the site must seek advice from such affected parties regarding the following matters concerning the proposed decommissioning:

(1) Whether provisions for institutional controls proposed by the licensee:

(a) Will provide reasonable assurance that the total effective dose equivalent (TEDE) from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 0.25 mSv (25 mrem) total effective dose equivalent (TEDE) per year;

(b) Will be enforceable; and

(c) Will not impose undue burdens on the local community or other affected parties.

(2) Whether the licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

(ii) In seeking advice on the issues identified in 180 NAC 4-017.01, (D)(i), the licensee must provide for:

(1) Participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;

(2) An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

(3) A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

(E) Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the total effective dose equivalent (TEDE) from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either;

(i) 1 mSv (100 mrem) per year; or (1 mSv) per year; or

(ii) 5 mSv (500 mrem) per year provided the licensee;

(1) Demonstrates that further reductions in residual radioactivity necessary to comply with the 1 mSv/y (100 mrem/y) value of 180 NAC 4-017.01, (E)(i), are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;

(2) Makes provisions for durable institutional controls;

(3) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site both to carry out periodic rechecks of the site, no less frequently than every five years to assure that the institutional controls necessary to meet the criteria of 180 NAC 4-017.01, (B) and to assume and carry out responsibilities

for any necessary control and, maintenance of those controls. Acceptable financial assurance mechanisms are those in 180 NAC 4-017.01, (C).

018. ALTERNATE CRITERIA FOR LICENSE TERMINATION. Alternate criteria for license termination are as follows.

018.01 CRITERIA. For the Department to consider terminating a license using alternate criteria greater than the dose criterion of 180 NAC 4-016, 4-017.01(B), and 4-017.01(D)(i)(1)(a), the licensee must:

(A) Provide assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 1 mSv per year (100 mrem per year) limit of 180 NAC 4-013.01(A) by submitting an analysis of possible sources of exposure;

(B) Employ to the extent practical restrictions on site use according to the provisions of 180 NAC 4-017 in minimizing exposures at the site;

(C) Reduce doses to as low as reasonably achievable (ALARA) levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal;

(D) Have submitted a decommissioning plan to the Department indicating the licensee's intent to decommission in accordance with 180 NAC 3-019.04 and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee must document in the decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice. In seeking such advice, the licensee must provide for:

(i) Participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;

(ii) An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and

(iii) A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

(E) Have provided sufficient financial assurance in the form of a trust fund to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

018.02 The use of alternate criteria to terminate a license requires the approval of the Department and will consider any comments provided by the Environmental Protection Agency and any public comments submitted according to 180 NAC 4-019.

019. PUBLIC NOTIFICATION AND PUBLIC PARTICIPATION. The process for public notification and participation in the Department's consideration of license termination under restricted and alternate conditions is as follows.

019.01 COMMENTS. Upon the receipt of the decommissioning plan from the licensee, or a proposal by the licensee for release of a site according to 180 NAC 4-017 and 4-018, or whenever the Department deems such notice to be in the public interest, the Department may:

(A) Notify and solicit comments from:

(i) Local and State governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and
(ii) The Environmental Protection Agency for cases where the licensee proposes to release a site according to 180 NAC 4-018.

019.02 PUBLICATION. A notice may be posted in local newspapers, letters to the State or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and comments may be solicited from affected parties.

020. MINIMIZATION OF CONTAMINATION. Contamination must be minimized as follows.

020.01 APPLICANTS. Applicants for licenses, other than renewals, must describe in the application how the facility design and the procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

020.02 LICENSEES. Licensees must, to the extent practical, conduct operations to minimize the introduction of residual radioactivity into the site, including the subsurface, in accordance with the existing radiation protection requirements in 180 NAC 4-004 and radiological criteria for license termination in 180 NAC 4-015 through 4-020.

021. SURVEYS AND MONITORING. Licensees and registrants must conduct surveys and monitor for radiation as follows.

021.01 AREA SURVEYS. Each licensee or registrant must make, or cause to be made, surveys of areas, including the subsurface, that:
(A) Are necessary for the licensee or registrant to comply with 180 NAC 4; and
(B) Are necessary under the circumstances to evaluate:
(i) The magnitude and extent of radiation levels; and
(ii) Concentrations or quantities of residual radioactivity; and
(iii) The potential radiological hazards of the radiation levels and residual radioactivity detected.

021.02 SUBSURFACE RESIDUAL RADIOACTIVITY. Despite the requirements of 180 NAC 4-048.01, records from surveys describing the location and amount of subsurface residual radioactivity identified at the site must be kept with records important for decommissioning, and those records must be retained in accordance with 180 NAC 3-018.07, as applicable.

021.03 SURVEY INSTRUMENT AND EQUIPMENT CALIBRATION. The licensee or registrant must ensure that instruments and equipment used for quantitative radiation measurements, including dose rate and effluent monitoring, are calibrated at intervals not to exceed 12 months for the radiation measured, except when a more frequent interval is specified in another applicable chapter or a license condition.

021.04 PERSONNEL DOSIMETERS. All personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any

extremity, that require processing to determine the radiation dose and that are used by licensees and registrants to comply with 180 NAC 4-005, with other applicable provisions of these regulations, or with conditions specified in a license or registration must be processed and evaluated by a dosimetry processor:

(A) Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

(B) Approved in this accreditation process for the type of radiation or radiations included in the National Voluntary Laboratory Accreditation Program (NVLAP) program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

021.05 DECEPTIVE EXPOSURE OF AN INDIVIDUAL MONITORING DEVICE. The licensee or registrant must ensure that adequate precautions are taken to prevent a deceptive exposure of an individual monitoring device.

022. CONDITIONS REQUIRING INDIVIDUAL MONITORING OF EXTERNAL AND INTERNAL OCCUPATIONAL DOSE. Each licensee or registrant must monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of 180 NAC 4 as follows.

022.01 OCCUPATIONAL EXPOSURE MONITORING. Each licensee or registrant must monitor occupational exposures to radiation from registered, licensed and unlicensed radiation sources under the control of the licensee or registrant and must supply and require the use of individual monitoring devices by:

(A) Adults likely to receive, in one year from sources external to the body, a dose in excess of 10% of the limits in 180 NAC 4-005.01; and

(B) Minors likely to receive, in one year, from sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem), a lens dose equivalent in excess of 1.5 mSv (0.15 rem), or a shallow dose equivalent to the skin or to the extremities in excess of 5 mSv (0.5 rem);

(C) Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem). All of the occupational doses in 180 NAC 4-005 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded;

(D) Individuals entering a high or very high radiation area; and

(E) Individuals working with medical fluoroscopic equipment:

(i) An individual monitoring device used for the dose to an embryo/fetus of a declared pregnant woman, according to 180 NAC 4-012.01, must be located under the protective apron at the waist;

(ii) An individual monitoring device used for lens dose equivalent must be located at the neck or collar, or an unshielded location closer to the eye, outside the protective apron; and

(iii) When only one individual monitoring device is used to determine the effective dose equivalent for external radiation according to 180 NAC 4-005.03, it must be located at the neck or collar outside the protective apron. When a second individual monitoring device is used for the same purpose, it must be located under the protective apron at the waist. The second individual monitoring device

is required for a declared pregnant woman.

022.02 OCCUPATIONAL INTAKE OF RADIOACTIVE MATERIAL. Each licensee or registrant must monitor, to determine compliance with 180 NAC 4-008, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

(A) Adults likely to receive, in one year, an intake in excess of 10% of the applicable annual limit on intake (ALI) in Table I, Columns 1 and 2, of Appendix of 180 NAC 4;

(B) Minors likely to receive, in one year, a committed effective dose equivalent in excess of 1 mSv (0.1 rem); and

(C) Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 1 mSv (0.1 rem).

023. CONTROL OF ACCESS TO HIGH RADIATION AREAS. The requirements for control of access to high radiation areas are as follows.

023.01 ACCESS POINTS. The licensee or registrant must ensure that each entrance or access point to a high radiation area has one or more of the following features:

(A) A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep dose equivalent of 1 mSv (0.1 rem) in one hour at 30 centimeters from the source of radiation from any surface that the radiation penetrates;

(B) A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or

(C) Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

023.02 CONTINUOUS DIRECT OR ELECTRONIC SURVEILLANCE. In place of the controls required by 180 NAC 4-023.01 for a high radiation area, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

023.03 APPLICATION FOR APPROVAL OF ALTERNATIVE METHODS. The licensee or registrant may apply to the Department for approval of alternative methods for controlling access to high radiation areas.

023.04 EGRESS. The licensee or registrant must establish the controls required by 180 NAC 4-023.01 and 4-023.03 in a way that does not prevent individuals from leaving a high radiation area.

023.05 RADIOACTIVE MATERIALS PACKAGED AND LABELED FOR TRANSPORT. The licensee is not required to control each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation provided that:

(A) The packages do not remain in the area longer than 3 days; and

(B) The dose rate at 1 meter from the external surface of any package does not exceed 0.1 mSv (0.01 rem) per hour.

023.06 PATIENTS CONTAINING RADIOACTIVE MATERIAL. The licensee is not required to control entrance or access to rooms or other areas in hospitals solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who are taking the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the established limits in 180 NAC 4 and to operate within the as low as reasonably achievable (ALARA) provisions of the licensee's radiation protection program.

023.07 EXCEPTION. The registrant is not required to control entrance or access to rooms or other areas containing sources of radiation capable of producing a high radiation area as described in 180 NAC 4-023 if the registrant has met all the specific requirements for access and control specified applicable chapters of Title 180, 180 NAC 5 for industrial radiography, 180 NAC 6 for x-rays in the healing arts, or 180 NAC 9 for particle accelerators.

024. CONTROL OF ACCESS TO VERY HIGH RADIATION AREAS. The requirements for control of access to very high radiation areas are as follows.

024.01 UNAUTHORIZED OR INADVERTENT ACCESS. In addition to the requirements in 180 NAC 4-023, the licensee or registrant must institute measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 5 Gy (500 rad) or more in 1 hour at 1 meter from a source of radiation or any surface through which the radiation penetrates. This requirement does not apply to rooms or areas in which diagnostic x-ray systems are the only source of radiation, or to non-self-shielded irradiators.

024.02 EXCEPTION. The registrant is not required to control entrance or access to rooms or other areas containing sources of radiation capable of producing a very high radiation area as described in 180 NAC 4-024.01 if the registrant has met all the specific requirements for access and control specified in applicable chapters of Title 180, 180 NAC 5 for industrial radiography, 180 NAC 6 for x-rays in the healing arts, or 180 NAC 9 for particle accelerators.

025. CONTROL OF ACCESS TO VERY HIGH RADIATION AREAS—IRRADIATORS. The requirements for control of access to very high radiation areas at non-self-shielded irradiators are as follows.

025.01 NON-SELF-SHIELDED IRRADIATORS. 180 NAC 4-025 applies to licensees or registrants with sources of radiation in non-self-shielded irradiators. 180 NAC 4-025 does not apply to sources of radiation that are used in teletherapy, in industrial radiography, or in completely self-shielded irradiators in which the source of radiation is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual.

025.02 AREA CONTROLS. Each area in which there may exist radiation levels in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a source of radiation that is used to irradiate materials must meet the following requirements.

025.02(A) ENTRANCE OR ACCESS POINT. Each entrance or access point must be

equipped with entry control devices that:

(i) Function automatically to prevent any individual from inadvertently entering a very high radiation area;

(ii) Permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the source of radiation, to be reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

(iii) Prevent operation of the source of radiation if it would produce radiation levels in the area that could result in a deep dose equivalent to an individual in excess of 1 mSv (0.1 rem) in 1 hour.

025.02(B) ADDITIONAL CONTROL DEVICES. Be provided with additional control devices upon failure of the entry control devices to function as required by 180 NAC 4-025.02(A):

(i) The radiation level within the area, from the source of radiation, is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make an individual attempting to enter the area aware of the hazard and at least one other authorized individual, who is physically present, familiar with the activity, and prepared to render or summon assistance, aware of the failure of the entry control devices.

025.02(C) FAILURE OR REMOVAL OF PHYSICAL RADIATION BARRIERS. The licensee or registrant must provide control devices so that, upon failure or removal of physical radiation barriers:

(i) The radiation level from the source of radiation is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

(ii) Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or registrant or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.

025.02(D) PERMANENT STRUCTURAL COMPONENTS. Physical radiation barriers that comprise permanent structural components or walls that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of 180 NAC 4-025.02(C).

025.02(E) VISIBLE AND AUDIBLE ALARMS. Each area must be equipped with devices that will automatically generate conspicuous visible and audible alarm signals to alert personnel in the area before the source of radiation can be put into operation and in time for any individual in the area to operate a clearly identified control device, which must be installed in the area and which can prevent the source of radiation from being put into operation.

025.02(F) AREA CONTROLS. Each area must be controlled by use of such administrative procedures and such devices as are necessary to ensure that the area is

cleared of personnel prior to each use of the source of radiation.

025.02(G) RADIATION MEASUREMENT. Each area must be checked by a radiation measurement to ensure that, prior to the first individual's entry into the area after any use of the source of radiation, the radiation level from the source of radiation in the area is below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour.

025.02(H) ENTRY CONTROL DEVICE TESTING. The entry control devices required in 180 NAC 4-025.02(A), must have been tested for proper functioning:

(i) Testing must be conducted prior to initial operation with the source of radiation on any day, unless operations were continued uninterrupted from the previous day;
(ii) Testing must be conducted prior to resumption of operation of the source of radiation after any unintentional interruption; and
(iii) The licensee or registrant must submit and adhere to a schedule for periodic tests of the entry control and warning systems.

025.02(I) FUNCTIONING CONTROL DEVICES. The licensee or registrant must not conduct operations, other than those necessary to place the source of radiation in safe condition or to effect repairs on controls, unless control devices are functioning properly.

025.02(J) ENTRY AND EXIT PORTALS. Entry and exit portals that are used in transporting materials to and from the irradiation area, and that are not intended for use by individuals, must be controlled by such devices and administrative procedures as are necessary to physically protect and warn against inadvertent entry by any individual through these portals.

025.03 ALTERNATIVE SAFETY MEASURES. Registrants or applicants for registrations for sources of radiation within the scope of 180 NAC 4-025.02 that will be used in a variety of positions or in locations that make it impracticable to comply with certain requirements of 180 NAC 4-025.02, may apply to the Department for approval of alternative safety measures. Alternative safety measures must provide personnel protection at least equivalent to those specified in 180 NAC 4-025.02. At least one of the alternative measures must include an entry-preventing interlock control based on a measurement of the radiation that ensures the absence of high radiation levels before an individual can gain access to the area where such sources of radiation are used.

025.04 ENTRY CONTROL DEVICES. The entry control devices required by 180 NAC 4-025.02 and 4-025.03 must be established in such a way that no individual will be prevented from leaving the area.

026. CONTROL OF CONCENTRATIONS OF RADIOACTIVE MATERIAL IN AIR. The licensee or registrant must use, to the extent practical, process or other engineering controls, containment, decontamination or ventilation to control the concentrations of radioactive material in air.

027. USE OF OTHER CONTROLS. The licensee may consider the following in limiting the concentrations of radioactive material in air.

027.01 INCREASED MONITORING AND LIMIT INTAKES. When it is not practical to apply process or other engineering controls to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the licensee or registrant must, consistent with maintaining the total effective dose equivalent as low as reasonably achievable (ALARA), increase monitoring and limit intakes by one or more of the following means:

(A) Control of access;
(B) Limitation of exposure times;
(C) Use of respiratory protection equipment; or
(D) Other controls.

027.02 SAFETY FACTORS. If the licensee performs an as low as reasonably achievable (ALARA) analysis to determine whether or not respirators should be used, the licensee may consider safety factors other than radiological factors. The licensee may also consider the impact of respirator use on workers' industrial health and safety.

028. USE OF INDIVIDUAL RESPIRATORY PROTECTION EQUIPMENT. This section addresses the use of respiratory protection equipment.

028.01 RESPIRATORY PROTECTION EQUIPMENT. If the licensee assigns or permits the use of respiratory protection equipment to limit the intake of radioactive material, according to 180 NAC 4-027 the licensee must:

(A) Use only respiratory protection equipment that is tested and certified by the National Institute for Occupational Safety and Health (NIOSH), except as provided in 180 NAC 4-028.01(B);
(B) Submit an application for authorized use if the licensee wishes to use equipment that has not been tested or certified by the National Institute for Occupational Safety and Health (NIOSH), or for which there is no schedule for testing or certification, except as provided in 180 NAC 4-028.01. The application must include evidence that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use. This must be demonstrated either by licensee testing or on the basis of reliable test information.
(C) Implement and maintain a respiratory protection program that includes:
    (i) Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate doses;
    (ii) Surveys and bioassays, as necessary, to evaluate actual intakes;
    (iii) Testing of respirators for operability consisting of a user seal check for face sealing devices and functional check for each other immediately prior to each use; and
    (iv) Written procedures regarding:
        (1) Monitoring, including air sampling and bioassays;
        (2) Supervision and training of respiratory users;
        (3) Fit testing;
        (4) Respiratory selection;
        (5) Breathing air quality;
        (6) Inventory and control;
        (7) Storage, issuance, maintenance, repair, testing, and quality assurance of respiratory protection equipment;

(8) Recordkeeping; and
(9) Limitations on periods of respirator use and relief from respirator use; and
(v) A determination by a physician that the individual user is medically fit to use the respiratory protection equipment:
(1) Before the initial fitting of a face sealing respiratory;
(2) Before the first field use of non-face sealing respirators, and
(3) Either every 12 months thereafter, or periodically at a frequency determined by a physician; and
(vi) Fit testing, with fit factor ≥10 times the assigned protection factor (APF) for negative pressure devices, and a fit factor ≥ 500 for any positive pressure, continuous flow, and pressure-demand devices, before the first field use of tight fitting face-sealing respirators and periodically thereafter at a frequency not to exceed one year. Fit testing must be performed with the facepiece operating in the negative pressure mode; and
(D) Advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief; and
(E) Consider limitations appropriate to the type and mode of use. When selecting respiratory devices the licensee must provide for vision correction, adequate communication, low temperature work environments, and the concurrent use of other safety or radiological protection equipment. The licensee must use equipment in such a way as not to interfere with the proper operation of the respirator; and
(F) Have standby rescue persons whenever one-piece atmosphere-supplying suits, or any combination of supplied air respiratory protection device and personnel protective equipment are used from which an unaided individual would have difficulty extricating themself. The standby persons must be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards. The standby rescue persons must observe or otherwise maintain continuous communication with the workers through visual, voice, signal line, telephone, radio, or other suitable means, and be immediately available to assist them in case of a failure of the air supply or for any other reason that requires relief from distress. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and to provide effective emergency rescue if needed; and
(G) Supply atmosphere-supplying respirators with respirable air of grade D quality or better as specified in the regulations of the Occupational Safety and Health Administration at 29 CFR 1910.134(i)(1)(ii)(2016). Grade D quality air criteria include:
(i) Oxygen content (v/v) of 19.5-23.5%;
(ii) Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
(iii) Carbon monoxide (CO) content of 10 ppm or less;
(iv) Carbon dioxide content of 1,000 ppm or less; and
(v) Lack of noticeable odor; and
(H) Ensure that no objects, materials or substances, such as facial hair, or any conditions that interfere with the face--facepiece seal or valve function, and that are under the control of the respirator wearer, are present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece; and
(I) Initially assume the concentration of radioactive material in the air that is inhaled when respirators are worn to be the ambient concentration in air without respiratory

protection, divided by the assigned protection factor when estimating the dose to individuals from intake of airborne radioactive materials. If the dose is later found to be greater than the estimated dose, the corrected value must be used. If the dose is later found to be less than the estimated dose, the corrected value may be used.

029. FURTHER RESTRICTIONS ON THE USE OF RESPIRATORY PROTECTION EQUIPMENT. Licensees must comply with restrictions imposed by the Department in addition to the provisions of 180 NAC 4-027, 4-028, and Appendix 4-A as follows.

029.01 AS LOW AS REASONABLY ACHIEVABLE (ALARA). Licensees must comply with further restrictions imposed by the Department to ensure that the respiratory protection program of the licensee is adequate to limit doses to individuals from intakes of airborne radioactive materials consistent with maintaining total effective dose equivalent as low as reasonably achievable (ALARA).

029.02 RELIANCE ON RESPIRATORY PROTECTION EQUIPMENT. Licensees must comply with any limits imposed by the Department on the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

030. APPLICATION FOR USE OF HIGHER ASSIGNED PROTECTION FACTORS. The licensee must obtain authorization from the Department before using assigned protection factors in excess of those specified in Appendix 4-A.

030.01 DESCRIPTION OF THE SITUATION. An application to use protection factors in excess of those specified in Appendix 4-A must describe the situation for which a need exists for higher protection factors.

030.02 CONDITIONS OF USE. An application to use protection factors in excess of those specified in Appendix 4-A must demonstrate that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

031. SECURITY AND CONTROL OF LICENSED OR REGISTERED SOURCES OF RADIATION. Licensed or registered sources of radiation must be secured and controlled as follows.

031.01 UNAUTHORIZED REMOVAL OR ACCESS OF RADIOACTIVE MATERIAL. The licensee or registrant must secure licensed or registered radioactive material from unauthorized removal or access.

031.02 UNAUTHORIZED USE OF RADIOACTIVE MATERIAL. The licensee or registrant must maintain constant surveillance, use devices and administrative procedures to prevent unauthorized use of licensed or registered radioactive material that is in an unrestricted area and that is not in storage.

031.03 MOBILE AND PORTABLE RADIATION MACHINES. The registrant must secure mobile or portable radiation machines that are capable of producing a high radiation area as defined in 180 NAC 1 from unauthorized removal.

031.04 UNAUTHORIZED USE OF RADIATION MACHINES. The registrant must use devices or administrative procedures to prevent unauthorized use of registered radiation machines.

031.05 SECURITY REQUIREMENTS FOR PORTABLE GAUGES. Each portable gauge licensee must use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal, whenever portable gauges are not under the control and constant surveillance of the licensee.

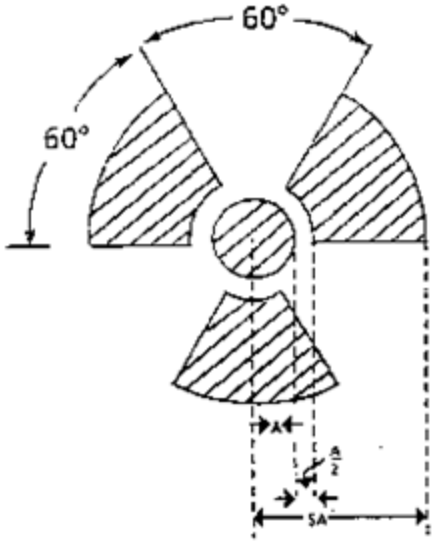
032. RESERVED.

033. CAUTION SIGNS. This section addresses caution signs and their appearance.

033.01 STANDARD RADIATION SYMBOL. Unless otherwise authorized by the Department, the symbol prescribed by 180 NAC 4-033 must use the colors magenta, or purple, or black on yellow background. The symbol prescribed is the three-bladed design as follows:

(A) Cross-hatched area is to be magenta, or purple, or black, and

(B) The background is to be yellow.



033.02 EXCEPTION TO COLOR REQUIREMENTS FOR STANDARD RADIATION SYMBOL. Despite the requirements of 180 NAC 4-033.01, licensees or registrants are authorized to label sources, source holders, or device components containing sources of radiation that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

033.03 ADDITIONAL INFORMATION ON SIGNS AND LABELS. In addition to the contents of signs and labels prescribed in 180 NAC 4, the licensee or registrant must provide, on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures.

034. POSTING REQUIREMENTS. This section address posting requirements.

034.01 POSTING OF RADIATION AREAS. The licensee or registrant must post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

034.02 POSTING OF HIGH RADIATION AREAS. The licensee or registrant must post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

034.03 POSTING OF VERY HIGH RADIATION AREAS. The licensee or registrant must post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA."

034.04 POSTING OF AIRBORNE RADIOACTIVITY AREAS. The licensee or registrant must post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

034.05 POSTING OF AREAS OR ROOMS IN WHICH LICENSED OR REGISTERED MATERIAL IS USED OR STORED. The licensee or registrant must post each area or room in which there is used or stored an amount of licensed or registered material exceeding ten times the quantity of such material specified in Appendix 4-C of 180 NAC 4 with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

035. EXCEPTIONS TO POSTING REQUIREMENTS. The exceptions to the posting requirements are as follows.

035.01 RADIATION FOR PERIODS OF LESS THAN EIGHT HOURS. A licensee or registrant is not required to post caution signs in areas or rooms containing sources of radiation for periods of less than eight hours, if each of the following conditions is met:

(A) The sources of radiation are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to sources of radiation in excess of the limits established in 180 NAC 4; and

(B) The area or room is subject to the licensee's or registrant's control.

035.02 PATIENT ROOMS AND AREAS. Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs according to 180 NAC 4-034 provided that the patient could be released from licensee control according to 180 NAC 7-037.

035.03 SEALED SOURCE. A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level at 30 centimeters from the surface of the sealed source container or housing does not exceed 0.05 mSv (0.005 rem) per hour.

035.04 TELETHERAPY. Rooms in hospitals or clinics that are used for teletherapy are exempt from the requirement to post caution signs in accordance with 180 NAC 4-034 if:

(A) Access to the room is controlled in accordance with 180 NAC 7-071; and

(B) Personnel in attendance take necessary precautions to prevent the inadvertent exposure of workers, other patients, and members of the public to radiation in excess of the limits established in 180 NAC 4-035.

036. LABELING CONTAINERS AND RADIATION MACHINES. The requirements for labeling containers and radiation machines are as follows.

036.01 RADIOACTIVE MATERIAL LABEL. The licensee or registrant must ensure that each container of licensed or registered material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must also provide information, such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment, to permit individuals handling or using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

036.02 RADIOACTIVE MATERIAL LABEL REMOVAL. Each licensee or registrant must, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

036.03 RADIATION MACHINE LABEL. Each registrant must ensure that each radiation machine is labeled in a conspicuous manner which cautions individuals that radiation is produced when it is energized.

037. EXEMPTIONS TO LABELING REQUIREMENTS. A licensee or registrant is not required to label:

037.01 CONTAINERS HOLDING QUANTITIES LESS THAN APPENDIX 4-C. Containers holding licensed or registered material in quantities less than the quantities listed in Appendix 4-C of 180 NAC 4;

037.02 CONTAINERS HOLDING CONCENTRATIONS LESS THAN TABLE III OF APPENDIX 4-B. Containers holding licensed or registered material in concentrations less than those specified in Table III of Appendix B of 180 NAC 4;

037.03 CONTAINERS ATTENDED BY AN INDIVIDUAL. Containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by 180 NAC 4;

037.04 CONTAINERS IN TRANSPORT. Containers when they are in transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation. Labeling of packages containing radioactive materials is required by the U.S. Department of Transportation if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by U.S. Department of Transportation regulations 49 CFR 173.403(m) and (w) and 173.421-424;

037.05 LIMITED ACCESS CONTAINERS. Containers that are accessible only to individuals

authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record. Examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells. The record must be retained as long as the containers are in use for the purpose indicated on the record; or

037.06 INSTALLED MANUFACTURING OR PROCESS EQUIPMENT. Installed manufacturing or process equipment, such as piping and tanks.

038. PROCEDURES FOR RECEIVING AND OPENING PACKAGES. This section addresses the procedures for opening packages containing radioactive materials.

038.01 RECEIPT. Each licensee who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in 180 NAC 13-002 and Appendix A of 180 NAC 13, must make arrangements to receive:

(A) The package when the carrier offers it for delivery; or

(B) Notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

038.02 MONITORING. Each licensee must monitor:

(A) The external surfaces of a labeled package for radioactive contamination unless the package contains only radioactive material in the form of a gas or in special form as defined in 180 NAC 1-002. A labeled package is a package labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436-440;

(B) The external surfaces of a labeled package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in 180 NAC 13-002 and Appendix A to 180 NAC 13. A labeled package is a package labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436-440; and

(C) All packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged.

038.03 MONITORING. The licensee must perform the monitoring required by 180 NAC 4-038.02 as soon as practical after receipt of the package, but not later than three hours after the package is received at the licensee's or registrant's facility if it is received during the licensee's or registrant's normal working hours, or not later than three hours from the beginning of the next working day if it is received after working hours.

038.04 IMMEDIATE NOTIFICATION. The licensee must immediately notify the final delivery carrier and the Department by telephone and telegram, mailgram, or facsimile when:

(A) Removable radioactive surface contamination exceeds the limits of 180 NAC 13-015.09; or

(B) External radiation levels exceed the limits of 180 NAC 13-015.10 and 13-015.11.

038.05 WRITTEN PROCEDURES. Each licensee must:

(A) Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and
(B) Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

038.06 EXEMPTION. Licensees transferring special form sources in vehicles owned or operated by the licensee to and from a work site are exempt from the contamination monitoring requirements of 180 NAC 4-038.02, but are not exempt from the monitoring requirement in 180 NAC 4-038.02 for measuring radiation levels that ensures that the source is still properly lodged in its shield.

039. WASTE DISPOSAL GENERAL REQUIREMENTS.

039.01 DISPOSAL. A licensee must dispose of licensed material only:
(A) By transfer to an authorized recipient as provided in 180 NAC 4-044 or in 180 NAC 3, 12 or 19, or to the U.S. Department of Energy; or
(B) By decay in storage in accordance with 180 NAC 4-039.03; or
(C) By release in effluents within the limits in 180 NAC 4-013; or
(D) As authorized according to 180 NAC 4-040 through 4-043 or 4-039.05 and 4-039.06.

039.02 RECEIVING WASTE. A person must be specifically licensed to receive waste containing licensed material from other persons for:
(A) Treatment prior to disposal; or
(B) Treatment or disposal by incineration; or
(C) Decay in storage; or
(D) Management at a facility licensed according to 180 NAC 12; or
(E) Storage until transferred to a storage or disposal facility authorized to receive the waste.

039.03 DECAY IN STORAGE. A licensee may hold radioactive material with a physical half-life of less than or equal to 120 days for decay-in-storage before disposal without regard to its radioactivity if the licensee:
(A) Holds radioactive material for decay a minimum of ten half-lives;
(B) Monitors radioactive material at the container surface before disposal and determines that its radioactivity cannot be distinguished from the background radiation level with an appropriate radiation detection survey instrument set on its most sensitive scale and with no interposed shielding;
(C) Removes or obliterates all radiation labels; except for materials that will be handled as biomedical waste after released; and
(D) Separates and monitors each generator column individually with all radiation shielding removed to ensure that its contents have decayed to background radiation level before disposal.

039.04 DECAY IN STORAGE RECORDS. For radioactive material disposed in accordance with 180 NAC 4-039.03, the licensee must retain a record of each disposal in accordance with 180 NAC 4-054.03.

039.05 DISPOSAL AT A LICENSED LOW-LEVEL RADIOACTIVE WASTE FACILITY.

Discrete sources of radium-226 and discrete sources of naturally occurring radioactive material may be disposed of at a facility licensed for land disposal of low-level radioactive waste, even though it is not defined as low-level radioactive waste. Therefore, any licensed radioactive material being disposed of at a facility, or transferred for ultimate disposal at a facility licensed for land disposal of low-level radioactive waste must meet the requirements of 180 NAC 4-044.02.

039.06 DISPOSAL AT SOLID OR HAZARDOUS WASTE FACILITY. A licensee may dispose of discrete sources of radium-226 and discrete sources of naturally occurring radioactive material, at a disposal facility authorized to dispose of such material in accordance with any Federal or State solid or hazardous waste law.

040. METHOD FOR OBTAINING APPROVAL OF PROPOSED DISPOSAL PROCEDURES. A licensee or applicant for a license may apply to the Department for approval of proposed procedures, not otherwise authorized in these regulations, to dispose of licensed material generated in the licensee's operations. Each application must include:

(A) A description of the waste containing licensed or registered material to be disposed of, including the physical and chemical properties that have an impact on risk evaluation, and the proposed manner and conditions of waste disposal; and
(B) An analysis and evaluation of pertinent information on the nature of the environment; and
(C) The nature and location of other potentially affected facilities; and
(D) Analyses and procedures to ensure that doses are maintained as low as reasonably achievable (ALARA) and within the dose limits in 180 NAC 4.

041. DISPOSAL BY RELEASE INTO SANITARY SEWERAGE. This section addresses disposal of radioactive material by release into sanitary sewerage.

041.01 CONDITIONS FOR DISCHARGE OF LICENSED MATERIAL INTO SANITARY SEWAGE. A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

(A) The material is readily soluble, or is readily dispersible biological material, in water;
(B) The quantity of licensed radioactive material that the licensee releases into the sewer in one month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in Table III of Appendix 4-B of 180 NAC 4;
(C) If more than one radionuclide is released, the following conditions must also be satisfied:
    (i) The licensee must determine the fraction of the limit in Table III of Appendix 4-B of 180 NAC 4 represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee or registrant into the sewer by the concentration of that radionuclide listed in Table III of Appendix 4-B of 180 NAC 4; and
    (ii) The sum of the fractions for each radionuclide required by 180 NAC 4-041.01, (C)(i) does not exceed unity; and
(D) The total quantity of licensed radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of hydrogen-3, 37 GBq (1 Ci) of carbon-14, and 37 GBq (1 Ci) of all other radioactive materials

combined.

041.02 EXCRETA. Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in 180 NAC 4-039.01.

042. TREATMENT OR DISPOSAL BY INCENERATION. A licensee may treat or dispose of licensed material by incineration only in the amounts and forms specified in 180 NAC 4-043 or as specifically approved by the Department according to 180 NAC 4-040.

043. DISPOSAL OF SPECIFIC WASTES. This section addresses the disposal of specific wastes.

043.01 DISPOSAL AS NOT RADIOACTIVE. A licensee may dispose of the following licensed material as if it were not radioactive:

(A) 1.85 kBq (0.05 µCi), or less, of Hydrogen-3, Carbon-14 or Iodine-125 per gram of medium used for liquid scintillation counting; and

(B) 1.85 kBq (0.05 µCi), or less, of Hydrogen-3, or Carbon-14 or Iodine-125 per gram of animal tissue, averaged over the weight of the entire animal.

043.02 DISPOSAL OF TISSUE. A licensee must not dispose of tissue according to 180 NAC 4-041.01, (B) in a manner that would permit its use either as food for humans or as animal feed.

043.03 RECORD MAINTENANCE. The licensee must maintain records in accordance within 180 NAC 4-054.

043.04 CURIE AND CONCENTRATION LIMITS. Any licensee may, upon Department approval of procedures required in 180 NAC 4-043.06, dispose of radioactive material included in Appendix 4-G of 180 NAC 4, provided that it does not exceed the concentration and total curie limits contained there. Any radioactive material included in Appendix 4-G of 180 NAC 4 may be disposed of at a city or county landfill facility authorized to receive the radioactive material.

043.05 SURVEYS AND LABEL REMOVAL. Each licensee who disposes of radioactive material described in 180 NAC 4-043.01 or 4-043.04 must:

(A) Make surveys adequate to assure that the limits of 180 NAC 4-043.01 or 4-043.04 are not exceeded; and

(B) Remove or otherwise obliterate all labels, tags, or other markings which would indicate that the material or its contents is radioactive.

043.06 PROCEDURES. Prior to the initiation of disposals authorized by 180 NAC 4-043.04, a licensee must submit procedures to the Department for:

(A) The physical delivery of the material to the disposal site, the physical placing of the material in the disposal location and that the material is properly covered;

(B) Surveys to be performed for compliance with 180 NAC 4-043.05(A);

(C) Maintaining secure packaging during transportation to the site;

(D) Maintaining records of disposals made under 180 NAC 4-043.04; and

(E) Written authorization by the landfill operator agreeing to such disposal.

043.07 MAINTAINING RECORDS. Nothing in 180 NAC 4, however, relieves the licensee of maintaining records showing the receipt, transfer, and disposal of such radioactive material as specified according to 180 NAC 1-004.

043.08 OTHER REGULATIONS. Nothing in 180 NAC 4 relieves the licensee from complying with other applicable federal, state or local regulations governing any other toxic or hazardous property of these materials.

043.09 EXCEPTION. Radioactive material disposed of under 180 NAC 4 is not subject to the requirements of 180 NAC 13.

044. TRANSFER FOR DISPOSAL AND WASTE MANIFESTS. This section addresses the requirements for transfer for disposal and waste manifests.

044.01 WASTE CONTROL AND WASTE MANIFEST TRACKING SYSTEM. The requirements of 180 NAC 4 and Appendix 4-D of 180 NAC 4 are designed to:

(A) Control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor license, as defined in 180 NAC 4, who ships low-level waste either directly, or indirectly through a waste collector or waste processor, to a licensed low-level waste disposal facility;
(B) Establish a manifest tracking system; and
(C) Supplement existing requirements concerning transfers and recordkeeping for those wastes.

044.02 WASTE MANIFEST. Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility must:

(A) Be accompanied by a shipment manifest as specified in Section I of Appendix 4-D OF 180 NAC 4; and
(B) Transfer this recorded manifest information to the intended consignee in accordance with Appendix 4-D of 180 NAC 4.

044.03 CERTIFICATION BY WASTE GENERATOR. Each shipment manifest must include a certification by waste generator as specified in Section II of Appendix 4-D of 180 NAC 4.

044.04 PERSONS INVOLVED IN THE TRANSFER. Each person involved in the transfer for disposal and disposal of waste, including the waste generator, waste collector, waste processor, and disposal facility operator, must comply with the requirements specified in Section III of Appendix 4-D of 180 NAC 4.

045. COMPLIANCE WITH ENVIRONMENTAL AND HEALTH PROTECTION REGULATIONS. Nothing in 180 NAC 4-039 through 4-044 relieves the licensee or registrant from complying with other applicable Federal, State, and local regulations governing any other toxic or hazardous properties of materials that may be disposed of according to 180 NAC 4-039 through 4-044.

046. GENERAL PROVISONS FOR RECORDS. This section addresses general provisions for records.

046.01 UNITS. Each licensee or registrant must use the International System of Units (SI)

units becquerel, gray, sievert and coulomb per kilogram, or the special units curie, rad, rem, and roentgen, including multiples and subdivisions, and must clearly indicate the units of all quantities on records required by 180 NAC 4.

046.02 SHIPMENT MANIFESTS. Despite of the requirements of 180 NAC 4-046.01, when recording information on shipment manifests, as required in 180 NAC 4-044.02(A), information must be recorded in the International System of Units (SI) or in SI and units as specified in 180 NAC 4-046.01.

046.03 CLEAR DISTINCTION AMONG QUANTITIES. The licensee or registrant must make a clear distinction among the quantities entered on the records required by 180 NAC 4, including total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, lens dose equivalent, deep dose equivalent, or committed effective dose equivalent.

047. RECORDS OF RADIATION PROTECTION PROGRAMS. This section addresses records of radiation protection programs.

047.01 RADIATION PROTECTION PROGRAM RECORDS. Each licensee or registrant must maintain records of the radiation protection program, including:

(A) The provisions of the program; and

(B) Audits and other reviews of program content and implementation.

047.02 RECORD RETENTION. The licensee or registrant must retain the records required by 180 NAC 4-047.01(A) until the Department terminates each pertinent license or registration requiring the record. The licensee or registrant must retain the records required by 180 NAC 4-047.01(B) for three years after the record is made.

048. RECORDS OF SURVEYS. This section addresses records of surveys.

048.01 SURVEYS AND CALIBRATIONS. Each licensee or registrant must maintain records showing the results of surveys and calibrations required by 180 NAC 4-021 and 4-038.02. The licensee or registrant must retain these records for three years after the record is made.

048.02 RECORD RETENTION. The licensee or registrant must retain each of the following records until the Department terminates each pertinent license or registration requiring the record:

(A) Records of the results of surveys to determine the dose from external sources of radiation used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents. This includes those records of results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents required under the standards for protection against radiation in effect prior to May 30, 1994;

(B) Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose. This includes those records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose required under the standards for protection against radiation in effect

prior to May 30, 1994.

(C) Records showing the results of air sampling, surveys, and bioassays required according to 180 NAC 4-028.01(C)(i). This includes those records showing the results of air sampling, surveys and bioassays required under the standards for protection against radiation in effect prior to May 30, 1994; and

(D) Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment. This includes those records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment required under the standards for protection against radiation in effect prior to May 30, 1994.

049. RECORDS OF TESTS FOR LEAKAGE OR CONTAMINATION OF SEALED SOURCES. Records of tests for leakage or contamination of sealed sources required by 180 NAC 1-011 must be kept in units of Becquerel or microcurie and maintained for inspection by the Department for five years after the records are made.

050. RECORDS OF PRIOR OCCUPATIONAL DOSE. For each individual who is likely to receive in a year, an occupational dose requiring monitoring according to 180 NAC 4-022 the licensee or registrant must retain records:

(A) Of prior occupational dose and exposure history as specified in 180 NAC 4-009 on Department Form NRH-1 or equivalent until the Department terminates each pertinent license or registration requiring this record; and

(B) Used in preparing Department Form NRH-1 for three years after the record is made.

051. RECORDS OF PLANNED SPECIAL EXPOSURES. This section addresses records of planned special exposures.

051.01 RECORD MAINTENANCE. For each use of the provisions of 180 NAC 4-010 for planned special exposures, the licensee or registrant must maintain records that describe:

(A) The exceptional circumstances requiring the use of a planned special exposure;

(B) The name of the management official who authorized the planned special exposure and a copy of the signed authorization;

(C) What actions were necessary;

(D) Why the actions were necessary;

(E) What precautions were taken to assure that doses were maintained as low as reasonably achievable (ALARA);

(F) What individual and collective doses were expected to result; and

(G) The doses actually received in the planned special exposure.

051.02 PLANNED SPECIAL EXPOSURE RECORD RETENTION. The licensee or registrant must retain the records until the Department terminates each pertinent license or registration requiring these records.

052. RECORDS OF INDIVIDUAL MONITORING RESULTS. This section addresses records of individual monitoring results.

052.01 RECORDKEEPING REQUIREMENT. Each licensee or registrant must maintain records of doses received by all individuals for whom monitoring was required according to

180 NAC 4-022 and records of doses received during planned special exposures, accidents, and emergency conditions. Assessments of dose equivalent and records made using units in effect before October 30, 1996 for 180 NAC 4 need not be changed. These records must include, when applicable:

(A) The deep dose equivalent to the whole body, lens dose equivalent, shallow dose equivalent to the skin, and shallow dose equivalent to the extremities;
(B) The estimated intake of radionuclides, see 180 NAC 4-006;
(C) The committed effective dose equivalent assigned to the intake of radionuclides;
(D) The specific information used to calculate the committed effective dose equivalent according to 180 NAC 4-008.03;
(E) The total effective dose equivalent when required by 180 NAC 4-006; and
(F) The total of the deep dose equivalent and the committed dose to the organ receiving the highest total dose.

052.02 RECORDKEEPING FREQUENCY. The licensee or registrant must make entries of the records specified in 180 NAC 4-052.01 at intervals not to exceed one year.

052.03 RECORDKEEPING FORMAT. The licensee or registrant must maintain the records specified in 180 NAC 4-052.01 on Department Form NRH-2, in accordance with the instructions for Department Form NRH-2, or in clear and legible records containing all the information required by Department Form NRH-2.

052.04 RECORD MAINTENANCE. The licensee or registrant must maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy, including the estimated date of conception, must also be kept on file, but may be maintained separately from the dose records.

052.05 RECORD RETENTION. The licensee or registrant must retain each required form or record until the Department terminates each pertinent license or registration requiring the record.

053. RECORDS OF DOSE TO INDIVIDUAL MEMBERS OF THE PUBLIC. This section addresses records of dose to individual members of the public.

053.01 RECORD MAINTENANCE. Each licensee or registrant must maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public. See 180 NAC 4-013.

053.02 RECORD RETENTION. The licensee or registrant must retain the records required by 180 NAC 4-053 until the Department terminates each pertinent license or registration requiring the record.

054. RECORDS OF WASTE DISPOSAL. This section addresses records of waste disposal.

054.01 PRIOR DISPOSALS. Each licensee must maintain records of the disposal of licensed materials made according to 180 NAC 4-040 through 4-043 and 180 NAC 12, and disposal by burial in soil, including burials authorized before August 22, 1982.

054.02 RECORD RETENTION. The licensee must retain the records required by 180 NAC 4-054.01 until the Department terminates each pertinent license requiring the record. Requirements for disposition of these records, prior to license termination, are located in 180 NAC 3-030 for activities licensed under 180 NAC 4. This includes records required under the standards for protection against radiation in effect prior to May 30, 1994.

054.03 DISPOSAL RECORDS. A licensee must maintain records of the disposal of licensed materials, as required by 180 NAC 4-039.03 for three years. The record must include the date of the disposal, the date on which the radioactive material was placed in storage, the specific survey instrument used, the background radiation level, the radiation level measured at the surface of each waste container, and the name of the individual who performed the survey.

055. RECORDS OF TESTING ENTRY CONTROL DEVICES FOR VERY HIGH RADIATION AREAS. This section addresses records of testing entry control devices for very high radiation areas.

055.01 RECORDS OF TESTS. Each licensee or registrant must maintain records of tests made according to 180 NAC 4-025.02(H), on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.

055.02 RECORD RETENTION. The licensee or registrant must retain the records required by 180 NAC 4-055.01 for three years after the record is made.

056. FORM OF RECORDS. Each record required by 180 NAC 4 must be legible throughout the specified retention period. The record must be the original or a reproduced copy or a microform, provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records, such as letters, drawings, and specifications, must include all pertinent information, such as stamps, initials, and signatures. The licensee or registrant must maintain adequate safeguards against tampering with and loss of records.

057. REPORTS OF STOLEN, LOST, OR MISSING LICENSED OR REGISTERED SOURCES OF RADIATION. This section addresses reports of stolen, lost or missing sources of radiation.

057.01 TELEPHONE REPORTS. Each licensee or registrant must report to the Department by telephone as follows:

(A) Immediately after its occurrence becomes known to the licensee or registrant, stolen, lost, or missing licensed radioactive material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in Appendix 4-C of 180 NAC 4 under such circumstances that it appears to the licensee that an exposure could result to individuals in unrestricted areas;

(B) Within 30 days after its occurrence becomes known to the licensee or registrant, lost, stolen, or missing licensed radioactive material in an aggregate quantity greater than 10 times the quantity specified in Appendix 4-C of 180 NAC 4 that is still missing; and

(C) Immediately after its occurrence becomes known to the registrant, a stolen, lost, or missing radiation machine.

057.02 WRITTEN REPORTS. Each licensee or registrant required to make a report according to 180 NAC 4-057.01 must, within 30 days after making the telephone report, make a written report to the Department setting forth the following information:

(A) A description of the licensed or registered source of radiation involved, including, for radioactive material, the kind, quantity, and chemical and physical form; and, for radiation machines, the manufacturer, model and serial number, type and maximum energy of radiation emitted;

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

(C) A statement of disposition, or probable disposition, of the licensed or registered source of radiation involved;

(D) Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas;

(E) Actions that have been taken, or will be taken, to recover the source of radiation; and

(F) Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed or registered sources of radiation.

057.03 ADDITIONAL SUBSTANTIVE INFORMATION. Subsequent to filing the written report, the licensee or registrant must also report additional substantive information on the loss or theft within 30 days after the licensee or registrant learns of such information.

057.04 NAMES OF INDIVIDUALS. The licensee or registrant must prepare any report filed with the Department according to 180 NAC 4-057 so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.

058. NOTIFICATION OF INCIDENTS. This section addresses notification requirements for incidents involving sources of radiation.

058.01 IMMEDIATE NOTIFICATION. In addition to other requirements for notification, each licensee or registrant must immediately report each event involving a source of radiation possessed by the licensee or registrant that may have caused or threatens to cause:

(A) An individual to receive:

(i) A total effective dose equivalent of 0.25 Sv (25 rem) or more;

(ii) A lens dose equivalent of 0.75 Sv (75 rem) or more; or

(iii) A shallow dose equivalent to the skin or extremities of 2.5 Gy (250 rad) or more; or

(B) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational annual limit on intake (ALI). This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

058.02 TWENTY-FOUR HOUR NOTIFICATION. Each licensee or registrant must, within 24 hours of discovery of the event, report to the Department each event involving loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause:

(A) An individual to receive, in a period of 24 hours:

(i) A total effective dose equivalent exceeding 0.05 Sv (5 rem);

(ii) A lens dose equivalent exceeding 0.15 Sv (15 rem); or
(iii) A shallow dose equivalent to the skin or extremities exceeding 0.5 Sv (50 rem); or

(B) The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake (ALI). This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

058.03 NAMES OF INDIVIDUALS. The licensee or registrant must prepare each report filed with the Department according to 180 NAC 4-058 so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

058.04 INITIAL CONTACT WITH THE DEPARTMENT. Licensees or registrants must make the reports required by 180 NAC 4-058.01 and 4-058.02 by initial contact by telephone to the Department and must confirm the initial contact by telegram, mailgram, or electronic media to the Department.

058.05 EXCEPTION. The provisions of 180 NAC 4-058 do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported according to180 NAC 4-060.

059. REPORTS OF EXPOSURES, RADIATION LEVELS, AND CONCENTRATIONS OF RADIOACTIVE MATERIAL EXCEEDING THE CONSTRAINTS OR LIMITS. This section addresses report of exposures, radiation levels and concentrations of radioactive material exceeding the constraints or limits.

059.01 REPORTABLE EVENTS. In addition to the notification required by 180 NAC 4-058, each licensee or registrant must submit a written report within 30 days after learning of any of:

(A) Any incident for which notification is required by 180 NAC 4-058; or
(B) Doses in excess of any of the following:
(i) The occupational dose limits for adults in 180 NAC 4-005;
(ii) The occupational dose limits for a minor in 180 NAC 4-011;
(iii) The limits for an embryo/fetus of a declared pregnant woman in 180 NAC 4-012;
(iv) The limits for an individual member of the public in 180 NAC 4-013;
(v) Any applicable limit in the license or registrant; or
(vi) The as low as reasonably achievable (ALARA) constraints for air emissions established under 180 NAC 4-004.04; or
(C) Levels of radiation or concentrations of radioactive material in:
(i) A restricted area in excess of applicable limits in the license; or
(ii) An unrestricted area in excess of 10 times the applicable limit in 180 NAC 4 or in the license, whether or not involving exposure of any individual in excess of the limits in 180 NAC 4-013; or
(D) Levels of radiation or releases of radioactive material in excess of U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190, or of license conditions related to those standards for licensees subject to

the provisions.

059.02 CONTENTS OF REPORTS. Each report:

(A) Required by 180 NAC 4-059 must describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

(i) Estimates of each individual's dose; and

(ii) The levels of radiation and concentrations of radioactive material involved; and

(iii) The cause of the elevated exposures, dose rates, or concentrations; and

(iv) Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, as low as reasonably achievable (ALARA) constraints, generally applicable environmental standards and associated license conditions; and

(B) Filed according to 180 NAC 4-059.01 must include for each individual exposed: the name, identifying number, and date of birth. With respect to the limit for the embryo fetus in 180 NAC 4-012, the identifiers should be those of the declared pregnant woman. The report must be prepared so that this information is stated in a separate and detachable portion of the report.

059.03 WRITTEN REPORTS OF EVENTS. All licensees or registrants who make reports according to 180 NAC 4-059.01 must submit the report in writing to the Department.

060. REPORTS OF PLANNED SPECIAL EXPOSURES. The licensee or registrant must submit a written report to the Department within 30 days following any planned special exposure conducted in accordance with 180 NAC 4-010, informing the Department that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by 180 NAC 4-051.

061. RESERVED.

062. REPORTS OF INDIVIDUAL MONITORING. This section addresses reports of individual monitoring.

062.01 APPLICIBILITY. 180 NAC 4 applies to each person:

(A) Licensed by the Department to possess or use sources of radiation for purposes of industrial radiography according to 180 NAC 3 or 180 NAC 5;

(B) Licensed by the Department to receive radioactive waste from other persons for disposal according to 180 NAC 12; or

(C) Licensed by the Department to possess or use at any time, for processing or manufacturing for distribution according to 180 NAC 3 or 180 NAC 7, radioactive material in quantities exceeding any one of the following quantities:

		Activity
Radionuclide	**Ci**	**GBq**
Cesium-137	1	37
Cobalt-60	1	37
Gold-198	100	3,700
Iodine-131	1	37
Iridium-192	10	370
Krypton-85	1,000	37,000
Promethium-147	10	370
Technetium-99m	1,000	37,000

(D) Licensees required by a license condition, rule, regulation, or order according to 180 NAC 1-007 who are licensed to use radionuclides not specified in 180 NAC 4-062.01(C) in quantities sufficient to cause comparable radiation levels.

062.02 ANNUAL REPORT. Each licensee in a category listed in 180 NAC 4-062.01 must submit an annual report of the results of individual monitoring carried out by the licensee for each individual for whom monitoring was required by 180 NAC 4-022 during that year. The licensee may include additional data for individuals for whom monitoring was provided but not required. The licensee must use Department Form NRH-2 or electronic media containing all the information required by Department Form NRH-2.

062.03 ANNUAL REPORT DEADLINE. The licensee submit to the Department the report required by 180 NAC 4-060.02, covering the preceding year, on or before April 30 of each year.

063. NOTIFICATIONS AND REPORTS TO INDIVIDUALS. This section addresses notifications and reports to individuals.

063.01 REPORTS. Requirements for notification and reports to individuals of exposure to radiation or radioactive material are specified in 180 NAC 10-004.

063.02 A When a licensee or registrant is required, according to the provisions of 180 NAC 4-059, 4-060, and 4-062, to report to the Department any exposure of identified occupationally exposed individual, or an identified member of the public, to radiation or radioactive material, the licensee or registrant must also provide a copy of the report submitted to the Department to the individual. This report must be transmitted at a time no later than the transmittal to the Department.

064. REPORTS OF LEAKING OR CONTAMINATED SEALED SOURCES. The licensee must file a report within 5 days with the Department if the test for leakage or contamination required

according to 180 NAC 1-011 indicates a sealed source is leaking or contaminated. The report must include the equipment involved, the test results and the corrective action taken.

065. VACATING PREMISES. Each specific licensee must, no less than 30 days before vacating or relinquishing possession or control of premises which may have been contaminated with radioactive material as a result of their activities, notify the Department in writing of intent to vacate. When deemed necessary by the Department, the licensee must decontaminate the premises in such a manner as the Department may specify.

066. REPORTS OF TRANSACTIONS INVOLVING NATIONALLY TRACKED SOURCES. Each licensee who manufactures, transfers, receives, disassembles, or disposes of a nationally tracked source (Refer to Appendix 4-H) must complete and submit a National Source Tracking Transaction Report as specified in 180 NAC 4-066.01 through 4-066.05 for each type of transaction.

066.01 MANUFACTURE. Each licensee who manufactures a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(A) The name, address, and license number of the reporting licensee;
(B) The name of the individual preparing the report;
(C) The manufacturer, model, and serial number of the source;
(D) The radioactive material in the source;
(E) The initial source strength in becquerels (curies) at the time of manufacture; and
(F) The manufacture date of the source.

066.02 TRANSFER. Each licensee that transfers a nationally tracked source to another person must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(A) The name, address, and license number of the reporting licensee;
(B) The name of the individual preparing the report;
(C) The name and license number of the recipient facility and the shipping address;
(D) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;
(E) The radioactive material in the source;
(F) The initial or current source strength in becquerels (curies);
(G) The date for which the source strength is reported;
(H) The shipping date;
(I) The estimated arrival date; and
(J) For nationally tracked sources transferred as waste under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification of the container with the nationally tracked source.

066.03 RECEIVE. Each licensee that receives a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

(A) The name, address, and license number of the reporting licensee;
(B) The name of the individual preparing the report;
(C) The name, address, and license number of the person that provided the source;

(D) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;
(E) The radioactive material in the source;
(F) The initial or current source strength in becquerels (curies);
(G) The date for which the source strength is reported;
(H) The date of receipt, and
(I) For material received under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification with the nationally tracked source.

066.04 DISASSEMBLE. Each licensee that disassembles a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:
(A) The name, address, and license number of the reporting licensee;
(B) The name of the individual preparing the report;
(C) The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;
(D) The radioactive material in the source;
(E) The initial or current source strength in becquerels (curies);
(F) The date for which the source strength is reported;
(G) The disassemble date of the source.

066.05 DISPOSE. Each licensee who disposes of a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:
(A) The name, address, and license number of the reporting licensee;
(B) The name of the individual preparing the report;
(C) The waste manifest number;
(D) The container identification with the nationally tracked source;
(E) The date of disposal; and
(F) The method of disposal.

066.06 SUBMISSION DEADLINE. The reports discussed in 180 NAC 4-066.01 through 4-066.05 must be submitted by the close of the next business day after the transaction. A single report may be submitted for multiple sources and transactions. The reports must be submitted to the National Source Tracking System by using:
(A) The on-line National Source Tracking System;
(B) Electronically using a computer readable format;
(C) By facsimile;
(D) By mail to the address on the National Source Tracking Transaction Report Form (NRC Form 748); or
(E) By telephone with follow-up by facsimile or mail.

066.07 ERROR CORRECTION. Each licensee must correct any error in previously filed reports or file a new report for any missed transaction within 5 business days of the discovery of the error or missed transaction. Such errors may be detected by a variety of methods such as administrative reviews or by physical inventories required by regulation. In addition, each licensee must reconcile the inventory of nationally tracked sources possessed by the licensee

against that licensee's data in the National Source Tracking System. The reconciliation must be conducted during the month of January in each year. The reconciliation process must include resolving any discrepancies between the National Source Tracking System and the actual inventory by filing the reports identified in 180 NAC 4-066.01 through 4-066.05. By January 31 of each year, each licensee must submit to the National Source Tracking System confirmation that the data in the National Source Tracking System is correct.

APPENDIX 4-A

PROTECTION FACTORS FOR RESPIRATORS[a]

	Operating mode	Assigned Protection Factors
I. Air Purifying Respirators [Particulate1A[b] only]1A[c]:		
Filtering facepiece disposable[d]	Negative Pressure	([d])
Facepiece, half [e]	Negative Pressure	10
Facepiece, full	Negative Pressure	100
Facepiece, half	Powered air-purifying respirators	50
Facepiece, full	Powered air-purifying respirators	1000
Helmet/hood	Powered air-purifying respirators	1000
Facepiece, loose-fitting	Powered air-purifying respirators	25
II. Atmosphere supplying respirators [particulate, gases and vapors1A[f]]:		
1. Air-line respirator:		
Facepiece, half	Demand	10
Facepiece, half	Continuous Flow	50
Facepiece, half	Pressure Demand	50
Facepiece, full	Demand	100
Facepiece, full	Continuous Flow	1000
Facepiece, full	Pressure Demand	1000
Helmet/hood	Continuous Flow	1000
Facepiece, loose-fitting	Continuous Flow	25
Suit	Continuous Flow	([g])
2. Self-contained breathing Apparatus (SCBA):		
Facepiece, full	Demand	[h]100
Facepiece, full	Pressure Demand	[i]10,000
Facepiece, full	Demand, Recirculating	[h]100
Facepiece, full	Positive Pressure Recirculating	[i]10,000
III. Combination Respirators:		
Any combination of air-purifying and atmosphere-supplying respirators	Assigned protection factor for type and mode of operation as listed above.	

[a] These assigned protection factors apply only in a respiratory protection program that meets the requirements of this Chapter. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances must also comply with U.S. Department of Labor regulations. Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix 4-B are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

[b] Air purifying respirators with assigned protection factors (APF) <100 must be equipped with particulate filters that are at least 95% efficient. Air purifying respirators with assigned protection factors (APF) = 100 must be equipped with particulate filters that are at least 99% efficient. Air purifying respirators with

assigned protection factors (APF) >100 must be equipped with particulate filters that are at least 99.97% efficient.

[c] The licensee may apply to the Department for the use of an assigned protection factors (APF) greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors, radioiodine.

[d] Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use user seal check on this type of device. All other respiratory protection program requirements listed in 180 NAC 4-028 apply. An assigned protection factor has not been assigned for these devices. However, an assigned protection factors (APF) equal to 10 may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

[e] Under-chin type only. No distinction is made in this Appendix between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece, disposable or reusable disposable. Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95% efficient and all other requirements of 180 NAC 4 are met.

[f] The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external, submersion, dose considerations.

[g] No National Institute for Occupational Safety and Health (NIOSH) approval schedule is currently available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met as required by 180 NAC 4-028.

[h] The licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health (IDLH).

[i] This type of respirator may be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure such as skin absorption must be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

APPENDIX 4-B

ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS (DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE

Introduction

For each radionuclide, Table I indicates the chemical form which is to be used for selecting the appropriate annual limit on intake (ALI) or derived air concentration (DAC) value. The annual limit on intake annual limit on intake (ALI)s and derived air concentration (DAC)s for inhalation are given for an aerosol with an activity median aerodynamic diameter (AMAD) of 1 μm, micron, and for three classes (D,W,Y) of radioactive material, which refer to their retention (approximately days, weeks or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. The class (D,W, or Y) given in the column headed "Class" applies only to the inhalation annual limit on intake (ALI)s and derived air concentration (DAC)s given in Table I, columns 2 and 3. Table II provides concentration limits for airborne and liquid effluents released to the general environment. Table III provides concentration limits for discharges to sanitary sewerage.

Note: The values in Tables I, II, and III are presented in the computer "E" notation. In this notation a value of 6E-02 represents a value of 6×10^{-2} or 0.06, 6E+2 represents 6×10^{2} or 600, and 6E+0 represents 6×10^{0} or 6.

Table I "Occupational Values"

Note that the columns in Table I of this appendix captioned "Oral Ingestion annual limit on intake (ALI)," "Inhalation annual limit on intake (ALI)," and " derived air concentration (DAC)" are applicable to occupational exposure to radioactive material.

The annual limit on intake (ALI)s in this appendix are the annual intakes of given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 0.05 Sv (5 rem), stochastic annual limit on intake (ALI), or (2) a committed dose equivalent of 0.5 Sv (50 rem) to an organ or tissue, non-stochastic annual limit on intake (ALI). The stochastic annual limit on intake (ALI)s were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of 0.05 Sv (5 rem). The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w_T. This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of w_T are listed under the definition of weighting factor in 180 NAC 4-02. The non-stochastic annual limit on intake (ALI)s were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

A value of $w_T = 0.06$ is applicable to each of the five organs or tissues in the "remainder" category receiving the highest dose equivalents, and the dose equivalents of all other remaining tissues may be disregarded. The following portions of the gastrointestinal (GI) tract -- stomach, small intestine, upper large intestine, and lower large intestine -- are to be treated as four separate organs.

Note that the dose equivalents for an extremity, skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

When an annual limit on intake (ALI) is defined by the stochastic dose limit, this value alone is given. When an annual limit on intake (ALI) is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the annual limit on intake (ALI) for the stochastic limit is shown in parentheses. Abbreviated organ or tissue designations are used:

LLI wall = lower large intestine wall;
St. wall = stomach wall;
Blad wall = bladder wall; and

Bone surf = bone surface.

The use of the annual limit on intake (ALI)s listed first, the more limiting of the stochastic and non-stochastic annual limit on intake (ALI)s, will ensure that non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low value. If, in a particular situation involving a radionuclide for which the nonstochastic annual limit on intake (ALI) is limiting, use of that non-stochastic annual limit on intake (ALI) is considered unduly conservative, the licensee may use the stochastic annual limit on intake (ALI) to determine the committed effective dose equivalent. However, the licensee shall also ensure that the 0.5 Sv (50 rem) dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the nonstochastic annual limit on intake (ALI)s (ALI_{ns}) that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is, $\sum$ (intake (in μCi) of each radionuclide/ALI_{ns}) $\leq$ 1.0. If there is an external deep dose equivalent contribution of H_d, then this sum must be less than 1 - (H_d/50), instead of $\leq$1.0.

The derived air concentration (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the derived air concentration (DAC) and the annual limit on intake (ALI) is given by:

derived air concentration (DAC) = annual limit on intake (ALI) (in μCi)/(2000 hours per working year x 60 minutes/hour x
2 x 10^4 ml per minute) = [annual limit on intake (ALI)/2.4 x 10^9] μCi/ml,

where 2 x 10^4 ml is the volume of air breathed per minute at work by Reference Man under working conditions of light work.

The derived air concentration (DAC) values relate to one of two modes of exposure: either external submersion or the internal committed dose equivalents resulting from inhalation of radioactive materials. derived air concentration (DAC)s based upon submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each radionuclide separately.

The annual limit on intake (ALI) and derived air concentration (DAC) values include contributions to exposure by the single radionuclide named and any in-growth of daughter radionuclides produced in the body by decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

The values of annual limit on intake (ALI) and derived air concentration (DAC) do not apply directly when the individual both ingests and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both, or when the individual is exposed to both internal and external irradiation. See 180 NAC 4-06. When an individual is exposed to radioactive materials which fall under several of the translocation classifications of the same radionuclide, such as, Class D, Class W, or Class Y, the exposure may be evaluated as if it were a mixture of different radionuclides.

It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical form of the compound and does not take into account the radiological half-life of different radionuclides. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table II "Effluent Concentrations"

The columns in Table II of this appendix captioned "Effluents," "Air" and "Water" are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of 180 NAC 4-014. The concentration values given in Columns 1 and 2 of Table II are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.5 mSv (0.05 rem).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to occur at or below the dose levels established for individual members of the public. For radionuclides, where the non-stochastic limit was governing in deriving the occupational derived air concentration (DAC), the stochastic annual limit on intake (ALI) was used in deriving the corresponding airborne effluent limit in Table II. For this reason, the derived air concentration (DAC) and airborne effluent limits are not always proportional as was the case in Appendix 1 180 NAC 4.

The air concentration values listed in Table II, Column 1 were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation annual limit on intake (ALI) was divided by 2.4×10^9ml, relating the inhalation annual limit on intake (ALI) to the derived air concentration (DAC), as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 0.05 Sv (5 rem) annual occupational dose limit to the 1 mSv (0.1 rem) limit for members of the public, a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values, derived for adults, so that they are applicable to other age groups.

For those radionuclides for which submersion, external dose, is limiting, the occupational derived air concentration (DAC) in Table I, Column 3 was divided by 219. The factor of 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year). Note that an additional factor of 2 for age considerations is not warranted in the submersion case.

The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion annual limit on intake (ALI) and dividing by 7.3×10^7. The factor of 7.3×10^7 (ml) includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^5 (ml) which is the annual water intake of Reference Man.

Note 2 at the end of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings, including occupational inhalation annual limit on intake (ALI)s and derived air concentration (DAC)s, air and water effluent concentrations and releases to sewer, require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of one of the listed radionuclides cannot be definitely excluded as being present either from knowledge of the radionuclide composition of the source or from actual measurements.

Table III "Releases to Sewers"

The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in 004.40. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion annual limit on intake (ALI) and dividing by 7.3×10^6 (ml). The factor of 7.3×10^6 (ml) is composed of a factor of 7.3×10^5 (ml), the annual water intake by Reference Man, and a factor of 10, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a Reference Man during a year, would result in a committed effective dose equivalent of 0.5 mSv (0.5 rem).

APPENDIX 4-B

LIST OF ELEMENTS

Name	Atomic Symbol	Atomic Number	Name	Atomic Symbol	Atomic Number
Actinium	Ac	89	Molybdenum	Mo	42
Aluminum	Al	13	Neodymium	Nd	60
Americium	Am	95	Neptunium	Np	93
Antimony	Sb	51	Nickel	Ni	28
Argon	Ar	18	Niobium	Nb	41
Arsenic	As	33	Nitrogen	N	7
Astatine	At	85	Osmium	Os	76
Barium	Ba	56	Oxygen	O	8
Berkelium	Bk	97	Palladium	Pd	46
Beryllium	Be	4	Phosphorus	P	15
Bismuth	Bi	83	Platinum	Pt	78
Bromine	Br	35	Plutonium	Pu	94
Cadmium	Cd	48	Polonium	Po	84
Calcium	Ca	20	Potassium	K	19
Californium	Cf	98	Praseodymium	Pr	59
Carbon	C	6	Promethium	Pm	61
Cerium	Ce	58	Protactinium	Pa	91
Cesium	Cs	55	Radium	Ra	88
Chlorine	Cl	17	Radon	Rn	86
Chromium	Cr	24	Rhenium	Re	75
Cobalt	Co	27	Rhodium	Rh	45
Copper	Cu	29	Rubidium	Rb	37
Curium	Cm	96	Ruthenium	Ru	44
Dysprosium	Dy	66	Samarium	Sm	62
Einsteinium	Es	99	Scandium	Sc	21
Erbium	Er	68	Selenium	Se	34
Europium	Eu	63	Silicon	Si	14
Fermium	Fm	100	Silver	Ag	47
Fluorine	F	9	Sodium	Na	11
Francium	Fr	87	Strontium	Sr	38
Gadolinium	Gd	64	Sulfur	S	16
Gallium	Ga	31	Tantalum	Ta	73
Germanium	Ge	32	Technetium	Tc	43
Gold	Au	79	Tellurium	Te	52
Hafnium	Hf	72	Terbium	Tb	65
Holmium	Ho	67	Thallium	Tl	81
Hydrogen	H	1	Thorium	Th	90
Indium	In	49	Thulium	Tm	69
Iodine	I	53	Tin	Sn	50
Iridium	Ir	77	Titanium	Ti	22
Iron	Fe	26	Tungsten	W	74
Krypton	Kr	36	Uranium	U	92
Lanthanum	La	57	Vanadium	V	23
Lead	Pb	82	Xenon	Xe	54
Lutetium	Lu	71	Ytterbium	Yb	70
Magnesium	Mg	12	Yttrium	Y	39
Manganese	Mn	25	Zinc	Zn	30
Mendelevium	Md	101	Zirconium	Zr	40
Mercury	Hg	80			

APPENDIX 4-B

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (µCi)	ALI (µCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Concentration (µCi/ml)
1	Hydrogen-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
	Gas (HT or T_2) Submersion[1]: Use above values as HT and T_2 oxidize in air and in the body to HTO.							
4	Beryllium-7	W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	63-4	6E-3
		Y, oxides, halides, and nitrates	-	2E+4	8E-6	3E-8	-	-
4	Beryllium-10	W, see ^{7}Be	1E+3 LLI wall (1E+3)	2E+2 -	6E-8 -	2E-10 -	- 2E-5	- 2E-4
		Y, see ^{7}Be	-	1E+1	6E-9	2E-11	-	-
6	Carbon-11[2]	Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
		Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
7	Nitrogen-13[2]	Submersion[1]	-	-	-	-	4E-6	2E-8
8	Oxygen-15[2]	Submersion[1]	-	-	-	-	4E-6	2E-8
9	Fluorine-18[2]	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4 St wall (5E+4)	7E+4 -	3E-5 -	1E-7 -	- 7E-4	- 7E-3
		W, fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re	-	9E+4	4E-5	1E-7	-	-
		Y, lanthanum fluoride	-	8E+4	3E-5	1E-7	-	-
11	Sodium-22	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	1E+3	5E-7	2E-9	-	-
13	Aluminum-26	D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	9E+1	4E-8	1E-10	-	-
14	Silicon-31	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and nitrates		3E+4	1E-5	5E-8	-	-
		Y, aluminosilicate glass		3E+4	1E-5	4E-8	-	-
14	Silicon-32	D, see ^{31}Si	2E+3 LLI wall (3E+3)	2E+2 -	1E-7 -	3E-10 -	- 4E-5	- 4E-4
		W, see ^{31}Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{31}Si	-	5E+0	2E-9	7E-12	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+}, S^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+}, and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		W, see ^{32}P	-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4 LLI wall (8E+3)	2E+4 -	7E-6 -	2E-8 -	- 1E-4	- 1E-3
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3 -	2E+3	9E-7	3E-9	-	-
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	-	2E+2	1E-7	3E-10	-	-
17	Chlorine-38[2]	D, see ^{36}Cl	2E+4 St wall (3E+4)	4E+4 -	2E-5 -	6E-8 -	- 3E-4	- 3E-3
		W, see ^{36}Cl	-	5E+4	2E-5	6E-8	-	-
18	Argon-37	Submersion[1]	-	-	1E+0	6E-3	-	-
18	Argon-39	Submersion[1]	-	-	2E-4	8E-7	-	-
18	Argon-41	Submersion[1]	-	-	3E-6	1E-8	-	-
19	Potassium-40	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
19	Potassium-42	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
19	Potassium-43	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	Potassium-44[2]	D, all compounds	2E+4 St wall (4E+4)	7E+4 -	3E-5 -	9E-8 -	- 5E-4	- 5E-3
19	Potassium-45[2]	D, all compounds	3E+4 St wall (5E+4)	1E+5 -	5E-5 -	2E-7 -	- 7E-4	- 7E-3
20	Calcium-41	W, all compounds	3E+3 Bone surf (4E+3)	4E+3 Bone surf (4E+3)	2E-6 -	- 5E-9	- 6E-5	- 6E-4
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
21	Scandium-44m	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3 LLI wall (3E+3)	3E+3 -	1E-6 -	4E-9 -	- 4E-5	- 4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49[2]	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E+1	1E-8	4E-11	-	-
		Y, SrTi0	-	6E+0	2E-9	8E-12	-	-
22	Titanium-45	D, see ^{44}Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{44}Ti	-	4E+4	1E-5	5E-8	-	-
		Y, see ^{44}Ti	-	3E+4	1E-5	4E-8	-	-
23	Vanadium-47[2]	D, all compounds except those given for W	3E+4 St wall	8E+4	3E-5	1E-7	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			(3E+4)	-	-	-	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see ^{47}V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
		W, see ^{47}V	-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ^{47}V	7E+4 LLI wall (9E+4)	3E+4 Bone surf (3E+4)	1E-5 -	- 5E-8	- 1E-3	- 1E-2
		W, see ^{47}V	-	2E+4	8E-6	2E-8	-	-
24	Chromium-48	D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
		Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49[2]	D, see ^{48}Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{48}Cr	-	1E+5	4E-5	1E-7	-	-
		Y, see ^{48}Cr	-	9E+4	4E-5	1E-7	-	-
24	Chromium-51	D, see ^{48}Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
		W, see ^{48}Cr	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{48}Cr	-	2E+4	8E-6	3E-8	-	-
25	Manganese-51[2]	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
25	Manganese-52m[2]	D, see ^{51}Mn	3E+4 St wall (4E+4)	9E+4 -	4E-5 -	1E-7 -	- 5E-4	- 5E-3
		W, see ^{51}Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see ^{51}Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
		W, see ^{51}Mn	-	9E+2	4E-7	1E-9	-	-
25	Manganese-53	D, see ^{51}Mn	5E+4 -	1E+4 Bone surf (2E+4)	5E-6 -	- 3E-8	7E-4 -	7E-3 -
		W, see ^{51}Mn	-	1E+4	5E-6	2E-8	-	-
25	Manganese-54	D, see ^{51}Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
		W, see ^{51}Mn	-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see ^{51}Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{51}Mn		2E+4	9E-6	3E-8	-	-
26	Iron-52	D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		W, oxides, hydroxides, and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ^{52}Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
		W, see ^{52}Fe	-	4E+3	2E-6	6E-9	-	-
26	Iron-59	D, see ^{52}Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		W, see ^{52}Fe	-	5E+2	2E-7	7E-10	-	-
26	Iron-60	D, see ^{52}Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
		W, see ^{52}Fe	-	2E+1	8E-9	3E-11	-	-
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
27	Cobalt-56	W, see ^{55}Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ^{55}Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ^{55}Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ^{55}Co	4E+3	7E+2	3E-7	9E-10	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
27	Cobalt-58m	W, see ^{55}Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ^{55}Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ^{55}Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ^{55}Co	1E+3	7E+2	3E-7	1E-9	-	-
27	Cobalt-60m[2]	W, see ^{55}Co	1E+6 St wall (1E+6)	4E+6 -	2E-3 -	6E-6 -	- 2E-2	- 2E-1
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	-	-
27	Cobalt-60	W, see ^{55}Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ^{55}Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-61[2]	W, see ^{55}Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{55}Co	2E+4	6E+4	2E-5	8E-8	-	-
27	Cobalt-62m[2]	W, see ^{55}Co	4E+4 St wall (5E+4)	2E+5 -	7E-5 -	2E-7 -	- 7E-4	- 7E-3
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	-	-
28	Nickel-56	D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		W, oxides, hydroxides, and carbides	-	1E+3	5E-7	2E-9	-	-
		Vapor	-	1E+3	5E-7	2E-9	-	-
28	Nickel-57	D, see ^{56}Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	6E+3	1E-6	9E-9	-	-
28	Nickel-59	D, see ^{56}Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
		W, see ^{56}Ni	-	7E+3	3E-6	1E-8	-	-
		Vapor	-	2E+3	8E-7	3E-9	-	-
28	Nickel-63	D, see ^{56}Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	8E+2	3E-7	1E-9	-	-
28	Nickel-65	D, see ^{56}Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{56}Ni	-	3E+4	1E-5	4E-8	-	-
		Vapor	-	2E+4	7E-6	2E-8	-	-
28	Nickel-66	D, see ^{56}Ni	4E+2 LLI wall (5E+2)	2E+3 -	7E-7 -	2E-9 -	- 6E-6	- 6E-5
		W, see ^{56}Ni	-	6E+2	3E-7	9E-10	-	-
		Vapor	-	3E+3	1E-6	4E-9	-	-
29	Copper-60[2]	D, all compounds except those given for W and Y	3E+4 St wall (3E+4)	9E+4 -	4E-5 -	1E-7 -	- 4E-4	- 4E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	4E-5	1E-7	-	-
29	Copper-61	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	4E+4	2E-5	6E-8	-	-
		Y, see ^{60}Cu	-	4E+4	1E-5	5E-8	-	-
29	Copper-64	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{60}Cu	-	2E+4	9E-6	3E-8	-	-
29	Copper-67	D, see ^{60}Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
		W, see ^{60}Cu	-	5E+3	2E-6	7E-9	-	-
		Y, see ^{60}Cu	-	5E+3	2E-6	6E-9	-	-
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63[2]	Y, all compounds	2E+4 St wall (3E+4)	7E+4 -	3E-5 -	9E-8 -	- 3E-4	- 3E-3
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
30	Zinc-69[2]	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
31	Gallium-65[2]	D, all compounds except those given for W	5E+4 St wall (6E+4)	2E+5 -	7E-5 -	2E-7 -	- 9E-4	- 9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	-	-
31	Gallium-66	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-67	D, see ^{65}Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
		W, see ^{65}Ga	-	1E+4	4E-6	1E-8	-	-
31	Gallium-68[2]	D, see ^{65}Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{65}Ga	-	5E+4	2E-5	7E-8	-	-
31	Gallium-70[2]	D, see ^{65}Ga	5E+4 St wall (7E+4)	2E+5 -	7E-5 -	2E-7 -	- 1E-3	- 1E-2
		W, see 65Ga	-	2E+5	8E-5	3E-7	-	-
31	Gallium-72	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-73	D, see ^{65}Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{65}Ga	-	2E+4	6E-6	2E-8	-	-
32	Germanium-66	D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
		W, oxides, sulfides, and halides	-	2E+4	8E-6	3E-8	-	-
32	Germanium-67[2]	D, see ^{66}Ge	3E+4 St wall (4E+4)	9E+4 -	4E-5 -	1E-7 -	- 6E-4	- 6E-3
		W, see ^{66}Ge	-	1E+5	4E-5	1E-7	-	-
32	Germanium-68	D, see ^{66}Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
		W, see ^{66}Ge	-	1E+2	4E-8	1E-10	-	-
32	Germanium-69	D, see ^{66}Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
		W, see ^{66}Ge	-	8E+3	3E-6	1E-8	-	-
32	Germanium-71	D, see ^{66}Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
		W, see ^{66}Ge	-	4E+4	2E-5	6E-8	-	-
32	Germanium-75[2]	D, see ^{66}Ge	4E+4 St wall (7E+4)	8E+4 -	3E-5 -	1E-7 -	- 9E-4	- 9E-3
		W, see ^{66}Ge	-	8E+4	4E-5	1E-7	-	-
32	Germanium-77	D, see ^{66}Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
		W, see ^{66}Ge	-	6E+3	2E-6	8E-9	-	-
32	Germanium-78[2]	D, see ^{66}Ge	2E+4 St wall (2E+4)	2E+4 -	9E-6 -	3E-8 -	- 3E-4	- 3E-3
		W, see ^{66}Ge	-	2E+4	9E-6	3E-8	-	-
33	Arsenic-69[2]	W, all compounds	3E+4 St wall (4E+4)	1E+5 -	5E-5 -	2E-7 -	- 6E-4	- 6E-3
33	Arsenic-70[2]	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	Arsenic-71	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds	4E+3	5E+3	2E-6	7E-9	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			LLI wall (5E+3)	-	-	-	6E-5	6E-4
33	Arsenic-78[2]	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Selenium-70[2]	D, all compounds except those given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	-	-
34	Selenium-^{73}m2	D, see ^{70}Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	6E-5	2E-7	-	-
34	Selenium-73	D, see ^{70}Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
		W, see ^{70}Se	-	2E+4	7E-6	2E-8	-	-
34	Selenium-75	D, see ^{70}Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
		W, see ^{70}Se	-	6E+2	3E-7	8E-10	-	-
34	Selenium-79	D, see ^{70}Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
		W, see ^{70}Se	-	6E+2	2E-7	8E-10	-	-
34	Selenium-81m[2]	D, see ^{70}Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{70}Se	2E+4	7E+4	3E-5	1E-7	-	-
34	Selenium-81[2]	D, see ^{70}Se	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
		W, see ^{70}Se	-	2E+5	1E-4	3E-7	-	-
34	Selenium-83[2]	D, see ^{70}Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	5E-5	2E-7	-	-
35	Bromine-74m[2]	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74[2]	D, see ^{74m}Br	2E+4	7E+4	3E-5	1E-7	-	-
			St Wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	8E+4	4E-5	1E-7	-	-
35	Bromine-75[2]	D, see ^{74m}Br	3E+4	5E+4	2E-5	7E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	5E+4	2E-5	7E-8	-	-
35	Bromine-76	D, see ^{74m}Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
		W, see ^{74m}Br	-	4E+3	2E-6	6E-9	-	-
35	Bromine-77	D, see ^{74m}Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
		W, see ^{74m}Br	-	2E+4	8E-6	3E-8	-	-
35	Bromine-80m	D, see ^{74m}Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
		W, see ^{74m}Br	-	1E+4	6E-6	2E-8	-	-
35	Bromine-80[2]	D, see ^{74m}Br	5E+4	2E+5	8E-5	3E-7	-	-
		W, see ^{74m}Br	-	2E+5	9E-5	3E-7	-	-
35	Bromine-82	D, see ^{74m}Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{74m}Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m}Br	5E+4	6E+4	3E-5	9E-8	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
35	Bromine-84[2]	D, see ^{74m}Br	2E+4	6E+4	2E-5	8E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
36	Krypton-74[2]	Submersion[1]	-	-	3E-6	1E-8	-	-
36	Krypton-76	Submersion[1]	-	-	9E-6	4E-8	-	-
36	Krypton-77[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
36	Krypton-79	Submersion[1]	-	-	2E-5	7E-8	-	-
36	Krypton-81	Submersion[1]	-	-	7E-4	3E-6	-	-
36	Krypton-83m[2]	Submersion[1]	-	-	1E-2	5E-5	-	-
36	Krypton-85m	Submersion[1]	-	-	2E-5	1E-7	-	-
36	Krypton-85	Submersion[1]	-	-	1E-4	7E-7	-	-
36	Krypton-87[2]	Submersion[1]	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion[1]	-	-	2E-6	9E-9	-	-
37	Rubidium-79[2]	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	5E-5 -	2E-7 -	- 8E-4	- 8E-3
37	Rubidium-81m[2]	D, all compounds	2E+5 St wall (3E+5)	3E+5 -	1E-4 -	5E-7 -	- 4E-3	- 4E-2
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88[2]	D, all compounds	2E+4 St wall (3E+4)	6E+4 -	3E-5 -	9E-8 -	- 4E-4	- 4E-3
37	Rubidium-89[2]	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	6E-5 -	2E-7 -	- 9E-4	- 9E-3
38	Strontium-80[2]	D, all soluble compounds except $SrTiO_3$	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and $SrTi0_3$	-	1E+4	5E-6	2E-8	-	-
38	Strontium-81[2]	D, see ^{80}Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{80}Sr	2E+4	8E+4	3E-5	1E-7	-	-
38	Strontium-82	D, see ^{80}Sr	3E+2 LLI wall (2E+2)	4E+2 -	2E-7 -	6E-10 -	- 3E-6	- 3E-5
		Y, see ^{80}Sr	2E+2	9E+1	4E-8	1E-10	-	-
38	Strontium-83	D, see ^{80}Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{80}Sr	2E+3	4E+3	1E-6	5E-9	-	-
38	Strontium-85m[2]	D, see ^{80}Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
		Y, see ^{80}Sr	-	8E+5	4E-4	1E-6	-	-
38	Strontium-85	D, see ^{80}Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see ^{80}Sr	-	2E+3	6E-7	2E-9	-	-
38	Strontium-87m	D, see ^{80}Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{80}Sr	4E+4	2E+5	6E-5	2E-7	-	-
38	Strontium-89	D, see ^{80}Sr	6E+2 LLI wall (6E+2)	8E+2 -	4E-7 -	1E-9 -	- 8E-6	- 8E-5
		Y, see ^{80}Sr	5E+2	1E+2	6E-8	2E-10	-	-
39	Yttrium-86m[2]	W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
39	Yttrium-86	W, see ^{86m}Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-87	W, see ^{86m}Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		Y, see ^{86m}Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-88	W, see ^{86m}Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
		Y, see ^{86m}Y	-	2E+2	1E-7	3E-10	-	-
39	Yttrium-90m	W, see ^{86m}Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
		Y, see ^{86m}Y	-	1E+4	5E-6	2E-8	-	-
39	Yttrium-91m[2]	W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
		Y, see ^{86m}Y	-	2E+5	7E-5	2E-7	-	-
39	Yttrium-91	W, see ^{86m}Y	5E+2 LLI Wall (6E+2)	2E+2 -	7E-8 -	2E-10 -	- 8E-6	- 8E-5
		Y, see ^{86m}Y	-	1E+2	5E-8	2E-10	-	-
39	Yttrium-92	W, see ^{86m}Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{86m}Y	-	8E+3	3E-6	1E-8	-	-
39	Yttrium-93	W, see ^{86m}Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	2E+3	1E-6	3E-9	-	-
39	Yttrium-94[2]	W, see ^{86m}Y	2E+4 St wall (3E+4)	8E+4 -	3E-5 -	1E-7 -	- 4E-4	- 4E-3
		Y, see ^{86m}Y	-	8E+4	3E-5	1E-7	-	-
39	Yttrium-95[2]	W, see ^{86m}Y	4E+4 St wall (5E+4)	2E+5 -	6E-5 -	2E-7 -	- 7E-4	- 7E-3
		Y, see ^{86m}Y	-	1E+5	6E-5	2E-7	-	-
40	Zirconium-86	D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
		Y, carbide	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-88	D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
		W, see ^{86}Zr	-	5E+2	2E-7	7E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-89	D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-93	D, see ^{86}Zr	1E+3 Bone surf (3E+3)	6E+0 Bone surf (2E+1)	3E-9 -	- 2E-11	- 4E-5	- 4E-4
		W, see ^{86}Zr	- -	2E+1 Bone surf (6E+1)	1E-8 -	- 9E-11	- -	- -
		Y, see ^{86}Zr	- -	6E+1 Bone surf (7E+1)	2E-8 -	- 9E-11	- -	- -
40	Zirconium-95	D, see ^{86}Zr	1E+3 -	1E+2 Bone surf (3E+2)	5E-8 -	- 4E-10	2E-5 -	2E-4 -
		W, see ^{86}Zr	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-97	D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ^{86}Zr	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{86}Zr	-	1E+3	5E-7	2E-9	-	-
41	Niobium-88[2]	W, all compounds except those given for Y	5E+4	2E+5	9E-5	3E-7	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89[2] (66 min)	W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
		Y, see ^{88}Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-89 (122 min)	W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{88}Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-90	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-93m	W, see ^{88}Nb	9E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+4)	-	-	-	2E-4	2E-3
		Y, see ^{88}Nb	-	2E+2	7E-8	2E-10	-	-
41	Niobium-94	W, see ^{88}Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+1	6E-9	2E-11	-	-
41	Niobium-95m	W, see ^{88}Nb	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{88}Nb	-	2E+3	9E-7	3E-9	-	-
41	Niobium-95	W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		Y, see ^{88}Nb	-	1E+3	5E-7	2E-9	-	-
41	Niobium-96	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-97[2]	W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{88}Nb	-	7E+4	3E-5	1E-7	-	-
41	Niobium-98[2]	W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
		Y, see ^{88}Nb	-	5E+4	2E-5	7E-8	-	-
42	Molybdenum-90	D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, oxides, hydroxides, and MoS_2	2E+3	5E+3	2E-6	6E-9	-	-
42	Molybdenum-93m	D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
		Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	-	-
42	Molybdenum-93	D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	-	-
42	Molybdenum-99	D, see ^{90}Mo	2E+3	3E+3	1E-6	4E-9	-	-
			LLI Wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	-	-
42	Molybdenum-101[2]	D, see ^{90}Mo	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{90}Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m[2]	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m}Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		W, see ^{93m}Tc	-	1E+5	4E-5	1E-7	-	-
43	Technetium-94m[2]	D, see ^{93m}Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{93m}Tc	-	6E+4	2E-5	8E-8	-	-
43	Technetium-94	D, see ^{93m}Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	1E-5	3E-8	-	-
43	Technetium-	D, see ^{93m}Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
	95m	W, see ^{93m}Tc	-	2E+3	8E-7	3E-9	-	-
43	Technetium-95	D, see ^{93m}Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	8E-6	3E-8	-	-
43	Technetium-96m[2]	D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-96	D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{93m}Tc	-	2E+3	9E-7	3E-9	-	-
43	Technetium-97m	D, see ^{93m}Tc	5E+3	7E+3	3E-6	-	6E-5	6E-4
			-	St wall (7E+3)	-	1E-8	-	-
		W, see ^{93m}Tc	-	1E+3	5E-7	2E-9	-	-
43	Technetium-97	D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		W, see ^{93m}Tc	-	6E+3	2E-6	8E-9	-	-
43	Technetium-98	D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{93m}Tc	-	3E+2	1E-7	4E-10	-	-
43	Technetium-99m	D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-99	D, see ^{93m}Tc	4E+3	5E+3	2E-6	-	6E-5	6E-4
			-	St wall (6E+3)	-	8E-9	-	-
		W, see ^{93m}Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101[2]	D, see ^{93m}Tc	9E+4	3E+5	1E-4	5E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
		W, see ^{93m}Tc	-	4E+5	2E-4	5E-7	-	-
43	Technetium-104[2]	D, see ^{93m}Tc	2E+4	7E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{93m}Tc	-	9E+4	4E-5	1E-7	-	-
44	Ruthenium-94[2]	D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, halides	-	6E+4	3E-5	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	2E-5	8E-8	-	-
44	Ruthenium-97	D, see ^{94}Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-103	D, see ^{94}Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ^{94}Ru	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{94}Ru	-	6E+2	3E-7	9E-10	-	-
44	Ruthenium-105	D, see ^{94}Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{94}Ru	-	1E+4	6E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-106	D, see ^{94}Ru	2E+2	9E+1	4E-8	1E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		W, see ^{94}Ru	-	5E+1	2E-8	8E-11	-	-
		Y, see ^{94}Ru	-	1E+1	5E-9	2E-11	-	-
45	Rhodium-99m	D, all compounds except those given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		W, halides	-	8E+4	3E-5	1E-7	-	-
		Y, oxides and hydroxides	-	7E+4	3E-5	9E-8	-	-
45	Rhodium-99	D, see ^{99m}Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{99m}Rh	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{99m}Rh	-	2E+3	8E-7	3E-9	-	-
45	Rhodium-100	D, see ^{99m}Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		W, see ^{99m}Rh	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{99m}Rh	-	4E+3	2E-6	5E-9	-	-
45	Rhodium-101m	D, see ^{99m}Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{99m}Rh	-	8E+3	4E-6	1E-8	-	-
		Y, see ^{99m}Rh	-	8E+3	3E-6	1E-8	-	-
45	Rhodium-101	D, see ^{99m}Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{99m}Rh	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{99m}Rh	-	2E+2	6E-8	2E-10	-	-
45	Rhodium-102m	D, see ^{99m}Rh	1E+3 LLI wall (1E+3)	5E+2 -	2E-7 -	7E-10 -	- 2E-5	- 2E-4
		W, see ^{99m}Rh	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{99m}Rh	-	1E+2	5E-8	2E-10	-	-
45	Rhodium-102	D, see ^{99m}Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
		W, see ^{99m}Rh	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{99m}Rh	-	6E+1	2E-8	8E-11	-	-
45	Rhodium-103m[2]	D, see ^{99m}Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
		W, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
		Y, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
45	Rhodium-105	D, see ^{99m}Rh	4E+3 LLI wall (4E+3)	1E+4 -	5E-6 -	2E-8 -	- 5E-5	- 5E-4
		W, see ^{99m}Rh	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{99m}Rh	-	6E+3	2E-6	8E-9	-	-
45	Rhodium-106m	D, see ^{99m}Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{99m}Rh	-	4E+4	2E-5	5E-8	-	-
		Y, see ^{99m}Rh	-	4E+4	1E-5	5E-8	-	-
45	Rhodium-107[2]	D, see ^{99m}Rh	7E+4 St wall (9E+4)	2E+5 -	1E-4 -	3E-7 -	- 1E-3	- 1E-2
		W, see ^{99m}Rh	-	3E+5	1E-4	4E-7	-	-
		Y, see ^{99m}Rh	-	3E+5	1E-4	3E-7	-	-
46	Palladium-100	D, all compounds except those given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
		W, nitrates	-	1E+3	5E-7	2E-9	-	-
		Y, oxides and hydroxides	-	1E+3	6E-7	2E-9	-	-
46	Palladium-101	D, see ^{100}Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{100}Pd	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{100}Pd	-	3E+4	1E-5	4E-8	-	-
46	Palladium-103	D, see ^{100}Pd	6E+3 LLI wall (7E+3)	6E+3 -	3E-6 -	9E-9 -	- 1E-4	- 1E-3
		W, see ^{100}Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{100}Pd	-	4E+3	1E-6	5E-9	-	-
46	Palladium-107	D, see ^{100}Pd	3E+4 LLI wall (4E+4)	2E+4 Kidneys (2E+4)	9E-6 -	- 3E-8	- 5E-4	- 5E-3
		W, see ^{100}Pd	-	7E+3	3E-6	1E-8	-	-
		Y, see ^{100}Pd	-	4E+2	2E-7	6E-10	-	-
46	Palladium-109	D, see ^{100}Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{100}Pd	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{100}Pd	-	5E+3	2E-6	6E-9	-	-
47	Silver-102[2]	D, all compounds except those given for W and Y	5E+4 St wall (6E+4)	2E+5 -	8E-5 -	2E-7 -	- 9E-4	- 9E-3
		W, nitrates and sulfides	-	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	-	2E+5	8E-5	3E-7	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
47	Silver-103[2]	D, see ^{102}Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104m[2]	D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104[2]	D, see ^{102}Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
47	Silver-105	D, see ^{102}Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
		W, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	D, see ^{102}Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-106[2]	D, see ^{102}Ag	6E+4 St wall (6E+4)	2E+5 -	8E-5 -	3E-7 -	- 9E-4	- 9E-3
		W, see ^{102}Ag	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{102}Ag	-	2E+5	8E-5	3E-7	-	-
47	Silver-108m	D, see ^{102}Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
		W, see ^{102}Ag	-	3E+2	1E-7	4E-10	-	-
		Y, see ^{102}Ag	-	2E+1	1E-8	3E-11	-	-
47	Silver-110m	D, see ^{102}Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
		W, see ^{102}Ag	-	2E+2	8E-8	3E-10	-	-
		Y, see ^{102}Ag	-	9E+1	4E-8	1E-10	-	-
47	Silver-111	D, see ^{102}Ag	9E+2 LLI wall (1E+3)	2E+3 Liver (2E+3) -	6E-7 -	- 2E-9	- 2E-5	- 2E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-112	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{102}Ag	-	1E+4	4E-6	1E-8	-	-
		Y, see ^{102}Ag	-	9E+3	4E-6	1E-8	-	-
47	Silver-115[2]	D, see ^{102}Ag	3E+4 St wall (3E+4)	9E+4 -	4E-5 -	1E-7 -	- 4E-4	- 4E-3
		W, see ^{102}Ag	-	9E+4	4E-5	1E-7	-	-
		Y, see ^{102}Ag	-	8E+4	3E-5	1E-7	-	-
48	Cadmium-104[2]	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
48	Cadmium-107	D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{104}Cd	-	6E+4	2E-5	8E-8	-	-
		Y, see ^{104}Cd	-	5E+4	2E-5	7E-8	-	-
48	Cadmium-109	D, see ^{104}Cd	3E+2 Kidneys (4E+2)	4E+1 Kidneys (5E+1)	1E-8 -	- 7E-11	- 6E-6	- 6E-5
		W, see ^{104}Cd	- -	1E+2 Kidneys (1E+2)	5E-8 -	- 2E-10	- -	- -
		Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
48	Cadmium-113m	D, see ^{104}Cd	2E+1 Kidneys (4E+1)	2E+0 Kidneys (4E+0)	1E-9 -	- 5E-12	- 5E-7	- 5E-6
		W, see ^{104}Cd	-	8E+0	4E-9	-	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			-	Kidneys (1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-
48	Cadmium-113	D, see ^{104}Cd	2E+1	2E+0	9E-10	-	-	-
			Kidneys (3E+1)	Kidneys (3E+0)	-	5E-12	4E-7	4E-
		W, see ^{104}Cd	-	8E+0	3E-9	-	-	-
			-	Kidneys (1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1	2E-8	-	4E-6	4E-5
			-	Kidneys (8E+1)	-	1E-10	-	-
		W, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	6E-8	2E-10	-	-
48	Cadmium-115	D, see ^{104}Cd	9E+2	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
		W, see ^{104}Cd	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
48	Cadmium-117m	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
48	Cadmium-117	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	9E-8	-	-
49	Indium-110[2] (69.1 min)	D, see ^{109}In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	6E+4	2E-5	8E-8	-	-
49	Indium-110 (4.9 h)	D, see ^{109}In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		W, see ^{109}In	-	2E+4	8E-6	3E-8	-	-
49	Indium-111	D, see ^{109}In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
		W, see ^{109}In	-	6E+3	3E-6	9E-9	-	-
49	Indium-112[2]	D, see ^{109}In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
		W, see ^{109}In	-	7E+5	3E-4	1E-6	-	-
49	Indium-113m[2]	D, see ^{109}In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		W, see ^{109}In	-	2E+5	8E-5	3E-7	-	-
49	Indium-114m	D, see ^{109}In	3E+2	6E+1	3E-8	9E-11	-	-
			LLI wall (4E+2)	-	-	-	5E-6	5E-5
		W, see ^{109}In	-	1E+2	4E-8	1E-10	-	-
49	Indium-115m	D, see ^{109}In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	5E+4	2E-5	7E-8	-	-
49	Indium-115	D, see ^{109}In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
		W, see ^{109}In	-	5E+0	2E-9	8E-12	-	-
49	Indium-116m[2]	D, see ^{109}In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{109}In	-	1E+5	5E-5	2E-7	-	-
49	Indium-117m[2]	D, see ^{109}In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{109}In	-	4E+4	2E-5	6E-8	-	-
49	Indium-117[2]	D, see ^{109}In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
		W, see ^{109}In	-	2E+5	9E-5	3E-7	-	-
49	Indium-119m[2]	D, see ^{109}In	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		W, see ^{109}In	-	1E+5	6E-5	2E-7	-	-
50	Tin-110	D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	-	1E+4	5E-6	2E-8	-	-
50	Tin-111[2]	D, see ^{110}Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
		W, see ^{110}Sn	-	3E+5	1E-4	4E-7	-	-
50	Tin-113	D, see ^{110}Sn	2E+3 LLI wall (2E+3)	1E+3 (2E+3)	5E-7 -	2E-9 3E-9	- 3E-5	- 3E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ^{110}Sn	2E+3 LLI wall (2E+3)	1E+3 Bone surf (2E+3)	5E-7 -	- 3E-9	- 3E-5	- 3E-4
		W, see ^{110}Sn	-	1E+3	6E-7	2E-9	-	-
50	Tin-119m	D, see ^{110}Sn	3E+3 LLI wall (4E+3)	2E+3 -	1E-6 -	3E-9 -	- 6E-5	- 6E-4
		W, see ^{110}Sn	-	1E+3	4E-7	1E-9	-	-
50	Tin-121m	D, see ^{110}Sn	3E+3 LLI wall (4E+3)	9E+2 -	4E-7 -	1E-9 -	- 5E-5	- 5E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-121	D, see ^{110}Sn	6E+3 LLI wall (6E+3)	2E+4 -	6E-6 -	2E-8 -	- 8E-5	- 8E-4
		W, see ^{110}Sn	-	1E+4	5E-6	2E-8	-	-
50	Tin-123m[2]	D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
		W, see ^{110}Sn	-	1E+5	6E-5	2E-7	-	-
50	Tin-123	D, see ^{110}Sn	5E+2 LLI wall (6E+2)	6E+2 -	3E-7 -	9E-10 -	- 9E-6	- 9E-5
		W, see ^{110}Sn	-	2E+2	7E-8	2E-10	-	-
50	Tin-125	D, see ^{110}Sn	4E+2 LLI wall (5E+2)	9E+2 -	4E-7 -	1E-9 -	- 6E-6	- 6E-5
		W, see ^{110}Sn	-	4E+2	1E-7	5E-10	-	-
50	Tin-126	D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
		W, see ^{110}Sn	-	7E+1	3E-8	9E-11	-	-
50	Tin-127	D, see ^{110}Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		W, see ^{110}Sn	-	2E+4	8E-6	3E-8	-	-
50	Tin-128[2]	D, see ^{110}Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{110}Sn	-	4E+4	1E-5	5E-8	-	-
51	Antimony-115[2]	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-	-
51	Antimony-116m[2]	D, see ^{115}Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{115}Sb	-	1E+5	6E-5	2E-7	-	-
51	Antimony-116[2]	D, see ^{115}Sb	7E+4 St wall (9E+4)	3E+5 -	1E-4 -	4E-7 -	- 1E-3	- 1E-2
		W, see ^{115}Sb	-	3E+5	1E-4	5E-7	-	-
51	Antimony-117	D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		W, see ^{115}Sb	-	3E+5	1E-4	4E-7	-	-
51	Antimony-118m	D, see ^{115}Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	-	-
51	Antimony-119	D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	-	-
51	Antimony-120[2] (16 min)	D, see ^{115}Sb	1E+5 St wall (2E+5)	4E+5 -	2E-4 -	6E-7 -	- 2E-3	- 2E-2
		W, see ^{115}Sb	-	5E+5	2E-4	7E-7	-	-
51	Antimony-120 (5.76 d)	D, see ^{115}Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		W, see ^{115}Sb	9E+2	1E+3	5E-7	2E-9	-	-
51	Antimony-122	D, see ^{115}Sb	8E+2 LLI wall (8E+2)	2E+3 -	1E-6 -	3E-9 -	- 1E-5	- 1E-4
		W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	-	-
51	Antimony-124m[2]	D, see ^{115}Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
		W, see ^{115}Sb	2E+5	6E+5	2E-4	8E-7	-	-
51	Antimony-124	D, see ^{115}Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	2E+2	1E-7	3E-10	-	-
51	Antimony-125	D, see ^{115}Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
		W, see ^{115}Sb	-	5E+2	2E-7	7E-10	-	-
51	Antimony-126m[2]	D, see ^{115}Sb	5E+4 St wall (7E+4)	2E+5 -	8E-5 -	3E-7 -	- 9E-4	- 9E-3
		W, see ^{115}Sb	-	2E+5	8E-5	3E-7	-	-
51	Antimony-126	D, see ^{115}Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	5E+2	2E-7	7E-10	-	-
51	Antimony-127	D, see ^{115}Sb	8E+2 LLI wall (8E+2)	2E+3 -	9E-7 -	3E-9 -	- 1E-5	- 1E-4
		W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	-	-
51	Antimony-128[2] (10.4 min)	D, see ^{115}Sb	8E+4 St wall (1E+5)	4E+5 -	2E-4 -	5E-7 -	- 1E-3	- 1E-2
		W, see ^{115}Sb	-	4E+5	2E-4	6E-7	-	-
51	Antimony-128 (9.01 h)	D, see ^{115}Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, see ^{115}Sb	-	3E+3	1E-6	5E-9	-	-
51	Antimony-129	D, see ^{115}Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, see ^{115}Sb	-	9E+3	4E-6	1E-8	-	-
51	Antimony-130[2]	D, see ^{115}Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{115}Sb	-	8E+4	3E-5	1E-7	-	-
51	Antimony-131[2]	D, see ^{115}Sb	1E+4 Thyroid (2E+4)	2E+4 Thyroid (4E+4)	1E-5 -	- 6E-8	- 2E-4	- 2E-3
		W, see ^{115}Sb	- -	2E+4 Thyroid (4E+4)	1E-5 -	6E-8	- -	- -
52	Tellurium-116	D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ^{116}Te	5E+2 Bone surf (7E+2)	2E+2 Bone surf (4E+2)	8E-8 -	- 5E-10	- 1E-5	- 1E-4
		W, see ^{116}Te	-	4E+2	2E-7	6E-10	-	-
52	Tellurium-121	D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{116}Te	-	3E+3	1E-6	4E-9	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (µCi)	ALI (µCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
52	Tellurium-123m	D, see ^{116}Te	6E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	9E-8 -	- 8E-10	- 1E-5	- 1E-4
		W, see ^{116}Te	-	5E+2	2E-7	8E-10	-	-
52	Tellurium-123	D, see ^{116}Te	5E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	8E-8 -	- 7E-10	- 2E-5	- 2E-4
		W, see ^{116}Te	- -	4E+2 Bone surf (1E+3)	2E-7 -	- 2E-9	- -	- -
52	Tellurium-125m	D, see ^{116}Te	1E+3 Bone surf (1E+3)	4E+2 Bone surf (1E+3)	2E-7 -	- 1E-9	- 2E-5	- 2E-4
		W, see ^{116}Te	-	7E+2	3E-7	1E-9	-	-
52	Tellurium-127m	D, see ^{116}Te	6E+2 -	3E+2 Bone surf (4E+2)	1E-7 -	- 6E-10	9E-6 -	9E-5 -
		W, see ^{116}Te	-	3E+2	1E-7	4E-10	-	-
52	Tellurium-127	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{116}Te	-	2E+4	7E-6	2E-8	-	-
52	Tellurium-129m	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
		W, see ^{116}Te	-	2E+2	1E-7	3E-10	-	-
52	Tellurium-129[2]	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{116}Te	-	7E+4	3E-5	1E-7	-	-
52	Tellurium-131m	D, see ^{116}Te	3E+2 Thyroid (6E+2)	4E+2 Thyroid (1E+3)	2E-7 -	- 2E-9	- 8E-6	- 8E-5
		W, see ^{116}Te	- -	4E+2 Thyroid (9E+2)	2E-7 -	- 1E-9	- -	- -
52	Tellurium-131[2]	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- 8E-5	- 8E-4
		W, see ^{116}Te	- -	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- -	- -
52	Tellurium-132	D, see ^{116}Te	2E+2 Thyroid (7E+2)	2E+2 Thyroid (8E+2)	9E-8 -	- 1E-9	- 9E-6	- 9E-5
		W, see ^{116}Te	- -	2E+2 Thyroid (6E+2)	9E-8 -	- 9E-10	- -	- -
52	Tellurium-133m[2]	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- 9E-5	- 9E-4
		W, see ^{116}Te	- -	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- -	- -
52	Tellurium-133[2]	D, see ^{116}Te	1E+4 Thyroid (3E+4)	2E+4 Thyroid (6E+4)	9E-6 -	- 8E-8	- 4E-4	- 4E-3
		W, see ^{116}Te	- -	2E+4 Thyroid (6E+4)	9E-6 -	- 8E-8	- -	- -
52	Tellurium-134[2]	D, see ^{116}Te	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5 -	- 7E-8	- 3E-4	- 3E-3
		W, see ^{116}Te	-	2E+4	1E-5	-	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			-	Thyroid (5E+4)	-	7E-8	-	-
53	Iodine-120m[2]	D, all compounds	1E+4 Thyroid (1E+4)	2E+4 -	9E-6 -	3E-8 -	- 2E-4	- 2E-3
53	Iodine-120[2]	D, all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6 -	- 7E-8	- 4E-4	- 4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8 -	- 4E-10	- 2E-6	- 2E-5
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8 -	- 3E-10	- 2E-6	- 2E-5
53	Iodine-128[2]	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	5E-5 -	2E-7 -	- 8E-4	- 8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9 -	- 4E-11	- 2E-7	- 2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7 -	- 3E-9	- 2E-5	- 2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8 -	- 2E-10	- 1E-6	- 1E-5
53	Iodine-132m[2]	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6 -	- 3E-8	- 1E-4	- 1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7 -	- 1E-9	- 7E-6	- 7E-5
53	Iodine-134[2]	D, all compounds	2E+4 Thyroid (3E+4)	5E+4 -	2E-5 -	6E-8 -	- 4E-4	- 4E-3
53	Iodine-135	D, all compounds	8E+2 Thyroid (3E+3)	2E+3 Thyroid (4E+3)	7E-7 -	- 6E-9	- 3E-5	- 3E-4
54	Xenon-120[2]	Submersion[1]	-	-	1E-5	4E-8	-	-
54	Xenon-121[2]	Submersion[1]	-	-	2E-6	1E-8	-	-
54	Xenon-122	Submersion[1]	-	-	7E-5	3E-7	-	-
54	Xenon-123	Submersion[1]	-	-	6E-6	3E-8	-	-
54	Xenon-125	Submersion[1]	-	-	2E-5	7E-8	-	-
54	Xenon-127	Submersion[1]	-	-	1E-5	6E-8	-	-
54	Xenon-129m	Submersion[1]	-	-	2E-4	9E-7	-	-
54	Xenon-131m	Submersion[1]	-	-	4E-4	2E-6	-	-
54	Xenon-133m	Submersion[1]	-	-	1E-4	6E-7	-	-
54	Xenon-133	Submersion[1]	-	-	1E-4	5E-7	-	-
54	Xenon-135m[2]	Submersion[1]	-	-	9E-6	4E-8	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
54	Xenon-135	Submersion[1]	-	-	1E-5	7E-8	-	-
54	Xenon-138[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
55	Cesium-125[2]	D, all compounds	5E+4 St wall (9E+4)	1E+5 -	6E-5 -	2E-7 -	- 1E-3	- 1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130[2]	D, all compounds	6E+4 St wall (1E+5)	2E+5 -	8E-5 -	3E-7 -	- 1E-3	- 1E-2
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
55	Cesium-132	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds	1E+5 St wall (1E+5)	1E+5 -	6E-5 -	2E-7 -	- 2E-3	- 2E-2
55	Cesium-134	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
55	Cesium-135m[2]	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
55	Cesium-137	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
55	Cesium-138[2]	D, all compounds	2E+4 St wall (3E+4)	6E+4 -	2E-5 -	8E-8 -	- 4E-4	- 4E-3
56	Barium-126[2]	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
56	Barium-128	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
56	Barium-131m[2]	D, all compounds	4E+5 St wall (5E+5)	1E+6 -	6E-4 -	2E-6 -	- 7E-3	- 7E-2
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds	2E+3 LLI wall (3E+3)	9E+3 -	4E-6 -	1E-8 -	- 4E-5	- 4E-4
56	Barium-133	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
56	Barium-139[2]	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds	5E+2 LLI wall (6E+2)	1E+3 -	6E-7 -	2E-9 -	- 8E-6	- 8E-5
56	Barium-141[2]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
56	Barium-142[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	Lanthanum-131[2]	D, all compounds except those given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-
57	Lanthanum-132	D, see ^{131}La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-135	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
57	Lanthanum-137	D, see ^{131}La	1E+4 -	6E+1 Liver (7E+1) -	3E-8 -	- 1E-10	2E-4 -	2E-3 -
		W, see ^{131}La	- -	3E+2 Liver (3E+2) -	1E-7 -	- 4E-10	- -	- -
57	Lanthanum-138	D, see ^{131}La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
		W, see ^{131}La	-	1E+1	6E-9	2E-11	-	-
57	Lanthanum-140	D, see ^{131}La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{131}La	-	1E+3	5E-7	2E-9	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (µCi)	ALI (µCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
57	Lanthanum-141	D, see ^{131}La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-142[2]	D, see ^{131}La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{131}La	-	3E+4	1E-5	5E-8	-	-
57	Lanthanum-143[2]	D, see ^{131}La	4E+4 St wall (4E+4)	1E+5 -	4E-5 -	1E-7 -	- 5E-4	- 5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
58	Cerium-134	W, all compounds except those given for Y	5E+2 LLI wall (6E+2)	7E+2 -	3E-7 -	1E-9 -	- 8E-6	- 8E-5
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	-	-
58	Cerium-135	W, see ^{134}Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		Y, see ^{134}Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137m	W, see ^{134}Ce	2E+3 LLI wall (2E+3)	4E+3 -	2E-6 -	6E-9 -	- 3E-5	- 3E-4
		Y, see ^{134}Ce	-	4E+3	2E-6	5E-9	-	-
58	Cerium-137	W, see ^{134}Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		Y, see ^{134}Ce	-	1E+5	5E-5	2E-7	-	-
58	Cerium-139	W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
		Y, see ^{134}Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-141	W, see ^{134}Ce	2E+3 LLI wall (2E+3)	7E+2 -	3E-7 -	1E-9 -	- 3E-5	- 3E-4
		Y, see ^{134}Ce	-	6E+2	2E-7	8E-10	-	-
58	Cerium-143	W, see ^{134}Ce	1E+3 LLI wall (1E+3)	2E+3 -	8E-7 -	3E-9 -	- 2E-5	- 2E-4
58	Cerium-144	W, see ^{134}Ce	2E+2 LLI wall (3E+2)	3E+1 -	1E-8 -	4E-11 -	- 3E-6	- 3E-5
		Y, see ^{134}Ce	-	1E+1	6E-9	2E-11	-	-
59	Praseodymium-136[2]	W, all compounds except those given for Y	5E+4 St wall (7E+4)	2E+5 -	1E-4 -	3E-7 -	- 1E-3	- 1E-2
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	-	-
59	Praseodymium-137[2]	W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-138m	W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
		Y, see ^{136}Pr	-	4E+4	2E-5	6E-8	-	-
59	Praseodymium-139	W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-142m[2]	W, see ^{136}Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-142	W, see ^{136}Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		Y, see ^{136}Pr	-	2E+3	8E-7	3E-9	-	-
59	Praseodymium-143	W, see ^{136}Pr	9E+2 LLI wall (1E+3)	8E+2 -	3E-7 -	1E-9 -	- 2E-5	- 2E-4
		Y, see ^{136}Pr	-	7E+2	3E-7	9E-10	-	-
59	Praseodymium-144[2]	W, see ^{136}Pr	3E+4 St wall (4E+4)	1E+5 -	5E-5 -	2E-7 -	- 6E-4	- 6E-3

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col.2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentration (µCi/ml)
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-145	W, see ^{136}Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{136}Pr	-	8E+3	3E-6	1E-8	-	-
59	Praseodymium-147[2]	W, see ^{136}Pr	5E+4 St wall (8E+4)	2E+5 -	8E-5 -	3E-7 -	- 1E-3	- 1E-2
		Y, see ^{136}Pr	-	2E+5	8E-5	3E-7	-	-
60	Neodymium-136[2]	W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
60	Neodymium-138	W, see ^{136}Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		Y, see ^{136}Nd	-	5E+3	2E-6	7E-9	-	-
60	Neodymium-139m	W, see ^{136}Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		Y, see ^{136}Nd	-	1E+4	6E-6	2E-8	-	-
60	Neodymium-139[2]	W, see ^{136}Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
		Y, see ^{136}Nd	-	3E+5	1E-4	4E-7	-	-
60	Neodymium-141	W, see ^{136}Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
		Y, see ^{136}Nd	-	6E+5	3E-4	9E-7	-	-
60	Neodymium-147	W, see ^{136}Nd	1E+3 LLI wall (1E+3)	9E+2 -	4E-7 -	1E-9 -	- 2E-5	- 2E-4
		Y, see ^{136}Nd	-	8E+2	4E-7	1E-9	-	-
60	Neodymium-149[2]	W, see ^{136}Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
		Y, see ^{136}Nd	-	2E+4	1E-5	3E-8	-	-
60	Neodymium-151[2]	W, see ^{136}Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		Y, see ^{136}Nd	-	2E+5	8E-5	3E-7	-	-
61	Promethium-141[2]	W, all compounds except those given for Y	5E+4 St wall (6E+4)	2E+5 -	8E-5 -	3E-7 -	- 8E-4	- 8E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	7E-5	2E-7	-	-
61	Promethium-143	W, see ^{141}Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	7E+2	3E-7	1E-9	-	-
61	Promethium-144	W, see ^{141}Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		Y, see ^{141}Pm	-	1E+2	5E-8	2E-10	-	-
61	Promethium-145	W, see ^{141}Pm	1E+4 -	2E+2 Bone Surf (2E+2)	7E-8 -	- 3E-10	1E-4 -	1E-3 -
		Y, see ^{141}Pm	-	2E+2	8E-8	3E-10	-	-
61	Promethium-146	W, see ^{141}Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
		Y, see ^{141}Pm	-	4E+1	2E-8	6E-11	-	-
61	Promethium-147	W, see ^{141}Pm	4E+3 LLI wall (5E+3)	1E+2 Bone surf (2E+2)	5E-8 -	- 3E-10	- 7E-5	- 7E-4
		Y, see ^{141}Pm	-	1E+2	6E-8	2E-10	-	-
61	Promethium-148m	W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		Y, see ^{141}Pm	-	3E+2	1E-7	5E-10	-	-
61	Promethium-148	W, see ^{141}Pm	4E+2 LLI wall (5E+2)	5E+2 -	2E-7 -	8E-10 -	- 7E-6	- 7E-5
		Y, see ^{141}Pm	-	5E+2	2E-7	7E-10	-	-
61	Promethium-149	W, see ^{141}Pm	1E+3 LLI wall (1E+3)	2E+3 -	8E-7 -	3E-9 -	- 2E-5	- 2E-4
		Y, see ^{141}Pm	-	2E+3	8E-7	2E-9	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
61	Promethium-150	W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{141}Pm	-	2E+4	7E-6	2E-8	-	-
61	Promethium-151	W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{141}Pm	-	3E+3	1E-6	4E-9	-	-
62	Samarium-141m[2]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Samarium-141[2]	W, all compounds	5E+4 St wall (6E+4)	2E+5 -	8E-5 -	2E-7 -	- 8E-4	- 8E-3
62	Samarium-142[2]	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1 Bone surf (3E+1)	4E-2 Bone surf (6E-2)	1E-11 -	- 9E-14	- 3E-7	- 3E-6
62	Samarium-147	W, all compounds	2E+1 Bone surf (3E+1)	4E-2 Bone surf (7E-2)	2E-11 -	- 1E-13	- 4E-7	- 4E-6
62	Samarium-151	W, all compounds	1E+4 LLI wall (1E+4)	1E+2 Bone surf (2E+2)	4E-8 -	- 2E-10	- 2E-4	- 2E-3
62	Samarium-153	W, all compounds	2E+3 LLI wall (2E+3)	3E+3 -	1E-6 -	4E-9 -	- 3E-5	- 3E-4
62	Samarium-155[2]	W, all compounds	6E+4 St wall (8E+4)	2E+5 -	9E-5 -	3E-7 -	- 1E-3	- 1E-2
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Europium-145	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Europium-150 (12.62 h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-152m	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	4E+3 -	9E+1 Bone surf (1E+2)	4E-8 -	- 2E-10	5E-5 -	5E-4 -
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
63	Europium-157	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
63	Europium-158[2]	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
64	Gadolinium-145[2]	D, all compounds except those given for W	5E+4 St wall (5E+4)	2E+5 -	6E-5 -	2E-7 -	- 6E-4	- 6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ^{145}Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ^{145}Gd	-	3E+2	1E-7	4E-10	-	-
64	Gadolinium-147	D, see ^{145}Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{145}Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ^{145}Gd	1E+1 Bone surf	8E+3 Bone surf	3E-12	-	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			(2E+1)	(2E-2)	-	2E-14	3E-7	3E-6
		W, see ^{145}Gd	-	3E-2 Bone surf	1E-11	-	-	-
			-	(6E-2)	-	8E-14	-	-
64	Gadolinium-149	D, see ^{145}Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ^{145}Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ^{145}Gd	6E+3	4E+2 Bone surf	2E-7	-	9E-5	9E-4
			-	(6E+2)	-	9E-10	-	-
		W, see ^{145}Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ^{145}Gd	2E+1 Bone surf	1E-2 Bone surf	4E-12	-	-	-
			(3E+1)	(2E-2)	-	3E-14	4E-7	4E-6
		W, see ^{145}Gd	-	4E-2 Bone surf	2E-11	-	-	-
			-	(8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ^{145}Gd	5E+3	1E+2 Bone surf	6E-8	-	6E-5	6E-4
			-	(2E+2)	-	3E-10	-	-
		W, see ^{145}Gd	-	6E+2	2E-7	8E-10	-	-
64	Gadolinium-159	D, see ^{145}Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{145}Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147[2]	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
65	Terbium-153	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Terbium-155	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Terbium-156m (5.0 h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
65	Terbium-156m (24.4 h)	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds	5E+4 LLI wall	3E+2 Bone surf	1E-7	-	-	-
			(5E+4)	(6E+2)	-	8E-10	7E-4	7E-3
65	Terbium-158	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds	2E+3 LLI wall	2E+3	7E-7	2E-9	-	-
			(2E+3)	-	-	-	3E-5	3E-4
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2 LLI wall	7E+2	3E-7	1E-9	-	-
			(8E+2)	-	-	-	1E-5	1E-4
67	Holmium-155[2]	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157[2]	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159[2]	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Holmium-162m[2]	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Holmium-162[2]	W, all compounds	5E+5 St wall	2E+6	1E-3	3E-6	-	-
			(8E+5)	-	-	-	1E-2	1E-1

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
67	Holmium-164m[2]	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Holmium-164[2]	W, all compounds	2E+5	6E+5	3E-4	9E-7	-	-
			St wall (2E+5)	-	-	-	3E-3	3E-2
67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds	9E+2	2E+3	7E-7	2E-9	-	-
			LLI wall (9E+2)	-	-	-	1E-5	1E-4
67	Holmium-167	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
68	Erbium-169	W, all compounds	3E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
68	Erbium-171	W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
68	Erbium-172	W, all compounds	1E+3	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
69	Thulium-162[2]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
69	Thulium-166	W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
69	Thulium-167	W, all compounds	2E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
69	Thulium-170	W, all compounds	8E+2	2E+2	9E-8	3E-10	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
69	Thulium-171	W, all compounds	1E+4	3E+2	1E-7	-	-	-
			LLI wall (1E+4)	Bone surf (6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
69	Thulium-173	W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
69	Thulium-175[2]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
70	Ytterbium-162[2]	W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
		Y, oxides, hydroxides, and fluorides	-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ^{162}Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167[2]	W, see ^{162}Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
		Y, see ^{162}Yb	-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ^{162}Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ^{162}Yb	3E+3	4E+3	1E-6	5E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{162}Yb	-	3E+3	1E-6	5E-9	-	-
70	Ytterbium-177[2]	W, see ^{162}Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	5E+4	2E-5	6E-8	-	-
70	Ytterbium-178[2]	W, see ^{162}Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	4E+4	2E-5	5E-8	-	-
71	Lutetium-169	W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		Y, oxides, hydroxides, and fluorides	-	4E+3	2E-6	6E-9	-	-
71	Lutetium-170	W, see ^{169}Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-171	W, see ^{169}Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-172	W, see ^{169}Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ^{169}Lu	-	1E+3	5E-7	2E-9	-	-
71	Lutetium-173	W, see ^{169}Lu	5E+3	3E+2 Bone surf (5E+2)	1E-7	- 6E-10	7E-5 -	7E-4 -
		Y, see ^{169}Lu	-	3E+2	1E-7	4E-10	-	-
71	Lutetium-174m	W, see ^{169}Lu	2E+3 LLI wall (3E+3)	2E+2 Bone surf (3E+2)	1E-7 -	- 5E-10	- 4E-5	- 4E-4
		Y, see ^{169}Lu	-	2E+2	9E-8	3E-10	-	-
71	Lutetium-174	W, see ^{169}Lu	5E+3	1E+2 Bone surf (2E+2)	5E-8 -	- 3E-10	7E-5 -	7E-4 -
		Y, see ^{169}Lu	-	2E+2	6E-8	2E-10	-	-
71	Lutetium-176m	W, see ^{169}Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		Y, see ^{169}Lu	-	2E+4	9E-6	3E-8	-	-
71	Lutetium-176	W, see ^{169}Lu	7E+2	5E+0 Bone surf (1E+1)	2E-9 -	- 2E-11	1E-5 -	1E-4 -
		Y, see ^{169}Lu	-	8E+0	3E-9	1E-11	-	-
71	Lutetium-177m	W, see ^{169}Lu	7E+2	1E+2 Bone surf (1E+2)	5E-8 -	- 2E-10	1E-5 -	1E-4 -
		Y, see ^{169}Lu	-	8E+1	3E-8	1E-10	-	-
71	Lutetium-177	W, see ^{169}Lu	2E+3 LLI wall (3E+3)	2E+3 -	9E-7 -	3E-9 -	- 4E-5	- 4E-4
		Y, see ^{169}Lu	-	2E+3	9E-7	3E-9	-	-
71	Lutetium-178m[2]	W, see ^{169}Lu	5E+4 St. wall (6E+4)	2E+5 -	8E-5 -	3E-7 -	- 8E-4	- 8E-3
		Y, see ^{169}Lu	-	2E+5	7E-5	2E-7	-	-
71	Lutetium-178[2]	W, see ^{169}Lu	4E+4 St wall (4E+4)	1E+5 -	5E-5 -	2E-7 -	- 6E-4	- 6E-3
		Y, see ^{169}Lu	-	1E+5	5E-5	2E-7	-	-
71	Lutetium-179	W, see ^{169}Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{169}Lu	-	2E+4	6E-6	3E-8	-	-
72	Hafnium-170	D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
		W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-
72	Hafnium-172	D, see ^{170}Hf	1E+3	9E+0 Bone surf (2E+1)	4E-9 -	- 3E-11	2E-5 -	2E-4 -
		W, see ^{170}Hf	-	4E+1 Bone surf (6E+1)	2E-8 -	- 8E-11	- -	- -
72	Hafnium-173	D, see ^{170}Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{170}Hf	-	1E+4	5E-6	2E-8	-	-
72	Hafnium-175	D, see ^{170}Hf	3E+3	9E+2	4E-7	-	4E-5	4E-4

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
				Bone surf				
			-	(1E+3)	-	1E-9	-	-
		W, see ^{170}Hf	-	1E+3	5E-7	2E-9	-	-
72	Hafnium-177m[2]	D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{170}Hf	-	9E+4	4E-5	1E-7	-	-
72	Hafnium-178m	D, see ^{170}Hf	3E+2	1E+0	5E-10	-	3E-6	3E-5
			-	Bone surf (2E+0)	-	3E-12	-	-
		W, see ^{170}Hf	-	5E+0	2E-9	-	-	-
			-	Bone surf (9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2	1E-7	-	1E-5	1E-4
			-	Bone surf (6E+2)	-	8E-10	-	-
		W, see ^{170}Hf	-	6E+2	3E-7	8E-10	-	-
72	Hafnium-180m	D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{170}Hf	-	3E+4	1E-5	4E-8	-	-
72	Hafnium-181	D, see ^{170}Hf	1E+3	2E+2	7E-8	-	2E-5	2E-4
			-	Bone surf (4E+2)	-	6E-10	-	-
		W, see ^{170}Hf	-	4E+2	2E-7	6E-10	-	-
72	Hafnium-182m[2]	D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
		W, see ^{170}Hf	-	1E+5	6E-5	2E-7	-	-
72	Hafnium-182	D, see ^{170}Hf	2E+2	8E-1	3E-10	-	-	-
			Bone surf (4E+2)	Bone surf (2E+0)	-	2E-12	5E-6	5E-5
		W, see ^{170}Hf	-	3E+0	1E-9	-	-	-
			-	Bone surf (7E+0)	-	1E-11	-	-
72	Hafnium-183[2]	D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{170}Hf	-	6E+4	2E-5	8E-8	-	-
72	Hafnium-184	D, see ^{170}Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{170}Hf	-	6E+3	3E-6	9E-9	-	-
73	Tantalum-172[2]	W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-
73	Tantalum-173	W, see ^{172}Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174[2]	W, see ^{172}Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	9E+4	4E-5	1E-7	-	-
73	Tantalum-175	W, see ^{172}Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
		Y, see ^{172}Ta	-	1E+4	6E-6	2E-8	-	-
73	Tantalum-176	W, see ^{172}Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		Y, see ^{172}Ta	-	1E+4	5E-6	2E-8	-	-
73	Tantalum-177	W, see ^{172}Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-178	W, see ^{172}Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
		Y, see ^{172}Ta	-	7E+4	3E-5	1E-7	-	-
73	Tantalum-179	W, see ^{172}Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
		Y, see ^{172}Ta	-	9E+2	4E-7	1E-9	-	-
73	Tantalum-180m	W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{172}Ta	-	6E+4	2E-5	8E-8	-	-
73	Tantalum-180	W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
		Y, see ^{172}Ta	-	2E+1	1E-8	3E-11	-	-
73	Tantalum-182m[2]	W, see ^{172}Ta	2E+5 St wall	5E+5	2E-4	8E-7	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			(2E+5)	-	-	-	3E-3	3E-2
		Y, see ^{172}Ta	-	4E+5	2E-4	6E-7	-	-
73	Tantalum-182	W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		Y, see ^{172}Ta	-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see ^{172}Ta	9E+2	1E+3	5E-7	2E-9	-	-
			LLI Wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{172}Ta	-	1E+3	4E-7	1E-9	-	-
73	Tantalum-184	W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
		Y, see ^{172}Ta	-	5E+3	2E-6	7E-9	-	-
73	Tantalum-185[2]	W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	6E+4	3E-5	9E-8	-	-
73	Tantalum-186[2]	W, see ^{172}Ta	5E+4	2E+5	1E-4	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, see ^{172}Ta	-	2E+5	9E-5	3E-7	-	-
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
74	Tungsten-179[2]	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
74	Tungsten-185	D, all compounds	2E+3	7E+3	3E-6	9E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
75	Rhenium-177[2]	D, all compounds except those given for W	9E+4	3E+5	1E-4	4E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-
75	Rhenium-178[2]	D, see ^{177}Re	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
		W, see ^{177}Re	-	3E+5	1E-4	4E-7	-	-
75	Rhenium-181	D, see ^{177}Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
		W, see ^{177}Re	-	9E+3	4E-6	1E-8	-	-
75	Rhenium-182 (12.7 h)	D, see ^{177}Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
		W, see ^{177}Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182 (64.0 h)	D, see ^{177}Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+3	9E-7	3E-9	-	-
75	Rhenium-184m	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	4E+2	2E-7	6E-10	-	-
75	Rhenium-184	D, see ^{177}Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{177}Re	-	1E+3	6E-7	2E-9	-	-
75	Rhenium-186m	D, see ^{177}Re	1E+3	2E+3	7E-7	-	-	-
			St wall (2E+3)	St wall (2E+3)	-	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+2	6E-8	2E-10	-	-
75	Rhenium-186	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	2E+3	7E-7	2E-9	-	-
75	Rhenium-187	D, see ^{177}Re	6E+5	8E+5	4E-4	-	8E-3	8E-2
			-	St wall (9E+5)	-	1E-6	-	-
		W, see ^{177}Re	-	1E+5	4E-5	1E-7	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
75	Rhenium-188m[2]	D, see ^{177}Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{177}Re	-	1E+5	6E-5	2E-7	-	-
75	Rhenium-188	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		W, see ^{177}Re	-	3E+3	1E-6	4E-9	-	-
75	Rhenium-189	D, see ^{177}Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
		W, see ^{177}Re	-	4E+3	2E-6	6E-9	-	-
76	Osmium-180[2]	D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
		W, halides and nitrates	-	5E+5	2E-4	7E-7	-	-
		Y, oxides and hydroxides	-	5E+5	2E-4	6E-7	-	-
76	Osmium-182	D, see ^{180}Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
		W, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
76	Osmium-185	D, see ^{180}Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
76	Osmium-189m	D, see ^{180}Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, see ^{180}Os	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{180}Os	-	2E+5	7E-5	2E-7	-	-
76	Osmium-191m	D, see ^{180}Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{180}Os	-	2E+4	8E-6	3E-8	-	-
		Y, see ^{180}Os	-	2E+4	7E-6	2E-8	-	-
76	Osmium-191	D, see ^{180}Os	2E+3 LLI wall (3E+3)	2E+3 -	9E-7 -	3E-9 -	- 3E-5	- 3E-4
		W, see ^{180}Os	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{180}Os	-	1E+3	6E-7	2E-9	-	-
76	Osmium-193	D, see ^{180}Os	2E+3 LLI wall (2E+3)	5E+3 -	2E-6 -	6E-9 -	- 2E-5	- 2E-4
		W, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
76	Osmium-194	D, see ^{180}Os	4E+2 LLI wall (6E+2)	4E+1 -	2E-8 -	6E-11 -	- 8E-6	- 8E-5
		W, see ^{180}Os	-	6E+1	2E-8	8E-11	-	-
		Y, see ^{180}Os	-	8E+0	3E-9	1E-11	-	-
77	Iridium-182[2]	D, all compounds except those given for W and Y	4E+4 St wall (4E+4)	1E+5 -	6E-5 -	2E-7 -	- 6E-4	- 6E-3
		W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
77	Iridium-184	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-185	D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{182}Ir	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{182}Ir	-	1E+4	4E-6	1E-8	-	-
77	Iridium-186	D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{182}Ir	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{182}Ir	-	6E+3	2E-6	8E-9	-	-
77	Iridium-187	D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-188	D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		W, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
		Y, see ^{182}Ir	-	3E+3	1E-6	5E-9	-	-
77	Iridium-189	D, see ^{182}Ir	5E+3 LLI wall (5E+3)	5E+3 -	2E-6 -	7E-9 -	- 7E-5	- 7E-4
		W, see ^{182}Ir	-	4E+3	2E-6	5E-9	-	-
		Y, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
77	Iridium-190m[2]	D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
		W, see ^{182}Ir	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{182}Ir	-	2E+5	8E-5	3E-7	-	-
77	Iridium-190	D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
		W, see ^{182}Ir	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{182}Ir	-	9E+2	4E-7	1E-9	-	-
77	Iridium-192m	D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
		W, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
		Y, see ^{182}Ir	-	2E+1	6E-9	2E-11	-	-
77	Iridium-192	D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		W, see ^{182}Ir	-	4E+2	2E-7	6E-10	-	-
		Y, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
77	Iridium-194m	D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
		W, see ^{182}Ir	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{182}Ir	-	1E+2	4E-8	1E-10	-	-
77	Iridium-194	D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{182}Ir	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{182}Ir	-	2E+3	8E-7	3E-9	-	-
77	Iridium-195m	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	2E+4	9E-6	3E-8	-	-
77	Iridium-195	D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{182}Ir	-	5E+4	2E-5	7E-8	-	-
		Y, see ^{182}Ir	-	4E+4	2E-5	6E-8	-	-
78	Platinum-186	D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
78	Platinum-193m	D, all compounds	3E+3 LLI wall (3E+4)	6E+3 -	3E-6 -	8E-9 -	- 4E-5	- 4E-4
78	Platinum-193	D, all compounds	4E+4 LLI wall (3E+4)	2E+4 -	1E-5 -	3E-8 -	- 4E-5	- 4E-4
78	Platinum-193	D, all compounds	4E+4 LLI wall (5E+4)	2E+4 -	1E-5 -	3E-8 -	- 6E-4	- 6E-3
78	Platinum-195m	D, all compounds	2E+3 LLI wall (2E+3)	4E+3 -	2E-6 -	6E-9 -	- 3E-5	- 3E-4
78	Platinum-197m[2]	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-199[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, halides and nitrates	-	2E+4	9E-6	3E-8	-	-
		Y, oxides and hydroxides	-	2E+4	8E-6	3E-8	-	-
79	Gold-194	D, see ^{193}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193}Au	-	5E+3	2E-6	8E-9	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		Y, see ^{193}Au	-	5E+3	2E-6	7E-9	-	-
79	Gold-195	D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{193}Au	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{193}Au	-	4E+2	2E-7	6E-10	-	-
79	Gold-198m	D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
79	Gold-198	D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	2E+3	8E-7	3E-9	-	-
		Y, see ^{193}Au	-	2E+3	7E-7	2E-9	-	-
79	Gold-199	D, see ^{193}Au	3E+3 LLI wall (3E+3)	9E+3 -	4E-6 -	1E-8 -	- 4E-5	- 4E-4
		W, see ^{193}Au	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{193}Au	-	4E+3	2E-6	5E-9	-	-
79	Gold-200m	D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{193}Au	-	2E+4	1E-6	3E-9	-	-
79	Gold-200[2]	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{193}Au	-	8E+4	3E-5	1E-7	-	-
		Y, see ^{193}Au	-	7E+4	3E-5	1E-7	-	-
79	Gold-201[2]	D, see ^{193}Au	7E+4 St wall (9E+4)	2E+5 -	9E-5 -	3E-7 -	- 1E-3	- 1E-2
		W, see ^{193}Au	-	2E+5	1E-4	3E-7	-	-
		Y, see ^{193}Au	-	2E+5	9E-5	3E-7	-	-
80	Mercury-193m	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		D, see ^{193m}Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	4E+4	2E-5	6E-8	-	-
80	Mercury-194	Vapor	-	3E+1	1E-8	4E-11	-	-
		Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
		D, see ^{193m}Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see ^{193m}Hg	-	1E+2	5E-8	2E-10	-	-
80	Mercury-195m	Vapor	-	4E+3	2E-6	6E-9	-	-
		Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
		D, see ^{193m}Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	4E+3	2E-6	5E-9	-	-
80	Mercury-195	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		D, see ^{193m}Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	3E+4	1E-5	5E-8	-	-
80	Mercury-197m	Vapor	-	5E+3	2E-6	7E-9	-	-
		Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		D, see ^{193m}Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193m}Hg	-	5E+3	2E-6	7E-9	-	-
80	Mercury-197	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
		D, see ^{193m}Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{193m}Hg	-	9E+3	4E-6	1E-8	-	-
80	Mercury-199m[2]	Vapor	-	8E+4	3E-5	1E-7	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		Organic D	6E+4	2E+5	7E-5	2E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
		D, see ^{193m}Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
		W, see ^{193m}Hg	-	2E+5	7E-5	2E-7	-	-
80	Mercury-203	Vapor	-	8E+2	4E-7	1E-9	-	-
		Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
		D, see ^{193m}Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	1E+3	5E-7	2E-9	-	-
81	Thallium-194m[2]	D, all compounds	5E+4	2E+5	6E-5	2E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
81	Thallium-194[2]	D, all compounds	3E+5	6E+5	2E-4	8E-7	-	-
			St wall (3E+5)	-	-	-	4E-3	4E-2
81	Thallium-195[2]	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198m[2]	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
81	Thallium-198	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Lead-195m[2]	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199[2]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E-1 Bone surf (1E+0)	2E-1 Bone surf (4E-1)	1E-10 -	6E-13	1E-8	1E-7
82	Lead-211[2]	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	8E+1 Bone surf (1E+2)	3E+1 -	1E-8 -	5E-11 -	- 2E-6	- 2E-5
82	Lead-214[2]	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bismuth-200[2]	D, nitrates	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, all other compounds	-	1E+5	4E-5	1E-7	-	-
83	Bismuth-201[2]	D, see ^{200}Bi	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{200}Bi	-	4E+4	2E-5	5E-8	-	-
83	Bismuth-202[2]	D, see ^{200}Bi	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{200}Bi	-	8E+4	3E-5	1E-7	-	-
83	Bismuth-203	D, see ^{200}Bi	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{200}Bi	-	6E+3	3E-6	9E-9	-	-
83	Bismuth-205	D, see ^{200}Bi	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{200}Bi	-	1E+3	5E-7	2E-9	-	-
83	Bismuth-206	D, see ^{200}Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{200}Bi	-	9E+2	4E-7	1E-9	-	-
83	Bismuth-207	D, see ^{200}Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-210m	D, see ^{200}Bi	4E+1	5E+0	2E-9	-	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			Kidneys (6E+1)	Kidneys (6E+0)	-	9E-12	8E-7	8E-6
		W, see ^{200}Bi	-	7E-1	3E-10	9E-13	-	-
83	Bismuth-210	D, see ^{200}Bi	8E+2	2E+2	1E-7	-	1E-5	1E-4
			-	Kidneys (4E+2)	-	5E-10	-	-
		W, see ^{200}Bi	-	3E+1	1E-8	4E-11	-	-
83	Bismuth-212[2]	D, see ^{200}Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
		W, see ^{200}Bi	-	3E+2	1E-7	4E-10	-	-
83	Bismuth-213[2]	D, see ^{200}Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-214[2]	D, see ^{200}Bi	2E+4 St wall (2E+4)	8E+2 -	3E-7 -	1E-9 -	- 3E-4	- 3E-3
		W, see ^{200}Bi	-	9E-2	4E-7	1E-9	-	-
84	Polonium-203[2]	D, all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, oxides, hydroxides, and nitrates	-	9E+4	4E-5	1E-7	-	-
84	Polonium-205[2]	D, see ^{203}Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
		W, see ^{203}Po	-	7E+4	3E-5	1E-7	-	-
84	Polonium-207	D, see ^{203}Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{203}Po	-	3E+4	1E-5	4E-8	-	-
84	Polonium-210	D, see ^{203}Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
		W, see ^{203}Po	-	6E-1	3E-10	9E-13	-	-
85	Astatine-207[2]	D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
		W	-	2E+3	9E-7	3E-9	-	-
85	Astatine-211	D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
		W	-	5E+1	2E-8	8E-11	-	-
86	Radon-220	With daughters removed	-	2E+4	7E-6	2E-8	-	-
		With daughters present	-	2E+1 (or 12 working level months)	9E-9 (or 1.0 working level)	3E-11	-	-
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2 (or 4 working level months)	3E-8 (or 0.33 working level)	1E-10	-	-
87	Francium-222[2]	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
87	Francium-223[2]	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	5E+0 Bone surf (9E+0)	7E-1 -	3E-10 -	9E-13 -	- 1E-7	- 1E-6
88	Radium-224	W, all compounds	8E+0 Bone surf (2E+1)	2E+0 -	7E-10 -	2E-12 -	- 2E-7	- 2E-6
88	Radium-225	W, all compounds	8E+0 Bone surf (2E+1)	7E-1 -	3E-10 -	9E-13 -	- 2E-7	- 2E-6
88	Radium-226	W, all compounds	2E+0 Bone surf (5E+0)	6E-1 -	3E-10 -	9E-13 -	- 6E-8	- 6E-7
88	Radium-227[2]	W, all compounds	2E+4 Bone surf (2E+4)	1E+4 (2E+4)	6E-6 -	- 3E-8	- 3E-4	- 3E-3
88	Radium-228	W, all compounds	2E+0	1E+0	5E-10	2E-12	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			Bone surf (4E+0)	-	-	-	6E-8	6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3	3E+1	1E-8	-	-	-
			LLI wall (2E+3)	Bone surf (4E+1)	-	5E-11	3E-5	3E-4
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D, see ^{224}Ac	5E+1	3E-1	1E-10	-	-	-
			LLI wall (5E+1)	Bone surf (5E-1)	-	7E-13	7E-7	7E-6
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D, see ^{224}Ac	5E+1	3E-1	1E-10	-	-	-
			LLI wall (5E+1)	Bone surf (5E-1)	-	7E-13	7E-7	7E-6
		W, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-226	D, see ^{224}Ac	1E+2	3E+0	1E-9	-	-	-
			LLI wall (1E+2)	Bone surf (4E+0)	-	5E-12	2E-6	2E-5
		W, see ^{224}Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ^{224}Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ^{224}Ac	2E-1	4E-4	2E-13	-	-	-
			Bone surf (4E-1)	Bone surf (8E-4)	-	1E-15	5E-9	5E-8
		W, see ^{224}Ac	-	2E-3	7E-13	-	-	-
			-	Bone surf (3E-3)	-	4E-15	-	-
		Y, see ^{224}Ac	-	4E-3	2E-12	6E-15	-	-
89	Actinium-228	D, see ^{224}Ac	2E+3	9E+0	4E-9	-	3E-5	3E-4
			-	Bone surf (2E+1)	-	2E-11	-	-
		W, see ^{224}Ac	-	4E+1	2E-8	-	-	-
			-	Bone surf (6E+1)	-	8E-11	-	-
		Y, see ^{224}Ac	-	4E+1	2E-8	6E-11	-	-
90	Thorium-226[2]	W, all compounds except those given for Y	5E+3	2E+2	6E-8	2E-10	-	-
			St wall (5E+3)	-	-	-	7E-5	7E-4
		Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	-	-
90	Thorium-227	W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
		Y, see ^{226}Th	-	3E-1	1E-10	5E-13	-	-
90	Thorium-228	W, see ^{226}Th	6E+0	1E-2	4E-12	-	-	-
			Bone surf (1E+1)	Bone surf (2E-2)	-	3E-14	2E-7	2E-6
		Y, see ^{226}Th	-	2E-2	7E-12	2E-14	-	-
90	Thorium-229	W, see ^{226}Th	6E-1	9E-4	4E-13	-	-	-
			Bone surf (1E+0)	Bone surf (2E-3)	-	3E-15	2E-8	2E-7
		Y, see ^{226}Th	-	2E-3	1E-12	-	-	-
			-	Bone surf (3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ^{226}Th	4E+0	6E-3	3E-12	-	-	-
			Bone surf (9E+0)	Bone surf (2E-2)	-	2E-14	1E-7	1E-6
		Y, see ^{226}Th	-	2E-2	6E-12	-	-	-
				Bone surf				

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			-	(2E-2)	-	3E-14	-	-
90	Thorium-231	W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
		Y, see ^{226}Th	-	6E+3	3E-6	9E-9	-	-
90	Thorium-232	W, see ^{226}Th	7E-1 Bone surf (2E+0)	1E-3 Bone surf (3E-3)	5E-13 -	- 4E-15	- 3E-8	- 3E-7
		Y, see ^{226}Th	- -	3E-3 Bone surf (4E-3)	1E-12 -	- 6E-15	- -	- -
90	Thorium-234	W, see ^{226}Th	3E+2 LLI wall (4E+2)	2E+2 -	8E-8 -	3E-10 -	- 5E-6	- 5E-5
		Y, see ^{226}Th	-	2E+2	6E-8	2E-10	-	-
91	Protactinium-227[2]	W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
		Y, oxides and hydroxides	-	1E+2	4E-8	1E-10	-	-
91	Protactinium-228	W, see ^{227}Pa	1E+3 -	1E+1 Bone surf (2E+1)	5E-9 -	- 3E-11	2E-5 -	2E-4 -
		Y, see ^{227}Pa	-	1E+1	5E-9	2E-11	-	-
91	Protactinium-230	W, see ^{227}Pa	6E+2 (9E+2)	5E+0 Bone surf -	2E-9 -	7E-12 -	- 1E-5	- 1E-4
		Y, see ^{227}Pa	-	4E+0	1E-9	5E-12	-	-
91	Protactinium-231	W, see ^{227}Pa	2E-1 Bone surf (5E-1)	2E-3 Bone surf (4E-3)	6E-13 -	- 6E-15	- 6E-9	- 6E-8
		Y, see ^{227}Pa	- -	4E-3 Bone surf (6E-3)	2E-12 -	- 8E-15	- -	- -
91	Protactinium-232	W, see ^{227}Pa	1E+3 -	2E+1 Bone surf (6E+1)	9E-9 -	- 8E-11	2E-5 -	2E-4 -
		Y, see ^{227}Pa	- -	6E+1 Bone surf (7E+1)	2E-8 -	- 1E-10	- -	- -
91	Protactinium-233	W, see ^{227}Pa	1E+3 LLI wall (2E+3)	7E+2 -	3E-7 -	1E-9 -	- 2E-5	- 2E-4
		Y, see ^{227}Pa	-	6E+2	2E-7	8E-10	-	-
91	Protactinium-234	W, see ^{227}Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{227}Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF_6, UO_2F_2, $UO_2(NO_3)_2$	4E+0 Bone surf (6E+0)	4E-1 Bone surf (6E-1)	2E-10 -	- 8E-13	- 8E-8	- 8E-7
		W, UO_3, UF_4, UCl_4	-	4E-1	1E-10	5E-13	-	-
		Y, UO_2, U_3O_8	-	3E-1	1E-10	4E-13	-	-
92	Uranium-231	D, see ^{230}U	5E+3 LLI wall (4E+3)	8E+3 -	3E-6 -	1E-8 -	- 6E-5	- 6E-4
		W, see ^{230}U	-	6E+3	2E-6	8E-9	-	-
		Y, see ^{230}U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see ^{230}U	2E+0 Bone surf (4E+0)	2E-1 Bone surf (4E-1)	9E-11 -	- 6E-13	- 6E-8	- 6E-7
		W, see ^{230}U	-	4E-1	2E-10	5E-13	-	-
		Y, see ^{230}U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-233	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-234[3]	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-235[3]	D, see ^{230}U	1E+1	1E+0	6E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-236	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-237	D, see ^{230}U	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ^{230}U	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{230}U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238[3]	D, see ^{230}U	1E+1	1E+0	6E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-239[2]	D, see ^{230}U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see ^{230}U	-	2E+5	7E-5	2E-7	-	-
		Y, see ^{230}U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see ^{230}U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{230}U	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{230}U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural[3]	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	9E-13	-	-
		Y, see ^{230}U	-	5E-2	2E-11	9E-14	-	-
93	Neptunium-232[2]	W, all compounds	1E+5	2E+3	7E-7	-	2E-3	2E-2
			Bone surf -	(5E+2)	-	6E-9	-	-
93	Neptunium-233[2]	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	2E+4	8E+2	3E-7	-	-	-
			LLI wall (2E+4)	Bone surf (1E+3)	-	2E-9	3E-4	3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	3E+0	2E-2	9E-12	-	-	-
			Bone surf (6E+0)	Bone surf (5E-2)	-	8E-14	9E-8	9E-7
93	Neptunium-236 (22.5 h)	W, all compounds	3E+3	3E+1	1E-8	-	-	-
			Bone surf (4E+3)	Bone surf (7E+1)	-	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	1E-14	2E-8	2E-7

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf (2E+2)	3E-8	-	2E-5	2E-4
			-		-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3 LLI wall (2E+3)	2E+3	9E-7	3E-9	-	-
			-	-	-	-	2E-5	2E-4
93	Neptunium-240[2]	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO_2	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO_2	-	2E+2	8E-8	3E-10	-	-
94	Plutonium-235[2]	W, see ^{234}Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
		Y, see ^{234}Pu	-	3E+6	1E-3	3E-6	-	-
94	Plutonium-236	W, see ^{234}Pu	2E+0 Bone surf (4E+0)	2E-2 Bone surf (4E-2)	8E-12	-	-	-
					-	5E-14	6E-8	6E-7
		Y, see ^{234}Pu	-	4E-2	2E-11	6E-14	-	-
94	Plutonium-237	W, see ^{234}Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
		Y, see ^{234}Pu	-	3E+3	1E-6	4E-9	-	-
94	Plutonium-238	W, see ^{234}Pu	9E-1 Bone surf (2E+0)	7E-3 Bone surf (1E-2)	3E-12	-	-	-
					-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	8E-12	2E-14	-	-
94	Plutonium-239	W, see ^{234}Pu	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
					-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12	-	-	-
			-		-	2E-14	-	-
94	Plutonium-240	W, see ^{234}Pu	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12	-	-	-
					-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12	-	-	-
			-		-	2E-14	-	-
94	Plutonium-241	W, see ^{234}Pu	4E+1 Bone surf (7E+1)	3E-1 Bone surf (6E-1)	1E-10	-	-	-
					-	8E-13	1E-6	1E-5
		Y, see ^{234}Pu	-	8E-1 Bone surf (1E+0)	3E-10	-	-	-
			-		-	1E-12	-	-
94	Plutonium-242	W, see ^{234}Pu	8E-1 Bone surf (1E+0)	7E-3 Bone surf (1E-2)	3E-12	-	-	-
					-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12	-	-	-
			-		-	2E-14	-	-
94	Plutonium-243	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ^{234}Pu	-	4E+4	2E-5	5E-8	-	-
94	Plutonium-244	W, see ^{234}Pu	8E-1 Bone surf (2E+0)	7E-3 Bone surf (1E-2)	3E-12	-	-	-
					-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf (2E-2)	7E-12	-	-	-
			-		-	2E-14	-	-
94	Plutonium-245	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		Y, see ^{234}Pu	-	4E+3	2E-6	6E-9	-	-
94	Plutonium-246	W, see ^{234}Pu	4E+2 LLI wall (4E+2)	3E+2	1E-7	4E-10	-	-
				-	-	-	6E-6	6E-5

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
		Y, see ^{234}Pu	-	3E+2	1E-7	4E-10	-	-
95	Americium-237[2]	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238[2]	W, all compounds	4E+4	3E+3	1E-6	-	5E-4	5E-3
			-	Bone surf (6E+3)	-	9E-9	-	-
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242m	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	4E+3	8E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (9E+1)	-	1E-10	-	-
95	Americium-243	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-244m[2]	W, all compounds	6E+4	4E+3	2E-6	-	-	-
			St wall (8E+4)	Bone surf (7E+3)	-	1E-8	1E-3	1E-2
95	Americium-244	W, all compounds	3E+3	2E+2	8E-8	-	4E-5	4E-4
			-	Bone surf (3E+2)	-	4E-10	-	-
95	Americium-245	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Americium-246m[2]	W, all compounds	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
95	Americium-246[2]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
96	Curium-238	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	6E+1	6E-1	2E-10	-	-	-
			Bone surf (8E+1)	Bone surf (6E-1)	-	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	1E+3	3E+1	1E-8	-	2E-5	2E-4
			-	Bone surf (4E+1)	-	5E-11	-	-
96	Curium-242	W, all compounds	3E+1	3E-1	1E-10	-	-	-
			Bone surf (5E+1)	Bone surf (3E-1)	-	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	1E+0	1E-2	5E-12	-	-	-
			Bone surf (3E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-246	W, all compounds	7E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-247	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
96	Curium-248	W, all compounds	2E-1	2E-3	7E-13	-	-	-
			Bone surf (4E-1)	Bone surf (3E-3)	-	4E-15	5E-9	5E-8

			Table I Occupational Values			Table II Effluent Concentrations		Table III Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
96	Curium-249[2]	W, all compounds	5E+4	2E+4	7E-6	-	7E-4	7E-3
			-	Bone surf (3E+4)	-	4E-8	-	-
96	Curium-250	W, all compounds	4E-2	3E-4	1E-13	-	-	-
			Bone surf (6E-2)	Bone surf (5E-4)	-	8E-16	9E-10	9E-9
97	Berkelium-245	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
97	Berkelium-246	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
97	Berkelium-247	W, all compounds	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
97	Berkelium-249	W, all compounds	2E+2	2E+0	7E-10	-	-	-
			Bone surf (5E+2)	Bone surf (4E+0)	-	5E-12	6E-6	6E-5
97	Berkelium-250	W, all compounds	9E+3	3E+2	1E-7	-	1E-4	1E-3
			-	Bone surf (7E+2)	-	1E-9	-	-
98	Californium-244[2]	W, all compounds except those given for Y	3E+4	6E+2	2E-7	8E-10	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
98	Californium-246	W, see ^{244}Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
		Y, see ^{244}Cf	-	9E+0	4E-9	1E-11	-	-
98	Californium-248	W, see ^{244}Cf	8E+0	6E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	2E-13	2E-7	2E-6
		Y, see ^{244}Cf	-	1E-1	4E-11	1E-13	-	-
98	Californium-249	W, see ^{244}Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2	4E-12	-	-	-
			-	Bone surf (1E-2)	-	2E-14	-	-
98	Californium-250	W, see ^{244}Cf	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	4E-14	-	-
98	Californium-251	W, see ^{244}Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2	4E-12	-	-	-
			-	Bone surf (1E-2)	-	2E-14	-	-
98	Californium-252	W, see ^{244}Cf	2E+0	2E-2	8E-12	-	-	-
			Bone surf (5E+0)	Bone surf (4E-2)	-	5E-14	7E-8	7E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	5E-14	-	-
98	Californium-253	W, see ^{244}Cf	2E+2	2E+0	8E-10	3E-12	-	-
			Bone surf (4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{244}Cf	-	2E+0	7E-10	2E-12	-	-
98	Californium-254	W, see ^{244}Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	2E-2	7E-12	2E-14	-	-
99	Einsteinium-250	W, all compounds	4E+4	5E+2	2E-7	-	6E-4	6E-3
			-	Bone surf (1E+3)	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2	4E-7	-	1E-4	1E-3
				Bone surf				

			Table I Occupational Values			**Table II** Effluent Concentrations		**Table III** Release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col.2	
Atomic No.	Radionuclide	Class	Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	Inhalation DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	Monthly Average Concentration (µCi/ml)
			-	(1E+3)	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
99	Einsteinium-254m	W, all compounds	3E+2 LLI wall (3E+2)	1E+1 -	4E-9 -	1E-11 -	- 4E-6	- 4E-5
99	Einsteinium-254	W, all compounds	8E+0 Bone surf (2E+1)	7E-2 Bone surf (1E-1)	3E-11 -	- 2E-13	- 2E-7	- 2E-6
100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	2E+1 Bone surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11 -	- 3E-13	- 5E-7	- 5E-6
101	Mendelevium-257	W, all compounds	7E+3 -	8E+1 Bone surf (9E+1)	4E-8 -	- 1E-10	1E-4 -	1E-3 -
101	Mendelevium-258	W, all compounds	3E+1 Bone surf (5E+1)	2E-1 Bone surf (3E-1)	1E-10 -	- 5E-13	- 6E-7	- 6E-6
-	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	Submersion[1]	-	2E+2	1E-7	1E-9	-	-
-	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		-	2E-1	1E-10	1E-12	1E-8	1E-7
-	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known		-	4E-4	2E-13	1E-15	2E-9	2E-8

FOOTNOTES:

[1]"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

[2]These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 µCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See180 NAC 4-007.)

[3]For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see180 NAC 4-004, item 5). If the percent by weight (enrichment) of U-235 is not greater than 5, the concentration value for a 40-hour workweek 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 8E-3 (SA) µCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U U-depleted

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col.2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentration (µCi/ml)

$SA = [0.4 + 0.38 (enrichment) + 0.0034 (enrichment)^2] E-6$, enrichment > 0.72

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

NOTE:

1. If the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.

2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture; or

+If it is known that Ac-227-D and Cm-250-W are not present	-	7E-4	3E-13	-	-	-
If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present	-	7E-3	3E-12	-	-	-
If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228-W,Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-254-W,Y are not present	-	7E-2	3E-11	-	-	-
If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present	-	7E-1	3E-10	-	-	-
If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D,W, La-138-D, Lu-176-W, Hf-178m-D,W, Hf-182-D,W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D,W,Y, Pa-230-W,Y, U-233-D,W, U-234-D,W, U-235-D,W, U-236-D,W, U-238-D,W, Pu-241-Y, Bk-249-W, Cf-253-W,Y, and Es-253-W are not present	-	7E+0	3E-9	-	-	-
If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th-232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present	-	-	1E-14	-	-	-
If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y	-	-	-	1E-13	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values Col. 1 Oral Ingestion ALI (µCi)	Table I Occupational Values Col. 2 Inhalation ALI (µCi)	Table I Occupational Values Col. 3 Inhalation DAC (µCi/ml)	Table II Effluent Concentrations Col. 1 Air (µCi/ml)	Table II Effluent Concentrations Col.2 Water (µCi/ml)	Table III Release to Sewers Monthly Average Concentration (µCi/ml)
are not present								
If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not Present			-	-	-	1E-12	-	-
If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present			-	-	-	-	1E-6	1E-5

3. If a mixture of radionuclides consists of uranium and its daughters in ore dust (10 µm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture: 6E-11 µCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 µCi of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.

4. If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in 180 NAC Appendix 4-B for the specific radionuclide when not in a mixture. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., "unity").

   Example: If radionuclides "A," "B," and "C" are present in concentrations CA, CB, and CC, and if the applicable DACs are DAC_A, DAC_B, and DAC_C, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{CA}{DACA} + \frac{CB}{DACB} + \frac{CC}{DACC} < 1$$

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Hydrogen-3	1,000	Manganese-56	1,000
Beryllium-7	1,000	Iron-52	100
Beryllium-10	1	Iron-55	100
Carbon-11	1,000	Iron-59	10
Carbon-14	100	Iron-60	1
Fluorine-18	1,000	Cobalt-55	100
Sodium-22	10	Cobalt-56	10
Sodium-24	100	Cobalt-57	100
Magnesium-28	100	Cobalt-58m	1,000
Aluminum-26	10	Cobalt-58	100
Silicon-31	1,000	Cobalt-60m	1,000
Silicon-32	1	Cobalt-60	1
Phosphorus-32	10	Cobalt-61	1,000
Phosphorus-33	100	Cobalt-62m	1,000
Sulfur-35	100	Nickel-56	100
Chlorine-36	10	Nickel-57	100
Chlorine-38	1,000	Nickel-59	100
Chlorine-39	1,000	Nickel-63	100
Argon-39	1,000	Nickel-65	1,000
Argon-41	1,000	Nickel-66	10
Potassium-40	100	Copper-60	1,000
Potassium-42	1,000	Copper-61	1,000
Potassium-43	1,000	Copper-64	1,000
Potassium-44	1,000	Copper-67	1,000
Potassium-45	1,000	Zinc-62	100
Calcium-41	100	Zinc-63	1,000
Calcium-45	100	Zinc-65	10
Calcium-47	100	Zinc-69m	100
Scandium-43	1,000	Zinc-69	1,000
Scandium-44m	100	Zinc-71m	1,000
Scandium-44	100	Zinc-72	100
Scandium-46	10	Gallium-65	1,000
Scandium-47	100	Gallium-66	100
Scandium-48	100	Gallium-67	1,000
Scandium-49	1,000	Gallium-68	1,000
Titanium-44	1	Gallium-70	1,000
Titanium-45	1,000	Gallium-72	100
Vanadium-47	1,000	Gallium-73	1,000
Vanadium-48	100	Germanium-66	1,000
Vanadium-49	1,000	Germanium-67	1,000
Chromium-48	1,000	Germanium-68	10
Chromium-49	1,000	Germanium-69	1,000
Chromium-51	1,000	Germanium-71	1,000
Manganese-51	1,000	Germanium-75	1,000
Manganese-52m	1,000	Germanium-77	1,000
Manganese-52	100	Germanium-78	1,000
Manganese-53	1,000	Arsenic-69	1,000
Manganese-54	100	Arsenic-70	1,000

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Arsenic-71	100	Strontium-85m	1,000
Arsenic-73	100	Strontium-85	100
Arsenic-74	100	Strontium-87m	1,000
Arsenic-76	100	Strontium-89	10
Arsenic-77	100	Strontium-90	0.1
Arsenic-78	1,000	Strontium-91	100
Selenium-70	1,000	Strontium-92	100
Selenium-73m	1,000	Yttrium-86m	1,000
Selenium-73	100	Yttrium-86	100
Selenium-75	100	Yttrium-87	100
Selenium-79	100	Yttrium-88	10
Selenium-81m	1,000	Yttrium-90m	1,000
Selenium-81	1,000	Yttrium-90	10
Selenium-83	1,000	Yttrium-91m	1,000
Bromine-74m	1,000	Yttrium-91	10
Bromine-74	1,000	Yttrium-92	100
Bromine-75	1,000	Yttrium-93	100
Bromine-76	100	Yttrium-94	1,000
Bromine-77	1,000	Yttrium-95	1,000
Bromine-80m	1,000	Zirconium-86	100
Bromine-80	1,000	Zirconium-88	10
Bromine-82	100	Zirconium-89	10
Bromine-83	1,000	Zirconium-93	1
Bromine-84	1,000	Zirconium-95	10
Krypton-74	1,000	Zirconium-97	100
Krypton-76	1,000	Niobium-88	1,000
Krypton-77	1,000	Niobium-89 (66 min)	1,000
Krypton-79	1,000	Niobium-89 (122 min)	1,000
Krypton-81	1,000	Niobium-90	100
Krypton-83m	1,000	Niobium-93m	10
Krypton-85m	1,000	Niobium-94	1
Krypton-85	1,000	Niobium-95m	100
Krypton-87	1,000	Niobium-95	100
Krypton-88	1,000	Niobium-96	100
Rubidium-79	1,000	Niobium-97	1,000
Rubidium-81m	1,000	Niobium-98	1,000
Rubidium-81	1,000	Molybdenum-90	100
Rubidium-82m	1,000	Molybdenum-93m	100
Rubidium-83	100	Molybdenum-93	10
Rubidium-84	100	Molybdenum-99	100
Rubidium-86	100	Molybdenum-101	1,000
Rubidium-87	100	Technetium-93m	1,000
Rubidium-88	1,000	Technetium-93	1,000
Rubidium-89	1,000	Technetium-94m	1,000
Strontium-80	100	Technetium-94	1,000
Strontium-81	1,000	Technetium-96m	1,000
Strontium-83	100	Technetium-96	100
Strontium-83	100	Technetium-97m	100

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Technetium-97	1,000	Indium-109	1,000
Technetium-98	10	Indium-110 (69.1m)	1,000
Technetium-99m	1,000	Indium-110 (4.9h)	1,000
Technetium-99	100	Indium-111	100
Technetium-101	1,000	Indium-112	1,000
Technetium-104	1,000	Indium-113m	1,000
Ruthenium-94	1,000	Indium-114m	10
Ruthenium-97	1,000	Indium-115m	1,000
Ruthenium-103	100	Indium-115	100
Ruthenium-105	1,000	Indium-116m	1,000
Ruthenium-106	1	Indium-117m	1,000
Rhodium-99m	1,000	Indium-117	1,000
Rhodium-99	100	Indium-119m	1,000
Rhodium-100	100	Tin-110	100
Rhodium-101m	1,000	Tin-111	1,000
Rhodium-101	10	Tin-113	100
Rhodium-102m	10	Tin-117m	100
Rhodium-102	10	Tin-119m	100
Rhodium-103m	1,000	Tin-121m	100
Rhodium-105	100	Tin-121	1,000
Rhodium-106m	1,000	Tin-123m	1,000
Rhodium-107	1,000	Tin-123 10	
Palladium-100	100	Tin-125 10	
Palladium-101	1,000	Tin-126 10	
Palladium-103	100	Tin-127	1,000
Palladium-107	10	Tin-128	1,000
Palladium-109	100	Antimony-115	1,000
Silver-102	1,000	Antimony-116m	1,000
Silver-103	1,000	Antimony-116	1,000
Silver-104m	1,000	Antimony-117	1,000
Silver-104	1,000	Antimony-118m	1,000
Silver-105	100	Antimony-119	1,000
Silver-106m	100	Antimony-120 (16min.)	1,000
Silver-106	1,000	Antimony-120 (5.76d)	100
Silver-108m	1	Antimony-122	100
Silver-110m	10	Antimony-124m	1,000
Silver-111	100	Antimony-124	10
Silver-112	100	Antimony-125	100
Silver-115	1,000	Antimony-126m	1,000
Cadmium-104	1,000	Antimony-126	100
Cadmium-107	1,000	Antimony-127	100
Cadmium-109	1	Antimony-128 (10.4min.)	1,000
Cadmium-113m	0.1	Antimony-128 (9.01h)	100
Cadmium-113	100	Antimony-129	100
Cadmium-115m	10	Antimony-130	1,000
Cadmium-115	100	Antimony-131	1,000
Cadmium-117m	1,000	Tellurium-116	1,000
Cadmium-117	1,000	Tellurium-121m	10

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Tellurium-121	100	Cesium-132	100
Tellurium-123m	10	Cesium-134m	1,000
Tellurium-123	100	Cesium-134	10
Tellurium-125m	10	Cesium-135m	1,000
Tellurium-127m	10	Cesium-135	100
Tellurium-127	1,000	Cesium-136	10
Tellurium-129m	10	Cesium-137	10
Tellurium-129	1,000	Cesium-138	1,000
Tellurium-131m	10	Barium-126	1,000
Tellurium-131	100	Barium-128	100
Tellurium-132	10	Barium-131m	1,000
Tellurium-133m	100	Barium-131	100
Tellurium-133	1,000	Barium-133m	100
Tellurium-134	1,000	Barium-133	100
Iodine-120m	1,000	Barium-135m	100
Iodine-120	100	Barium-139	1,000
Iodine-121	1,000	Barium-140	100
Iodine-123	100	Barium-141	1,000
Iodine-124	10	Barium-142	1,000
Iodine-125	1	Lanthanum-131	1,000
Iodine-126	1	Lanthanum-132	100
Iodine-128	1,000	Lanthanum-135	1,000
Iodine-129	1	Lanthanum-137	10
Iodine-130	10	Lanthanum-138	100
Iodine-131	1	Lanthanum-140	100
Iodine-132m	100	Lanthanum-141	100
Iodine-132	100	Lanthanum-142	1,000
Iodine-133	10	Lanthanum-143	1,000
Iodine-134	1,000	Cerium-134	100
Iodine-135	100	Cerium-135	100
Xenon-120	1,000	Cerium-137m	100
Xenon-121	1,000	Cerium-137	1,000
Xenon-122	1,000	Cerium-139	100
Xenon-123	1,000	Cerium-141	100
Xenon-125	1,000	Cerium-143	100
Xenon-127	1,000	Cerium-144	1
Xenon-129m	1,000	Praseodymium-136	1,000
Xenon-131m	1,000	Praseodymium-137	1,000
Xenon-133m	1,000	Praseodymium-138m	1,000
Xenon-133	1,000	Praseodymium-139	1,000
Xenon-135m	1,000	Praseodymium-142m	1,000
Xenon-135	1,000	Praseodymium-142	100
Xenon-138	1,000	Praseodymium-143	100
Cesium-125	1,000	Praseodymium-144	1,000
Cesium-127	1,000	Praseodymium-145	100
Cesium-129	1,000	Praseodymium-147	1,000
Cesium-130	1,000	Neodymium-136	1,000
Cesium-131	1,000	Neodymium-138	100

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Neodymium-139m	1,000	Gadolinium-153	10
Neodymium-139	1,000	Gadolinium-159	100
Neodymium-141	1,000	Terbium-147	1,000
Neodymium-147	100	Terbium-149	100
Neodymium-149	1,000	Terbium-150	1,000
Neodymium-151	1,000	Terbium-151	100
Promethium-141	1,000	Terbium-153	1,000
Promethium-143	100	Terbium-154	100
Promethium-144	10	Terbium-155	1,000
Promethium-145	10	Terbium-156m (5.0h)	1,000
Promethium-146	1	Terbium-156m (24.4h)	1,000
Promethium-147	10	Terbium-156	100
Promethium-148m	10	Terbium-157	10
Promethium-148	10	Terbium-158	1
Promethium-149	100	Terbium-160	10
Promethium-150	1,000	Terbium-161	100
Promethium-151	100	Dysprosium-155	1,000
Samarium-141m	1,000	Dysprosium-157	1,000
Samarium-141	1,000	Dysprosium-159	100
Samarium-142	1,000	Dysprosium-165	1,000
Samarium-145	100	Dysprosium-166	100
Samarium-146	1	Holmium-155	1,000
Samarium-147	100	Holmium-157	1,000
Samarium-151	10	Holmium-159	1,000
Samarium-153	100	Holmium-161	1,000
Samarium-155	1,000	Holmium-162m	1,000
Samarium-156	1,000	Holmium-162	1,000
Europium-145	100	Holmium-164m	1,000
Europium-146	100	Holmium-164	1,000
Europium-147	100	Holmium-166m	1
Europium-148	10	Holmium-166	100
Europium-149	100	Holmium-167	1,000
Europium-150 (12.62h)	100	Erbium-161	1,000
Europium-150 (34.2y)	1	Erbium-165	1,000
Europium-152m	100	Erbium-169	100
Europium-152	1	Erbium-171	100
Europium-154	1	Erbium-172	100
Europium-155	10	Thulium-162	1,000
Europium-156	100	Thulium-166	100
Europium-157	100	Thulium-167	100
Europium-158	1,000	Thulium-170	10
Gadolinium-145	1,000	Thulium-171	10
Gadolinium-146	10	Thulium-172	100
Gadolinium-147	100	Thulium-173	100
Gadolinium-148	0.001	Thulium-175	1,000
Gadolinium-149	100	Ytterbium-162	1,000
Gadolinium-151	10	Ytterbium-166	100
Gadolinium-152	100	Ytterbium-167	1,000

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Ytterbium-169	100	Tungsten-177	1,000
Ytterbium-175	100	Tungsten-178	1,000
Ytterbium-177	1,000	Tungsten-179	1,000
Ytterbium-178	1,000	Tungsten-181	1,000
Lutetium-169	100	Tungsten-185	100
Lutetium-170	100	Tungsten-187	100
Lutetium-171	100	Tungsten-188	10
Lutetium-172	100	Rhenium-177	1,000
Lutetium-173	10	Rhenium-178	1,000
Lutetium-174m	10	Rhenium-181	1,000
Lutetium-174	10	Rhenium-182 (12.7h)	1,000
Lutetium-176m	1,000	Rhenium-182 (64.0h)	100
Lutetium-176	100	Rhenium-184m	10
Lutetium-177m	10	Rhenium-184	100
Lutetium-177	100	Rhenium-186m	10
Lutetium-178m	1,000	Rhenium-186	100
Lutetium-178	1,000	Rhenium-187	1,000
Lutetium-179	1,000	Rhenium-188m	1,000
Hafnium-170	100	Rhenium-188	100
Hafnium-172	1	Rhenium-189	100
Hafnium-173	1,000	Osmium-180	1,000
Hafnium-175	100	Osmium-181	1,000
Hafnium-177m	1,000	Osmium-182	100
Hafnium-178m	0.1	Osmium-185	100
Hafnium-179m	10	Osmium-189m	1,000
Hafnium-180m	1,000	Osmium-191m	1,000
Hafnium-181	10	Osmium-191	100
Hafnium-182m	1,000	Osmium-193	100
Hafnium-182	0.1	Osmium-194	1
Hafnium-183	1,000	Iridium-182	1,000
Hafnium-184	100	Iridium-184	1,000
Tantalum-172	1,000	Iridium-185	1,000
Tantalum-173	1,000	Iridium-186	100
Tantalum-174	1,000	Iridium-187	1,000
Tantalum-175	1,000	Iridium-188	100
Tantalum-176	100	Iridium-189	100
Tantalum-177	1,000	Iridium-190m	1,000
Tantalum-178	1,000	Iridium-190	100
Tantalum-179	100	Iridium-192 (73.8d)	1
Tantalum-180m	1,000	Iridium-192m (1.4min.)	10
Tantalum-180	100	Iridium-194m	10
Tantalum-182m	1,000	Iridium-194	100
Tantalum-182	10	Iridium-195m	1,000
Tantalum-183	100	Iridium-195	1,000
Tantalum-184	100	Platinum-186	1,000
Tantalum-185	1,000	Platinum-188	100
Tantalum-186	1,000	Platinum-189	1,000
Tungsten-176	1,000	Platinum-191	100

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Platinum-193m	100	Lead-212	1
Platinum-193	1,000	Lead-214	100
Platinum-195m	100	Bismuth-200	1,000
Platinum-197m	1,000	Bismuth-201	1,000
Platinum-197	100	Bismuth-202	1,000
Platinum-199	1,000	Bismuth-203	100
Platinum-200	100	Bismuth-205	100
Gold-193	1,000	Bismuth-206	100
Gold-194	100	Bismuth-207	10
Gold-195	10	Bismuth-210m	0.1
Gold-198m	100	Bismuth-210	1
Gold-198	100	Bismuth-212	10
Gold-199	100	Bismuth-213	10
Gold-200m	100	Bismuth-214	100
Gold-200	1,000	Polonium-203	1,000
Gold-201	1,000	Polonium-205	1,000
Mercury-193m	100	Polonium-207	1,000
Mercury-193	1,000	Polonium-210	0.1
Mercury-194	1	Astatine-207	100
Mercury-195m	100	Astatine-211	10
Mercury-195	1,000	Radon-220	1
Mercury-197m	100	Radon-222	1
Mercury-197	1,000	Francium-222	100
Mercury-199m	1,000	Francium-223	100
Mercury-203	100	Radium-223	0.1
Thallium-194m	1,000	Radium-224	0.1
Thallium-194	1,000	Radium-225	0.1
Thallium-195	1,000	Radium-226	0.1
Thallium-197	1,000	Radium-227	1,000
Thallium-198m	1,000	Radium-228	0.1
Thallium-198	1,000	Actinium-224	1
Thallium-199	1,000	Actinium-225	0.01
Thallium-200	1,000	Actinium-226	0.1
Thallium-201	1,000	Actinium-227	0.001
Thallium-202	100	Actinium-228	1
Thallium-204	100	Thorium-226	10
Lead-195m	1,000	Thorium-227	0.01
Lead-198	1,000	Thorium-228	0.001
Lead-199	1,000	Thorium-229	0.001
Lead-200	100	Thorium-230	0.001
Lead-201	1,000	Thorium-231	100
Lead-202m	1,000	Thorium-232	100
Lead-202	10	Thorium-234	10
Lead-203	1,000	Thorium-natural	100
Lead-205	100	Protactinium-227	10
Lead-209	1,000	Protactinium-228	1
Lead-210	0.01	Protactinium-230	0.1
Lead-211	100	Protactinium-231	0.001

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Protactinium-232	1	Americium-246m	1,000
Protactinium-233	100	Americium-246	1,000
Protactinium-234	100	Curium-238	100
Uranium-230	0.01	Curium-240	0.1
Uranium-231	100	Curium-241	1
Uranium-232	0.001	Curium-242	0.01
Uranium-233	0.001	Curium-243	0.001
Uranium-234	0.001	Curium-244	0.001
Uranium-235	0.001	Curium-245	0.001
Uranium-236	0.001	Curium-246	0.001
Uranium-237	100	Curium-247	0.001
Uranium-238	100	Curium-248	0.001
Uranium-239	1,000	Curium-249	1,000
Uranium-240	100	Berkelium-245	100
Uranium-natural	100	Berkelium-246	100
Neptunium-232	100	Berkelium-247	0.001
Neptunium-233	1,000	Berkelium-249	0.1
Neptunium-234	100	Berkelium-250	10
Neptunium-235	100	Californium-244	100
Neptunium-236 (1.15×10^5y)	0.001	Californium-246	1
Neptunium-236 (22.5h)	1	Californium-248	0.01
Neptunium-237	0.001	Californium-249	0.001
Neptunium-238	10	Californium-250	0.001
Neptunium-239	100	Californium-251	0.001
Neptunium-240	1,000	Californium-252	0.001
Plutonium-234	10	Californium-253	0.1
Plutonium-235	1,000	Californium-254	0.001
Plutonium-236	0.001	Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Plutonium-237	100		
Plutonium-238	0.001		
Plutonium-239	0.001		
Plutonium-240	0.001	Einsteinium-250	100
Plutonium-241	0.01	Einsteinium-251	100
Plutonium-242	0.001	Einsteinium-253	0.1
Plutonium-243	1,000	Einsteinium-254m	1
Plutonium-244	0.001	Einsteinium-254	0.01
Plutonium-245	100	Fermium-252	1
Americium-237	1,000	Fermium-253	1
Americium-238	100	Fermium-254	10
Americium-239	1,000	Fermium-255	1
Americium-240	100	Fermium-257	0.01
Americium-241	0.001	Mendelevium-257	10
Americium-242m	0.001	Mendelevium-258	0.01
Americium-242	10	Any radionuclide other than alpha-emitting radionuclides not listed above, or mixtures of beta- emitters of unknown composition	0.01
Americium-243	0.001		
Americium-244m	100		
Americium-244	10		
Americium-245	1,000		

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

*To convert μCi to kBq, multiply the μCi value by 37.

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
[1]The quantities listed above were derived by taking 1/10th of the most restrictive annual limit on intake (ALI) listed in Table I, Columns 1 and 2, of Appendix 004-B to Section 004, rounding to the nearest factor of 10, and constraining the values listed between 37 Bq and 37 MBq (0.001 and 1,000 μCi). Values of 3.7 MBq (100 μCi) have been assigned for radionuclides having a radioactive half-life in excess of 109 years, except rhenium, 37 MBq (1,000 μCi), to take into account their low specific activity.		**NOTE:** For purposes of 180 NAC 4-34.05, 4-037.01 and 4-057.01 where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" or unity.	

APPENDIX 4-D

REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE WASTE INTENDED FOR DISPOSAL AT LICENSED DISPOSAL FACILITIES AND MANIFESTS

SECTION I - MANIFEST

A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste disposal facility must prepare a Manifest reflecting information requested on the following forms, U.S. Nuclear Regulatory Commission (U.S. NRC) U.S. NRC 540, (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper) and U.S. Form NRC 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description) and if necessary, on Agency Form NRC 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation). U.S. NRC 540 and U.S. NRC 540A must be completed and must physically accompany the pertinent low-level radioactive waste shipment. Upon agreement between shipper and consignee, U.S. Forms U.S. NRC 541 and U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by the Agency to comply with the manifesting requirements of this section when they ship:

(a) Low-Level Waste for processing and expect its return (that is, for storage under their license) prior to disposal at a licensed land disposal facility;

(b) Low-Level Waste that is being returned to the licensee who is the “waste generator” or “generator,” as defined in this section; or

(c) Radioactively contaminated material to a “waste processor” that becomes the processor’s “residual waste”.

For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this appendix may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

Forms U.S. NRC 540, U.S. NRC 541, U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A and the accompanying instructions, in hard copy, may be obtained from:

Department of Health and Human Services
Division of Public Health, Radiological Health
301 Centennial Mall South
P.O. Box 95026
Lincoln, Nebraska 68509-5026

This appendix includes information requirements of the Department of Transportation, as codified in 49 CFR part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency regulations, as codified in 40 CFR parts 259, 261 or elsewhere, is not addressed in this section, and must be provided on the required EPA forms. However, the required EPA forms must accompany the Uniform Low-Level Radioactive Waste Manifest required by this section.

As used in this appendix, the following definitions apply:

CHELATING AGENT. Chelating agent has the same meaning as that given in 180 NAC 1-002.

CHEMICAL DESCRIPTION. Chemical description is a description of the principal chemical characteristics of a low-level radioactive waste.

COMPUTER-READABLE MEDIUM. The Department's computer can transfer the information from the medium into its memory is computer-readable medium.

CONSIGNEE. Consignee is the designated receiver of the shipment of low-level radioactive waste.

DECONTAMINATION FACILITY. A decontamination facility is a facility operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State or license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this section, is not considered to be a consignee for low-level waste shipments.

DISPOSAL CONTAINER. A disposal container is a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility. See "high integrity container". For some shipments the disposal container may be the transport package.

EPA IDENTIFICATION NUMBER. An EPA identification number is the number received by a transporter following application to the Administrator of the Environmental Protection Agency (EPA) as required by 40 CFR part 263.

GENERATOR. A generator is a licensee operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license who (1) is a waste generator as defined in this part, or (2) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985, waste generated as a result of decontamination or recycle activities.

HIGH INTEGRITY CONTAINER (HIC). A high integrity container (HIC) is a container commonly designed to meet the structural stability requirements of Appendix 4-E, section II 180 NAC 4, and to meet Department of Transportation requirements for a Type A package.

U.S. NRC FORMS 540, 540A, 541, 541A, 542, AND 542A. U. S. Nuclear Regulatory Commission (NRC) forms 540, 540A, 541, 542 and 542A are forms referenced in this appendix. Licensees need not use originals of these U.S. Nuclear Regulatory Commission (NRC) forms as long as any substitute forms are equivalent to the original document in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, U.S. Nuclear Regulatory Commission (NRC) forms 541, 541A, 542 and 542A may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

PACKAGE. A package is an assembly of components necessary to ensure compliance with the packaging requirements of Department of Transportation (DOT) regulations, together with its radioactive contents, as presented for transport.

PHYSICAL DESCRIPTION. A physical description is the items called for on Form U.S. Nuclear Regulatory Commission (NRC) 541 to describe a low-level radioactive waste.

RESIDUAL WASTE. Residual waste is low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

SHIPPER. A shipper is a licensed entity, the waste generator, waste collector, or waste processor, who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

SHIPPING PAPER. U.S. Nuclear Regulatory Commission (NRC) 540 and, if required form U.S. Nuclear Regulatory Commission (NRC) 540A, which includes the information required by DOT in 49 CFR part 172.

SOURCE MATERIAL. Source material has the same meaning as that given in180 NAC 1-002.

SPECIAL NUCLEAR MATERIAL. Special nuclear material has the same meaning as that given in 180 NAC 1-002.

UNIFORM LOW-LEVEL RADIOACTIVE WASTE MANIFEST OR UNIFORM MANIFEST. Uniform low-level radioactive waste manifest or uniform manifest means the combination of U.S. Nuclear Regulatory Commission (NRC) Forms 540, 541, and if necessary, 542, and their respective continuation sheets as needed, or equivalent.

WASTE COLLECTOR. A waste collector is an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed disposal facility.

WASTE DESCRIPTION. A waste description is the physical, chemical and radiological description of a low-level radioactive waste as called for on Form U.S. Nuclear Regulatory Commission (NRC) 541.

WASTE GENERATOR. A waste generator is an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, who (1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use, and (2) transfers this material or component to a licensed disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a "waste generator" if the transfer of low-level radioactive waste from its facility is defined as "residual waste."

WASTE PROCESSOR. A waste processor is an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste disposal facility.

WASTE TYPE. Waste type is a waste within a disposal container having a unique physical description that is, a specific waste descriptor code or description; or a waste absorbed on or solidified in a specifically defined media.

INFORMATION REQUIREMENTS

A. General Information

The shipper of the low-level radioactive waste must provide the following information on the uniform manifest:

1. The name, facility address, and telephone number of the licensee shipping the waste;
2. An explicit declaration indicting whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and
3. The name, address, and telephone number, or the name and Environmental Protection Agency (EPA) identification number for the carrier transporting the waste.

B. Shipment Information

The shipper of the radioactive waste must provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages/disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment.

5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in the form of special nuclear material, and the total mass of uranium and thorium in the form of source material.

C. Disposal Container and Waste Information

The shipper of the radioactive waste must provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of any high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material. For discrete waste types, activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides associated with a disposal container must be reported;
11. The total radioactivity within each container; and
12. For wastes consigned to a disposal facility, the classification of the waste pursuant to Appendix 4-E, Section I. Waste not meeting the structural stability requirements of Appendix 4-E, Section II(b) must be identified.

D. Uncontainerized Waste Information

The shipper of the radioactive waste must provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;
3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;
4. For waste consigned to a disposal facility, the classification of the waste pursuant to Appendix 4-E, Section I of 180 NAC 4. Waste not meeting the structural stability requirements of Appendix 4-E, Section II(b) of 180 NAC 4 must be identified.
5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

E. Multi-Generator Disposal Container Information

This section applies to disposal containers enclosing mixtures of waste originating from different generators. Licensees note that the origin of the low-level waste resulting from a processor's activities may be attributable to one or more "generators", including "waste generators", as defined in this section.

It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators:

1. For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.
2. For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types, activated materials, contaminated equipment, mechanical filters, sealed source or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:
   (a) The volume of waste within the disposal container;
   (b) A physical and chemical description of the waste, including the solidification agent, if any;
   (c) The total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
   (d) The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in Appendix 4-E, Section II(b) of 180 NAC 4; and
   (e) Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material if contained in the waste.

SECTION II - CERTIFICATION

An authorized representative of the waste generator, processor, or collector must certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Department. A collector in signing the certification is certifying that nothing has been done to the collected waste which would invalidate the waste generator's certification.

SECTION III - CONTROL AND TRACKING

A. Any licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector must comply with the requirements in A.1 through 9 of this section. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging of A.4 through 9 of this section. A licensee must:
   1. Prepare all wastes so that the waste is classified according to Appendix 4-E, Section I of 180 NAC 4 and meets waste characteristics requirements in Appendix 4-E, Section II of 180 NAC 4.
   2. Label each disposal container, or transport package if potential radiation hazards preclude labeling of the individual disposal container, of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, as required by Appendix 4-E, Section I of 180 NAC 4.
   3. Conduct a quality assurance program to assure compliance with Appendix 4-E, Section I and Section II of 180 NAC 4. The program must include management evaluation of audits;
   4. Prepare the Department Uniform Low-Level Radioactive Waste Manifest as required by this appendix;
   5. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
   6. Include forms U.S. Nuclear Regulatory Commission (NRC) 540 and U.S. Nuclear Regulatory Commission (NRC) 540A, if required, with the shipment regardless of the option in Paragraph A.5 of this section;
   7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record

of transfer of licensed material as required by 180 NAC 3. This includes those manifests and documents required under the standards for protection against radiation in effect prior to May 30, 1994; and

8. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Appendix 4-D of 180 NAC 4.
9. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times specified in this appendix, conduct an investigation in accordance with Paragraph E of this appendix.

B. Any waste collector licensee who handles only prepackaged waste must:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of form U.S. Nuclear Regulatory Commission (NRC) 540.
2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this appendix. The waste collector must ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;
3. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) Receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
4. Include forms U.S. Nuclear Regulatory Commission (NRC) 540 and U.S. Nuclear Regulatory Commission (NRC) 540A, if required, with the shipment regardless of the option chosen in Paragraph B.3 of this section;
5. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3, and retain information from generator manifest until the license is terminated. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994;
6. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt;
7. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times specified in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
8. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

C. Any licensed waste processor who treats or repackages waste must:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of Form U.S. Nuclear Regulatory Commission (NRC) 540;
2. Prepare a new manifest that meets the requirements of this appendix. Preparation of the new manifest reflects that the processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest must identify the waste generators, the preprocessed waste volume, and other information as required in Section I.E. of this appendix;
3. Prepare all wastes so that the waste is classified according to Appendix 4-D, Section I., paragraph E of 180 NAC 4 and meets the waste characteristics requirements in Appendix 4-E, Section II of 180 NAC 4;
4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with Appendix 4-E, Section I and Section III of 180 NAC 4;
5. Conduct a quality assurance program to assure compliance with Appendix 4-E, Sections I and II, the program must include management evaluation of audits of 180 NAC 4;
6. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
7. Include forms U.S. Nuclear Regulatory Commission (NRC) 540 and U.S. Nuclear Regulatory

Commission (NRC) 540A, if required, with the shipment regardless of the option chosen in Paragraph C.6 of this section;

8. Retain copies of the original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994; and
9. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3;
10. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times specified in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
11. Notify the shipper and the Department when any shipment, or any part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

D. The land disposal facility operator must:

1. Acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of Form U.S. NRC 540 to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the Uniform Low-Level Radioactive Waste Manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating that discrepancy.
2. Maintain copies of all completed manifests or equivalent documentation until the license is terminated. This includes those manifests or equivalent documents required under the standards for protection against radiation in effect prior to May 30, 1994.
3. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

E. Any shipments or part of a shipment for which acknowledgment is not received within the times specified in this section must:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and
2. Be traced and reported. The investigation must include tracing the shipment and filing a report with the Department. Each licensee who conducts a trace investigation must file a written report with the Department within two weeks of completion of the investigation.

APPENDIX 4-E

CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE

I. Classification of Radioactive Waste for Land Disposal

a) Considerations. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides, and their shorter-lived precursors, whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

b) Classes of waste.

1) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements specified in Section II. (a). If Class A waste also meets the stability requirements specified in Section II. (b), it is not necessary to segregate the waste for disposal.

2) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements specified in Section II.

3) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements specified in Section II.

c) Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table I, classification must be determined as follows:

1) If the concentration does not exceed 0.1 times the value in Table I, the waste is Class A.

2) If the concentration exceeds 0.1 times the value in Table I, but does not exceed the value in Table I, the waste is Class C.

3) If the concentration exceeds the value in Table I, the waste is not generally acceptable for near surface disposal.

4) For wastes containing mixtures of radionuclides listed in Table I, the total concentration must be determined by the sum of fractions rule described in Section I. (g).

Table I		
Radionuclide	**Concentration** curie/cubic meter[a]	nanocurie/gram[b]
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half-life greater than five years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100
[a]To convert the Ci/m^3 values to gigabecquerel (Gbq) per cubic meter, multiply the Ci/m^3 value by 37.		
[b]To convert the nCi/g values to becquerel (Bq) per gram, multiply the nCi/g value by 37.		

d) Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table I classification must be determined based on the concentrations shown in Table II. However, as specified in Section I. (f), if radioactive waste does not contain any nuclides listed in either Table I or II, it is Class A.

1) If the concentration does not exceed the value in Column 1, the waste is Class A.
2) If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.
3) If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.
4) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.
5) For wastes containing mixtures of the radionuclides listed in Table II, the total concentration must be determined by the sum of fractions rule described in Section I. (g).

Table II

	Concentration, curie/cubic meter*		
Radionuclide	Column 1	Column 2	Column 3
Total of all radionuclides with less than 5-year half-life	700	-----	-----
H-3	40	-----	-----
Co-60	700	-----	-----
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

*To convert the Ci/m^3 value to gigabecquerel (Gbq) per cubic meter, multiply the curies (Ci)/m^3 value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table II determine the waste to be Class C independent of these radionuclides.

e) Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table I and some of which are listed in Table II, classification must be determined as follows:
   1) If the concentration of a radionuclide listed in Table I is less than 0.1 times the value listed in Table I, the class must be that determined by the concentration of radionuclides listed in Table II.
   2) If the concentration of a radionuclide listed in Table I exceeds 0.1 times the value listed in Table I, but does not exceed the value in Table I, the waste must be Class C, provided the concentration of radionuclides listed in Table II does not exceed the value shown in Column 3 of Table II.

f) Classification of wastes with radionuclides other than those listed in Tables I and II. If the waste does not contain any radionuclides listed in either Table I or II, it is Class A.

g) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 1.85 TBq/m3 (50 Ci/m^3) and Cs-137 in a concentration of 814 GBq/m^3 (22 Ci/m^3). Since the concentrations both exceed the values in Column 1, Table II, they must be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33., for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

h) Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as becquerel (nanocurie) per

gram.

II. Radioactive Waste Characteristics

a) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and safety of personnel at the disposal site.

1) Wastes must be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of 180 NAC 4, the site license conditions shall govern.
2) Wastes must not be packaged for disposal in cardboard or fiberboard boxes.
3) Liquid waste must be packaged in sufficient absorbent material to absorb twice the volume of the liquid.
4) Solid waste containing liquid must contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.
5) Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.
6) Waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with Section II. (a)(8).
7) Waste must not be pyrophoric. Pyrophoric materials contained in wastes must be treated, prepared, and packaged to be nonflammable.1
8) Wastes in a gaseous form shall be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20µC. Total activity must not exceed 3.7 TBq (100 Ci) per container.
9) Wastes containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

b) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

1) Waste must have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.
2) Notwithstanding the provisions in Section II. (a)(3) and (4), liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.
3) Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.

III. Labeling

Each package of waste must be clearly labeled to identify whether it is Class A, Class B, or Class C waste, in accordance with Section I.

APPENDIX 4-F

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert µCi to kBq, multiply the µCi value by 37.)

Material	Microcurie
Americium-241	0.01
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
Florine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert µCi to kBq, multiply the µCi value by 37.)

Material	Microcurie
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
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

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert µCi to kBq, multiply the µCi value by 37.)

Material	Microcurie
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
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	0.01
Polonium-210	0.1
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
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	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert µCi to kBq, multiply the µCi value by 37.)

Material	Microcurie
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
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-22	1
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulfur-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

QUANTITIES FOR USE WITH DECOMMISSIONING
(To convert µCi to kBq, multiply the µCi value by 37.)

Material	Microcurie
Thallium-204	10
Thorium (natural)[1]	100
Thulium-170	10
Thulium-171	
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
Uranium (natural)[2]	100
Uranium-233	0.01
Uranium-234	0.01
Uranium-235	0.01
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
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.1
Any radionuclide other than alpha emitting Radionuclides, not listed above or mixtures of Beta emitters of unknown composition	0.1

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" is unity.

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

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

APPENDIX 4-G

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY
(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
F-18	3E-1	8
Si-31	1E-2	3E+3
Na-24	9E-4	2E-2
P-32	2	5E+1
P-33	10	3E+2
S-35	9	2E+2
Ar-41	3E-1	8
K-42	2E-2	5E-1
Ca-45	4	1E+2
Ca-47	2E-2	5E-1
Sc-46	2E-3	5E-2
Cr-51	6E-1	2E+1
Fe-59	5E-3	1E-1
Co-57	6E-2	2
Co-58	1E-2	3E-1
Zn-65	7E-3	2E-1
Ga-67	3E-1	8
Se-75	5E-2	1
Br-82	2E-3	5E-2
Rb-86	4E-2	1
Sr-85	2E-2	5E-1
Sr-89	8	2E+2
Y-90	4	1E+2
Y-91	4E-1	10
Zr-95	8E-3	2E-1
Nb-95	8E-3	2E-1
Mo-99	5E-2	1
Tc-99m	1	3E+1
Rh-106	1	3E+1
Ag-110m	2E-3	5E-2
Cd-115m	2E-1	5
In-111	9E-2	2
In-113m	9	2E+2
Sn-113	6E-2	2
Sn-119	2E+1	5E+2
Sb-124	2E-3	5E-2

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY

(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
Te-129	2E-1	5
I-123	4E-1	1E+1
I-125	7E-1	2E+1
I-131	4E-2	1
I-133	2E-2	5E-1
Xe-127	8E-2	2
Xe-133	1	3E+1
Ba-140	2E-3	5E-2
La-140	2E-3	5E-2
Ce-141	4E-1	1E+1
Ce-144	1E-3	3E-2
Pr-143	6	2E+2
Nd-147	7E-2	2
Yb-169	6E-2	2
Ir-192	1E-2	3E-1
Au-198	3E-2	8E-1
Hg-197	8E-1	2E+1
TI-201	4E-1	1E+1
Hg-203	1E-1	3

In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this Appendix must be determined as follows:

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in Appendix 004-G 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" or “unity".

Examples: If radionuclides a, b, and c are present in concentrations C_a, C_b, and C_c, and if the applicable concentrations are CL_a, CL_b, and CL_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_a/CL_a) + (C_b/CL_b) + (C_c/CL_c) < 1$$

If the total curies for radionuclides a, b, and c are represented A_a, A_b, and A_c, and the annual curie limit for each radionuclide is AL_a, AL_b, and AL_c, then the generator is limited to the following:

$$(A_a /AL_a) + (Ab/AL=) + (A_c/AL_c) < 1$$

APPENDIX 4-H

NATIONALLY TRACKED SOURCE THRESHOLDS

The Terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values are provided for practical usefulness only and are rounded after conversion.

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Actinium-227	20	540	0.2	5.4
Americium-241	60	1,600	0.6	16
Americium-241/Be	60	1,600	0.6	16
Californium-252	20	540	0.2	5.4
Cobalt-60	30	810	0.3	8.1
Curium-244	50	1,400	0.5	14
Cesium-137	100	2,700	1.0	27
Gadolinium-153	1,000	27,000	10	270
Iridum-192	80	2,200	0.8	22
Plutonium-238	60	1,600	0.6	16
Plutonium-239/Be	60	1,600	0.6	16
Polonium-210	60	1,600	0.6	16
Promethium-147	40,000	1,100,000	400	11,000
Radium-226	40	1,100	0.4	11
Selenium-75	200	5,400	2	54
Strontium-90	1,000	27,000	10	270
Thorium-228	20	540	0.2	5.4
Thorium-229	20	540	0.2	5.4
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81

PAGE______OF______

Nebraska Department of Health and Human Services, Radiological Health

CUMULATIVE OCCUPATIONAL EXPOSURE HISTORY

NRH-1
EFFECTIVE DATE November 28, 2016

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX MALE ☐ FEMALE ☐	5. DATE OF BIRTH

6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE
6. MONITORING PERIOD		7. LICENSEE OR REGISTRANT NAME		8. LICENSE OR REGISTRATION NUMBER		9. RECORD ☐ ESTIMATE ☐ NO RECORD ☐	10. ROUTINE ☐ PSE ☐
11. DDE	12. LDE	13. SDE, WB	14. SDE, ME	15. CEDE	16. CDE	17. TEDE	18. TODE

19. SIGNATURE OF MONITORED INDIVIDUAL	20. DATE SIGNED	21. CERTIFYING ORGANIZATION	22. SIGNATURE OF DESIGNEE	23. DATE SIGNED

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRH-1
(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee, registrant, or facility not licensed by the Department that provided monitoring.

8. Enter the Department license or registration number or numbers.

9. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee or registrant intends to assign the record dose on the basis of TLD results that are not yet available.

10. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE).

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ.

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the monitored individual. The signature of the monitored individual on this form indicates that the information contained on the form is complete and correct to the best of his or her knowledge.

20. Enter the date this form was signed by the monitored individual.

21. [OPTIONAL] Enter the name of the licensee, registrant or facility not licensed by the Department, providing monitoring for exposure to radiation (such as a DOE facility) or the employer if the individual is not employed by the licensee or registrant and the employer chooses to maintain exposure records for its employees.

22. [OPTIONAL] Signature of the person designated to represent the licensee, registrant or employer entered in item 21. The licensee, registrant or employer who chooses to countersign the form should have on file documentation of all the information on the Department Form Y being signed.

23. [OPTIONAL] Enter the date this form was signed by the designated representative.

Nebraska Department of Health and Human Services, Radiological Health

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

NRH-2
EFFECTIVE DATE November 28, 2016

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX MALE ____ FEMALE ____	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER(S)	9A.		9B.	
				RECORD		ROUTINE
				ESTIMATE		PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN ΦCi

DOSES (in rem)

DEEP DOSE EQUIVALENT (DDE)	11.
EYE DOSE EQUIVALENT TO THE LENS OF THE EYE (LDE)	12.
SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE,WB)	13.
SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE,ME)	14.
COMMITTED EFFECTIVE DOSE EQUIVALENT (CEDE)	15.
COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN (CDE)	16.
TOTAL EFFECTIVE DOSE EQUIVALENT (BLOCKS 11+15) (TEDE)	17.
TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN (BLOCKS 11+16) (TODE)	18.
19. COMMENTS	

20. SIGNATURE -- LICENSEE OR REGISTRANT	21. DATE PREPARED

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRH-2
(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee or registrant.

8. Enter the Department license or registration number or numbers.

9A. Place an "X" in Record or Estimate. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.

9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs.

10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-###x," for instance, Cs-137 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to Part D (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."

10D. Enter the intake of each radionuclide in ΦCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the person designated to represent the licensee or registrant.

20. Enter the date this form was prepared.

21. COMMENTS.
In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Department in reference to the exposure report.

TITLE 180 CONTROL OF RADIATION

CHAPTER 4 STANDARDS FOR PROTECTION AGAINST RADIATION

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Copies of the Code of Federal Regulations (CFR) cited in this Chapter are located at: http://www.gpoaccess.gov/cfr/index.html

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TITLE 180 CONTROL OF RADIATION

CHAPTER 4 STANDARDS FOR PROTECTION AGAINST RADIATION

4-001 SCOPE AND AUTHORITY

4-001.01 180 NAC 4 establishes standards for protection against ionizing radiation resulting from activities conducted pursuant to licenses or registrations issued by the Department. The regulations are authorized by and implement the Nebraska Radiation Control Act, Neb. Stat. Rev. §§ 71-3501 to 71-3520.

4-001.02 The requirements of 180 NAC 4 are designed to control the receipt, possession, use, transfer, and disposal of sources of radiation by any licensee or registrant so the total dose to an individual, including doses resulting from all sources of radiation other than background radiation, does not exceed the standards for protection against radiation prescribed in 180 NAC 4. However, nothing in 180 NAC 4 will be construed as limiting actions that may be necessary to protect health and safety.

4-001.03 Except as specifically provided in other Chapters of Title 180, 180 NAC 4 applies to persons licensed or registered by the Department to receive, possess, use, transfer, or dispose of sources of radiation. The limits in 180 NAC 4 do not apply to doses due to background radiation, to exposure of patients to radiation for the purpose of medical diagnosis or therapy, to exposure from individuals administered radioactive material and released in accordance with 180 NAC 7-037 or to voluntary participation in medical research programs.

4-001.04 40 CFR as published on July 1, 2013 and 49 CFR as published October 1, 2013 and referred throughout this Chapter are herein incorporated by reference and available for viewing at the Nebraska Department of Health and Human Services, Radiological Health, 301 Centennial Mall South, 3rd Floor, Lincoln, Nebraska 68509.

4-001.05 National Council on Radiation Protection and Measurement (NRCP) 116, International Commission on Radiological Protection (ICRP) 23 and Compressed Gas Association Publication G7.1 as referred to in this Chapter are herein incorporated by reference and available for viewing at the Nebraska Department of Health and Human Services, Radiological Health, 301 Centennial Mall South, 3rd Floor, Lincoln, Nebraska 68509.

4-002 DEFINITIONS

Air-purifying respirator means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Annual limit on intake (ALI) means the derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of 0.05 Sv (5 rem) or a committed dose equivalent of 0.5 Sv (50 rem) to

any individual organ or tissue. ALI values for intake by ingestion and by inhalation of selected radionuclides are given in Table I, Columns 1 and 2, of Appendix 180 NAC 4-B.

Assigned protection factor (APF) means the expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF.

Atmosphere-supplying respirator means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Class means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times: for Class D (Days) of less than 10 days, for Class W (Weeks) from 10 to 100 days, and for Class Y (Years) of greater than 100 days. For purposes of these regulations, "lung class" and "inhalation class" are equivalent terms.

Declared pregnant woman means a woman who has voluntarily informed the licensee, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing or is no longer pregnant.

Demand respirator means an atmosphere-supplying respirator that admits breathing air to the face piece only when a negative pressure is created inside the face piece by inhalation.

Derived air concentration (DAC) means the concentration of a given radionuclide in air which, if breathed by the reference man for working year of 2,000 hours under conditions of light work, (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in Table I, Column 3, of Appendix 180 NAC 4-B.

Derived air concentration-hour (DAC-hour) means the product of the concentration of radioactive material in air, expressed as a fraction or multiple of the derived air concentration for each radionuclide, and the time of exposure to that radionuclide, in hours. A licensee or registrant may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of 0.05 Sv (5 rem).

Disposable respirator means a respirator for which maintenance is not intended and that is designed to be discarded after excessive breathing resistance, sorbent exhaustion, physical damage, or end-of-service-life renders it unsuitable for use. Examples of this type of respirator are a disposable half-mask respirator or a disposable escape-only self-contained breathing apparatus (SCBA).

Dose *or* radiation dose is a generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined in other paragraphs of this section.

Dosimetry processor means an individual or an organization that processes and evaluates individual monitoring devices in order to determine the radiation dose delivered to the monitoring devices.

Filtering facepiece (dust mask) means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps.

Fit factor means a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit test means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

Helmet means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

Hood means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

Inhalation class [See "Class"].

Loose-fitting facepiece means a respiratory inlet covering that is designed to form a partial seal with the face.

Lung class [See "Class"].

Negative pressure respirator (tight fitting) means a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Nonstochastic effect means a health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect. For purposes of these regulations, a "deterministic effect" is an equivalent term.

Planned special exposure means an infrequent exposure to radiation, separate from and in addition to the annual occupational dose limits.

Positive pressure respirator means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Powered air-purifying respirator (PAPR) means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Pressure-demand respirator means a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece

by inhalation.

Qualitative fit test (QLFT) means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

Quantitative fit test (QNFT) means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Quarter means a period of time equal to one-fourth of the year observed by the licensee or registrant, approximately 13 consecutive weeks, providing that the beginning of the first quarter in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

Reference man means a hypothetical aggregation of human physical and physiological characteristics determined by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base. A description of the Reference Man is contained in the International Commission on Radiological Protection Report, ICRP Publication 23, "Report of the Task Group on Reference Man."

Respiratory protective equipment means an apparatus, such as a respirator, used to reduce an individual's intake of airborne radioactive materials.

Sanitary sewerage means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by the licensee.

Self-contained breathing apparatus (SCBA) means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Stochastic effect means a health effect that occurs randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

Supplied-air respirator (SAR) *or* airline respirator means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Tight-fitting facepiece means a respiratory inlet covering that forms a complete seal with the face.

User seal check (fit check) means an action conducted by the respirator user to determine if the respirator is properly seated to the face. Examples include negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.

Very high radiation area means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in

excess of 5 Gy (500 rad) in 1 hour at 1 meter from a radiation source or 1 meter from any surface that the radiation penetrates.[1]

Weighting factor w_T for an organ or tissue (T) means the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly. For calculating the effective dose equivalent, the values of w_T are:

ORGAN DOSE WEIGHTING FACTORS	
Organ or Tissue	w_T
Gonads	0.25
Breast	0.15
Red Bone Marrow	0.12
Lung	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder	0.30[a]
Whole Body	1.00[b]

[a] 0.30 results from 0.06 for each of 5 "remainder" organs, excluding the skin and the lens of the eye, that receive the highest doses.

[b] For the purpose of weighting the external whole body dose, for adding it to the internal dose, a single weighting factor, $w_T = 1.0$, has been specified. The use of other weighting factors for external exposure will be approved on a case-by-case basis until such time as specific guidance is issued.

4-003 IMPLEMENTATION

4-003.01 Any existing license condition that is more restrictive than 180 NAC 4 remains in force until there is an amendment or renewal of the license.

4-003.02 If a license condition exempts a licensee from a provision of 180 NAC 4 in effect on or before May 30, 1994, it also exempts the licensee from the corresponding provision of 180 NAC 4.

[1] At very high doses received at high dose rates, units of absorbed dose, gray and rad, are appropriate, rather than units of dose equivalent, sievert and rem.

4-003.03 If a license condition cites provisions of 180 NAC 4 in effect prior to May 30, 1994, which do not correspond to any provisions of 180 NAC 4, the license condition remains in force until there is an amendment or renewal of the license that modifies or removes this condition.

RADIATION PROTECTION PROGRAMS Removed.

4-004 RADIATION PROTECTION PROGRAMS

4-004.01 Each licensee or registrant must develop, document, and implement a radiation protection program sufficient to ensure compliance with the provisions of 180 NAC 4. See 180 NAC 4-047 for recordkeeping requirements relating to these programs.

4-004.02 The licensee or registrant must use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and public doses that are as low as is reasonably achievable (ALARA).

4-004.03 The licensee or registrant must, at intervals not to exceed 12 months, review the radiation protection program content and implementation.

4-004.04 To implement the ALARA requirements of 180 NAC 4-004.02 and notwithstanding the requirements in 180 NAC 4-013, a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters must be established by licensees, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 0.1 mSv (10 mrem) per year from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee must report the exceedance as provided in 180 NAC 4-059 and promptly take appropriate corrective action to ensure against a recurrence.

OCCUPATIONAL DOSE LIMITS Removed.

4-005 OCCUPATIONAL DOSE LIMITS FOR ADULTS

4-005.01 The licensee or registrant must control the occupational dose to individual adults, except for planned special exposures pursuant to 180 NAC 4-010, to the following dose limits:

1. An annual limit, which is the more limiting of:

   a. The total effective dose equivalent being equal to 0.05 Sv (5 rem); or
   b. The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 0.5 Sv (50 rem).

2. The annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:

   a. A lens dose equivalent of 0.15 Sv (15 rem), and

b. A shallow dose equivalent of 0.5 Sv (50 rem) to the skin of the whole body or to the skin of any extremity.

4-005.02 Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year and during the individual's lifetime. See 4-010 item 5.a. and 5.b.

4-005.03

1. When the external exposure is determined by measurement with an external personal monitoring device, the deep-dose equivalent must be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the U.S. Nuclear Regulatory Commission. The assigned deep-dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow-dose equivalent must be the dose averaged over the contiguous 10 square centimeters of skin receiving the highest exposure. The deep-dose equivalent, lens dose equivalent, and shallow-dose equivalent may be assessed from surveys or other radiation measurements for the purpose of demonstrating compliance with the occupational dose limits, if the individual monitoring device was not in the region of highest potential exposure, or the results of individual monitoring are unavailable.

2. When a protective apron is worn while working with medical fluoroscopic equipment and monitoring is conducted as specified in 180 NAC 4-022.01, item 5, the effective dose equivalent for external radiation must be determined as follows:

   a. When only one individual monitoring device is used and it is located at the neck (collar) outside the protective apron, the reported deep dose equivalent must be the effective dose equivalent for external radiation; or
   b. When only one individual monitoring device is used and it is located at the neck (collar) outside the protective apron, and the reported dose exceeds 25% of the limit specified in 180 NAC 4-005.01, the reported deep dose equivalent value multiplied by 0.3 must be the effective dose equivalent for external radiation; or
   c. When individual monitoring devices are worn, both under the protective apron at the waist and outside the protective apron at the neck, the effective dose equivalent for external radiation must be assigned the value of the sum of the deep dose equivalent reported for the individual monitoring device located at the waist under the protective apron multiplied by 1.5 and the deep dose equivalent reported for the individual monitoring device located at the neck outside the protective apron multiplied by 0.04

4-005.04 Derived air concentration (DAC) and annual limit on intake (ALI) values are presented in Table I of Appendix 180 NAC 4-B and may be used to determine the individual's dose and to demonstrate compliance with the occupational dose limits. See180 NAC 4-052.

4-005.05 Notwithstanding the annual dose limits, the licensee must limit the soluble uranium intake by an individual to 10 milligrams in a week in consideration of chemical toxicity. See footnote 3 of Appendix 180 NAC 4-B.

4-005.06 The licensee or registrant must reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person. See180 NAC 4-009.05.

4-006 COMPLIANCE WITH REQUIREMENTS FOR SUMMATION OF EXTERNAL AND INTERNAL DOSES

4-006.01 If the licensee is required to monitor pursuant to both 180 NAC 4-022.01 and 4-022.02, the licensee must demonstrate compliance with the dose limits by summing external and internal doses. If the licensee or registrant is required to monitor only pursuant to 180 NAC 4-022.01 or only pursuant to 180 NAC 4-022.02 then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses pursuant to 180 NAC 4-006.02 through 4-006.04. The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

4-006.02 Intake by Inhalation. If the only intake of radionuclides is by inhalation, the total effective dose equivalent limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

1. The sum of the fractions of the inhalation ALI for each radionuclide, or
2. The total number of derived air concentration-hours (DAC-hours) for all radionuclides divided by 2,000, or
3. The sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this requirement, an organ or tissue is deemed to be significantly irradiated if, for that organ or tissue, the product of the weighting factors, w_T, and the committed dose equivalent, $H_{T,50}$, per unit intake is greater than 10% of the maximum weighted value of $H_{T,50}$, (i.e., $w_T H_{T,50}$,) per unit intake for any organ or tissue.

4-006.03 Intake by Oral Ingestion. If the occupationally exposed individual also receives an intake of radionuclides by oral ingestion greater than 10% of the applicable oral ALI, the licensee or registrant must account for this intake and include it in demonstrating compliance with the limits.

4-006.04 Intake through Wounds or Absorption through Skin. The licensee or registrant must evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin has been included in the calculation of DAC for hydrogen-3 and does not need to be evaluated or accounted for pursuant to 180 NAC 4-006.04.

4-007 DETERMINATION OF EXTERNAL DOSE FROM AIRBORNE RADIOACTIVE MATERIAL

4-007.01 Licensees must, when determining the dose from airborne radioactive material, include the contribution to the deep dose equivalent, lens dose equivalent, and shallow dose equivalent from external exposure to the radioactive cloud. See Appendix 180 NAC 4-B, footnotes 1 and 2.

4-007.02 Airborne radioactivity measurements and DAC values must not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep dose equivalent to an individual must be based upon measurements using instruments or individual monitoring devices.

4-008 DETERMINATION OF INTERNAL EXPOSURE

4-008.01 For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, the licensee must, when required under 180 NAC 4-022 take suitable and timely measurements of:

1. Concentrations of radioactive materials in air in work areas; or
2. Quantities of radionuclides in the body; or
3. Quantities of radionuclides excreted from the body; or
4. Combinations of these measurements.

4-008.02 Unless respiratory protective equipment is used, as provided in 180 NAC 4-028 or the assessment of intake is based on bioassays, the licensee must assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

4-008.03 When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior or the material in an individual is known, the licensee may:

1. Use that information to calculate the committed effective dose equivalent, and, if used, the licensee must document that information in the individual's record; and
2. Upon prior approval of the Department, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and
3. Separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide to the committed effective dose equivalent. See Appendix 180 NAC 4-B.

4-008.04 If the licensee chooses to assess intakes of Class Y material using the measurements given in 180 NAC 4-008.01, item 2 or 3, the licensee may delay the recording and reporting of the assessments for periods up to seven months, unless

otherwise required by 180 NAC 4-058 or 4-059. This delay permits the licensee to make additional measurements basic to the assessments.

4-008.05 If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours must be either:

1. The sum of the ratios of the concentration to the appropriate DAC value, (for example, D, W, or Y) from Appendix 180 NAC 4-B for each radionuclide in the mixture; or
2. The ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

4-008.06 If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture must be the most restrictive DAC of any radionuclide in the mixture.

4-008.07 When a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

1. The licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in 180 NAC 4-005 and in complying with the monitoring requirements in 180 NAC 4-022, and
2. The concentration of any radionuclide disregarded is less than 10% of its DAC, and
3. The sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30%.

4-008.08 When determining the committed effective dose equivalent, the following information may be considered:

1. In order to calculate the committed effective dose equivalent, the licensee may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of 0.05 Sv (5 rem) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent.

2. For an ALI (and the associated DAC) determined by the nonstochastic organ dose limit of 0.5 Sv (50 rem), the intake of radionuclides that would result in a committed effective dose equivalent of 0.05 Sv (5 rem), (the stochastic ALI) is listed in parentheses in Table I of Appendix 180 NAC 4-B. The licensee may, as a simplifying assumption, use the stochastic ALI to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALI, the licensee must also demonstrate that the limit in 180 NAC 4-005.01, item 1.b. is met.

4-009 DETERMINATION OF PRIOR OCCUPATIONAL DOSE

4-009.01 For each individual who may enter the licensee's or registrant's restricted area and is likely to receive, in a year, an occupational dose requiring monitoring pursuant to 180 NAC 4-022, the licensee or registrant must:

1. Determine the occupational radiation dose received during the current year; and
2. Attempt to obtain the records of cumulative occupational radiation dose.

4-009.02 Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant must determine:

1. The internal and external doses from all previous planned special exposures; and
2. All doses in excess of the limits (including doses received during accidents and emergencies) received during the lifetime of the individual.

4-009.03 In complying with the requirements of 180 NAC 4-009.01, a licensee or registrant may:

1. Accept, as a record of the occupational dose that the individual received during the current year, a written signed statement from the individual, or from the individual's most recent employer for work involving radiation exposure, that discloses the nature and the amount of any occupational dose that the individual received during the current year;
2. Accept, as the record of cumulative radiation dose, an up-to-date Department Form NRH-1, or equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee or registrant; and
3. Obtain reports of the individual's dose equivalent from the most recent employer for work involving radiation exposure, or the individual's current employer, if the individual is not employed by the licensee or registrant, by telephone, telegram, electronic media, or letter. The licensee or registrant must request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

4-009.04 The licensee or registrant must record the exposure history, as required by 180 NAC 4-009.01, on Department Form NRH-1, or other clear and legible record, including all of the information required on that form.

1. The form or record must show each period in which the individual received occupational exposure to radiation or radioactive material and must be signed by the individual who received the exposure. For each period for which the licensee or registrant obtains reports, the licensee or registrant must use the dose shown in the report in preparing Department Form NRH-1 or equivalent. For any period in which the licensee or registrant does not obtain a report, the licensee or registrant must place a notation on Department Form NRH-1 indicating the periods of time for which data are not available.

2. Licensees or registrants are not required to partition historical dose between external dose equivalent(s) and internal committed dose equivalent(s). Further, occupational exposure histories obtained and recorded on Department Form NRH-1 before the May 30, 1994, might not have included effective dose equivalent, but may be used in the absence of specific information on the intake of radionuclides by the individual.

4-009.05 If the licensee or registrant is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee or registrant must assume:

1. In establishing administrative controls under 180 NAC 4-005.06 for the current year, that the allowable dose limit for the individual is reduced by 12.5 mSv (1.25 rem) for each quarter for which records were unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and
2. That the individual is not available for planned special exposures.

4-009.06 The licensee or registrant must retain the records on Department Form NRH-1 or equivalent until the Department terminates each pertinent license or registration requiring this record. The licensee or registrant must retain records used in preparing Department Form NRH-1 or equivalent for three years after the record is made. This includes records required under the standards for protection against radiation in effect prior to May 30, 1994.

4-010 PLANNED SPECIAL EXPOSURES: A licensee or registrant may authorize an adult worker to receive doses in addition to and accounted for separately from the doses received under the limits specified in 180 NAC 4-005 provided that each of the following conditions is satisfied:

1. The licensee or registrant authorizes a planned special exposure only in an exceptional situation when alternatives that might avoid the dose estimated to result from the planned special exposure are unavailable or impractical.
2. The licensee or registrant, and employer if the employer is not the licensee or registrant, specifically authorizes the planned special exposure, in writing, before the exposure occurs.
3. Before a planned special exposure, the licensee or registrant ensures that each individual involved is:

   a. Informed of the purpose of the planned operation; and
   b. Informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and
   c. Instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present.

4. Prior to permitting an individual to participate in a planned special exposure, the licensee or registrant ascertains prior doses as required by 180 NAC 4-009.02 during the lifetime of the individual for each individual involved.

5. Subject to 180 NAC 4-005.02, the licensee or registrant must not authorize a planned special exposure that would cause an individual to receive a dose from all planned special exposures and all doses in excess of the limits to exceed:

   a. The numerical values of any of the dose limits in 180 NAC 4-005.01 in any year; and
   b. Five times the annual dose limits in 180 NAC 4-005.01 during the individual's lifetime.

6. The licensee or registrant maintains records of the conduct of a planned special exposure in accordance with 180 NAC 4-051 and submits a written report in accordance with 180 NAC 4-060.
7. The licensee or registrant records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposures must not be considered in controlling future occupational dose of the individual pursuant to 180 NAC 4-005.01 but must be included in evaluations required by 180 NAC 4-010.04 and 4-010.05.

4-011 OCCUPATIONAL DOSE LIMITS FOR MINORS: The annual occupational dose limits for minors are 10% of the annual occupational dose limits specified for adult workers in 180 NAC 4-005.

4-012 DOSE EQUIVALENT TO AN EMBRYO/FETUS

4-012.01 The licensee or registrant must ensure that the dose equivalent to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 5 mSv (0.5 rem). See 180 NAC 4-052 for record keeping requirements.

4-012.02 The licensee or registrant must make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in 180 NAC 4-012.01.[2]

4-012.03 The dose equivalent to an embryo/fetus is the sum of:

1. The deep dose equivalent to the declared pregnant woman; and
2. The equivalent dose to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

4-012.04 If the dose equivalent to the embryo/fetus is found to have exceeded 5 mSv (0.5 rem), or is within 0.5 mSv (0.05 rem) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee or registrant must be deemed to be in compliance

[2]The National Council on Radiation Protection and Measurements recommended in NCRP Report No. 91 "Recommendations on Limits for Exposure to Ionizing Radiation" (June 1, 1987) that no more than 0.5 mSv (0.05 rem) to the embryo\fetus be received in any one month. Removed

with 180 NAC 4-012.01 if the additional dose to the embryo/fetus does not exceed 0.5 mSv (0.05 rem) during the remainder of the pregnancy.

RADIATION DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC Removed.

4-013 DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC

4-013.01 Each licensee or registrant must conduct operations so that:

1. The total effective dose equivalent to individual members of the public from the licensed or registered operation does not exceed 1 mSv (0.1 rem) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with 180 NAC 7-037, from voluntary participation in medical research programs, and from the licensee's or registrant's disposal of radioactive material into sanitary sewerage in accordance with 180 NAC 4-041, and
2. The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with 180 NAC 7-037, does not exceed 0.02 mSv (0.002 rem) in any one hour.

4-013.02 If the licensee or registrant permits members of the public to have access to restricted areas, the limits for members of the public continue to apply to those individuals.

4-013.03 Notwithstanding 180 NAC 4-013.01, item 1 a licensee may permit visitors to an individual who cannot be released, under 180 NAC 7-037, to receive a radiation dose greater than 1 mSv (0.1 rem) if:

1. The radiation dose received does not exceed 5 mSv (0.5 rem); and
2. The authorized user, as defined in 180 NAC 7, has determined before the visit that it is appropriate.

4-013.04 A licensee, registrant, or an applicant for a license or registration may apply for prior Department authorization to operate up to an annual dose limit for an individual member of the public of 5 mSv (0.5 rem). This application must include the following information:

1. Demonstration of the need for and the expected duration of operations in excess of the limit in 180 NAC 4-013.01; and
2. The licensee's or registrant's program to assess and control dose within the 5 mSv (0.5 rem) annual limit; and
3. The procedures to be followed to maintain the dose ALARA.

4-013.05 In addition to the requirements of 180 NAC 4, a licensee or registrant subject to the provisions of the U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190 must comply with those standards.

4-013.06 The Department may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee or registrant may release in effluents in order to restrict the collective dose.

4-014 COMPLIANCE WITH DOSE LIMITS FOR INDIVIDUAL MEMBERS OF THE PUBLIC

4-014.01 The licensee or registrant must make or cause to be made surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas to demonstrate compliance with the dose limits for individual members of the public in 180 NAC 4-013.

4-014.02 A licensee or registrant must show compliance with the annual dose limit in 180 NAC 4-013 by:

1. Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed or registered operation does not exceed the annual dose limit; or
2. Demonstrating that:

    a. The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in Table II of Appendix 180 NAC 4-B; and
    b. If an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.02 mSv (0.002 rem) in an hour and 0.5 mSv (0.05 rem) in a year.

4-014.03 Upon approval from the Department, the licensee or registrant may adjust the effluent concentration values in Appendix 180 NAC 4-B, Table II, for members of the public, to take into account the actual physical and chemical characteristics of the effluents, such as, aerosol size distribution, solubility, density, radioactive decay equilibrium, and chemical form.

RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION Removed.

4-015 GENERAL PROVISIONS AND SCOPE

4-015.01 The criteria in 180 NAC 4 apply to the decommissioning of facilities licensed under 180 NAC 3 and 12, as well as other facilities subject to the Department's jurisdiction under the Act for low-level waste disposal facilities (180 NAC 12), the criteria apply only to ancillary surface facilities that support radioactive waste disposal activities. The criteria do not apply to uranium and thorium recovery facilities or to uranium solution extraction facilities.

4-015.02 The criteria in 180 NAC 4 do not apply to sites which:

1. Have been decommissioned prior to May 27, 2000 in accordance criteria identified in the Site Decommissioning Management Plan Action Plan of April 16, 1992 (57 FR 13389);
2. Have previously submitted and received Department approval on a decommissioning plan that is compatible with the Site Decommissioning Management Plan Action Plan criteria; or
3. Submit a sufficient decommissioning plan within one year after May 27, 2000 and such decommissioning plan is approved by the Department within two years after May 27, 2000 and in accordance with the criteria identified in the Site Decommissioning Management Plan, except that if an Environmental Impact Statement is required in the submittal, there will be a provision for day-for-day extension. Removed.

4-015.03 After a site has been decommissioned and the license terminated in accordance with the criteria in 180 NAC 4, the Department will require additional cleanup only if, based on new information, it determines that the criteria of 180 NAC 4 were not met and residual radioactivity remaining at the site could result in significant threat to public health and safety.

4-015.04 When calculating TEDE to the average member of the critical group the license must determine the peak annual TEDE dose expected within the first 1000 years after decommissioning.

4-016 RADIOLOGICAL CRITERIA FOR UNRESTRICTED USE: A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 0.25 mSv (25 mrem) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

4-017 CRITERIA FOR LICENSE TERMINATION UNDER RESTRICTED CONDITIONS

4-017.01 A site will be considered acceptable for license termination under restricted conditions if:

1. The licensee can demonstrate that further reductions in residual radioactivity necessary to comply with the provisions of 180 NAC 4-016 would result in net public or environmental harm or were not being made because the residual levels associated with restricted conditions are ALARA. Determination of the levels which are ALARA must take into account consideration of any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal;
2. The licensee has made provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 0.25 mSv (25 mrem) per year;

3. The licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site. Acceptable financial assurance mechanisms are:

    a. Funds placed into an account segregated from the licensee's assets and outside the licensee's administrative control, and in which the adequacy of the trust funds is to be assessed based on an assumed annual one percent real rate of return on investment.
    b. A statement of intent in the case of Federal, State or local Government licensees, as described in 180 NAC 3-018.06, item 4; or
    c. When a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by such governmental entity.

4. The licensee has submitted a decommissioning plan to the Department indicating the licensee's intent to decommission in accordance with 180 NAC 3-018.01, and specifying that the licensee intends to decommission by restricting use of the site. The licensee must document in the decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and incorporated, as appropriate, following analysis of that advice.

    a. Licensees proposing to decommission by restricting use of the site must seek advice from such affected parties regarding the following matters concerning the proposed decommissioning:

        (1) Whether provisions for institutional controls proposed by the licensee;

            (a) Will provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 0.25 mSv (25 mrem) TEDE per year;
            (b) Will be enforceable; and
            (c) Will not impose undue burdens on the local community or other affected parties.

        (2) Whether the licensee has provided sufficient financial assurance to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

    b. In seeking advice on the issues identified in 180 NAC 4-017.01, item 4.a., the licensee must provide for:

(1) Participation by representatives of a broad cross section of community interests who may be affected by the decommissioning;
(2) An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and
(3) A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues; and

5. Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is as low as reasonably achievable and would not exceed either;

a. 1 mSv (100 mrem) per year; or (1 mSv) per year; or
b. 5 mSv (500 mrem) per year provided the licensee;

(1) Demonstrates that further reductions in residual radioactivity necessary to comply with the 1 mSv/y (100 mrem/y) value of 180 NAC 4-017.01, item 5.a. are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;
(2) Makes provisions for durable institutional controls;
(3) Provides sufficient financial assurance to enable a responsible government entity or independent third party, including a governmental custodian of a site both to carry out periodic rechecks of the site, no less frequently than every five years to assure that the institutional controls necessary to meet the criteria of 180 NAC 4-017.01, item 2 and to assume and carry out responsibilities for any necessary control and, maintenance of those controls. Acceptable financial assurance mechanisms are those in 180 NAC 4-017.01, item 3.

4-018 ALTERNATE CRITERIA FOR LICENSE TERMINATION

4-018.01 The Department may terminate a license using alternate criteria greater than the dose criterion of 180 NAC 4-016, 4-017.01, item 2 and 4-017.01, item 4.a.(1)(a), if the licensee:

1. Provides assurance that public health and safety would continue to be protected, and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 1 mSv/y (100 mrem/y) limit of 180 NAC 4-013.01, item 1, by submitting an analysis of possible sources of exposure;
2. Has employed to the extent practical restrictions on site use according to the provisions of 180 NAC 4-017 in minimizing exposures at the site; and

3. Reduces doses to ALARA levels, taking into consideration any detriments such as traffic accidents expected to potentially result from decontamination and waste disposal.
4. Has submitted a decommissioning plan to the Department indicating the licensee's intent to decommission in accordance with 180 NAC 3-019.04 and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee must document in the decommissioning plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice. In seeking such advice, the licensee must provide for:

    a. Participation by representatives of a broad cross section of community interests who may be affected by the decommissioning:
    b. An opportunity for a comprehensive, collective discussion on the issues by the participants represented; and
    c. A publicly available summary of the results of all such discussions, including a description of the individual viewpoints of the participants on the issues and the extent of agreement and disagreement among the participants on the issues.
5. Has provided sufficient financial assurance in the form of a trust fund to enable an independent third party, including a governmental custodian of a site, to assume and carry out responsibilities for any necessary control and maintenance of the site.

4-018.02 The use of alternate criteria to terminate a license requires the approval of the Department after consideration of the Department staff's recommendations that will address any comments provided by the Environmental Protection Agency and any public comments submitted pursuant to180 NAC 4-019.

4-019 PUBLIC NOTIFICATION AND PUBLIC PARTICIPATION

4-019.01 Upon the receipt of the decommissioning plan from the licensee, or a proposal by the licensee for release of a site pursuant to 180 NAC 4-017 and 4-018, or whenever the Department deems such notice to be in the public interest, the Department must:

1. Notify and solicit comments from:

    a. Local and State governments in the vicinity of the site and any Indian Nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and
    b. The Environmental Protection Agency for cases where the licensee proposes to release a site pursuant to180 NAC 4-018.

4-019.02 Publish a notice in a forum, such as local newspapers, letters to the State or local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site, and solicit comments from affected parties.

4-020 MINIMIZATION OF CONTAMINATION:

4-020.01 Applicants for licenses, other than renewals, must describe in the application how the facility design and the procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.

4-020.02 Licensees must, to the extent practical, conduct operations to minimize the introduction of residual radioactivity into the site, including the subsurface, in accordance with the existing radiation protection requirements in 180 NAC 4-004 and radiological criteria for license termination in 180 NAC 4-015 thru 4-020.

SURVEYS AND MONITORING Removed.

4-021 GENERAL

4-021.01 Each licensee or registrant must make, or cause to be made, surveys of areas, including the subsurface, that:

1. Are necessary for the licensee or registrant to comply with 180 NAC 4; and
2. Are necessary under the circumstances to evaluate:

    a. The magnitude and extent of radiation levels; and
    b. Concentrations or quantities of residual radioactivity; and
    c. The potential radiological hazards of the radiation levels and residual radioactivity detected.

4-021.02 Notwithstanding 180 NAC 4-048.01, records from surveys describing the location and amount of subsurface residual radioactivity identified at the site must be kept with records important for decommissioning, and such records must be retained in accordance with 180 NAC 3-018.07, as applicable.

4-021.03 The licensee or registrant must ensure that instruments and equipment used for quantitative radiation measurements for example, dose rate and effluent monitoring are calibrated at intervals not to exceed 12 months for the radiation measured, except when a more frequent interval is specified in another applicable chapter or a license condition.

4-021.04 All personnel dosimeters (except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to any extremity) that require processing to determine the radiation dose and that are used by licensees and registrants to comply with 180 NAC 4-005, with other applicable provisions of these regulations, or with conditions specified in a license or registration must be processed and evaluated by a dosimetry processor:

1. Holding current personnel dosimetry accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology; and

2. Approved in this accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

4-021.05 The licensee or registrant must ensure that adequate precautions are taken to prevent a deceptive exposure of an individual monitoring device.

4-022 CONDITIONS REQUIRING INDIVIDUAL MONITORING OF EXTERNAL AND INTERNAL OCCUPATIONAL DOSE: Each licensee or registrant must monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of 180 NAC 4. As a minimum:

4-022.01 Each licensee or registrant must monitor occupational exposures to radiation from registered, licensed and unlicensed radiation sources under the control of the licensee or registrant and must supply and require the use of individual monitoring devices by:

1. Adults likely to receive, in one year from sources external to the body, a dose in excess of 10% of the limits in 180 NAC 4-005.01; and
2. Minors likely to receive, in one year, from sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem), a lens dose equivalent in excess of 1.5 mSv (0.15 rem), or a shallow dose equivalent to the skin or to the extremities in excess of 5 mSv (0.5 rem);
3. Declared pregnant women likely to receive during the entire pregnancy, from radiation sources external to the body, a deep dose equivalent in excess of 1 mSv (0.1 rem);[3] and
4. Individuals entering a high or very high radiation area.
5. Individuals working with medical fluoroscopic equipment.

    a. An individual monitoring device used for the dose to an embryo/fetus of a declared pregnant woman, pursuant to 180 NAC 4-012.01, must be located under the protective apron at the waist.
    b. An individual monitoring device used for lense dose equivalent must be located at the neck (collar), or an unshielded location closer to the eye, outside the protective apron.
    c. When only one individual monitoring device is used to determine the effective dose equivalent for external radiation pursuant to 180 NAC 4-005.03, it must be located at the neck (collar) outside the protective apron. When a second individual monitoring device is used for the same purpose, it must be located under the protective apron at the waist. The second individual monitoring device is required for a declared pregnant woman.

[3] All of the occupational doses in 180 NAC 4-005 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded.

4-022.02 Each licensee or registrant must monitor, to determine compliance with 180 NAC 4-008, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

1. Adults likely to receive, in one year, an intake in excess of 10% of the applicable ALI in Table I, Columns 1 and 2, of Appendix 180 NAC 4-B; and
2. Minors likely to receive, in one year, a committed effective dose equivalent in excess of 1 mSv (0.1 rem).
3. Declared pregnant women likely to receive, during the entire pregnancy, a committed effective dose equivalent in excess of 1 mSv (0.1 rem).

CONTROL OF EXPOSURE FROM EXTERNAL SOURCES IN RESTRICTED AREAS Removed.

4-023 CONTROL OF ACCESS TO HIGH RADIATION AREAS

4-023.01 The licensee or registrant must ensure that each entrance or access point to a high radiation area has one or more of the following features:

1. A control device that, upon entry into the area, causes the level of radiation to be reduced below that level at which an individual might receive a deep dose equivalent of 1 mSv (0.1 rem) in one hour at 30 centimeters from the source of radiation from any surface that the radiation penetrates; or
2. A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or
3. Entryways that are locked, except during periods when access to the areas is required, with positive control over each individual entry.

4-023.02 In place of the controls required by 180 NAC 4-023.01 for a high radiation area, the licensee or registrant may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

4-023.03 The licensee or registrant may apply to the Department for approval of alternative methods for controlling access to high radiation areas.

4-023.04 The licensee or registrant must establish the controls required by 180 NAC 4-023.01 and 4-023.03 in a way that does not prevent individuals from leaving a high radiation area.

4-023.05 The licensee or registrant is not required to control each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation provided that:

1. The packages do not remain in the area longer than 3 days; and
2. The dose rate at 1 meter from the external surface of any package does not exceed 0.1 mSv (0.01 rem) per hour.

4-023.06 The licensee is not required to control entrance or access to rooms or other areas in hospitals solely because of the presence of patients containing radioactive material, provided that there are personnel in attendance who are taking the necessary precautions to prevent the exposure of individuals to radiation or radioactive material in excess of the established limits in 180 NAC 4 and to operate within the ALARA provisions of the licensee's or registrant's radiation protection program.

4-023.07 The registrant is not required to control entrance or access to rooms or other areas containing sources of radiation capable of producing a high radiation area as described in 180 NAC 4-023 if the registrant has met all the specific requirements for access and control specified in other applicable 180 NAC Chapters, such as, 180 NAC 5 for industrial radiography, 180 NAC 6 for x-rays in the healing arts, and 180 NAC 9 for particle accelerators.

4-024 CONTROL OF ACCESS TO VERY HIGH RADIATION AREAS

4-024.01 In addition to the requirements in 180 NAC 4-023, the licensee or registrant must institute measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 5 Gy (500 rad) or more in 1 hour at 1 meter from a source of radiation or any surface through which the radiation penetrates. This requirement does not apply to rooms or areas in which diagnostic x-ray systems are the only source of radiation, or to non-self-shielded irradiators.

4-024.02 The registrant is not required to control entrance or access to rooms or other areas containing sources of radiation capable of producing a very high radiation area as described in 180 NAC 4-024.01 if the registrant has met all the specific requirements for access and control specified in other applicable 180 NAC Chapters, such as, 180 NAC 5 for industrial radiography, 180 NAC 6 for x-rays in the healing arts, and 180 NAC 9 for particle accelerators.

4-025 CONTROL OF ACCESS TO VERY HIGH RADIATION AREAS--IRRADIATORS

4-025.01 180 NAC 4-025 applies to licensees or registrants with sources of radiation in non-self-shielded irradiators. 180 NAC 4-025 does not apply to sources of radiation that are used in teletherapy, in industrial radiography, or in completely self-shielded irradiators in which the source of radiation is both stored and operated within the same shielding radiation barrier and, in the designed configuration of the irradiator, is always physically inaccessible to any individual and cannot create high levels of radiation in an area that is accessible to any individual.

4-025.02 Each area in which there may exist radiation levels in excess of 5 Gy (500 rad) in 1 hour at 1 meter from a source of radiation that is used to irradiate materials must meet the following requirements:

1. Each entrance or access point must be equipped with entry control devices which:

a. Function automatically to prevent any individual from inadvertently entering a very high radiation area; and

b. Permit deliberate entry into the area only after a control device is actuated that causes the radiation level within the area, from the source of radiation, to be reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

c. Prevent operation of the source of radiation if it would produce radiation levels in the area that could result in a deep dose equivalent to an individual in excess of 1 mSv (0.1 rem) in 1 hour.

2. Additional control devices must be provided so that, upon failure of the entry control devices to function as required by 180 NAC 4-025.02, item 1:

a. The radiation level within the area, from the source of radiation, is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

b. Conspicuous visible and audible alarm signals are generated to make an individual attempting to enter the area aware of the hazard and at least one other authorized individual, who is physically present, familiar with the activity, and prepared to render or summon assistance, aware of the failure of the entry control devices.

3. The licensee or registrant must provide control devices so that, upon failure or removal of physical radiation barriers:

a. The radiation level from the source of radiation is reduced below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour; and

b. Conspicuous visible and audible alarm signals are generated to make potentially affected individuals aware of the hazard and the licensee or registrant or at least one other individual, who is familiar with the activity and prepared to render or summon assistance, aware of the failure or removal of the physical barrier.

4. Physical radiation barriers that comprise permanent structural components, such as walls, that have no credible probability of failure or removal in ordinary circumstances need not meet the requirements of 180 NAC 4-025.02, item 3.

5. Each area must be equipped with devices that will automatically generate conspicuous visible and audible alarm signals to alert personnel in the area before the source of radiation can be put into operation and in time for any individual in the area to operate a clearly identified control device, which must be installed in the area and which can prevent the source of radiation from being put into operation.

6. Each area must be controlled by use of such administrative procedures and such devices as are necessary to ensure that the area is cleared of personnel prior to each use of the source of radiation.

7. Each area must be checked by a radiation measurement to ensure that, prior to the first individual's entry into the area after any use of the source of radiation, the radiation level from the source of radiation in the area is below that at which it would be possible for an individual to receive a deep dose equivalent in excess of 1 mSv (0.1 rem) in 1 hour.
8. The entry control devices required in 180 NAC 4-025.02, item 1 must have been tested for proper functioning. See 180 NAC 4-055 for record keeping requirements.

    a. Testing must be conducted prior to initial operation with the source of radiation on any day, unless operations were continued uninterrupted from the previous day; and
    b. Testing must be conducted prior to resumption of operation of the source of radiation after any unintentional interruption; and
    c. The licensee or registrant must submit and adhere to a schedule for periodic tests of the entry control and warning systems.

9. The licensee or registrant must not conduct operations, other than those necessary to place the source of radiation in safe condition or to effect repairs on controls, unless control devices are functioning properly.
10. Entry and exit portals that are used in transporting materials to and from the irradiation area, and that are not intended for use by individuals, must be controlled by such devices and administrative procedures as are necessary to physically protect and warn against inadvertent entry by any individual through these portals.

4-025.03 Registrants or applicants for registrations for sources of radiation within the purview of 180 NAC 4-025.02 which will be used in a variety of positions or in locations, such as open fields or forests, that make it impracticable to comply with certain requirements of 180 NAC 4-025.02, such as those for the automatic control of radiation levels, may apply to the Department for approval of alternative safety measures. Alternative safety measures must provide personnel protection at least equivalent to those specified in 180 NAC 4-025.02. At least one of the alternative measures must include an entry-preventing interlock control based on a measurement of the radiation that ensures the absence of high radiation levels before an individual can gain access to the area where such sources of radiation are used.

4-025.04 The entry control devices required by 180 NAC 4-025.02 and 4-025.03 must be established in such a way that no individual will be prevented from leaving the area.

RESPIRATORY PROTECTION AND CONTROLS TO RESTRICT INTERNAL EXPOSURE IN RESTRICTED AREAS Removed.

4-026 USE OF PROCESS OR OTHER ENGINEERING CONTROLS: The licensee or registrant must use, to the extent practical, process or other engineering controls (for example, containment, decontamination, or ventilation) to control the concentrations of radioactive material in air.

4-027 USE OF OTHER CONTROLS

4-027.01 When it is not practical to apply process or other engineering controls to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, the licensee or registrant must, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

1. Control of access; or
2. Limitation of exposure times; or
3. Use of respiratory protection equipment; or
4. Other controls.

4-027.02 If the licensee performs an ALARA analysis to determine whether or not respirators should be used, the licensee may consider safety factors other than radiological factors. The licensee should also consider the impact of respirator use on workers' industrial health and safety.

4-028 USE OF INDIVIDUAL RESPIRATORY PROTECTION EQUIPMENT

4-028.01 If the licensee assigns or permits the use of respiratory protection equipment to limit the intake of radioactive material, pursuant to 180 NAC 4-027:

1. Except as provided in 180 NAC 4-028.01, item 2, the licensee must use only respiratory protection equipment that is tested and certified by the National Institute for Occupational Safety and Health (NIOSH) except as otherwise noted in this part.

2. If the licensee wishes to use equipment that has not been tested or certified by the NIOSH, or for which there is no schedule for testing or certification, the licensee or registrant must submit an application for authorized use of this equipment, except as provided in 180 NAC 4-028.01. The application must include evidence that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use. This must be demonstrated either by licensee testing or on the basis of reliable test information.

3. The licensee must implement and maintain a respiratory protection program that includes:

   a. Air sampling sufficient to identify the potential hazard, permit proper equipment selection, and estimate doses;
   b. Surveys and bioassays, as necessary, to evaluate actual intakes;
   c. Testing of respirators for operability (user seal check for face sealing devices and functional check for each other) immediately prior to each use; and
   d. Written procedures regarding--

(1) Monitoring, including air sampling and bioassays;
(2) Supervision and training of respiratory users;
(3) Fit testing;
(4) Respiratory selection
(5) Breathing air quality;
(6) Inventory and control
(7) Storage, issuance, maintenance, repair, testing, and quality assurance of respiratory protection equipment;
(8) Recordkeeping; and
(9) Limitations on periods of respirator use and relief from respirator use;

e. Determination by a physician that the individual user is medically fit to use the respiratory protection equipment; before

(1) The initial fitting of a face sealing respiratory;
(2) Before the first field use of non-face sealing respirators, and
(3) Either every 12 months thereafter, or periodically at a frequency determined by a physician.

f. Fit testing, with fit factor ≥10 times the assigned protection factor (APF) for negative pressure devices, and a fit factor ≥500 for any positive pressure, continuous flow, and pressure-demand devices, before the first field use of tight fitting face-sealing respirators and periodically thereafter at a frequency not to exceed one year. Fit testing must be performed with the facepeice operating in the negative pressure mode.

4. The licensee must advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief.

5. The licensee must also consider limitations appropriate to the type and mode of use. When selecting respiratory devices the licensee must provide for vision correction, adequate communication, low temperature work environments, and the concurrent use of other safety or radiological protection equipment. The licensee must use equipment in such a way as not to interfere with the proper operation of the respirator.

6. Standby rescue persons are required whenever one-piece atmosphere-supplying suits, or any combination of supplied air respiratory protection device and personnel protective equipment are used from which an unaided individual would have difficulty extricating him/herself. The standby persons must be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards. The standby rescue persons must observe or otherwise maintain continuous communication with the workers (visual, voice, signal line, telephone, radio, or other suitable means), and be immediately available to assist them in case of a failure of the air supply or for any other reason that

requires relief from distress. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and to provide effective emergency rescue if needed.

7. Atmosphere-supplying respirators must be supplied with respirable air of grade D quality or better as specified in the regulations of the Occupational Safety and Health Administration at 29 CFR 1910.134(i)(1)(ii)(2016). Grade D quality air criteria include:

(a) Oxygen content (v/v) of 19.5-23.5%;
(b) Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;
(c) Carbon monoxide (CO) content of 10 ppm or less;
(d) Carbon dioxide content of 1,000 ppm or less; and
(e) Lack of noticeable odor.

8. The licensee must ensure that no objects, materials or substances, such as facial hair, or any conditions that interfere with the face--facepiece seal or valve function, and that are under the control of the respirator wearer, are present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece.

9. In estimating the dose to individuals from intake of airborne radioactive materials, the concentration of radioactive material in the air that is inhaled when respirators are worn is initially assumed to be the ambient concentration in air without respiratory protection, divided by the assigned protection factor. If the dose is later found to be greater than the estimated dose, the corrected value must be used. If the dose is later found to be less than the estimated dose, the corrected value may be used.

4-029 FURTHER RESTRICTIONS ON THE USE OF RESPIRATORY PROTECTION EQUIPMENT

The Department may impose restrictions in addition to the provisions of 180 NAC 4-027, 4-028, and Appendix 4-A in order to:

4-029.01 Ensure that the respiratory protection program of the licensee is adequate to limit doses to individuals from intakes of airborne radioactive materials consistent with maintaining total effective dose equivalent ALARA; and

4-029.02 Limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

4-030 APPLICATION FOR USE OF HIGHER ASSIGNED PROTECTION FACTORS

The licensee must obtain authorization from the Department before using assigned protection factors in excess of those specified in Appendix 4-A. The Department may authorize a licensee to use higher assigned protection factors on receipt of an application that:

4-030.01 Describes the situation for which a need exists for higher protection factors; and

4-030.02 Demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

STORAGE AND CONTROL OF LICENSED OR REGISTERED SOURCES OF RADIATION Removed.

4-031 SECURITY AND CONTROL OF LICENSED OR REGISTERED SOURCES OF RADIATION:

4-031.01 The licensee or registrant must secure licensed or registered radioactive material from unauthorized removal or access.

4-031.02 The licensee or registrant must maintain constant surveillance, use devices and/or administrative procedures to prevent unauthorized use of licensed or registered radioactive material that is in an unrestricted area and that is not in storage.

4-031.03 The registrant must secure mobile or portable radiation machines that are capable of producing a high radiation area as defined in 180 NAC 1 from unauthorized removal.

4-031.04 The registrant must use devices or administrative procedures to prevent unauthorized use of registered radiation machines.

4-031.05 Security requirements for portable gauges. Each portable gauge licensee must use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal, whenever portable gauges are not under the control and constant surveillance of the licensee.

4-032 RESERVED:

PRECAUTIONARY PROCEDURES Removed.

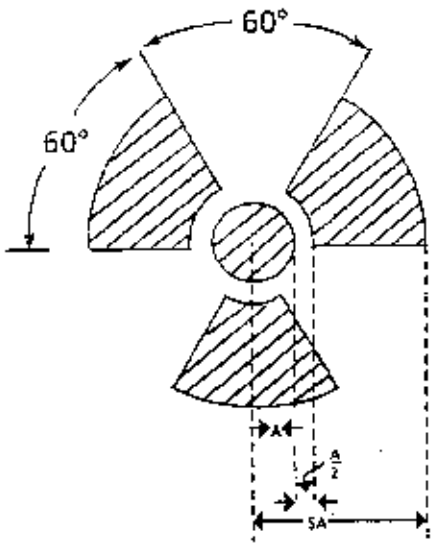
4-033 CAUTION SIGNS

4-033.01 Standard Radiation Symbol: Unless otherwise authorized by the Department, the symbol prescribed by 180 NAC 4-033 must use the colors magenta, or purple, or black on yellow background. The symbol prescribed is the three-bladed design as follows:

RADIATION SYMBOL Removed.

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

2. The background is to be yellow.



4-033.02 Exception to Color Requirements for Standard Radiation Symbol: Notwithstanding the requirements of 180 NAC 4-033.01, licensees or registrants are authorized to label sources, source holders, or device components containing sources of radiation that are subjected to high temperatures, with conspicuously etched or stamped radiation caution symbols and without a color requirement.

4-033.03 Additional Information on Signs and Labels: In addition to the contents of signs and labels prescribed in 180 NAC 4, the licensee or registrant must provide, on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures.

4-034 POSTING REQUIREMENTS

4-034.01 Posting of Radiation Areas: The licensee or registrant must post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

4-034.02 Posting of High Radiation Areas: The licensee or registrant must post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

4-034.03 Posting of Very High Radiation Areas: The licensee or registrant must post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and words "GRAVE DANGER, VERY HIGH RADIATION AREA."

4-034.04 Posting of Airborne Radioactivity Areas: The licensee or registrant must post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation

symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

4-034.05 Posting of Areas or Rooms in which Licensed or Registered Material is Used or Stored: The licensee or registrant must post each area or room in which there is used or stored an amount of licensed or registered material exceeding ten times the quantity of such material specified in Appendix 180 NAC 4-C with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL(S)" or "DANGER, RADIOACTIVE MATERIAL(S)."

4-035 EXCEPTIONS TO POSTING REQUIREMENT:

4-035.01 A licensee or registrant is not required to post caution signs in areas or rooms containing sources of radiation for periods of less than eight hours, if each of the following conditions is met:

1. The sources of radiation are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to sources of radiation in excess of the limits established in 180 NAC 4; and
2. The area or room is subject to the licensee's or registrant's control.

4-035.02 Rooms or other areas in hospitals that are occupied by patients are not required to be posted with caution signs pursuant to 180 NAC 4-034 provided that the patient could be released from licensee control pursuant to 180 NAC 7-037.

4-035.03 A room or area is not required to be posted with a caution sign because of the presence of a sealed source provided the radiation level at 30 centimeters from the surface of the sealed source container or housing does not exceed 0.05 mSv (0.005 rem) per hour.

4-035.04 Rooms in hospitals or clinics that are used for teletherapy are exempt from the requirement to post caution signs in accordance with 180 NAC 4-034 if:

1. Access to the room is controlled in accordance with 180 NAC 7-071; and

2. Personnel in attendance take necessary precautions to prevent the inadvertent exposure of workers, other patients, and members of the public to radiation in excess of the limits established in 180 NAC 4-035.

4-036 LABELING CONTAINERS AND RADIATION MACHINES

4-036.01 The licensee or registrant must ensure that each container of licensed or registered material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must also provide information, such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment, to permit individuals handling or

using the containers, or working in the vicinity of the containers, to take precautions to avoid or minimize exposures.

4-036.02 Each licensee or registrant must, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

4-036.03 Each registrant must ensure that each radiation machine is labeled in a conspicuous manner which cautions individuals that radiation is produced when it is energized.

4-037 EXEMPTIONS TO LABELING REQUIREMENTS: A licensee or registrant is not required to label:

4-037.01 Containers holding licensed or registered material in quantities less than the quantities listed in Appendix 180 NAC 4-C; or

4-037.02 Containers holding licensed or registered material in concentrations less than those specified in Table III of Appendix 180 NAC 4-B; or

4-037.03 Containers attended by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by 180 NAC 4;

4-037.04 Containers when they are in transport and packaged and labeled in accordance with the regulations of the U.S. Department of Transportation[4]; or

4-037.05 Containers that are accessible only to individuals authorized to handle or use them, or to work in the vicinity of the containers, if the contents are identified to these individuals by a readily available written record. Examples of containers of this type are containers in locations such as water-filled canals, storage vaults, or hot cells. The record must be retained as long as the containers are in use for the purpose indicated on the record; or

4-037.06 Installed manufacturing or process equipment, such as piping and tanks.

4-038 PROCEDURES FOR RECEIVING AND OPENING PACKAGES

4-038.01 Each licensee who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity, as defined in 180 NAC 13-002 and Appendix A of 180 NAC 13, must make arrangements to receive:

[4]Labeling of packages containing radioactive materials is required by the U.S. Department of Transportation if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited by U.S. Department of Transportation regulations 49 CFR 173.403(m) and (w) and 173.421-424.

1. The package when the carrier offers it for delivery; or
2. Notification of the arrival of the package at the carrier's terminal and to take possession of the package expeditiously.

4-038.02 Each licensee must:

1. Monitor the external surfaces of a labeled[5] package for radioactive contamination unless the package contains only radioactive material in the form of a gas or in special form as defined in 180 NAC 1-002; and
2. Monitor the external surfaces of a labeled[6] package for radiation levels unless the package contains quantities of radioactive material that are less than or equal to the Type A quantity, as defined in 180 NAC 13-002 and Appendix A to 180 NAC 13; and
3. Monitor all packages known to contain radioactive material for radioactive contamination and radiation levels if there is evidence of degradation of package integrity, such as packages that are crushed, wet, or damaged.

4-038.03 The licensee must perform the monitoring required by 180 NAC 4-038.02 as soon as practical after receipt of the package, but not later than three hours after the package is received at the licensee's or registrant's facility if it is received during the licensee's or registrant's normal working hours, or not later than three hours from the beginning of the next working day if it is received after working hours.

4-038.04 The licensee must immediately notify the final delivery carrier and, by telephone and telegram, mailgram, or facsimile, the Department when:

1. Removable radioactive surface contamination exceeds the limits of 180 NAC 13-015.09; or
2. External radiation levels exceed the limits of 180 NAC 13-015.10 and 13-015.11

4-038.05 Each licensee must:

1. Establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and
2. Ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

4-038.06 Licensees transferring special form sources in vehicles owned or operated by the licensee to and from a work site are exempt from the contamination monitoring requirements of 180 NAC 4-038.02, but are not exempt from the monitoring requirement

[5]Labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436-440.

[6]Labeled with a Radioactive White I, Yellow II, or Yellow III label as specified in U.S. Department of Transportation regulations, 49 CFR 172.403 and 172.436-440.

in 180 NAC 4-038.02 for measuring radiation levels that ensures that the source is still properly lodged in its shield.

WASTE DISPOSAL Removed.

4-039 GENERAL REQUIREMENTS

4-039.01 A licensee must dispose of licensed material only:

1. By transfer to an authorized recipient as provided in 180 NAC 4-044 or in 180 NAC 3, 12 or 19, or to the U.S. Department of Energy; or
2. By decay in storage in accordance with 180 NAC 4-039.03; or
3. By release in effluents within the limits in 180 NAC 4-013; or
4. As authorized pursuant to 180 NAC 4-040 through 4-043 or 4-039.05 and 4-039.06.

4-039.02 A person must be specifically licensed to receive waste containing licensed material from other persons for:

1. Treatment prior to disposal; or
2. Treatment or disposal by incineration; or
3. Decay in storage; or
4. Management at a facility licensed pursuant to 180 NAC 12; or
5. Storage until transferred to a storage or disposal facility authorized to receive the waste.

4-039.03 A licensee may hold radioactive material with a physical half-life of less than or equal to 120 days for decay-in-storage before disposal without regard to its radioactivity if the licensee:

1. Holds radioactive material for decay a minimum of ten half-lives;
2. Monitors radioactive material at the container surface before disposal and determines that its radioactivity cannot be distinguished from the background radiation level with an appropriate radiation detection survey instrument set on its most sensitive scale and with no interposed shielding;
3. Removes or obliterates all radiation labels; except for materials that will be handled as biomedical waste after released; and
4. Separates and monitors each generator column individually with all radiation shielding removed to ensure that its contents have decayed to background radiation level before disposal.

4-039.04 For radioactive material disposed in accordance with 180 NAC 4-039.03, the licensee must retain a record of each disposal in accordance with 180 NAC 4-054.03.

4-039.05 Discrete sources of Radium 226 and discrete sources of naturally occurring radioactive material may be disposed of in accordance with 180 NAC 12, even though it is not defined as low-level radioactive waste. Therefore, any licensed radioactive material

being disposed of at a facility, or transferred for ultimate disposal at a facility under 180 NAC 12 must meet the requirements of 180 NAC 4-044.02.

4-039.06 A licensee may dispose of discrete sources of Radium 226 and discrete sources of naturally occurring radioactive material, at a disposal facility authorized to dispose of such material in accordance with any Federal or State solid or hazardous waste law.

4-040 METHOD FOR OBTAINING APPROVAL OF PROPOSED DISPOSAL PROCEDURES: A licensee or applicant for a license may apply to the Department for approval of proposed procedures, not otherwise authorized in these regulations, to dispose of licensed material generated in the licensee's operations. Each application must include:

1. A description of the waste containing licensed or registered material to be disposed of, including the physical and chemical properties that have an impact on risk evaluation, and the proposed manner and conditions of waste disposal; and
2. An analysis and evaluation of pertinent information on the nature of the environment; and
3. The nature and location of other potentially affected facilities; and
4. Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in 180 NAC 4.

4-041 DISPOSAL BY RELEASE INTO SANITARY SEWERAGE

4-041.01 A licensee may discharge licensed material into sanitary sewerage if each of the following conditions is satisfied:

1. The material is readily soluble, or is readily dispersible biological material, in water; and
2. The quantity of licensed radioactive material that the licensee releases into the sewer in one month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in Table III of Appendix 180 NAC 4-B; and
3. If more than one radionuclide is released, the following conditions must also be satisfied:

    a. The licensee must determine the fraction of the limit in Table III of Appendix 180 NAC 4-B represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee or registrant into the sewer by the concentration of that radionuclide listed in Table III of Appendix 180 NAC 4-B; and
    b. The sum of the fractions for each radionuclide required by 180 NAC 4-041.01, item 3.a. does not exceed unity; and

4. The total quantity of licensed radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of hydrogen-3, 37 GBq (1 Ci) of carbon-14, and 37 GBq (1 Ci) of all other radioactive materials combined.

4-041.02 Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in 180 NAC 4-039.01.

4-042 TREATMENT OR DISPOSAL BY INCENERATION: A licensee may treat or dispose of licensed material by incineration only in the amounts and forms specified in 180 NAC 4-043 or as specifically approved by the Department pursuant to 180 NAC 4-040.

4-043 DISPOSAL OF SPECIFIC WASTES

4-043.01 A licensee may dispose of the following licensed material as if it were not radioactive:

1. 1.85 kBq (0.05 μCi), or less, of Hydrogen-3, Carbon-14 or Iodine-125 per gram of medium used for liquid scintillation counting; and
2. 1.85 kBq (0.05 μCi), or less, of Hydrogen-3, or Carbon-14 or Iodine-125 per gram of animal tissue, averaged over the weight of the entire animal.

4-043.02 A licensee must not dispose of tissue pursuant to 180 NAC 4-041.01, item 2 in a manner that would permit its use either as food for humans or as animal feed.

4-043.03 The licensee must maintain records in accordance within 180 NAC 4-052.

4-043.04 Any licensee may, upon Department approval of procedures required in 180 NAC 4-043.06, dispose of radioactive material included in Appendix 180 NAC 4-G, provided that it does not exceed the concentration and total curie limits contained therein. Any radioactive material included in Appendix 180 NAC 4-G may be disposed of at a city or county landfill facility authorized to receive the radioactive material.

4-043.05 Each licensee who disposes of radioactive material described in 180 NAC 4-043.01 or 4-043.04 must:

1. Make surveys adequate to assure that the limits of 180 NAC 4-043.01 or 4-043.04 are not exceeded; and
2. Remove or otherwise obliterate all labels, tags, or other markings which would indicate that the material or its contents is radioactive.

4-043.06 Prior to the initiation of disposals authorized by 180 NAC 4-043.04, a licensee must submit procedures to the Department for:

1. The physical delivery of the material to the disposal site, the physical placing of the material in the disposal location and that the material is properly covered;
2. Surveys to be performed for compliance with 180 NAC 4-043.05, item 1;
3. Maintaining secure packaging during transportation to the site;
4. Maintaining records of disposals made under 180 NAC 4-043.04; and
5. Written authorization by the landfill operator agreeing to such disposal.

4-043.07 Nothing in 180 NAC 4, however, relieves the licensee of maintaining records showing the receipt, transfer, and disposal of such radioactive material as specified pursuant to 180 NAC 1-004.

4-043.08 Nothing in 180 NAC 4 relieves the licensee from complying with other applicable federal, state or local regulations governing any other toxic or hazardous property of these materials.

4-043.09 Radioactive material disposed of under 180 NAC 4 is not subject to the requirements of 180 NAC 13.

4-044 TRANSFER FOR DISPOSAL AND MANIFESTS

4-044.01 The requirements of 180 NAC 4 and Appendix 180 NAC 4-D are designed to:

1. Control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor license, as defined in 180 NAC 4, who ships low-level waste either directly, or indirectly through a waste collector or waste processor, to a licensed low-level waste disposal facility.
2. Establish a manifest tracking system; and
3. Supplement existing requirements concerning transfers and recordkeeping for those wastes.

4-044.02 All affected licensees must use Appendix 180 NAC 4-D and comply with 180 NAC 4-044.02, item 2.

1. Each shipment of radioactive waste intended for disposal at a licensed low-level radioactive waste disposal facility must be accompanied by a shipment manifest as specified in Section I of Appendix 180 NAC 4-D.
2. Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility must document the information required on the Department's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee in accordance with Appendix 180 NAC 4-D.

4-044.03 Each shipment manifest must include a certification by waste generator as specified in Section II of Appendix 180 NAC 4-D.

4-044.04 Each person involved in the transfer for disposal and disposal of waste, including the waste generator, waste collector, waste processor, and disposal facility operator, must comply with the requirements specified in Section III of Appendix 180 NAC 4-D.

4-045 COMPLIANCE WITH ENVIRONMENTAL AND HEALTH PROTECTION REGULATIONS: Nothing in 180 NAC 4-039 through 4-044 relieves the licensee or registrant from complying with other applicable Federal, State, and local regulations governing any other toxic or hazardous properties of materials that may be disposed of pursuant to 180 NAC 4-039 through 4-044.

RECORDS Removed.

4-046 GENERAL PROVISONS

4-046.01 Each licensee or registrant must use the SI units becquerel, gray, sievert and coulomb per kilogram, or the special units curie, rad, rem, and roentgen, including multiples and subdivisions, and must clearly indicate the units of all quantities on records required by 180 NAC 4.

4-046.02 Not withstanding the requirements of 180 NAC 4-046.01, when recording information on shipment manifests, as required in 180 NAC 4-044.02, item 1, information must be recorded in the International System of Units (SI) or in SI and units as specified in 180 NAC 4-046.01.

4-046.03 The licensee or registrant must make a clear distinction among the quantities entered on the records required by 180 NAC 4, such as, total effective dose equivalent, total organ dose equivalent, shallow dose equivalent, lens dose equivalent, deep dose equivalent, or committed effective dose equivalent.

4-047 RECORDS OF RADIATION PROTECTION PROGRAMS

4-047.01 Each licensee or registrant must maintain records of the radiation protection program, including:

1. The provisions of the program; and
2. Audits and other reviews of program content and implementation.

4-047.02 The licensee or registrant must retain the records required by 180 NAC 4-047.01, item 1 until the Department terminates each pertinent license or registration requiring the record. The licensee or registrant must retain the records required by 180 NAC 4-047.01, item 2 for three years after the record is made.

4-048 RECORDS OF SURVEYS

4-048.01 Each licensee or registrant must maintain records showing the results of surveys and calibrations required by 180 NAC 4-021 and 4-038.02. The licensee or registrant must retain these records for three years after the record is made.

4-048.02 The licensee or registrant must retain each of the following records until the Department terminates each pertinent license or registration requiring the record:

1. Records of the results of surveys to determine the dose from external sources of radiation used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents. This includes those records of results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents required under the standards for protection against radiation in effect prior to May 30, 1994; and

2. Records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose. This includes those records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose required under the standards for protection against radiation in effect prior to May 30, 1994.
3. Records showing the results of air sampling, surveys, and bioassays required pursuant to 180 NAC 4-028.01, item 3.a. This includes those records showing the results of air sampling, surveys and bioassays required under the standards for protection against radiation in effect prior to May 30, 1994; and
4. Records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment. This includes those records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment required under the standards for protection against radiation in effect prior to May 30, 1994.

4-049 RECORDS OF TESTS FOR LEAKAGE OR CONTAMINATION OF SEALED SOURCES: Records of tests for leakage or contamination of sealed sources required by 180 NAC 1-011 must be kept in units of becquerel or microcuries and maintained for inspection by the Department for five years after the records are made.

4-050 RECORDS OF PRIOR OCCUPATIONAL DOSE: For each individual who is likely to receive in a year, an occupational dose requiring monitoring pursuant to 180 NAC 4-022 the licensee or registrant must: Retain the records of prior occupational dose and exposure history as specified in 180 NAC 4-009 on Department Form NRH-1 or equivalent until the Department terminates each pertinent license or registration requiring this record. The licensee or registrant must retain records used in preparing Department Form NRH-1 for three years after the record is made.

4-051 RECORDS OF PLANNED SPECIAL EXPOSURES

4-051.01 For each use of the provisions of 180 NAC 4-010 for planned special exposures, the licensee or registrant must maintain records that describe:

1. The exceptional circumstances requiring the use of a planned special exposure; and
2. The name of the management official who authorized the planned special exposure and a copy of the signed authorization; and
3. What actions were necessary; and
4. Why the actions were necessary; and
5. What precautions were taken to assure that doses were maintained ALARA; and
6. What individual and collective doses were expected to result; and
7. The doses actually received in the planned special exposure.

4-051.02 The licensee or registrant must retain the records until the Department terminates each pertinent license or registration requiring these records.

4-052 RECORDS OF INDIVIDUAL MONITORING RESULTS

4-052.01 Recordkeeping Requirement. Each licensee or registrant must maintain records of doses received by all individuals for whom monitoring was required pursuant to 180 NAC 4-022 and records of doses received during planned special exposures, accidents, and emergency conditions. Assessments of dose equivalent and records made using units in effect before October 30, 1996 for 180 NAC 4 need not be changed. These records must include, when applicable:

1. The deep dose equivalent to the whole body, lens dose equivalent, shallow dose equivalent to the skin, and shallow dose equivalent to the extremities; and
2. The estimated intake of radionuclides, see 180 NAC 4-006; and
3. The committed effective dose equivalent assigned to the intake of radionuclides;
4. The specific information used to calculate the committed effective dose equivalent pursuant to 180 NAC 4-008.03;
5. The total effective dose equivalent when required by 180 NAC 4-006; and
6. The total of the deep dose equivalent and the committed dose to the organ receiving the highest total dose.

4-052.02 Recordkeeping Frequency. The licensee or registrant must make entries of the records specified in 180 NAC 4-052.01 at intervals not to exceed one year.

4-052.03 Recordkeeping Format. The licensee or registrant must maintain the records specified in 180 NAC 4-052.01 on Department Form NRH-2, in accordance with the instructions for Department Form NRH-2, or in clear and legible records containing all the information required by Department Form NRH-2.

4-052.04 The licensee or registrant must maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy, including the estimated date of conception, must also be kept on file, but may be maintained separately from the dose records.

4-052.05 The licensee or registrant must retain each required form or record until the Department terminates each pertinent license or registration requiring the record.

4-053 RECORDS OF DOSE TO INDIVIDUAL MEMBERS OF THE PUBLIC

4-053.01 Each licensee or registrant must maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public. See 180 NAC 4-013.

4-053.02 The licensee or registrant must retain the records required by 180 NAC 4-053 until the Department terminates each pertinent license or registration requiring the record.

4-054 RECORDS OF WASTE DISPOSAL

4-054.01 Each licensee must maintain records of the disposal of licensed materials made pursuant to 180 NAC 4-040 through 4-043 and 180 NAC 12, and disposal by burial in soil, including burials authorized before August 22, 1982.[4]

4-054.02 The licensee must retain the records required by 180 NAC 4-054.01 until the Department terminates each pertinent license requiring the record. Requirements for disposition of these records, prior to license termination, are located in 180 NAC 3-030 for activities licensed under 180 NAC 4. This includes records required under the standards for protection against radiation in effect prior to May 30, 1994.

4-054.03 A licensee must maintain records of the disposal of licensed materials, as required by 180 NAC 4-039.03 for three years. The record must include the date of the disposal, the specific survey instrument used, the background radiation level, the radiation level measured at the surface of each waste container, and the name of the individual who performed the survey.

4-055 RECORDS OF TESTING ENTRY CONTROL DEVICES FOR VERY HIGH RADIATION AREAS

4-055.01 Each licensee or registrant must maintain records of tests made pursuant to 180 NAC 4-025.02, item 8 on entry control devices for very high radiation areas. These records must include the date, time, and results of each such test of function.

4-055.02 The licensee or registrant must retain the records required by 180 NAC 4-055.01 for three years after the record is made.

4-056 FORM OF RECORDS: Each record required by 180 NAC 4 must be legible throughout the specified retention period. The record must be the original or a reproduced copy or a microform, provided that the copy or microform is authenticated by authorized personnel and that the microform is capable of producing a clear copy throughout the required retention period. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records, such as letters, drawings, and specifications, must include all pertinent information, such as stamps, initials, and signatures. The licensee or registrant must maintain adequate safeguards against tampering with and loss of records.

REPORTS Removed.

4-057 REPORTS OF STOLEN, LOST, OR MISSING LICENSED OR REGISTERED SOURCES OF RADIATION

4-057.01 Telephone Reports. Each licensee or registrant must report to the Department by telephone as follows:

[4] A previous 180 NAC 1-004.23, (January 1974) permitted burial of small quantities of licensed material in soil before August 22, 1982, without specific Department authorization. Removed

1. Immediately after its occurrence becomes known to the licensee or registrant, stolen, lost, or missing licensed radioactive material in an aggregate quantity equal to or greater than 1,000 times the quantity specified in Appendix 180 NAC 4-C under such circumstances that it appears to the licensee or registrant that an exposure could result to individuals in unrestricted areas; or
2. Within 30 days after its occurrence becomes known to the licensee or registrant, lost, stolen, or missing licensed radioactive material in an aggregate quantity greater than 10 times the quantity specified in Appendix 180 NAC 4-C that is still missing.
3. Immediately after its occurrence becomes known to the registrant, a stolen, lost, or missing radiation machine.

4-057.02 Written Reports. Each licensee or registrant required to make a report pursuant to 180 NAC 4-057.01 must, within 30 days after making the telephone report, make a written report to the Department setting forth the following information:

1. A description of the licensed or registered source of radiation involved, including, for radioactive material, the kind, quantity, and chemical and physical form; and, for radiation machines, the manufacturer, model and serial number, type and maximum energy of radiation emitted;
2. A description of the circumstances under which the loss or theft occurred; and
3. A statement of disposition, or probable disposition, of the licensed or registered source of radiation involved; and
4. Exposures of individuals to radiation, circumstances under which the exposures occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and
5. Actions that have been taken, or will be taken, to recover the source of radiation; and
6. Procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed or registered sources of radiation.

4-057.03 Subsequent to filing the written report, the licensee or registrant must also report additional substantive information on the loss or theft within 30 days after the licensee or registrant learns of such information.

4-057.04 The licensee or registrant must prepare any report filed with the Department pursuant to 180 NAC 4-057 so that names of individuals who may have received exposure to radiation are stated in a separate and detachable portion of the report.

4-058 NOTIFICATION OF INCIDENTS

4-058.01 Immediate Notification: Notwithstanding other requirements for notification, each licensee or registrant must immediately report each event involving a source of radiation possessed by the licensee or registrant that may have caused or threatens to cause any of the following conditions:

1. An individual to receive:

a. A total effective dose equivalent of 0.25 Sv (25 rem) or more; or
b. A lens dose equivalent of 0.75 Sv (75 rem) or more; or
c. A shallow dose equivalent to the skin or extremities of 2.5 Gy (250 rad) or more; or

2. The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

4-058.02 Twenty-Four Hour Notification: Each licensee or registrant must, within 24 hours of discovery of the event, report to the Department each event involving loss of control of a licensed or registered source of radiation possessed by the licensee or registrant that may have caused, or threatens to cause, any of the following conditions:

1. An individual to receive, in a period of 24 hours:

a. A total effective dose equivalent exceeding 0.05 Sv (5 rem); or
b. A lens dose equivalent exceeding 0.15 Sv (15 rem); or
c. A shallow dose equivalent to the skin or extremities exceeding 0.5 Sv (50 rem); or

2. The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational ALI. This provision does not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.

4-058.03 The licensee or registrant must prepare each report filed with the Department pursuant to 180 NAC 4-058 so that names of individuals who have received exposure to sources of radiation are stated in a separate and detachable portion of the report.

4-058.04 Licensees or registrants must make the reports required by 180 NAC 4-058.01 and 4-058.02 by initial contact by telephone to the Department and must confirm the initial contact by telegram, mailgram, or electronic media to the Department.

4-058.05 The provisions of 180 NAC 4-058 do not apply to doses that result from planned special exposures, provided such doses are within the limits for planned special exposures and are reported pursuant to180 NAC 4-060.

4-059 REPORTS OF EXPOSURES, RADIATION LEVELS, AND CONCENTRATIONS OF RADIOACTIVE MATERIAL EXCEEDING THE CONSTRAINTS OR LIMITS

4-059.01 Reportable Events: In addition to the notification required by 180 NAC 4-058, each licensee or registrant must submit a written report within 30 days after learning of any of the following occurrences:

1. Any incident for which notification is required by 180 NAC 4-058; or
2. Doses in excess of any of the following:

   a. The occupational dose limits for adults in 180 NAC 4-005; or
   b. The occupational dose limits for a minor in 180 NAC 4-011; or
   c. The limits for an embryo/fetus of a declared pregnant woman in 180 NAC 4-012; or
   d. The limits for an individual member of the public in 180 NAC 4-013; or
   e. Any applicable limit in the license or registrant; or
   f. The ALARA constraints for air emissions established under 180 NAC 4-004.04; or

3. Levels of radiation or concentrations of radioactive material in:

   a. A restricted area in excess of applicable limits in the license; or
   b. An unrestricted area in excess of 10 times the applicable limit set forth in 180 NAC 4 or in the license, whether or not involving exposure of any individual in excess of the limits in 180 NAC 4-013; or

4. For licensees subject to the provisions of U.S. Environmental Protection Agency's generally applicable environmental radiation standards in 40 CFR 190, levels of radiation or releases of radioactive material in excess of those standards, or of license conditions related to those standards.

4-059.02 Contents of Reports

1. Each report required by 180 NAC 4-059 must describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

   a. Estimates of each individual's dose; and
   b. The levels of radiation and concentrations of radioactive material involved; and
   c. The cause of the elevated exposures, dose rates, or concentrations; and
   d. Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards and associated license conditions.

2. Each report filed pursuant to 180 NAC 4-059.01 must include for each individual exposed: the name, Social Security account number, and date of birth. With respect to the limit for the embryo fetus in 180 NAC 4-012, the identifiers should be those of the declared pregnant woman. The report must be prepared so that this information is stated in a separate and detachable portion of the report.

4-059.03 All licensees or registrants who make reports pursuant to 180 NAC 4-059.01 must submit the report in writing to the Department.

4-060 REPORTS OF PLANNED SPECIAL EXPOSURES: The licensee or registrant must submit a written report to the Department within 30 days following any planned special exposure conducted in accordance with 180 NAC 4-010, informing the Department that a planned special exposure was conducted and indicating the date the planned special exposure occurred and the information required by 180 NAC 4-051.

4-061 [Reserved]

4-062 REPORTS OF INDIVIDUAL MONITORING

4-062.01 180 NAC 4 applies to each person licensed by the Department to:

1. Possess or use sources of radiation for purposes of industrial radiography pursuant to 180 NAC 3 or 180 NAC 5; or.
2. Receive radioactive waste from other persons for disposal pursuant to 180 NAC 12; or
3. Possess or use at any time, for processing or manufacturing for distribution pursuant to 180 NAC 3 or 180 NAC 7, radioactive material in quantities exceeding any one of the following quantities:

	Activity[a]	
Radionuclide	**Ci**	**GBq**
Cesium-137	1	37
Cobalt-60	1	37
Gold-198	100	3,700
Iodine-131	1	37
Iridium-192	10	370
Krypton-85	1,000	37,000
Promethium-147	10	370
Technetium-99m	1,000	37,000

[a]The Department may require as a license condition, or by rule, regulation, or order pursuant to 180 NAC 1-007, reports from licensees who are licensed to use radionuclides not on this list, in quantities sufficient to cause comparable radiation levels.

4-062.02 Each licensee in a category listed in 180 NAC 4-062.01 must submit an annual report of the results of individual monitoring carried out by the licensee for each individual for whom monitoring was required by 180 NAC 4-022 during that year. The licensee may include additional data for individuals for whom monitoring was provided but not required. The licensee must use Department Form NRH-2 or electronic media containing all the information required by Department Form NRH-2.

4-062.03 The licensee must file the report required by 180 NAC 4-060.02, covering the preceding year, on or before April 30 of each year. The licensee must submit the report to the Department.

4-063 NOTIFICATIONS AND REPORTS TO INDIVIDUALS

4-063.01 Requirements for notification and reports to individuals of exposure to radiation or radioactive material are specified in 180 NAC 10-004.

4-063.02 When a licensee or registrant is required, pursuant to the provisions of 180 NAC 4-059, 4-060, and 4-062, to report to the Department any exposure of identified occupationally exposed individual, or an identified member of the public, to radiation or radioactive material, the licensee or registrant must also provide a copy of the report submitted to the Department to the individual. This report must be transmitted at a time no later than the transmittal to the Department.

4-064 REPORTS OF LEAKING OR CONTAMINATED SEALED SOURCES: The licensee must file a report within 5 days with the Department if the test for leakage or contamination required pursuant to 180 NAC 1-011 indicates a sealed source is leaking or contaminated. The report must include the equipment involved, the test results and the corrective action taken.

ADDITIONAL REQUIREMENTS Removed.

4-065 VACATING PREMISES: Each specific licensee must, no less than 30 days before vacating or relinquishing possession or control of premises which may have been contaminated with radioactive material as a result of his/her activities, notify the Department in writing of intent to vacate. When deemed necessary by the Department, the licensee must decontaminate the premises in such a manner as the Department may specify.

4-066 REPORTS OF TRANSACTIONS INVOLVING NATIONALLY TRACKED SOURCES: Each licensee who manufactures, transfers, receives, disassembles, or disposes of a nationally tracked source (Refer to Appendix 4-H) must complete and submit a National Source Tracking Transaction Report as specified in 180 NAC 4-066.01 through 4-066.05 for each type of transaction.

4-066.01 Each licensee who manufactures a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

1. The name, address, and license number of the reporting licensee;
2. The name of the individual preparing the report;
3. The manufacturer, model, and serial number of the source;
4. The radioactive material in the source;
5. The initial source strength in becquerels (curies) at the time of manufacture; and
6. The manufacture date of the source.

4-066.02 Each licensee that transfers a nationally tracked source to another person must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

1. The name, address, and license number of the reporting licensee;
2. The name of the individual preparing the report;
3. The name and license number of the recipient facility and the shipping address;
4. The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;
5. The radioactive material in the source;
6. The initial or current source strength in becquerels (curies);
7. The date for which the source strength is reported;
8. The shipping date;
9. The estimated arrival date; and
10. For nationally tracked sources transferred as waste under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification of the container with the nationally tracked source.

4-066.03 Each licensee that receives a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

1. The name, address, and license number of the reporting licensee;
2. The name of the individual preparing the report;
3. The name, address, and license number of the person that provided the source;
4. The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;
5. The radioactive material in the source;
6. The initial or current source strength in becquerels (curies);
7. The date for which the source strength is reported;
8. The date of receipt, and
9. For material received under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification with the nationally tracked source.

4-066.04 Each licensee that disassembles a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

1. The name, address, and license number of the reporting licensee;
2. The name of the individual preparing the report;
3. The manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;
4. The radioactive material in the source;
5. The initial or current source strength in becquerels (curies);
6. The date for which the source strength is reported;

7. The disassemble date of the source.

4-066.05 Each licensee who disposes of a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

1. The name, address, and license number of the reporting licensee;
2. The name of the individual preparing the report;
3. The waste manifest number;
4. The container identification with the nationally tracked source;
5. The date of disposal; and
6. The method of disposal.

4-066.06 The reports discussed in 180 NAC 4-066.01 through 4-066.05 must be submitted by the close of the next business day after the transaction. A single report may be submitted for multiple sources and transactions. The reports must be submitted to the National Source Tracking System by using:

1. The on-line National Source Tracking System;
2. Electronically using a computer readable format;
3. By facsimile;
4. By mail to the address on the National Source Tracking Transaction Report Form (NRC Form 748); or
5. By telephone with followup by facsimile or mail.

4-066.07 Each licensee must correct any error in previously filed reports or file a new report for any missed transaction within 5 business days of the discovery of the error or missed transaction. Such errors may be detected by a variety of methods such as administrative reviews or by physical inventories required by regulation. In addition, each licensee must reconcile the inventory of nationally tracked sources possessed by the licensee against that licensee's data in the National Source Tracking System. The reconciliation must be conducted during the month of January in each year. The reconciliation process must include resolving any discrepancies between the National Source Tracking System and the actual inventory by filing the reports identified in 180 NAC 4-066.01 through 4-066.05. By January 31 of each year, each licensee must submit to the National Source Tracking System confirmation that the data in the National Source Tracking System is correct.

4-066.08 Each licensee that possesses Category 1 nationally tracked sources must report its initial inventory of Category 1 nationally tracked sources to the National Source Tracking System by January 31, 2009. Each licensee that possesses Category 2 nationally tracked sources must report its initial inventory of Category 2 nationally tracked sources to the National Source Tracking System by January 31, 2009. The information may be submitted by using any of the methods identified in 180 NAC 4-066.06, items 1 through 4. The initial inventory report must include the following information:

1. The name, address, and license number of the reporting licensee:
2. The name of the individual preparing the report;

3. The manufacturer, model, and serial number of each nationally tracked source or, if not available, other information to uniquely identify the source;
4. The radioactive material in the sealed source;
5. The initial or current source strength in becquerels (curies); and
6. The date for which the source strength is reported.

Removed.

APPENDIX 4-A

PROTECTION FACTORS FOR RESPIRATORS[a]

	Operating mode	Assigned Protection Factors
I. Air Purifying Respirators [Particulate1A[b] only]1A[c]:		
Filtering facepiece disposable[d]	Negative Pressure	([d])
Facepiece, half [e]	Negative Pressure	10
Facepiece, full	Negative Pressure	100
Facepiece, half	Powered air-purifying respirators	50
Facepiece, full	Powered air-purifying respirators	1000
Helmet/hood	Powered air-purifying respirators	1000
Facepiece, loose-fitting	Powered air-purifying respirators	25
II. Atmosphere supplying respirators [particulate, gases and vapors1A[f]]:		
1. Air-line respirator:		
Facepiece, half	Demand	10
Facepiece, half	Continuous Flow	50
Facepiece, half	Pressure Demand	50
Facepiece, full	Demand	100
Facepiece, full	Continuous Flow	1000
Facepiece, full	Pressure Demand	1000
Helmet/hood	Continuous Flow	1000
Facepiece, loose-fitting	Continuous Flow	25
Suit	Continuous Flow	([g])
2. Self-contained breathing Apparatus (SCBA):		
Facepiece, full	Demand	[h]100
Facepiece, full	Pressure Demand	[i]10,000
Facepiece, full	Demand, Recirculating	[h]100
Facepiece, full	Positive Pressure Recirculating	[i]10,000
III. Combination Respirators:		
Any combination of air-purifying and atmosphere-supplying respirators	Assigned protection factor for type and mode of operation as listed above.	

[a] These assigned protection factors apply only in a respiratory protection program that meets the requirements of this Chapter. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances must also comply with U.S. Department of Labor regulations.

Radioactive contaminants for which the concentration values in Table 1, Column 3 of Appendix 4-B are based on internal dose due to inhalation may, in addition, present external exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

[b] Air purifying respirators with APF <100 must be equipped with particulate filters that are at least 95% efficient. Air purifying respirators with APF = 100 must be equipped with particulate filters that are at least 99% efficient. Air purifying respirators with APFs >100 must be equipped with particulate filters that are at least 99.97% efficient.

[c] The licensee may apply to the Department for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors (e.g., radioiodine).

[d] Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use user seal check on this type of device. All other respiratory protection program requirements listed in 180 NAC 4-028 apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to 10 may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

[e] Under-chin type only. No distinction is made in this Appendix between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece (that is, disposable or reusable disposable). Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95% efficient and all other requirements of 180 NAC 4 are met.

[f] The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard, and protective actions for these contaminants should be based on external (submersion) dose considerations.

[g] No NIOSH approval schedule is currently available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements, with the exception of fit testing, are met (that is, 180 NAC 4-028).

[h] The licensee should implement institutional controls to assure that these devices are not used in areas immediately dangerous to life or health (IDLH).

[i] This type of respirator may be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure such as skin absorption must be taken into account in these circumstances. This device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

APPENDIX 4-B

ANNUAL LIMITS ON INTAKE (ALI) AND DERIVED AIR CONCENTRATIONS (DAC) OF RADIONUCLIDES FOR OCCUPATIONAL EXPOSURE; EFFLUENT CONCENTRATIONS; CONCENTRATIONS FOR RELEASE TO SANITARY SEWERAGE

Introduction

For each radionuclide, Table I indicates the chemical form which is to be used for selecting the appropriate ALI or DAC value. The ALIs and DACs for inhalation are given for an aerosol with an activity median aerodynamic diameter (AMAD) of 1 μm, micron, and for three classes (D,W,Y) of radioactive material, which refer to their retention (approximately days, weeks or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times for D if less than 10 days, for W from 10 to 100 days, and for Y greater than 100 days. The class (D,W, or Y) given in the column headed "Class" applies only to the inhalation ALIs and DACs given in Table I, columns 2 and 3. Table II provides concentration limits for airborne and liquid effluents released to the general environment. Table III provides concentration limits for discharges to sanitary sewerage.

Note: The values in Tables I, II, and III are presented in the computer "E" notation. In this notation a value of 6E-02 represents a value of 6×10^{-2} or 0.06, 6E+2 represents 6×10^{2} or 600, and 6E+0 represents 6×10^{0} or 6.

Table I "Occupational Values"

Note that the columns in Table I of this appendix captioned "Oral Ingestion ALI," "Inhalation ALI," and "DAC," are applicable to occupational exposure to radioactive material.

The ALIs in this appendix are the annual intakes of given radionuclide by "Reference Man" which would result in either (1) a committed effective dose equivalent of 0.05 Sv (5 rem), stochastic ALI, or (2) a committed dose equivalent of 0.5 Sv (50 rem) to an organ or tissue, non-stochastic ALI. The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of 0.05 Sv (5 rem). The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, w_T. This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of w_T are listed under the definition of weighting factor in 180 NAC 4-02. The non-stochastic ALIs were derived to avoid non-stochastic effects, such as prompt damage to tissue or reduction in organ function.

A value of $w_T = 0.06$ is applicable to each of the five organs or tissues in the "remainder" category receiving the highest dose equivalents, and the dose equivalents of all other remaining tissues may be disregarded. The following portions of the GI tract -- stomach, small intestine, upper large intestine, and lower large intestine -- are to be treated as four separate organs.

Note that the dose equivalents for an extremity, skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined by the non-stochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses. Abbreviated organ or tissue designations are used:

LLI wall = lower large intestine wall;
St. wall = stomach wall;
Blad wall = bladder wall; and
Bone surf = bone surface.

The use of the ALIs listed first, the more limiting of the stochastic and non-stochastic ALIs, will ensure that non-stochastic effects are avoided and that the risk of stochastic effects is limited to an acceptably low value. If, in a particular situation involving a radionuclide for which the nonstochastic ALI is limiting, use of that non-stochastic ALI is considered unduly conservative, the licensee may use the stochastic ALI to determine the committed effective dose equivalent. However, the licensee shall also ensure that the 0.5 Sv (50 rem) dose equivalent limit for any organ or tissue is not exceeded by the sum of the external deep dose equivalent plus the internal committed dose equivalent to that organ, not the effective dose. For the case where there is no external dose contribution, this would be demonstrated if the sum of the fractions of the nonstochastic ALIs (ALI_{ns}) that contribute to the committed dose equivalent to the organ receiving the highest dose does not exceed unity, that is, $\sum$ (intake (in μCi) of each radionuclide/ALI_{ns}) $\leq$ 1.0. If there is an external deep dose equivalent contribution of H_d, then this sum must be less than 1 - (H_d/50), instead of $\leq$1.0.

The derived air concentration (DAC) values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by:

DAC = ALI(in μCi)/(2000 hours per working year x 60 minutes/hour x 2 x 10^4 ml per minute) = [ALI/2.4 x 10^9] μCi/ml,

where 2 x 10^4 ml is the volume of air breathed per minute at work by Reference Man under working conditions of light work.

The DAC values relate to one of two modes of exposure: either external submersion or the internal committed dose equivalents resulting from inhalation of radioactive materials. DACs based upon submersion are for immersion in a semi-infinite cloud of uniform concentration and apply to each radionuclide separately.

The ALI and DAC values include contributions to exposure by the single radionuclide named and any in-growth of daughter radionuclides produced in the body by decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

The values of ALI and DAC do not apply directly when the individual both ingests and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both, or when the individual is exposed to both internal and external irradiation. See 180 NAC 4-06. When an individual is exposed to radioactive materials which fall under several of the translocation classifications of the same radionuclide, such as, Class D, Class W, or Class Y, the exposure may be evaluated as if it were a mixture of different radionuclides.

It should be noted that the classification of a compound as Class D, W, or Y is based on the chemical form of the compound and does not take into account the radiological half-life of different radionuclides. For this reason, values are given for Class D, W, and Y compounds, even for very short-lived radionuclides.

Table II "Effluent Concentrations"

The columns in Table II of this appendix captioned "Effluents," "Air" and "Water" are applicable to the assessment and control of dose to the public, particularly in the implementation of the provisions of 180 NAC 4-014. The concentration values given in Columns 1 and 2 of Table II are equivalent to the radionuclide concentrations which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.5 mSv (0.05 rem).

Consideration of non-stochastic limits has not been included in deriving the air and water effluent concentration limits because non-stochastic effects are presumed not to occur at or below the dose levels established for individual members of the public. For radionuclides, where the non-stochastic

limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in Table II. For this reason, the DAC and airborne effluent limits are not always proportional as was the case in Appendix 1 180 NAC 4.

The air concentration values listed in Table II, Column 1 were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by 2.4×10^9ml, relating the inhalation ALI to the DAC, as explained above, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the 0.05 Sv (5 rem) annual occupational dose limit to the 1 mSv (0.1 rem) limit for members of the public, a factor of 3 to adjust for the difference in exposure time and the inhalation rate for a worker and that for members of the public; and a factor of 2 to adjust the occupational values, derived for adults, so that they are applicable to other age groups.

For those radionuclides for which submersion (external dose) is limiting, the occupational DAC in Table I, Column 3 was divided by 219. The factor of 219 is composed of a factor of 50, as described above, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year). Note that an additional factor of 2 for age considerations is not warranted in the submersion case.

The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^7. The factor of 7.3×10^7 (ml) includes the following components: the factors of 50 and 2 described above and a factor of 7.3×10^5 (ml) which is the annual water intake of Reference Man.

Note 2 at the end of this appendix provides groupings of radionuclides which are applicable to unknown mixtures of radionuclides. These groupings, including occupational inhalation ALIs and DACs, air and water effluent concentrations and releases to sewer, require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of one of the listed radionuclides cannot be definitely excluded as being present either from knowledge of the radionuclide composition of the source or from actual measurements.

Table III "Releases to Sewers"

The monthly average concentrations for release to sanitary sewerage are applicable to the provisions in 004.40. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^6 (ml). The factor of 7.3×10^6 (ml) is composed of a factor of 7.3×10^5 (ml), the annual water intake by Reference Man, and a factor of 10, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a Reference Man during a year, would result in a committed effective dose equivalent of 0.5 mSv (0.5 rem).

APPENDIX 4-B

LIST OF ELEMENTS

Name	Atomic Symbol	Atomic Number	Name	Atomic Symbol	Atomic Number
Actinium	Ac	89	Neodymium	Nd	60
Aluminum	Al	13	Neptunium	Np	93
Americium	Am	95	Nickel	Ni	28
Antimony	Sb	51	Niobium	Nb	41
Argon	Ar	18	Nitrogen	N	7
Arsenic	As	33	Osmium	Os	76
Astatine	At	85	Oxygen	O	8
Barium	Ba	56	Palladium	Pd	46
Berkelium	Bk	97	Phosphorus	P	15
Beryllium	Be	4	Platinum	Pt	78
Bismuth	Bi	83	Plutonium	Pu	94
Bromine	Br	35	Polonium	Po	84
Cadmium	Cd	48	Potassium	K	19
Calcium	Ca	20	Praseodymium	Pr	59
Californium	Cf	98	Promethium	Pm	61
Carbon	C	6	Protactinium	Pa	91
Cerium	Ce	58	Radium	Ra	88
Cesium	Cs	55	Radon	Rn	86
Chlorine	Cl	17	Rhenium	Re	75
Chromium	Cr	24	Rhodium	Rh	45
Cobalt	Co	27	Rubidium	Rb	37
Copper	Cu	29	Ruthenium	Ru	44
Curium	Cm	96	Samarium	Sm	62
Dysprosium	Dy	66	Scandium	Sc	21
Einsteinium	Es	99	Selenium	Se	34
Erbium	Er	68	Silicon	Si	14
Europium	Eu	63	Silver	Ag	47
Fermium	Fm	100	Sodium	Na	11
Fluorine	F	9	Strontium	Sr	38
Francium	Fr	87	Sulfur	S	16
Gadolinium	Gd	64	Tantalum	Ta	73
Gallium	Ga	31	Technetium	Tc	43
Germanium	Ge	32	Tellurium	Te	52
Gold	Au	79	Terbium	Tb	65
Hafnium	Hf	72	Thallium	Tl	81
Holmium	Ho	67	Thorium	Th	90
Hydrogen	H	1	Thulium	Tm	69
Indium	In	49	Tin	Sn	50
Iodine	I	53	Titanium	Ti	22
Iridium	Ir	77	Tungsten	W	74
Iron	Fe	26	Uranium	U	92
Krypton	Kr	36	Vanadium	V	23
Lanthanum	La	57	Xenon	Xe	54
Lead	Pb	82	Ytterbium	Yb	70
Lutetium	Lu	71	Yttrium	Y	39
Magnesium	Mg	12	Zinc	Zn	30
Manganese	Mn	25	Zirconium	Zr	40
Mendelevium	Md	101			
Mercury	Hg	80			
Molybdenum	Mo	42			

Appendix 4-B

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
1	Hydrogen-3	Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
		Gas (HT or T_2) Submersion[1]: Use above values as HT and T_2 oxidize in air and in the body to HTO.						
4	Beryllium-7	W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
		Y, oxides, halides, and nitrates	-	2E+4	8E-6	3E-8	-	-
4	Beryllium-10	W, see ^{7}Be	1E+3	2E+2	6E-8	2E-10	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{7}Be	-	1E+1	6E-9	2E-11	-	-
6	Carbon-11[2]	Monoxide	-	1E+6	5E-4	2E-6	-	-
		Dioxide	-	6E+5	3E-4	9E-7	-	-
		Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2
6	Carbon-14	Monoxide	-	2E+6	7E-4	2E-6	-	-
		Dioxide	-	2E+5	9E-5	3E-7	-	-
		Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
7	Nitrogen-13[2]	Submersion[1]			4E-6	2E-8		
8	Oxygen-15[2]	Submersion[1]			4E-6	2E-8		
9	Fluorine-18[2]	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4	7E+4	3E-5	1E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		W, fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re	-	9E+4	4E-5	1E-7	-	-
		Y, lanthanum fluoride	-	8E+4	3E-5	1E-7	-	-
11	Sodium-22	D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	1E+3	5E-7	2E-9	-	-
13	Aluminum-26	D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	9E+1	4E-8	1E-10	-	-
14	Silicon-31	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		W, oxides, hydroxides, carbides, and nitrates	-	3E+4	1E-5	5E-8	-	-
		Y, aluminosilicate glass	-	3E+4	1E-5	4E-8	-	-
14	Silicon-32	D, see ^{31}Si	2E+3 LLI wall (3E+3)	2E+2 -	1E-7 -	3E-10 -	- 4E-5	- 4E-4
		W, see ^{31}Si	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{31}Si	-	5E+0	2E-9	7E-12	-	-
15	Phosphorus-32	D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+}, S^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+}, and lanthanides	-	4E+2	2E-7	5E-10	-	-
15	Phosphorus-33	D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
		W, see ^{32}P	-	3E+3	1E-6	4E-9	-	-
16	Sulfur-35	Vapor	-	1E+4	6E-6	2E-8	-	-
		D, sulfides and sulfates except those given for W	1E+4 LLI wall (8E+3)	2E+4 -	7E-6 -	2E-8 -	- 1E-4	- 1E-3
		W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	6E+3 -	2E+3	9E-7	3E-9	-	-
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	-	2E+2	1E-7	3E-10	-	-
17	Chlorine-38[2]	D, see ^{36}Cl	2E+4 St wall (3E+4)	4E+4 -	2E-5 -	6E-8 -	- 3E-4	- 3E-3
		W, see ^{36}Cl	-	5E+4	2E-5	6E-8	-	-
17	Chlorine-39[2]	D, see ^{36}Cl	2E+4 St wall (4E+4)	5E+4 -	2E-5 -	7E-8 -	- 5E-4	- 5E-3
		W, see ^{36}Cl	-	6E+4	2E-5	8E-8	-	-
18	Argon-37	Submersion[1]	-	-	1E+0	6E-3	-	-
18	Argon-39	Submersion[1]	-	-	2E-4	8E-7	-	-
18	Argon-41	Submersion[1]	-	-	3E-6	1E-8	-	-
19	Potassium-40	D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5

Appendix 4-B

Atomic No.	Radionuclide	Class	Table 1 Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
			ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
19	Potassium-42	D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
19	Potassium-43	D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
19	Potassium-44[2]	D, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
19	Potassium-45[2]	D, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
20	Calcium-41	W, all compounds	3E+3	4E+3	2E-6	-	-	-
			Bone surf (4E+3)	Bone surf (4E+3)	-	5E-9	6E-5	6E-4
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
21	Scandium-43	Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
21	Scandium-44m	Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
21	Scandium-48	Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
21	Scandium-49[2]	Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	-	3E+1	1E-8	4E-11	-	-
		Y, SrTi0	-	6E+0	2E-9	8E-12	-	-
22	Titanium-45	D, see ^{44}Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{44}Ti	-	4E+4	1E-5	5E-8	-	-
		Y, see ^{44}Ti	-	3E+4	1E-5	4E-8	-	-
23	Vanadium-47[2]	D, all compounds except those given for W	3E+4	8E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	-	1E+5	4E-5	1E-7	-	-
23	Vanadium-48	D, see ^{47}V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
		W, see ^{47}V	-	6E+2	3E-7	9E-10	-	-
23	Vanadium-49	D, see ^{47}V	7E+4	3E+4	1E-5	-	-	-
			LLI wall	Bone surf				

Appendix 4-B

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
			(9E+4)	(3E+4)	-	5E-8	1E-3	1E-2
		W, see ^{47}V	-	2E+4	8E-6	2E-8	-	-
24	Chromium-48	D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, halides and nitrates	-	7E+3	3E-6	1E-8	-	-
		Y, oxides and hydroxides	-	7E+3	3E-6	1E-8	-	-
24	Chromium-49[2]	D, see ^{48}Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{48}Cr	-	1E+5	4E-5	1E-7	-	-
		Y, see ^{48}Cr	-	9E+4	4E-5	1E-7	-	-
24	Chromium-51	D, see ^{48}Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
		W, see ^{48}Cr	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{48}Cr	-	2E+4	8E-6	3E-8	-	-
25	Manganese-51[2]	D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	8E-8	-	-
25	Manganese-52m[2]	D, see ^{51}Mn	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{51}Mn	-	1E+5	4E-5	1E-7	-	-
25	Manganese-52	D, see ^{51}Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
		W, see ^{51}Mn	-	9E+2	4E-7	1E-9	-	-
25	Manganese-53	D, see ^{51}Mn	5E+4	1E+4	5E-6	-	7E-4	7E-3
			-	Bone surf (2E+4)	-	3E-8	-	-
		W, see ^{51}Mn	-	1E+4	5E-6	2E-8	-	-
25	Manganese-54	D, see ^{51}Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
		W, see ^{51}Mn	-	8E+2	3E-7	1E-9	-	-
25	Manganese-56	D, see ^{51}Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{51}Mn	-	2E+4	9E-6	3E-8	-	-
26	Iron-52	D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
		W, oxides, hydroxides, and halides	-	2E+3	1E-6	3E-9	-	-
26	Iron-55	D, see ^{52}Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
		W, see ^{52}Fe	-	4E+3	2E-6	6E-9	-	-
26	Iron-59	D, see ^{52}Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		W, see ^{52}Fe	-	5E+2	2E-7	7E-10	-	-
26	Iron-60	D, see ^{52}Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
		W, see ^{52}Fe	-	2E+1	8E-9	3E-11	-	-
27	Cobalt-55	W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-

Appendix 4-B

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
27	Cobalt-56	W, see ^{55}Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
		Y, see ^{55}Co	4E+2	2E+2	8E-8	3E-10	-	-
27	Cobalt-57	W, see ^{55}Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
		Y, see ^{55}Co	4E+3	7E+2	3E-7	9E-10	-	-
27	Cobalt-58m	W, see ^{55}Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
		Y, see ^{55}Co	-	6E+4	3E-5	9E-8	-	-
27	Cobalt-58	W, see ^{55}Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
		Y, see ^{55}Co	1E+3	7E+2	3E-7	1E-9	-	-
27	Cobalt-60m[2]	W, see ^{55}Co	1E+6	4E+6	2E-3	6E-6	-	-
			St wall (1E+6)	-	-	-	2E-2	2E-1
		Y, see ^{55}Co	-	3E+6	1E-3	4E-6	-	-
27	Cobalt-60	W, see ^{55}Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
		Y, see ^{55}Co	2E+2	3E+1	1E-8	5E-11	-	-
27	Cobalt-61[2]	W, see ^{55}Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{55}Co	2E+4	6E+4	2E-5	8E-8	-	-
27	Cobalt-62m[2]	W, see ^{55}Co	4E+4	2E+5	7E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{55}Co	-	2E+5	6E-5	2E-7	-	-
28	Nickel-56	D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		W, oxides, hydroxides, and carbides	-	1E+3	5E-7	2E-9	-	-
		Vapor	-	1E+3	5E-7	2E-9	-	-
28	Nickel-57	D, see ^{56}Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	6E+3	3E-6	9E-9	-	-
28	Nickel-59	D, see ^{56}Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
		W, see ^{56}Ni	-	7E+3	3E-6	1E-8	-	-
		Vapor	-	2E+3	8E-7	3E-9	-	-
28	Nickel-63	D, see ^{56}Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
		W, see ^{56}Ni	-	3E+3	1E-6	4E-9	-	-
		Vapor	-	8E+2	3E-7	1E-9	-	-
28	Nickel-65	D, see ^{56}Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{56}Ni	-	3E+4	1E-5	4E-8	-	-
		Vapor	-	2E+4	7E-6	2E-8	-	-
28	Nickel-66	D, see ^{56}Ni	4E+2	2E+3	7E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
		W, see ^{56}Ni	-	6E+2	3E-7	9E-10	-	-
		Vapor	-	3E+3	1E-6	4E-9	-	-
29	Copper-60[2]	D, all compounds except those given for W and Y	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	4E-5	1E-7	-	-
29	Copper-61	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	4E+4	2E-5	6E-8	-	-
		Y, see ^{60}Cu	-	4E+4	1E-5	5E-8	-	-
29	Copper-64	D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{60}Cu	-	2E+4	1E-5	3E-8	-	-
		Y, see ^{60}Cu	-	2E+4	9E-6	3E-8	-	-
29	Copper-67	D, see ^{60}Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
		W, see ^{60}Cu	-	5E+3	2E-6	7E-9	-	-
		Y, see ^{60}Cu	-	5E+3	2E-6	6E-9	-	-
30	Zinc-62	Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
30	Zinc-63[2]	Y, all compounds	2E+4	7E+4	3E-5	9E-8	-	-
			St wall (3E+4)	-	-	-	3E-4	3E-3
30	Zinc-65	Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
30	Zinc-69m	Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
30	Zinc-69[2]	Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
30	Zinc-72	Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
31	Gallium-65[2]	D, all compounds except those given for W	5E+4	2E+5	7E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	-	2E+5	8E-5	3E-7	-	-
31	Gallium-66	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-67	D, see ^{65}Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
		W, see ^{65}Ga	-	1E+4	4E-6	1E-8	-	-
31	Gallium-68[2]	D, see ^{65}Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{65}Ga	-	5E+4	2E-5	7E-8	-	-
31	Gallium-70[2]	D, see ^{65}Ga	5E+4	2E+5	7E-5	2E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		W, see ^{65}Ga	-	2E+5	8E-5	3E-7	-	-
31	Gallium-72	D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{65}Ga	-	3E+3	1E-6	4E-9	-	-
31	Gallium-73	D, see ^{65}Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{65}Ga	-	2E+4	6E-6	2E-8	-	-

Appendix 4-B

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
32	Germanium-66	D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
		W, oxides, sulfides, and halides	-	2E+4	8E-6	3E-8	-	-
32	Germanium-67[2]	D, see ^{66}Ge	3E+4	9E+4	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		W, see ^{66}Ge	-	1E+5	4E-5	1E-7	-	-
32	Germanium-68	D, see ^{66}Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
		W, see ^{66}Ge	-	1E+2	4E-8	1E-10	-	-
32	Germanium-69	D, see ^{66}Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
		W, see ^{66}Ge	-	8E+3	3E-6	1E-8	-	-
32	Germanium-71	D, see ^{66}Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
		W, see ^{66}Ge	-	4E+4	2E-5	6E-8	-	-
32	Germanium-75[2]	D, see ^{66}Ge	4E+4	8E+4	3E-5	1E-7	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{66}Ge	-	8E+4	4E-5	1E-7	-	-
32	Germanium-77	D, see ^{66}Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3
		W, see ^{66}Ge	-	6E+3	2E-6	8E-9	-	-
32	Germanium-78[2]	D, see ^{66}Ge	2E+4	2E+4	9E-6	3E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, see ^{66}Ge	-	2E+4	9E-6	3E-8	-	-
33	Arsenic-69[2]	W, all compounds	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
33	Arsenic-70[2]	W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
33	Arsenic-71	W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds	4E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	6E-5	6E-4
33	Arsenic-78[2]	W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
34	Selenium-70[2]	D, all compounds except those given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
		W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
34	Selenium-73m[2]	D, see ^{70}Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	6E-5	2E-7	-	-
34	Selenium-73	D, see ^{70}Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
		W, see ^{70}Se	-	2E+4	7E-6	2E-8	-	-
34	Selenium-75	D, see ^{70}Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
		W, see ^{70}Se	-	6E+2	3E-7	8E-10	-	-
34	Selenium-79	D, see ^{70}Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
		W, see ^{70}Se	-	6E+2	2E-7	8E-10	-	-
34	Selenium-81m[2]	D, see ^{70}Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{70}Se	2E+4	7E+4	3E-5	1E-7	-	-
34	Selenium-81[2]	D, see ^{70}Se	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
		W, see ^{70}Se	-	2E+5	1E-4	3E-7	-	-
34	Selenium-83[2]	D, see ^{70}Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
		W, see ^{70}Se	3E+4	1E+5	5E-5	2E-7	-	-
35	Bromine-74m[2]	D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	-	-
			St wall (2E+4)	-	-	-	3E-4	3E-3
		W, bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	-	4E+4	2E-5	6E-8	-	-
35	Bromine-74[2]	D, see ^{74m}Br	2E+4	7E+4	3E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	8E+4	4E-5	1E-7	-	-
35	Bromine-75[2]	D, see ^{74m}Br	3E+4	5E+4	2E-5	7E-8	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{74m}Br	-	5E+4	2E-5	7E-8	-	-
35	Bromine-76	D, see ^{74m}Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
		W, see ^{74m}Br	-	4E+3	2E-6	6E-9	-	-
35	Bromine-77	D, see ^{74m}Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
		W, see ^{74m}Br	-	2E+4	8E-6	3E-8	-	-
35	Bromine-80m	D, see ^{74m}Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
		W, see ^{74m}Br	-	1E+4	6E-6	2E-8	-	-
35	Bromine-80[2]	D, see ^{74m}Br	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		W, see ^{74m}Br	-	2E+5	9E-5	3E-7	-	-
35	Bromine-82	D, see ^{74m}Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{74m}Br	-	4E+3	2E-6	5E-9	-	-
35	Bromine-83	D, see ^{74m}Br	5E+4	6E+4	3E-5	9E-8	-	-
			St wall (7E+4)	-	-	-	9E-4	9E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
35	Bromine-84[2]	D, see ^{74m}Br	2E+4	6E+4	2E-5	8E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		W, see ^{74m}Br	-	6E+4	3E-5	9E-8	-	-
36	Krypton-74[2]	Submersion[1]	-	-	3E-6	1E-8	-	-
36	Krypton-76	Submersion[1]	-	-	9E-6	4E-8	-	-
36	Krypton-77[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
36	Krypton-79	Submersion[1]	-	-	2E-5	7E-8	-	-
36	Krypton-81	Submersion[1]	-	-	7E-4	3E-6	-	-
36	Krypton-83m[2]	Submersion[1]	-	-	1E-2	5E-5	-	-
36	Krypton-85m	Submersion[1]	-	-	2E-5	1E-7	-	-
36	Krypton-85	Submersion[1]	-	-	1E-4	7E-7	-	-
36	Krypton-87[2]	Submersion[1]	-	-	5E-6	2E-8	-	-
36	Krypton-88	Submersion[1]	-	-	2E-6	9E-9	-	-
37	Rubidium-79[2]	D, all compounds	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
37	Rubidium-81m[2]	D, all compounds	2E+5	3E+5	1E-4	5E-7	-	-
			St wall (3E+5)	-	-	-	4E-3	4E-2
37	Rubidium-81	D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
37	Rubidium-88[2]	D, all compounds	2E+4	6E+4	3E-5	9E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89[2]	D, all compounds	4E+4	1E+5	6E-5	2E-7	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			St wall (6E+4)	-	-	-	9E-4	9E-3
38	Strontium-80[2]	D, all soluble compounds except $SrTiO_3$	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and $SrTiO_3$	-	1E+4	5E-6	2E-8	-	-
38	Strontium-81[2]	D, see [80]Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see [80]Sr	2E+4	8E+4	3E-5	1E-7	-	-
38	Strontium-82	D, see [80]Sr	3E+2	4E+2	2E-7	6E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		Y, see [80]Sr	2E+2	9E+1	4E-8	1E-10	-	-
38	Strontium-83	D, see [80]Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, see [80]Sr	2E+3	4E+3	1E-6	5E-9	-	-
38	Strontium-85m[2]	D, see [80]Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
		Y, see [80]Sr	-	8E+5	4E-4	1E-6	-	-
38	Strontium-85	D, see [80]Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
		Y, see [80]Sr	-	2E+3	6E-7	2E-9	-	-
38	Strontium-87m	D, see [80]Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see [80]Sr	4E+4	2E+5	6E-5	2E-7	-	-
38	Strontium-89	D, see [80]Sr	6E+2	8E+2	4E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see [80]Sr	5E+2	1E+2	6E-8	2E-10	-	-
38	Strontium-90	D, see [80]Sr	3E+1	2E+1	8E-9	-	-	-
			Bone surf (4E+1)	Bone surf (2E+1)	-	3E-11	5E-7	5E-6
		Y, see [80]Sr	-	4E+0	2E-9	6E-12	-	-
38	Strontium-91	D, see [80]Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
		Y, see [80]Sr	-	4E+3	1E-6	5E-9	-	-
38	Strontium-92	D, see [80]Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see [80]Sr	-	7E+3	3E-6	9E-9	-	-
39	Yttrium-86m[2]	W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		Y, oxides and hydroxides	-	5E+4	2E-5	8E-8	-	-
39	Yttrium-86	W, see [86m]Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
		Y, see [86m]Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-87	W, see [86m]Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		Y, see [86m]Y	-	3E+3	1E-6	5E-9	-	-
39	Yttrium-88	W, see [86m]Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
		Y, see [86m]Y	-	2E+2	1E-7	3E-10	-	-
39	Yttrium-90m	W, see [86m]Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
		Y, see [86m]Y	-	1E+4	5E-6	2E-8	-	-

Appendix 4-B

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
39	Yttrium-90	W, see ^{86m}Y	4E+2	7E+2	3E-7	9E-10	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{86m}Y	-	6E+2	3E-7	9E-10	-	-
39	Yttrium-91m[2]	W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
		Y, see ^{86m}Y	-	2E+5	7E-5	2E-7	-	-
39	Yttrium-91	W, see ^{86m}Y	5E+2	2E+2	7E-8	2E-10	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, see ^{86m}Y	-	1E+2	5E-8	2E-10	-	-
39	Yttrium-92	W, see ^{86m}Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{86m}Y	-	8E+3	3E-6	1E-8	-	-
39	Yttrium-93	W, see ^{86m}Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{86m}Y	-	2E+3	1E-6	3E-9	-	-
39	Yttrium-94[2]	W, see ^{86m}Y	2E+4	8E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
		Y, see ^{86m}Y	-	8E+4	3E-5	1E-7	-	-
39	Yttrium-95[2]	W, see ^{86m}Y	4E+4	2E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{86m}Y	-	1E+5	6E-5	2E-7	-	-
40	Zirconium-86	D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	-	3E+3	1E-6	4E-9	-	-
		Y, carbide	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-88	D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
		W, see ^{86}Zr	-	5E+2	2E-7	7E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-
40	Zirconium-89	D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
		Y, see ^{86}Zr	-	2E+3	1E-6	3E-9	-	-
40	Zirconium-93	D, see ^{86}Zr	1E+3	6E+0	3E-9	-	-	-
			Bone surf (3E+3)	Bone surf (2E+1)	-	2E-11	4E-5	4E-4
		W, see ^{86}Zr	-	2E+1	1E-8	-	-	-
			-	Bone surf (6E+1)	-	9E-11	-	-
		Y, see ^{86}Zr	-	6E+1	2E-8	-	-	-
			-	Bone surf (7E+1)	-	9E-11	-	-
40	Zirconium-95	D, see ^{86}Zr	1E+3	1E+2	5E-8	-	2E-5	2E-4
			-	Bone surf (3E+2)	-	4E-10	-	-
		W, see ^{86}Zr	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{86}Zr	-	3E+2	1E-7	4E-10	-	-

Appendix 4-B

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
40	Zirconium-97	D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
		W, see ^{86}Zr	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{86}Zr	-	1E+3	5E-7	2E-9	-	-
41	Niobium-88[2]	W, all compounds except those given for Y	5E+4	2E+5	9E-5	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, oxides and hydroxides	-	2E+5	9E-5	3E-7	-	-
41	Niobium-89[2] (66 min)	W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3
		Y, see ^{88}Nb	-	4E+4	2E-5	5E-8	-	-
41	Niobium-89 (122 min)	W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{88}Nb	-	2E+4	6E-6	2E-8	-	-
41	Niobium-90	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-93m	W, see ^{88}Nb	9E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+4)	-	-	-	2E-4	2E-3
		Y, see ^{88}Nb	-	2E+2	7E-8	2E-10	-	-
41	Niobium-94	W, see ^{88}Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
		Y, see ^{88}Nb	-	2E+1	6E-9	2E-11	-	-
41	Niobium-95m	W, see ^{88}Nb	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{88}Nb	-	2E+3	9E-7	3E-9	-	-
41	Niobium-95	W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		Y, see ^{88}Nb	-	1E+3	5E-7	2E-9	-	-
41	Niobium-96	W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		Y, see ^{88}Nb	-	2E+3	1E-6	3E-9	-	-
41	Niobium-97[2]	W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		Y, see ^{88}Nb	-	7E+4	3E-5	1E-7	-	-
41	Niobium-98[2]	W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
		Y, see ^{88}Nb	-	5E+4	2E-5	7E-8	-	-
42	Molybdenum-90	D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
		Y, oxides, hydroxides, and MoS_2	2E+3	5E+3	2E-6	6E-9	-	-
42	Molybdenum-93m	D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
		Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	-	-
42	Molybdenum-93	D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	-	-
42	Molybdenum-99	D, see ^{90}Mo	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	-	-
42	Molybdenum-101[2]	D, see ^{90}Mo	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	7E-4	7E-3
		Y, see ^{90}Mo	-	1E+5	6E-5	2E-7	-	-
43	Technetium-93m[2]	D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, and nitrates	-	3E+5	1E-4	4E-7	-	-
43	Technetium-93	D, see ^{93m}Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		W, see ^{93m}Tc	-	1E+5	4E-5	1E-7	-	-
43	Technetium-94m[2]	D, see ^{93m}Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{93m}Tc	-	6E+4	2E-5	8E-8	-	-
43	Technetium-94	D, see ^{93m}Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	1E-5	3E-8	-	-
43	Technetium-95m	D, see ^{93m}Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
		W, see ^{93m}Tc	-	2E+3	8E-7	3E-9	-	-
43	Technetium-95	D, see ^{93m}Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{93m}Tc	-	2E+4	8E-6	3E-8	-	-
43	Technetium-96m[2]	D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-96	D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{93m}Tc	-	2E+3	9E-7	3E-9	-	-
43	Technetium-97m	D, see ^{93m}Tc	5E+3	7E+3	3E-6	-	6E-5	6E-4
			-	St wall (7E+3)	-	1E-8	-	-
		W, see ^{93m}Tc	-	1E+3	5E-7	2E-9	-	-
43	Technetium-97	D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
		W, see ^{93m}Tc	-	6E+3	2E-6	8E-9	-	-
43	Technetium-98	D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{93m}Tc	-	3E+2	1E-7	4E-10	-	-
43	Technetium-99m	D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{93m}Tc	-	2E+5	1E-4	3E-7	-	-
43	Technetium-99	D, see ^{93m}Tc	4E+3	5E+3	2E-6	-	6E-5	6E-4
			-	St wall (6E+3)	-	8E-9	-	-
		W, see ^{93m}Tc	-	7E+2	3E-7	9E-10	-	-
43	Technetium-101[2]	D, see ^{93m}Tc	9E+4	3E+5	1E-4	5E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
		W, see ^{93m}Tc	-	4E+5	2E-4	5E-7	-	-
43	Technetium-104[2]	D, see ^{93m}Tc	2E+4	7E+4	3E-5	1E-7	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
		W, see ^{93m}Tc	-	9E+4	4E-5	1E-7	-	-
44	Ruthenium-94[2]	D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, halides	-	6E+4	3E-5	9E-8	-	-
		Y, oxides and hydroxides	-	6E+4	2E-5	8E-8	-	-
44	Ruthenium-97	D, see ^{94}Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
		W, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-103	D, see ^{94}Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
		W, see ^{94}Ru	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{94}Ru	-	6E+2	3E-7	9E-10	-	-
44	Ruthenium-105	D, see ^{94}Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
		W, see ^{94}Ru	-	1E+4	6E-6	2E-8	-	-
		Y, see ^{94}Ru	-	1E+4	5E-6	2E-8	-	-
44	Ruthenium-106	D, see ^{94}Ru	2E+2	9E+1	4E-8	1E-10	-	-
			LLI wall (2E+2)	-	-	-	3E-6	3E-5
		W, see ^{94}Ru	-	5E+1	2E-8	8E-11	-	-
		Y, see ^{94}Ru	-	1E+1	5E-9	2E-11	-	-
45	Rhodium-99m	D, all compounds except those given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		W, halides	-	8E+4	3E-5	1E-7	-	-
		Y, oxides and hydroxides	-	7E+4	3E-5	9E-8	-	-
45	Rhodium-99	D, see ^{99m}Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{99m}Rh	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{99m}Rh	-	2E+3	8E-7	3E-9	-	-
45	Rhodium-100	D, see ^{99m}Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
		W, see ^{99m}Rh	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{99m}Rh	-	4E+3	2E-6	5E-9	-	-
45	Rhodium-101m	D, see ^{99m}Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{99m}Rh	-	8E+3	4E-6	1E-8	-	-
		Y, see ^{99m}Rh	-	8E+3	3E-6	1E-8	-	-
45	Rhodium-101	D, see ^{99m}Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{99m}Rh	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{99m}Rh	-	2E+2	6E-8	2E-10	-	-
45	Rhodium-102m	D, see ^{99m}Rh	1E+3	5E+2	2E-7	7E-10	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		W, see ^{99m}Rh	-	4E+2	2E-7	5E-10	-	-
		Y, see ^{99m}Rh	-	1E+2	5E-8	2E-10	-	-
45	Rhodium-102	D, see ^{99m}Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
		W, see ^{99m}Rh	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{99m}Rh	-	6E+1	2E-8	8E-11	-	-
45	Rhodium-103m[2]	D, see ^{99m}Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
		W, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-
		Y, see ^{99m}Rh	-	1E+6	5E-4	2E-6	-	-

Appendix 4-B

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
45	Rhodium-105	D, see ^{99m}Rh	4E+3	1E+4	5E-6	2E-8	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
		W, see ^{99m}Rh	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{99m}Rh	-	6E+3	2E-6	8E-9	-	-
45	Rhodium-106m	D, see ^{99m}Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{99m}Rh	-	4E+4	2E-5	5E-8	-	-
		Y, see ^{99m}Rh	-	4E+4	1E-5	5E-8	-	-
45	Rhodium-107[2]	D, see ^{99m}Rh	7E+4	2E+5	1E-4	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{99m}Rh	-	3E+5	1E-4	4E-7	-	-
		Y, see ^{99m}Rh	-	3E+5	1E-4	3E-7	-	-
46	Palladium-100	D, all compounds except those given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
		W, nitrates	-	1E+3	5E-7	2E-9	-	-
		Y, oxides and hydroxides	-	1E+3	6E-7	2E-9	-	-
46	Palladium-101	D, see ^{100}Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{100}Pd	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{100}Pd	-	3E+4	1E-5	4E-8	-	-
46	Palladium-103	D, see ^{100}Pd	6E+3	6E+3	3E-6	9E-9	-	-
			LLI wall (7E+3)	-	-	-	1E-4	1E-3
		W, see ^{100}Pd	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{100}Pd	-	4E+3	1E-6	5E-9	-	-
46	Palladium-107	D, see ^{100}Pd	3E+4	2E+4	9E-6	-	-	-
			LLI wall (4E+4)	Kidneys (2E+4)	-	3E-8	5E-4	5E-3
		W, see ^{100}Pd	-	7E+3	3E-6	1E-8	-	-
		Y, see ^{100}Pd	-	4E+2	2E-7	6E-10	-	-
46	Palladium-109	D, see ^{100}Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		W, see ^{100}Pd	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{100}Pd	-	5E+3	2E-6	6E-9	-	-
47	Silver-102[2]	D, all compounds except those given for W and Y	5E+4	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	9E-4	9E-3
		W, nitrates and sulfides	-	2E+5	9E-5	3E-7	-	-
		Y, oxides and hydroxides	-	2E+5	8E-5	3E-7	-	-
47	Silver-103[2]	D, see ^{102}Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104m[2]	D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
		W, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	5E-5	2E-7	-	-
47	Silver-104[2]	D, see ^{102}Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-
		Y, see ^{102}Ag	-	1E+5	6E-5	2E-7	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
47	Silver-105	D, see ^{102}Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
		W, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{102}Ag	-	2E+3	7E-7	2E-9	-	-
47	Silver-106m	D, see ^{102}Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-106[2]	D, see ^{102}Ag	6E+4 St. wall (6E+4)	2E+5	8E-5	3E-7	-	-
			-	-	-	-	9E-4	9E-3
		W, see ^{102}Ag	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{102}Ag	-	2E+5	8E-5	3E-7	-	-
47	Silver-108m	D, see ^{102}Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5
		W, see ^{102}Ag	-	3E+2	1E-7	4E-10	-	-
		Y, see ^{102}Ag	-	2E+1	1E-8	3E-11	-	-
47	Silver-110m	D, see ^{102}Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
		W, see ^{102}Ag	-	2E+2	8E-8	3E-10	-	-
		Y, see ^{102}Ag	-	9E+1	4E-8	1E-10	-	-
47	Silver-111	D, see ^{102}Ag	9E+2	2E+3	6E-7	-	-	-
			LLI wall (1E+3)	Liver (2E+3)	-	2E-9	2E-5	2E-4
		W, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
		Y, see ^{102}Ag	-	9E+2	4E-7	1E-9	-	-
47	Silver-112	D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{102}Ag	-	1E+4	4E-6	1E-8	-	-
		Y, see ^{102}Ag	-	9E+3	4E-6	1E-8	-	-
47	Silver-115[2]	D, see ^{102}Ag	3E+4 St wall (3E+4)	9E+4	4E-5	1E-7	-	-
			-	-	-	-	4E-4	4E-3
		W, see ^{102}Ag	-	9E+4	4E-5	1E-7	-	-
		Y, see ^{102}Ag	-	8E+4	3E-5	1E-7	-	-
48	Cadmium-104[2]	D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates	-	1E+5	5E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
48	Cadmium-107	D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{104}Cd	-	6E+4	2E-5	8E-8	-	-
		Y, see ^{104}Cd	-	5E+4	2E-5	7E-8	-	-
48	Cadmium-109	D, see ^{104}Cd	3E+2 Kidneys (4E+2)	4E+1 Kidneys (5E+1)	1E-8	-	-	-
					-	7E-11	6E-6	6E-5
		W, see ^{104}Cd	-	1E+2 Kidneys (1E+2)	5E-8	-	-	-
			-		-	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
48	Cadmium-113m	D, see ^{104}Cd	2E+1 Kidneys	2E+0 Kidneys	1E-9	-	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(4E+1)	(4E+0)	-	5E-12	5E-7	5E-6
		W, see ^{104}Cd	-	8E+0	4E-9	-	-	-
			-	Kidneys (1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	5E-9	2E-11	-	-
48	Cadmium-113	D, see ^{104}Cd	2E+1	2E+0	9E-10	-	-	-
			Kidneys (3E+1)	Kidneys (3E+0)	-	5E-12	4E-7	4E-6
		W, see ^{104}Cd	-	8E+0	3E-9	-	-	-
			-	Kidneys (1E+1)	-	2E-11	-	-
		Y, see ^{104}Cd	-	1E+1	6E-9	2E-11	-	-
48	Cadmium-115m	D, see ^{104}Cd	3E+2	5E+1	2E-8	-	4E-6	4E-5
			-	Kidneys (8E+1)	-	1E-10	-	-
		W, see ^{104}Cd	-	1E+2	5E-8	2E-10	-	-
		Y, see ^{104}Cd	-	1E+2	6E-8	2E-10	-	-
48	Cadmium-115	D, see ^{104}Cd	9E+2	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
		W, see ^{104}Cd	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{104}Cd	-	1E+3	6E-7	2E-9	-	-
48	Cadmium-117m	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
48	Cadmium-117	D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		W, see ^{104}Cd	-	2E+4	7E-6	2E-8	-	-
		Y, see ^{104}Cd	-	1E+4	6E-6	2E-8	-	-
49	Indium-109	D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	-	6E+4	3E-5	9E-8	-	-
49	Indium-110[2] (69.1 min)	D, see ^{109}In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	6E+4	2E-5	8E-8	-	-
49	Indium-110 (4.9 h)	D, see ^{109}In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		W, see ^{109}In	-	2E+4	8E-6	3E-8	-	-
49	Indium-111	D, see ^{109}In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
		W, see ^{109}In	-	6E+3	3E-6	9E-9	-	-
49	Indium-112[2]	D, see ^{109}In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
		W, see ^{109}In	-	7E+5	3E-4	1E-6	-	-
49	Indium-113m[2]	D, see ^{109}In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		W, see ^{109}In	-	2E+5	8E-5	3E-7	-	-
49	Indium-114m	D, see ^{109}In	3E+2	6E+1	3E-8	9E-11	-	-
			LLI wall (4E+2)	-	-	-	5E-6	5E-5
		W, see ^{109}In	-	1E+2	4E-8	1E-10	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
49	Indium-115m	D, see ^{109}In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{109}In	-	5E+4	2E-5	7E-8	-	-
49	Indium-115	D, see ^{109}In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
		W, see ^{109}In	-	5E+0	2E-9	8E-12	-	-
49	Indium-116m[2]	D, see ^{109}In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{109}In	-	1E+5	5E-5	2E-7	-	-
49	Indium-117m[2]	D, see ^{109}In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{109}In	-	4E+4	2E-5	6E-8	-	-
49	Indium-117[2]	D, see ^{109}In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
		W, see ^{109}In	-	2E+5	9E-5	3E-7	-	-
49	Indium-119m[2]	D, see ^{109}In	4E+4 St wall (5E+4)	1E+5 -	5E-5 -	2E-7 -	7E-4	7E-3
		W, see ^{109}In	-	1E+5	6E-5	2E-7	-	-
50	Tin-110	D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	-	1E+4	5E-6	2E-8	-	-
50	Tin-111[2]	D, see ^{110}Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
		W, see ^{110}Sn	-	3E+5	1E-4	4E-7	-	-
50	Tin-113	D, see ^{110}Sn	2E+3 LLI wall (2E+3)	1E+3 -	5E-7 -	2E-9 -	3E-5	3E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ^{110}Sn	2E+3 LLI wall (2E+3)	1E+3 Bone surf (2E+3)	5E-7 -	- 3E-9	- 3E-5	- 3E-4
		W, see ^{110}Sn	-	1E+3	6E-7	2E-9	-	-
50	Tin-119m	D, see ^{110}Sn	3E+3 LLI wall (4E+3)	2E+3 -	1E-6 -	3E-9 -	- 6E-5	- 6E-4
		W, see ^{110}Sn	-	1E+3	4E-7	1E-9	-	-
50	Tin-121m	D, see ^{110}Sn	3E+3 LLI wall (4E+3)	9E+2 -	4E-7 -	1E-9 -	- 5E-5	- 5E-4
		W, see ^{110}Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-121	D, see ^{110}Sn	6E+3 LLI wall (6E+3)	2E+4 -	6E-6 -	2E-8 -	- 8E-5	- 8E-4
		W, see ^{110}Sn	-	1E+4	5E-6	2E-8	-	-
50	Tin-123m[2]	D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
		W, see ^{110}Sn	-	1E+5	6E-5	2E-7	-	-
50	Tin-123	D, see ^{110}Sn	5E+2 LLI wall	6E+2	3E-7	9E-10	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(6E+2)	-	-	-	9E-6	9E-5
		W, see ^{110}Sn	-	2E+2	7E-8	2E-10	-	-
50	Tin-125	D, see ^{110}Sn	4E+2	9E+2	4E-7	1E-9	-	-
			LLI wall (5E+2)	-	-	-	6E-6	6E-5
		W, see ^{110}Sn	-	4E+2	1E-7	5E-10	-	-
50	Tin-126	D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
		W, see ^{110}Sn	-	7E+1	3E-8	9E-11	-	-
50	Tin-127	D, see ^{110}Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		W, see ^{110}Sn	-	2E+4	8E-6	3E-8	-	-
50	Tin-128[2]	D, see ^{110}Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, see ^{110}Sn	-	4E+4	1E-5	5E-8	-	-
51	Antimony-115[2]	D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	-	3E+5	1E-4	4E-7	-	-
51	Antimony-116m[2]	D, see ^{115}Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
		W, see ^{115}Sb	-	1E+5	6E-5	2E-7	-	-
51	Antimony-116[2]	D, see ^{115}Sb	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{115}Sb	-	3E+5	1E-4	5E-7	-	-
51	Antimony-117	D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
		W, see ^{115}Sb	-	3E+5	1E-4	4E-7	-	-
51	Antimony-118m	D, see ^{115}Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	-	-
51	Antimony-119	D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	-	-
51	Antimony-120[2] (16 min)	D, see ^{115}Sb	1E+5	4E+5	2E-4	6E-7	-	-
			St wall (2E+5)	-	-	-	2E-3	2E-2
		W, see ^{115}Sb	-	5E+5	2E-4	7E-7	-	-
51	Antimony-120 (5.76 d)	D, see ^{115}Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		W, see ^{115}Sb	9E+2	1E+3	5E-7	2E-9	-	-
51	Antimony-122	D, see ^{115}Sb	8E+2	2E+3	1E-6	3E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
		W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	-	-
51	Antimony-124m[2]	D, see ^{115}Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
		W, see ^{115}Sb	2E+5	6E+5	2E-4	8E-7	-	-
51	Antimony-124	D, see ^{115}Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	2E+2	1E-7	3E-10	-	-
51	Antimony-125	D, see ^{115}Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
		W, see ^{115}Sb	-	5E+2	2E-7	7E-10	-	-
51	Antimony-126m[2]	D, see ^{115}Sb	5E+4 St wall (7E+4)	2E+5 -	8E-5 -	3E-7 -	- 9E-4	- 9E-3
		W, see ^{115}Sb	-	2E+5	8E-5	3E-7	-	-
51	Antimony-126	D, see ^{115}Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5
		W, see ^{115}Sb	5E+2	5E+2	2E-7	7E-10	-	-
51	Antimony-127	D, see ^{115}Sb	8E+2 LLI wall (8E+2)	2E+3 -	9E-7 -	3E-9 -	- 1E-5	- 1E-4
		W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	-	-
51	Antimony-128[2] (10.4 min)	D, see ^{115}Sb	8E+4 St wall (1E+5)	4E+5 -	2E-4 -	5E-7 -	- 1E-3	- 1E-2
		W, see ^{115}Sb	-	4E+5	2E-4	6E-7	-	-
51	Antimony-128 (9.01 h)	D, see ^{115}Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
		W, see ^{115}Sb	-	3E+3	1E-6	5E-9	-	-
51	Antimony-129	D, see ^{115}Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, see ^{115}Sb	-	9E+3	4E-6	1E-8	-	-
51	Antimony-130[2]	D, see ^{115}Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, see ^{115}Sb	-	8E+4	3E-5	1E-7	-	-
51	Antimony-131[2]	D, see ^{115}Sb	1E+4 Thyroid (2E+4)	2E+4 Thyroid (4E+4)	1E-5 -	- 6E-8	- 2E-4	- 2E-3
		W, see ^{115}Sb	- -	2E+4 Thyroid (4E+4)	1E-5 -	6E-8	- -	- -
52	Tellurium-116	D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ^{116}Te	5E+2 Bone surf (7E+2)	2E+2 Bone surf (4E+2)	8E-8 -	- 5E-10	- 1E-5	- 1E-4
		W, see ^{116}Te	-	4E+2	2E-7	6E-10	-	-
52	Tellurium-121	D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
		W, see ^{116}Te	-	3E+3	1E-6	4E-9	-	-
52	Tellurium-123m	D, see ^{116}Te	6E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	9E-8 -	- 8E-10	- 1E-5	- 1E-4
		W, see ^{116}Te	-	5E+2	2E-7	8E-10	-	-
52	Tellurium-123	D, see ^{116}Te	5E+2 Bone surf (1E+3)	2E+2 Bone surf (5E+2)	8E-8 -	- 7E-10	- 2E-5	- 2E-4
		W, see ^{116}Te	- -	4E+2 Bone surf (1E+3)	2E-7 -	- 2E-9	- -	- -

			Table 1 Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
52	Tellurium-125m	D, see ^{116}Te	1E+3 Bone surf (1E+3)	4E+2 Bone surf (1E+3)	2E-7 -	- 1E-9	- 2E-5	- 2E-4
		W, see ^{116}Te	-	7E+2	3E-7	1E-9	-	-
52	Tellurium-127m	D, see ^{116}Te	6E+2	3E+2 Bone surf (4E+2)	1E-7 -	- 6E-10	9E-6 -	9E-5 -
		W, see ^{116}Te	-	3E+2	1E-7	4E-10	-	-
52	Tellurium-127	D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{116}Te	-	2E+4	7E-6	2E-8	-	-
52	Tellurium-129m	D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
		W, see ^{116}Te	-	2E+2	1E-7	3E-10	-	-
52	Tellurium-129[2]	D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{116}Te	-	7E+4	3E-5	1E-7	-	-
52	Tellurium-131m	D, see ^{116}Te	3E+2 Thyroid (6E+2)	4E+2 Thyroid (1E+3)	2E-7 -	- 2E-9	- 8E-6	- 8E-5
		W, see ^{116}Te	-	4E+2 Thyroid (9E+2)	2E-7 -	- 1E-9	- -	- -
52	Tellurium-131[2]	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- 8E-5	- 8E-4
		W, see ^{116}Te	-	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- -	- -
52	Tellurium-132	D, see ^{116}Te	2E+2 Thyroid (7E+2)	2E+2 Thyroid (8E+2)	9E-8 -	- 1E-9	- 9E-6	- 9E-5
		W, see ^{116}Te	-	2E+2 Thyroid (6E+2)	9E-8 -	- 9E-10	- -	- -
52	Tellurium-133m[2]	D, see ^{116}Te	3E+3 Thyroid (6E+3)	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- 9E-5	- 9E-4
		W, see ^{116}Te	-	5E+3 Thyroid (1E+4)	2E-6 -	- 2E-8	- -	- -
52	Tellurium-133[2]	D, see ^{116}Te	1E+4 Thyroid (3E+4)	2E+4 Thyroid (6E+4)	9E-6 -	- 8E-8	- 4E-4	- 4E-3
		W, see ^{116}Te	-	2E+4 Thyroid (6E+4)	9E-6 -	- 8E-8	- -	- -
52	Tellurium-134[2]	D, see ^{116}Te	2E+4 Thyroid (2E+4)	2E+4 Thyroid (5E+4)	1E-5 -	- 7E-8	- 3E-4	- 3E-3
		W, see ^{116}Te	-	2E+4 Thyroid	1E-5	-	-	-

			Table 1 Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
			-	(5E+4)	-	7E-8	-	-
53	Iodine-120m[2]	D, all compounds	1E+4 Thyroid (1E+4)	2E+4 -	9E-6 -	3E-8 -	- 2E-4	- 2E-3
53	Iodine-120[2]	D, all compounds	4E+3 Thyroid (8E+3)	9E+3 Thyroid (1E+4)	4E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-121	D, all compounds	1E+4 Thyroid (3E+4)	2E+4 Thyroid (5E+4)	8E-6 -	- 7E-8	- 4E-4	- 4E-3
53	Iodine-123	D, all compounds	3E+3 Thyroid (1E+4)	6E+3 Thyroid (2E+4)	3E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-124	D, all compounds	5E+1 Thyroid (2E+2)	8E+1 Thyroid (3E+2)	3E-8 -	- 4E-10	- 2E-6	- 2E-5
53	Iodine-125	D, all compounds	4E+1 Thyroid (1E+2)	6E+1 Thyroid (2E+2)	3E-8 -	- 3E-10	- 2E-6	- 2E-5
53	Iodine-126	D, all compounds	2E+1 Thyroid (7E+1)	4E+1 Thyroid (1E+2)	1E-8 -	- 2E-10	- 1E-6	- 1E-5
53	Iodine-128[2]	D, all compounds	4E+4 St wall (6E+4)	1E+5 -	5E-5 -	2E-7 -	- 8E-4	- 8E-3
53	Iodine-129	D, all compounds	5E+0 Thyroid (2E+1)	9E+0 Thyroid (3E+1)	4E-9 -	- 4E-11	- 2E-7	- 2E-6
53	Iodine-130	D, all compounds	4E+2 Thyroid (1E+3)	7E+2 Thyroid (2E+3)	3E-7 -	- 3E-9	- 2E-5	- 2E-4
53	Iodine-131	D, all compounds	3E+1 Thyroid (9E+1)	5E+1 Thyroid (2E+2)	2E-8 -	- 2E-10	- 1E-6	- 1E-5
53	Iodine-132m[2]	D, all compounds	4E+3 Thyroid (1E+4)	8E+3 Thyroid (2E+4)	4E-6 -	- 3E-8	- 1E-4	- 1E-3
53	Iodine-132	D, all compounds	4E+3 Thyroid (9E+3)	8E+3 Thyroid (1E+4)	3E-6 -	- 2E-8	- 1E-4	- 1E-3
53	Iodine-133	D, all compounds	1E+2 Thyroid (5E+2)	3E+2 Thyroid (9E+2)	1E-7 -	- 1E-9	- 7E-6	- 7E-5
53	Iodine-134[2]	D, all compounds	2E+4	5E+4	2E-5	6E-8	-	-

Appendix 4-B

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Table III release to Sewers Monthly Average Concentration (μCi/ml)
			Thyroid (3E+4)	-	-	-	4E-4	4E-3
53	Iodine-135	D, all compounds	8E+2	2E+3	7E-7	-	-	-
			Thyroid (3E+3)	Thyroid (4E+3)	-	6E-9	3E-5	3E-4
54	Xenon-120[2]	Submersion[1]	-	-	1E-5	4E-8	-	-
54	Xenon-121[2]	Submersion[1]	-	-	2E-6	1E-8	-	-
54	Xenon-122	Submersion[1]	-	-	7E-5	3E-7	-	-
54	Xenon-123	Submersion[1]	-	-	6E-6	3E-8	-	-
54	Xenon-125	Submersion[1]	-	-	2E-5	7E-8	-	-
54	Xenon-127	Submersion[1]	-	-	1E-5	6E-8	-	-
54	Xenon-129m	Submersion[1]	-	-	2E-4	9E-7	-	-
54	Xenon-131m	Submersion[1]	-	-	4E-4	2E-6	-	-
54	Xenon-133m	Submersion[1]	-	-	1E-4	6E-7	-	-
54	Xenon-133	Submersion[1]	-	-	1E-4	5E-7	-	-
54	Xenon-135m[2]	Submersion[1]	-	-	9E-6	4E-8	-	-
54	Xenon-135	Submersion[1]	-	-	1E-5	7E-8	-	-
54	Xenon-138[2]	Submersion[1]	-	-	4E-6	2E-8	-	-
55	Cesium-125[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
55	Cesium-127	D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
55	Cesium-130[2]	D, all compounds	6E+4	2E+5	8E-5	3E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
55	Cesium-131	D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
55	Cesium-132	D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds	1E+5	1E+5	6E-5	2E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
55	Cesium-134	D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
55	Cesium-135m[2]	D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
55	Cesium-137	D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
55	Cesium-138[2]	D, all compounds	2E+4	6E+4	2E-5	8E-8	-	-
			St wall (3E+4)	-	-	-	4E-4	4E-3
56	Barium-126[2]	D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4
56	Barium-128	D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
56	Barium-131m[2]	D, all compounds	4E+5	1E+6	6E-4	2E-6	-	-
			St wall (5E+5)	-	-	-	7E-3	7E-2
56	Barium-131	D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds	2E+3	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
56	Barium-133	D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
56	Barium-139[2]	D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds	5E+2	1E+3	6E-7	2E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
56	Barium-141[2]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
56	Barium-142[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
57	Lanthanum-131[2]	D, all compounds except those given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		W, oxides and hydroxides	-	2E+5	7E-5	2E-7	-	-
57	Lanthanum-132	D, see ^{131}La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-
57	Lanthanum-135	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
57	Lanthanum-137	D, see ^{131}La	1E+4	6E+1 Liver	3E-8	-	2E-4	2E-3
			-	(7E+1)	-	1E-10	-	-
		W, see ^{131}La	-	3E+2 Liver	1E-7	-	-	-
			-	(3E+2)	-	4E-10	-	-
57	Lanthanum-138	D, see ^{131}La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
		W, see ^{131}La	-	1E+1	6E-9	2E-11	-	-
57	Lanthanum-140	D, see ^{131}La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{131}La	-	1E+3	5E-7	2E-9	-	-
57	Lanthanum-141	D, see ^{131}La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		W, see ^{131}La	-	1E+4	5E-6	2E-8	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
57	Lanthanum-142[2]	D, see ^{131}La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{131}La	-	3E+4	1E-5	5E-8	-	-
57	Lanthanum-143[2]	D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	-	-
			St wall (4E+4)	-	-	-	5E-4	5E-3
		W, see ^{131}La	-	9E+4	4E-5	1E-7	-	-
58	Cerium-134	W, all compounds except those given for Y	5E+2	7E+2	3E-7	1E-9	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		Y, oxides, hydroxides, and fluorides	-	7E+2	3E-7	9E-10	-	-
58	Cerium-135	W, see ^{134}Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		Y, see ^{134}Ce	-	4E+3	1E-6	5E-9	-	-
58	Cerium-137m	W, see ^{134}Ce	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	4E+3	2E-6	5E-9	-	-
58	Cerium-137	W, see ^{134}Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
		Y, see ^{134}Ce	-	1E+5	5E-5	2E-7	-	-
58	Cerium-139	W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
		Y, see ^{134}Ce	-	7E+2	3E-7	9E-10	-	-
58	Cerium-141	W, see ^{134}Ce	2E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		Y, see ^{134}Ce	-	6E+2	2E-7	8E-10	-	-
58	Cerium-143	W, see ^{134}Ce	1E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{134}Ce	-	2E+3	7E-7	2E-9	-	-
58	Cerium-144	W, see ^{134}Ce	2E+2	3E+1	1E-8	4E-11	-	-
			LLI wall (3E+2)	-	-	-	3E-6	3E-5
		Y, see ^{134}Ce	-	1E+1	6E-9	2E-11	-	-
59	Praseodymium-136[2]	W, all compounds except those given for Y	5E+4	2E+5	1E-4	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, oxides, hydroxides, carbides, and fluorides	-	2E+5	9E-5	3E-7	-	-
59	Praseodymium-137[2]	W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-138m	W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
		Y, see ^{136}Pr	-	4E+4	2E-5	6E-8	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I: Col. 2 Inhalation ALI (μCi)	Table I: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
59	Praseodymium-139	W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-142m[2]	W, see ^{136}Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
		Y, see ^{136}Pr	-	1E+5	6E-5	2E-7	-	-
59	Praseodymium-142	W, see ^{136}Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
		Y, see ^{136}Pr	-	2E+3	8E-7	3E-9	-	-
59	Praseodymium-143	W, see ^{136}Pr	9E+2	8E+2	3E-7	1E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Pr	-	7E+2	3E-7	9E-10	-	-
59	Praseodymium-144[2]	W, see ^{136}Pr	3E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{136}Pr	-	1E+5	5E-5	2E-7	-	-
59	Praseodymium-145	W, see ^{136}Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		Y, see ^{136}Pr	-	8E+3	3E-6	1E-8	-	-
59	Praseodymium-147[2]	W, see ^{136}Pr	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
		Y, see ^{136}Pr	-	2E+5	8E-5	3E-7	-	-
60	Neodymium-136[2]	W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
		Y, oxides, hydroxides, carbides, and fluorides	-	5E+4	2E-5	8E-8	-	-
60	Neodymium-138	W, see ^{136}Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
		Y, see ^{136}Nd	-	5E+3	2E-6	7E-9	-	-
60	Neodymium-139m	W, see ^{136}Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
		Y, see ^{136}Nd	-	1E+4	6E-6	2E-8	-	-
60	Neodymium-139[2]	W, see ^{136}Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
		Y, see ^{136}Nd	-	3E+5	1E-4	4E-7	-	-
60	Neodymium-141	W, see ^{136}Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
		Y, see ^{136}Nd	-	6E+5	3E-4	9E-7	-	-
60	Neodymium-147	W, see ^{136}Nd	1E+3	9E+2	4E-7	1E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{136}Nd	-	8E+2	4E-7	1E-9	-	-
60	Neodymium-149[2]	W, see ^{136}Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
		Y, see ^{136}Nd	-	2E+4	1E-5	3E-8	-	-
60	Neodymium-151[2]	W, see ^{136}Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		Y, see ^{136}Nd	-	2E+5	8E-5	3E-7	-	-
61	Promethium-141[2]	W, all compounds except those given for Y	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
		Y, oxides, hydroxides,						

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		carbides, and fluorides	-	2E+5	7E-5	2E-7	-	-
61	Promethium-143	W, see ^{141}Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	7E+2	3E-7	1E-9	-	-
61	Promethium-144	W, see ^{141}Pm	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		Y, see ^{141}Pm	-	1E+2	5E-8	2E-10	-	-
61	Promethium-145	W, see ^{141}Pm	1E+4	2E+2	7E-8	-	1E-4	1E-3
			-	Bone surf (2E+2)	-	3E-10	-	-
		Y, see ^{141}Pm	-	2E+2	8E-8	3E-10	-	-
61	Promethium-146	W, see ^{141}Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
		Y, see ^{141}Pm	-	4E+1	2E-8	6E-11	-	-
61	Promethium-147	W, see ^{141}Pm	4E+3	1E+2	5E-8	-	-	-
			LLI wall (5E+3)	Bone surf (2E+2)	-	3E-10	7E-5	7E-4
		Y, see ^{141}Pm	-	1E+2	6E-8	2E-10	-	-
61	Promethium-148m	W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		Y, see ^{141}Pm	-	3E+2	1E-7	5E-10	-	-
61	Promethium-148	W, see ^{141}Pm	4E+2	5E+2	2E-7	8E-10	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
		Y, see ^{141}Pm	-	5E+2	2E-7	7E-10	-	-
61	Promethium-149	W, see ^{141}Pm	1E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{141}Pm	-	2E+3	8E-7	2E-9	-	-
61	Promethium-150	W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
		Y, see ^{141}Pm	-	2E+4	7E-6	2E-8	-	-
61	Promethium-151	W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		Y, see ^{141}Pm	-	3E+3	1E-6	4E-9	-	-
62	Samarium-141m[2]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
62	Samarium-141[2]	W, all compounds	5E+4	2E+5	8E-5	2E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
62	Samarium-142[2]	W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds	1E+1	4E-2	1E-11	-	-	-
			Bone surf (3E+1)	Bone surf (6E-2)	-	9E-14	3E-7	3E-6
62	Samarium-147	W, all compounds	2E+1	4E-2	2E-11	-	-	-
			Bone surf (3E+1)	Bone surf (7E-2)	-	1E-13	4E-7	4E-6
62	Samarium-151	W, all compounds	1E+4	1E+2	4E-8	-	-	-
			LLI wall	Bone surf				

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(1E+4)	(2E+2)	-	2E-10	2E-4	2E-3
62	Samarium-153	W, all compounds	2E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
62	Samarium-155[2]	W, all compounds	6E+4	2E+5	9E-5	3E-7	-	-
			St wall (8E+4)	-	-	-	1E-3	1E-2
62	Samarium-156	W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
63	Europium-145	W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
63	Europium-150 (12.62 h)	W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
63	Europium-150 (34.2 y)	W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
63	Europium-152m	W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	4E+3	9E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (1E+2)	-	2E-10	-	-
63	Europium-156	W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
63	Europium-157	W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
63	Europium-158[2]	W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
64	Gadolinium-145[2]	D, all compounds except those given for W	5E+4	2E+5	6E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	6E-4	6E-3
		W, oxides, hydroxides, and fluorides	-	2E+5	7E-5	2E-7	-	-
64	Gadolinium-146	D, see ^{145}Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
		W, see ^{145}Gd	-	3E+2	1E-7	4E-10	-	-
64	Gadolinium-147	D, see ^{145}Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{145}Gd	-	4E+3	1E-6	5E-9	-	-
64	Gadolinium-148	D, see ^{145}Gd	1E+1	8E+3	3E-12	-	-	-
			Bone surf	Bone surf				

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(2E+1)	(2E-2)	-	2E-14	3E-7	3E-6
		W, see ^{145}Gd	-	3E-2	1E-11	-	-	-
			-	Bone surf (6E-2)	-	8E-14	-	-
64	Gadolinium-149	D, see ^{145}Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
		W, see ^{145}Gd	-	2E+3	1E-6	3E-9	-	-
64	Gadolinium-151	D, see ^{145}Gd	6E+3	4E+2	2E-7	-	9E-5	9E-4
			-	Bone surf (6E+2)	-	9E-10	-	-
		W, see ^{145}Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ^{145}Gd	2E+1	1E-2	4E-12	-	-	-
			Bone surf (3E+1)	Bone surf (2E-2)	-	3E-14	4E-7	4E-6
		W, see ^{145}Gd	-	4E-2	2E-11	-	-	-
			-	Bone surf (8E-2)	-	1E-13	-	-
64	Gadolinium-153	D, see ^{145}Gd	5E+3	1E+2	6E-8	-	6E-5	6E-4
			-	Bone surf (2E+2)	-	3E-10	-	-
		W, see ^{145}Gd	-	6E+2	2E-7	8E-10	-	-
64	Gadolinium-159	D, see ^{145}Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{145}Gd	-	6E+3	2E-6	8E-9	-	-
65	Terbium-147[2]	W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
65	Terbium-153	W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
65	Terbium-155	W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
65	Terbium-156m (5.0 h)	W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
65	Terbium-156m (24.4 h)	W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds	5E+4	3E+2	1E-7	-	-	-
			LLI wall (5E+4)	Bone surf (6E+2)	-	8E-10	7E-4	7E-3
65	Terbium-158	W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds	2E+3 LLI wall	2E+3	7E-7	2E-9	-	-

Appendix 4-B

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
			(2E+3)	-	-	-	3E-5	3E-4
66	Dysprosium-155	W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds	6E+2	7E+2	3E-7	1E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
67	Holmium-155[2]	W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
67	Holmium-157[2]	W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
67	Holmium-159[2]	W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
67	Holmium-162m[2]	W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
67	Holmium-162[2]	W, all compounds	5E+5	2E+6	1E-3	3E-6	-	-
			St wall (8E+5)	-	-	-	1E-2	1E-1
67	Holmium-164m[2]	W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
67	Holmium-164[2]	W, all compounds	2E+5	6E+5	3E-4	9E-7	-	-
			St wall (2E+5)	-	-	-	3E-3	3E-2
67	Holmium-166m	W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds	9E+2	2E+3	7E-7	2E-9	-	-
			LLI wall (9E+2)	-	-	-	1E-5	1E-4
67	Holmium-167	W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
68	Erbium-165	W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
68	Erbium-169	W, all compounds	3E+3	3E+3	1E-6	4E-9	-	-
			LLI wall (4E+3)	-	-	-	5E-5	5E-4
68	Erbium-171	W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
68	Erbium-172	W, all compounds	1E+3	1E+3	6E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
69	Thulium-162[2]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
69	Thulium-166	W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
69	Thulium-167	W, all compounds	2E+3	2E+3	8E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
69	Thulium-170	W, all compounds	8E+2	2E+2	9E-8	3E-10	-	-
			LLI wall (1E+3)	-	-	-	1E-5	1E-4
69	Thulium-171	W, all compounds	1E+4	3E+2	1E-7	-	-	-
			LLI wall (1E+4)	Bone surf (6E+2)	-	8E-10	2E-4	2E-3
69	Thulium-172	W, all compounds	7E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
69	Thulium-173	W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
69	Thulium-175[2]	W, all compounds	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
70	Ytterbium-162[2]	W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
		Y, oxides, hydroxides, and fluorides	-	3E+5	1E-4	4E-7	-	-
70	Ytterbium-166	W, see ^{162}Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	2E+3	8E-7	3E-9	-	-
70	Ytterbium-167[2]	W, see ^{162}Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
		Y, see ^{162}Yb	-	7E+5	3E-4	1E-6	-	-
70	Ytterbium-169	W, see ^{162}Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
		Y, see ^{162}Yb	-	7E+2	3E-7	1E-9	-	-
70	Ytterbium-175	W, see ^{162}Yb	3E+3	4E+3	1E-6	5E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{162}Yb	-	3E+3	1E-6	5E-9	-	-
70	Ytterbium-177[2]	W, see ^{162}Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	5E+4	2E-5	6E-8	-	-
70	Ytterbium-178[2]	W, see ^{162}Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		Y, see ^{162}Yb	-	4E+4	2E-5	5E-8	-	-
71	Lutetium-169	W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
		Y, oxides, hydroxides, and fluorides	-	4E+3	2E-6	6E-9	-	-
71	Lutetium-170	W, see ^{169}Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-
71	Lutetium-171	W, see ^{169}Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
		Y, see ^{169}Lu	-	2E+3	8E-7	3E-9	-	-

Appendix 4-B

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
71	Lutetium-172	W, see ^{169}Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
		Y, see ^{169}Lu	-	1E+3	5E-7	2E-9	-	-
71	Lutetium-173	W, see ^{169}Lu	5E+3	3E+2	1E-7	-	7E-5	7E-4
			-	Bone surf (5E+2)	-	6E-10	-	-
		Y, see ^{169}Lu	-	3E+2	1E-7	4E-10	-	-
71	Lutetium-174m	W, see ^{169}Lu	2E+3	2E+2	1E-7	-	-	-
			LLI wall (3E+3)	Bone surf (3E+2)	-	5E-10	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+2	9E-8	3E-10	-	-
71	Lutetium-174	W, see ^{169}Lu	5E+3	1E+2	5E-8	-	7E-5	7E-4
			-	Bone surf (2E+2)	-	3E-10	-	-
		Y, see ^{169}Lu	-	2E+2	6E-8	2E-10	-	-
71	Lutetium-176m	W, see ^{169}Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		Y, see ^{169}Lu	-	2E+4	9E-6	3E-8	-	-
71	Lutetium-176	W, see ^{169}Lu	7E+2	5E+0	2E-9	-	1E-5	1E-4
			-	Bone surf (1E+1)	-	2E-11	-	-
		Y, see ^{169}Lu	-	8E+0	3E-9	1E-11	-	-
71	Lutetium-177m	W, see ^{169}Lu	7E+2	1E+2	5E-8	-	1E-5	1E-4
			-	Bone surf (1E+2)	-	2E-10	-	-
		Y, see ^{169}Lu	-	8E+1	3E-8	1E-10	-	-
71	Lutetium-177	W, see ^{169}Lu	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		Y, see ^{169}Lu	-	2E+3	9E-7	3E-9	-	-
71	Lutetium-178m[2]	W, see ^{169}Lu	5E+4	2E+5	8E-5	3E-7	-	-
			St. wall (6E+4)	-	-	-	8E-4	8E-3
		Y, see ^{169}Lu	-	2E+5	7E-5	2E-7	-	-
71	Lutetium-178[2]	W, see ^{169}Lu	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		Y, see ^{169}Lu	-	1E+5	5E-5	2E-7	-	-
71	Lutetium-179	W, see ^{169}Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{169}Lu	-	2E+4	6E-6	3E-8	-	-
72	Hafnium-170	D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
		W, oxides, hydroxides, carbides, and nitrates	-	5E+3	2E-6	6E-9	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
72	Hafnium-172	D, see ^{170}Hf	1E+3	9E+0	4E-9	-	2E-5	2E-4
			-	Bone surf (2E+1)	-	3E-11	-	-
		W, see ^{170}Hf	-	4E+1	2E-8	-	-	-
			-	Bone surf (6E+1)	-	8E-11	-	-
72	Hafnium-173	D, see ^{170}Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{170}Hf	-	1E+4	5E-6	2E-8	-	-
72	Hafnium-175	D, see ^{170}Hf	3E+3	9E+2	4E-7	-	4E-5	4E-4
			-	Bone surf (1E+3)	-	1E-9	-	-
		W, see ^{170}Hf	-	1E+3	5E-7	2E-9	-	-
72	Hafnium-177m[2]	D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
		W, see ^{170}Hf	-	9E+4	4E-5	1E-7	-	-
72	Hafnium-178m	D, see ^{170}Hf	3E+2	1E+0	5E-10	-	3E-6	3E-5
			-	Bone surf (2E+0)	-	3E-12	-	-
		W, see ^{170}Hf	-	5E+0	2E-9	-	-	-
			-	Bone surf (9E+0)	-	1E-11	-	-
72	Hafnium-179m	D, see ^{170}Hf	1E+3	3E+2	1E-7	-	1E-5	1E-4
			-	Bone surf (6E+2)	-	8E-10	-	-
		W, see ^{170}Hf	-	6E+2	3E-7	8E-10	-	-
72	Hafnium-180m	D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
		W, see ^{170}Hf	-	3E+4	1E-5	4E-8	-	-
72	Hafnium-181	D, see ^{170}Hf	1E+3	2E+2	7E-8	-	2E-5	2E-4
			-	Bone surf (4E+2)	-	6E-10	-	-
		W, see ^{170}Hf	-	4E+2	2E-7	6E-10	-	-
72	Hafnium-182m[2]	D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
		W, see ^{170}Hf	-	1E+5	6E-5	2E-7	-	-
72	Hafnium-182	D, see ^{170}Hf	2E+2	8E-1	3E-10	-	-	-
			Bone surf (4E+2)	Bone surf (2E+0)	-	2E-12	5E-6	5E-5
		W, see ^{170}Hf	-	3E+0	1E-9	-	-	-
			-	Bone surf (7E+0)	-	1E-11	-	-
72	Hafnium-183[2]	D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
		W, see ^{170}Hf	-	6E+4	2E-5	8E-8	-	-
72	Hafnium-184	D, see ^{170}Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		W, see ^{170}Hf	-	6E+3	3E-6	9E-9	-	-
73	Tantalum-172[2]	W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
		Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	-	1E+5	4E-5	1E-7	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
73	Tantalum-173	W, see ^{172}Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-174[2]	W, see ^{172}Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	9E+4	4E-5	1E-7	-	-
73	Tantalum-175	W, see ^{172}Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
		Y, see ^{172}Ta	-	1E+4	6E-6	2E-8	-	-
73	Tantalum-176	W, see ^{172}Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
		Y, see ^{172}Ta	-	1E+4	5E-6	2E-8	-	-
73	Tantalum-177	W, see ^{172}Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
		Y, see ^{172}Ta	-	2E+4	7E-6	2E-8	-	-
73	Tantalum-178	W, see ^{172}Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3
		Y, see ^{172}Ta	-	7E+4	3E-5	1E-7	-	-
73	Tantalum-179	W, see ^{172}Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
		Y, see ^{172}Ta	-	9E+2	4E-7	1E-9	-	-
73	Tantalum-180m	W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
		Y, see ^{172}Ta	-	6E+4	2E-5	8E-8	-	-
73	Tantalum-180	W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
		Y, see ^{172}Ta	-	2E+1	1E-8	3E-11	-	-
73	Tantalum-182m[2]	W, see ^{172}Ta	2E+5	5E+5	2E-4	8E-7	-	-
			St wall (2E+5)	-	-	-	3E-3	3E-2
		Y, see ^{172}Ta	-	4E+5	2E-4	6E-7	-	-
73	Tantalum-182	W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
		Y, see ^{172}Ta	-	1E+2	6E-8	2E-10	-	-
73	Tantalum-183	W, see ^{172}Ta	9E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (1E+3)	-	-	-	2E-5	2E-4
		Y, see ^{172}Ta	-	1E+3	4E-7	1E-9	-	-
73	Tantalum-184	W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
		Y, see ^{172}Ta	-	5E+3	2E-6	7E-9	-	-
73	Tantalum-185[2]	W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
		Y, see ^{172}Ta	-	6E+4	3E-5	9E-8	-	-
73	Tantalum-186[2]	W, see ^{172}Ta	5E+4	2E+5	1E-4	3E-7	-	-
			St wall (7E+4)	-	-	-	1E-3	1E-2
		Y, see ^{172}Ta	-	2E+5	9E-5	3E-7	-	-
74	Tungsten-176	D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
74	Tungsten-177	D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
74	Tungsten-178	D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
74	Tungsten-179[2]	D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
74	Tungsten-181	D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
74	Tungsten-185	D, all compounds	2E+3	7E+3	3E-6	9E-9	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2	1E+3	5E-7	2E-9	-	-
			LLI wall (5E+2)	-	-	-	7E-6	7E-5
75	Rhenium-177[2]	D, all compounds except those given for W	9E+4	3E+5	1E-4	4E-7	-	-
			St wall (1E+5)	-	-	-	2E-3	2E-2
		W, oxides, hydroxides, and nitrates	-	4E+5	1E-4	5E-7	-	-
75	Rhenium-178[2]	D, see ^{177}Re	7E+4	3E+5	1E-4	4E-7	-	-
			St wall (1E+5)	-	-	-	1E-3	1E-2
		W, see ^{177}Re	-	3E+5	1E-4	4E-7	-	-
75	Rhenium-181	D, see ^{177}Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
		W, see ^{177}Re	-	9E+3	4E-6	1E-8	-	-
75	Rhenium-182 (12.7 h)	D, see ^{177}Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4
		W, see ^{177}Re	-	2E+4	6E-6	2E-8	-	-
75	Rhenium-182 (64.0 h)	D, see ^{177}Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+3	9E-7	3E-9	-	-
75	Rhenium-184m	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	4E+2	2E-7	6E-10	-	-
75	Rhenium-184	D, see ^{177}Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
		W, see ^{177}Re	-	1E+3	6E-7	2E-9	-	-
75	Rhenium-186m	D, see ^{177}Re	1E+3	2E+3	7E-7	-	-	-
			St wall (2E+3)	St wall (2E+3)	-	3E-9	2E-5	2E-4
		W, see ^{177}Re	-	2E+2	6E-8	2E-10	-	-
75	Rhenium-186	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
		W, see ^{177}Re	-	2E+3	7E-7	2E-9	-	-
75	Rhenium-187	D, see ^{177}Re	6E+5	8E+5	4E-4	-	8E-3	8E-2
			-	St wall (9E+5)	-	1E-6	-	-
		W, see ^{177}Re	-	1E+5	4E-5	1E-7	-	-
75	Rhenium-188m[2]	D, see ^{177}Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
		W, see ^{177}Re	-	1E+5	6E-5	2E-7	-	-
75	Rhenium-188	D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
		W, see ^{177}Re	-	3E+3	1E-6	4E-9	-	-
75	Rhenium-189	D, see ^{177}Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
		W, see ^{177}Re	-	4E+3	2E-6	6E-9	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
76	Osmium-180[2]	D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
		W, halides and nitrates	-	5E+5	2E-4	7E-7	-	-
		Y, oxides and hydroxides	-	5E+5	2E-4	6E-7	-	-
76	Osmium-181[2]	D, see ^{180}Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{180}Os	-	5E+4	2E-5	6E-8	-	-
		Y, see ^{180}Os	-	4E+4	2E-5	6E-8	-	-
76	Osmium-182	D, see ^{180}Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
		W, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{180}Os	-	4E+3	2E-6	6E-9	-	-
76	Osmium-185	D, see ^{180}Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
		W, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
		Y, see ^{180}Os	-	8E+2	3E-7	1E-9	-	-
76	Osmium-189m	D, see ^{180}Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
		W, see ^{180}Os	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{180}Os	-	2E+5	7E-5	2E-7	-	-
76	Osmium-191m	D, see ^{180}Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
		W, see ^{180}Os	-	2E+4	8E-6	3E-8	-	-
		Y, see ^{180}Os	-	2E+4	7E-6	2E-8	-	-
76	Osmium-191	D, see ^{180}Os	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (3E+3)	-	-	-	3E-5	3E-4
		W, see ^{180}Os	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{180}Os	-	1E+3	6E-7	2E-9	-	-
76	Osmium-193	D, see ^{180}Os	2E+3	5E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
		W, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{180}Os	-	3E+3	1E-6	4E-9	-	-
76	Osmium-194	D, see ^{180}Os	4E+2	4E+1	2E-8	6E-11	-	-
			LLI wall (6E+2)	-	-	-	8E-6	8E-5
		W, see ^{180}Os	-	6E+1	2E-8	8E-11	-	-
		Y, see ^{180}Os	-	8E+0	3E-9	1E-11	-	-
77	Iridium-182[2]	D, all compounds except those given for W and Y	4E+4	1E+5	6E-5	2E-7	-	-
			St wall (4E+4)	-	-	-	6E-4	6E-3
		W, halides, nitrates, and metallic iridium	-	2E+5	6E-5	2E-7	-	-
		Y, oxides and hydroxides	-	1E+5	5E-5	2E-7	-	-
77	Iridium-184	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	5E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-185	D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{182}Ir	-	1E+4	5E-6	2E-8	-	-
		Y, see ^{182}Ir	-	1E+4	4E-6	1E-8	-	-
77	Iridium-186	D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
		W, see ^{182}Ir	-	6E+3	3E-6	9E-9	-	-
		Y, see ^{182}Ir	-	6E+3	2E-6	8E-9	-	-
77	Iridium-187	D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
77	Iridium-188	D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		W, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
		Y, see ^{182}Ir	-	3E+3	1E-6	5E-9	-	-
77	Iridium-189	D, see ^{182}Ir	5E+3	5E+3	2E-6	7E-9	-	-
			LLI wall (5E+3)	-	-	-	7E-5	7E-4
		W, see ^{182}Ir	-	4E+3	2E-6	5E-9	-	-
		Y, see ^{182}Ir	-	4E+3	1E-6	5E-9	-	-
77	Iridium-190m^{2}	D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
		W, see ^{182}Ir	-	2E+5	9E-5	3E-7	-	-
		Y, see ^{182}Ir	-	2E+5	8E-5	3E-7	-	-
77	Iridium-190	D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
		W, see ^{182}Ir	-	1E+3	4E-7	1E-9	-	-
		Y, see ^{182}Ir	-	9E+2	4E-7	1E-9	-	-
77	Iridium-192m	D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
		W, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
		Y, see ^{182}Ir	-	2E+1	6E-9	2E-11	-	-
77	Iridium-192	D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
		W, see ^{182}Ir	-	4E+2	2E-7	6E-10	-	-
		Y, see ^{182}Ir	-	2E+2	9E-8	3E-10	-	-
77	Iridium-194m	D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
		W, see ^{182}Ir	-	2E+2	7E-8	2E-10	-	-
		Y, see ^{182}Ir	-	1E+2	4E-8	1E-10	-	-
77	Iridium-194	D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{182}Ir	-	2E+3	9E-7	3E-9	-	-
		Y, see ^{182}Ir	-	2E+3	8E-7	3E-9	-	-
77	Iridium-195m	D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{182}Ir	-	3E+4	1E-5	4E-8	-	-
		Y, see ^{182}Ir	-	2E+4	9E-6	3E-8	-	-
77	Iridium-195	D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{182}Ir	-	5E+4	2E-5	7E-8	-	-
		Y, see ^{182}Ir	-	4E+4	2E-5	6E-8	-	-
78	Platinum-186	D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
78	Platinum-193m	D, all compounds	3E+3	6E+3	3E-6	8E-9	-	-
			LLI wall (3E+4)	-	-	-	4E-5	4E-4

Appendix 4-B

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
78	Platinum-193	D, all compounds	4E+4	2E+4	1E-5	3E-8	-	-
			LLI wall (5E+4)	-	-	-	6E-4	6E-3
78	Platinum-195m	D, all compounds	2E+3	4E+3	2E-6	6E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
78	Platinum-197m[2]	D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
78	Platinum-199[2]	D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
		W, halides and nitrates	-	2E+4	9E-6	3E-8	-	-
		Y, oxides and hydroxides	-	2E+4	8E-6	3E-8	-	-
79	Gold-194	D, see ^{193}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193}Au	-	5E+3	2E-6	8E-9	-	-
		Y, see ^{193}Au	-	5E+3	2E-6	7E-9	-	-
79	Gold-195	D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
		W, see ^{193}Au	-	1E+3	6E-7	2E-9	-	-
		Y, see ^{193}Au	-	4E+2	2E-7	6E-10	-	-
79	Gold-198m	D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
		W, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
		Y, see ^{193}Au	-	1E+3	5E-7	2E-9	-	-
79	Gold-198	D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	2E+3	8E-7	3E-9	-	-
		Y, see ^{193}Au	-	2E+3	7E-7	2E-9	-	-
79	Gold-199	D, see ^{193}Au	3E+3	9E+3	4E-6	1E-8	-	-
			LLI wall (3E+3)	-	-	-	4E-5	4E-4
		W, see ^{193}Au	-	4E+3	2E-6	6E-9	-	-
		Y, see ^{193}Au	-	4E+3	2E-6	5E-9	-	-
79	Gold-200m	D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
		W, see ^{193}Au	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{193}Au	-	2E+4	1E-6	3E-9	-	-
79	Gold-200[2]	D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
		W, see ^{193}Au	-	8E+4	3E-5	1E-7	-	-
		Y, see ^{193}Au	-	7E+4	3E-5	1E-7	-	-
79	Gold-201[2]	D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
		W, see ^{193}Au	-	2E+5	1E-4	3E-7	-	-
		Y, see ^{193}Au	-	2E+5	9E-5	3E-7	-	-
80	Mercury-193m	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
		D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
		W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
80	Mercury-193	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		D, see ^{193m}Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	4E+4	2E-5	6E-8	-	-
80	Mercury-194	Vapor	-	3E+1	1E-8	4E-11	-	-
		Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
		D, see ^{193m}Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
		W, see ^{193m}Hg	-	1E+2	5E-8	2E-10	-	-
80	Mercury-195m	Vapor	-	4E+3	2E-6	6E-9	-	-
		Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
		D, see ^{193m}Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	4E+3	2E-6	5E-9	-	-
80	Mercury-195	Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
		D, see ^{193m}Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
		W, see ^{193m}Hg	-	3E+4	1E-5	5E-8	-	-
80	Mercury-197m	Vapor	-	5E+3	2E-6	7E-9	-	-
		Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
		D, see ^{193m}Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4
		W, see ^{193m}Hg	-	5E+3	2E-6	7E-9	-	-
80	Mercury-197	Vapor	-	8E+3	4E-6	1E-8	-	-
		Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
		D, see ^{193m}Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
		W, see ^{193m}Hg	-	9E+3	4E-6	1E-8	-	-
80	Mercury-199m[2]	Vapor	-	8E+4	3E-5	1E-7	-	-
		Organic D	6E+4 St wall (1E+5)	2E+5 -	7E-5 -	2E-7 -	- 1E-3	- 1E-2
		D, see ^{193m}Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
		W, see ^{193m}Hg	-	2E+5	7E-5	2E-7	-	-
80	Mercury-203	Vapor	-	8E+2	4E-7	1E-9	-	-
		Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
		D, see ^{193m}Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
		W, see ^{193m}Hg	-	1E+3	5E-7	2E-9	-	-
81	Thallium-194m[2]	D, all compounds	5E+4 St wall (7E+4)	2E+5 -	6E-5 -	2E-7 -	- 1E-3	- 1E-2
81	Thallium-194[2]	D, all compounds	3E+5 St wall (3E+5)	6E+5 -	2E-4 -	8E-7 -	- 4E-3	- 4E-2
81	Thallium-195[2]	D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
81	Thallium-198m[2]	D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
81	Thallium-198	D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4
82	Lead-195m[2]	D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
82	Lead-199[2]	D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	6E-1 Bone surf (1E+0)	2E-1 Bone surf (4E-1)	1E-10 -	- 6E-13	- 1E-8	- 1E-7
82	Lead-211[2]	D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	8E+1 Bone surf (1E+2)	3E+1 -	1E-8 -	5E-11 -	- 2E-6	- 2E-5
82	Lead-214[2]	D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
83	Bismuth-200[2]	D, nitrates W, all other compounds	3E+4 -	8E+4 1E+5	4E-5 4E-5	1E-7 1E-7	4E-4 -	4E-3 -
83	Bismuth-201[2]	D, see ^{200}Bi W, see ^{200}Bi	1E+4 -	3E+4 4E+4	1E-5 2E-5	4E-8 5E-8	2E-4 -	2E-3 -
83	Bismuth-202[2]	D, see ^{200}Bi W, see ^{200}Bi	1E+4 -	4E+4 8E+4	2E-5 3E-5	6E-8 1E-7	2E-4 -	2E-3 -
83	Bismuth-203	D, see ^{200}Bi W, see ^{200}Bi	2E+3 -	7E+3 6E+3	3E-6 3E-6	9E-9 9E-9	3E-5 -	3E-4 -
83	Bismuth-205	D, see ^{200}Bi W, see ^{200}Bi	1E+3 -	3E+3 1E+3	1E-6 5E-7	3E-9 2E-9	2E-5 -	2E-4 -

Appendix 4-B

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
83	Bismuth-206	D, see ^{200}Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
		W, see ^{200}Bi	-	9E+2	4E-7	1E-9	-	-
83	Bismuth-207	D, see ^{200}Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-210m	D, see ^{200}Bi	4E+1 Kidneys (6E+1)	5E+0 Kidneys (6E+0)	2E-9 -	- 9E-12	- 8E-7	- 8E-6
		W, see ^{200}Bi	-	7E-1	3E-10	9E-13	-	-
83	Bismuth-210	D, see ^{200}Bi	8E+2 - -	2E+2 Kidneys (4E+2)	1E-7 -	- 5E-10	1E-5 -	1E-4 -
		W, see ^{200}Bi	-	3E+1	1E-8	4E-11	-	-
83	Bismuth-212[2]	D, see ^{200}Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
		W, see ^{200}Bi	-	3E+2	1E-7	4E-10	-	-
83	Bismuth-213[2]	D, see ^{200}Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
		W, see ^{200}Bi	-	4E+2	1E-7	5E-10	-	-
83	Bismuth-214[2]	D, see ^{200}Bi	2E+4 St wall (2E+4)	8E+2 -	3E-7 -	1E-9 -	- 3E-4	- 3E-3
		W, see ^{200}Bi	-	9E-2	4E-7	1E-9	-	-
84	Polonium-203[2]	D, all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
		W, oxides, hydroxides, and nitrates	-	9E+4	4E-5	1E-7	-	-
84	Polonium-205[2]	D, see ^{203}Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
		W, see ^{203}Po	-	7E+4	3E-5	1E-7	-	-
84	Polonium-207	D, see ^{203}Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
		W, see ^{203}Po	-	3E+4	1E-5	4E-8	-	-
84	Polonium-210	D, see ^{203}Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
		W, see ^{203}Po	-	6E-1	3E-10	9E-13	-	-
85	Astatine-207[2]	D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
		W	-	2E+3	9E-7	3E-9	-	-
85	Astatine-211	D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
		W	-	5E+1	2E-8	8E-11	-	-
86	Radon-220	With daughters removed	-	2E+4	7E-6	2E-8	-	-
		With daughters present	-	2E+1 (or 12 working level months)	9E-9 (or 1.0 working level)	3E-11	-	-
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2 (or 4 working level months)	3E-8 (or 0.33 working level)	1E-10	-	-
87	Francium-222[2]	D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
87	Francium-223[2]	D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	5E+0 Bone surf (9E+0)	7E-1 -	3E-10 -	9E-13 -	- 1E-7	- 1E-6
88	Radium-224	W, all compounds	8E+0 Bone surf (2E+1)	2E+0 -	7E-10 -	2E-12 -	- 2E-7	- 2E-6
88	Radium-225	W, all compounds	8E+0 Bone surf (2E+1)	7E-1 -	3E-10 -	9E-13 -	- 2E-7	- 2E-6
88	Radium-226	W, all compounds	2E+0 Bone surf (5E+0)	6E-1 -	3E-10 -	9E-13 -	- 6E-8	- 6E-7
88	Radium-227[2]	W, all compounds	2E+4 Bone surf (2E+4)	1E+4 Bone surf (2E+4)	6E-6 -	- 3E-8	- 3E-4	- 3E-3
88	Radium-228	W, all compounds	2E+0 Bone surf (4E+0)	1E+0 -	5E-10 -	2E-12 -	- 6E-8	- 6E-7
89	Actinium-224	D, all compounds except those given for W and Y	2E+3 LLI wall (2E+3)	3E+1 Bone surf (4E+1)	1E-8 -	- 5E-11	- 3E-5	- 3E-4
		W, halides and nitrates	-	5E+1	2E-8	7E-11	-	-
		Y, oxides and hydroxides	-	5E+1	2E-8	6E-11	-	-
89	Actinium-225	D, see ^{224}Ac	5E+1 LLI wall (5E+1)	3E-1 Bone surf (5E-1)	1E-10 -	- 7E-13	- 7E-7	- 7E-6
		W, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
		Y, see ^{224}Ac	-	6E-1	3E-10	9E-13	-	-
89	Actinium-226	D, see ^{224}Ac	1E+2 LLI wall (1E+2)	3E+0 Bone surf (4E+0)	1E-9 -	- 5E-12	- 2E-6	- 2E-5
		W, see ^{224}Ac	-	5E+0	2E-9	7E-12	-	-
		Y, see ^{224}Ac	-	5E+0	2E-9	6E-12	-	-
89	Actinium-227	D, see ^{224}Ac	2E-1 Bone surf (4E-1)	4E-4 Bone surf (8E-4)	2E-13 -	- 1E-15	- 5E-9	- 5E-8
		W, see ^{224}Ac	- -	2E-3 Bone surf (3E-3)	7E-13 -	- 4E-15	- -	- -
		Y, see ^{224}Ac	-	4E-3	2E-12	6E-15	-	-
89	Actinium-228	D, see ^{224}Ac	2E+3 -	9E+0 Bone surf (2E+1)	4E-9 -	- 2E-11	3E-5 -	3E-4 -
		W, see ^{224}Ac	-	4E+1 Bone surf	2E-8	-	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Col. 2 Inhalation ALI (μCi)	Table I Occupational Values: Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
			-	(6E+1)	-	8E-11	-	-
		Y, see ^{224}Ac	-	4E+1	2E-8	6E-11	-	-
90	Thorium-226[2]	W, all compounds except those given for Y	5E+3	2E+2	6E-8	2E-10	-	-
			St wall (5E+3)	-	-	-	7E-5	7E-4
		Y, oxides and hydroxides	-	1E+2	6E-8	2E-10	-	-
90	Thorium-227	W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
		Y, see ^{226}Th	-	3E-1	1E-10	5E-13	-	-
90	Thorium-228	W, see ^{226}Th	6E+0	1E-2	4E-12	-	-	-
			Bone surf (1E+1)	Bone surf (2E-2)	-	3E-14	2E-7	2E-6
		Y, see ^{226}Th	-	2E-2	7E-12	2E-14	-	-
90	Thorium-229	W, see ^{226}Th	6E-1	9E-4	4E-13	-	-	-
			Bone surf (1E+0)	Bone surf (2E-3)	-	3E-15	2E-8	2E-7
		Y, see ^{226}Th	-	2E-3	1E-12	-	-	-
				Bone surf (3E-3)	-	4E-15	-	-
90	Thorium-230	W, see ^{226}Th	4E+0	6E-3	3E-12	-	-	-
			Bone surf (9E+0)	Bone surf (2E-2)	-	2E-14	1E-7	1E-6
		Y, see ^{226}Th	-	2E-2	6E-12	-	-	-
			-	Bone surf (2E-2)	-	3E-14	-	-
90	Thorium-231	W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
		Y, see ^{226}Th	-	6E+3	3E-6	9E-9	-	-
90	Thorium-232	W, see ^{226}Th	7E-1	1E-3	5E-13	-	-	-
			Bone surf (2E+0)	Bone surf (3E-3)	-	4E-15	3E-8	3E-7
		Y, see ^{226}Th	-	3E-3	1E-12	-	-	-
			-	Bone surf (4E-3)	-	6E-15	-	-
90	Thorium-234	W, see ^{226}Th	3E+2	2E+2	8E-8	3E-10	-	-
			LLI wall (4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{226}Th	-	2E+2	6E-8	2E-10	-	-
91	Protactinium-227[2]	W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
		Y, oxides and hydroxides	-	1E+2	4E-8	1E-10	-	-
91	Protactinium-228	W, see ^{227}Pa	1E+3	1E+1	5E-9	-	2E-5	2E-4
			-	Bone surf (2E+1)	-	3E-11	-	-
		Y, see ^{227}Pa	-	1E+1	5E-9	2E-11	-	-
91	Protactinium-230	W, see ^{227}Pa	6E+2	5E+0	2E-9	7E-12	-	-
			Bone surf (9E+2)	-	-	-	1E-5	1E-4
		Y, see ^{227}Pa	-	4E+0	1E-9	5E-12	-	-

			Table 1 Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
91	Protactinium-231	W, see ^{227}Pa	2E-1	2E-3	6E-13	-	-	-
			Bone surf (5E-1)	Bone surf (4E-3)	-	6E-15	6E-9	6E-8
		Y, see ^{227}Pa	-	4E-3	2E-12	-	-	-
				Bone surf				
			-	(6E-3)	-	8E-15	-	-
91	Protactinium-232	W, see ^{227}Pa	1E+3	2E+1	9E-9	-	2E-5	2E-4
			-	Bone surf (6E+1)	-	8E-11	-	-
		Y, see ^{227}Pa	-	6E+1	2E-8	-	-	-
				Bone surf				
			-	(7E+1)	-	1E-10	-	-
91	Protactinium-233	W, see ^{227}Pa	1E+3	7E+2	3E-7	1E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
		Y, see ^{227}Pa	-	6E+2	2E-7	8E-10	-	-
91	Protactinium-234	W, see ^{227}Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
		Y, see ^{227}Pa	-	7E+3	3E-6	9E-9	-	-
92	Uranium-230	D, UF_6, UO_2F_2, $UO_2(NO_3)_2$	4E+0	4E-1	2E-10	-	-	-
			Bone surf (6E+0)	Bone surf (6E-1)	-	8E-13	8E-8	8E-7
		W, UO_3, UF_4, UCl_4	-	4E-1	1E-10	5E-13	-	-
		Y, UO_2, U_3O_8	-	3E-1	1E-10	4E-13	-	-
92	Uranium-231	D, see ^{230}U	5E+3	8E+3	3E-6	1E-8	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ^{230}U	-	6E+3	2E-6	8E-9	-	-
		Y, see ^{230}U	-	5E+3	2E-6	6E-9	-	-
92	Uranium-232	D, see ^{230}U	2E+0	2E-1	9E-11	-	-	-
			Bone surf (4E+0)	Bone surf (4E-1)	-	6E-13	6E-8	6E-7
		W, see ^{230}U	-	4E-1	2E-10	5E-13	-	-
		Y, see ^{230}U	-	8E-3	3E-12	1E-14	-	-
92	Uranium-233	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-234[3]	D, see ^{230}U	1E+1	1E+0	5E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	7E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	5E-14	-	-
92	Uranium-235[3]	D, see ^{230}U	1E+1	1E+0	6E-10	-	-	-
			Bone surf (2E+1)	Bone surf (2E+0)	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
92	Uranium-236	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10	-	-	-
			-	-	-	3E-12	3E-7	3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-237	D, see ^{230}U	2E+3 LLI wall (2E+3)	3E+3 -	1E-6 -	4E-9 -	- 3E-5	- 3E-4
		W, see ^{230}U	-	2E+3	7E-7	2E-9	-	-
		Y, see ^{230}U	-	2E+3	6E-7	2E-9	-	-
92	Uranium-238[3]	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	6E-10 -	- 3E-12	- 3E-7	- 3E-6
		W, see ^{230}U	-	8E-1	3E-10	1E-12	-	-
		Y, see ^{230}U	-	4E-2	2E-11	6E-14	-	-
92	Uranium-239[2]	D, see ^{230}U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
		W, see ^{230}U	-	2E+5	7E-5	2E-7	-	-
		Y, see ^{230}U	-	2E+5	6E-5	2E-7	-	-
92	Uranium-240	D, see ^{230}U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
		W, see ^{230}U	-	3E+3	1E-6	4E-9	-	-
		Y, see ^{230}U	-	2E+3	1E-6	3E-9	-	-
92	Uranium-natural[3]	D, see ^{230}U	1E+1 Bone surf (2E+1)	1E+0 Bone surf (2E+0)	5E-10 -	- 3E-12	- 3E-7	- 3E-6
		W, see ^{230}U	-	8E-1	3E-10	9E-13	-	-
		Y, see ^{230}U	-	5E-2	2E-11	9E-14	-	-
93	Neptunium-232[2]	W, all compounds	1E+5	2E+3 Bone surf (5E+2)	7E-7 -	- 6E-9	2E-3 -	2E-2 -
93	Neptunium-233[2]	W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	2E+4 LLI wall (2E+4)	8E+2 Bone surf (1E+3)	3E-7 -	- 2E-9	- 3E-4	- 3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	3E+0 Bone surf (6E+0)	2E-2 Bone surf (5E-2)	9E-12 -	- 8E-14	- 9E-8	- 9E-7
93	Neptunium-236 (22.5 h)	W, all compounds	3E+3 Bone surf (4E+3)	3E+1 Bone surf (7E+1)	1E-8 -	- 1E-10	- 5E-5	- 5E-4
93	Neptunium-237	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (1E-2)	2E-12 -	- 1E-14	- 2E-8	- 2E-7
93	Neptunium-238	W, all compounds	1E+3	6E+1 Bone surf (2E+2)	3E-8 -	- 2E-10	2E-5 -	2E-4 -

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
93	Neptunium-239	W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4
93	Neptunium-240[2]	W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO_2	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO_2	-	2E+2	8E-8	3E-10	-	-
94	Plutonium-235[2]	W, see ^{234}Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
		Y, see ^{234}Pu	-	3E+6	1E-3	3E-6	-	-
94	Plutonium-236	W, see ^{234}Pu	2E+0	2E-2	8E-12	-	-	-
			Bone surf (4E+0)	Bone surf (4E-2)	-	5E-14	6E-8	6E-7
		Y, see ^{234}Pu	-	4E-2	2E-11	6E-14	-	-
94	Plutonium-237	W, see ^{234}Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
		Y, see ^{234}Pu	-	3E+3	1E-6	4E-9	-	-
94	Plutonium-238	W, see ^{234}Pu	9E-1	7E-3	3E-12	-	-	-
			Bone surf (2E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	8E-12	2E-14	-	-
94	Plutonium-239	W, see ^{234}Pu	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-240	W, see ^{234}Pu	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-241	W, see ^{234}Pu	4E+1	3E-1	1E-10	-	-	-
			Bone surf (7E+1)	Bone surf (6E-1)	-	8E-13	1E-6	1E-5
		Y, see ^{234}Pu	-	8E-1	3E-10	-	-	-
			-	Bone surf (1E+0)	-	1E-12	-	-
94	Plutonium-242	W, see ^{234}Pu	8E-1	7E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2	7E-12	-	-	-
			-	Bone surf (2E-2)	-	2E-14	-	-
94	Plutonium-243	W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
		Y, see ^{234}Pu	-	4E+4	2E-5	5E-8	-	-
94	Plutonium-244	W, see ^{234}Pu	8E-1	7E-3	3E-12	-	-	-
			Bone surf	Bone surf				

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			(2E+0)	(1E-2)	-	2E-14	2E-8	2E-7
		Y, see ^{234}Pu	-	2E-2 Bone surf	7E-12	-	-	-
			-	(2E-2)	-	2E-14	-	-
94	Plutonium-245	W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
		Y, see ^{234}Pu	-	4E+3	2E-6	6E-9	-	-
94	Plutonium-246	W, see ^{234}Pu	4E+2	3E+2	1E-7	4E-10	-	-
			LLI wall (4E+2)	-	-	-	6E-6	6E-5
		Y, see ^{234}Pu	-	3E+2	1E-7	4E-10	-	-
95	Americium-237[2]	W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2
95	Americium-238[2]	W, all compounds	4E+4	3E+3	1E-6	-	5E-4	5E-3
			-	Bone surf (6E+3)	-	9E-9	-	-
95	Americium-239	W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242m	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	4E+3	8E+1	4E-8	-	5E-5	5E-4
			-	Bone surf (9E+1)	-	1E-10	-	-
95	Americium-243	W, all compounds	8E-1	6E-3	3E-12	-	-	-
			Bone surf (1E+0)	Bone surf (1E-2)	-	2E-14	2E-8	2E-7
95	Americium-244m[2]	W, all compounds	6E+4	4E+3	2E-6	-	-	-
			St wall (8E+4)	Bone surf (7E+3)	-	1E-8	1E-3	1E-2
95	Americium-244	W, all compounds	3E+3	2E+2	8E-8	-	4E-5	4E-4
			-	Bone surf (3E+2)	-	4E-10	-	-
95	Americium-245	W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
95	Americium-246m[2]	W, all compounds	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (6E+4)	-	-	-	8E-4	8E-3
95	Americium-246[2]	W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
96	Curium-238	W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	6E+1	6E-1	2E-10	-	-	-
			Bone surf (8E+1)	Bone surf (6E-1)	-	9E-13	1E-6	1E-5

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1	Col. 2	Col. 3	Col. 1	Col. 2	
			Oral Ingestion	Inhalation				Monthly Average
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Concentration (μCi/ml)
96	Curium-241	W, all compounds	1E+3	3E+1 Bone surf (4E+1)	1E-8 -	- 5E-11	2E-5 -	2E-4 -
96	Curium-242	W, all compounds	3E+1 Bone surf (5E+1)	3E-1 Bone surf (3E-1)	1E-10 -	- 4E-13	- 7E-7	- 7E-6
96	Curium-243	W, all compounds	1E+0 Bone surf (2E+0)	9E-3 Bone surf (2E-2)	4E-12 -	- 2E-14	- 3E-8	- 3E-7
96	Curium-244	W, all compounds	1E+0 Bone surf (3E+0)	1E-2 Bone surf (2E-2)	5E-12 -	- 3E-14	- 3E-8	- 3E-7
96	Curium-245	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
96	Curium-246	W, all compounds	7E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
96	Curium-247	W, all compounds	8E-1 Bone surf (1E+0)	6E-3 Bone surf (1E-2)	3E-12 -	- 2E-14	- 2E-8	- 2E-7
96	Curium-248	W, all compounds	2E-1 Bone surf (4E-1)	2E-3 Bone surf (3E-3)	7E-13 -	- 4E-15	- 5E-9	- 5E-8
96	Curium-249[2]	W, all compounds	5E+4	2E+4 Bone surf (3E+4)	7E-6 -	- 4E-8	7E-4 -	7E-3 -
96	Curium-250	W, all compounds	4E-2 Bone surf (6E-2)	3E-4 Bone surf (5E-4)	1E-13 -	- 8E-16	- 9E-10	- 9E-9
97	Berkelium-245	W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
97	Berkelium-246	W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
97	Berkelium-247	W, all compounds	5E-1 Bone surf (1E+0)	4E-3 Bone surf (9E-3)	2E-12 -	- 1E-14	- 2E-8	- 2E-7
97	Berkelium-249	W, all compounds	2E+2 Bone surf (5E+2)	2E+0 Bone surf (4E+0)	7E-10 -	- 5E-12	- 6E-6	- 6E-5
97	Berkelium-250	W, all compounds	9E+3	3E+2 Bone surf (7E+2)	1E-7 -	- 1E-9	1E-4 -	1E-3 -
98	Californium-244[2]	W, all compounds except those given for Y	3E+4	6E+2	2E-7	8E-10	-	-

			Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide	Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
			St wall (3E+4)	-	-	-	4E-4	4E-3
		Y, oxides and hydroxides	-	6E+2	2E-7	8E-10	-	-
98	Californium-246	W, see ^{244}Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
		Y, see ^{244}Cf	-	9E+0	4E-9	1E-11	-	-
98	Californium-248	W, see ^{244}Cf	8E+0	6E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	2E-13	2E-7	2E-6
		Y, see ^{244}Cf	-	1E-1	4E-11	1E-13	-	-
98	Californium-249	W, see ^{244}Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2	4E-12	-	-	-
				Bone surf (1E-2)	-	2E-14	-	-
98	Californium-250	W, see ^{244}Cf	1E+0	9E-3	4E-12	-	-	-
			Bone surf (2E+0)	Bone surf (2E-2)	-	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	4E-14	-	-
98	Californium-251	W, see ^{244}Cf	5E-1	4E-3	2E-12	-	-	-
			Bone surf (1E+0)	Bone surf (9E-3)	-	1E-14	2E-8	2E-7
		Y, see ^{244}Cf	-	1E-2	4E-12	-	-	-
				Bone surf (1E-2)	-	2E-14	-	-
98	Californium-252	W, see ^{244}Cf	2E+0	2E-2	8E-12	-	-	-
			Bone surf (5E+0)	Bone surf (4E-2)	-	5E-14	7E-8	7E-7
		Y, see ^{244}Cf	-	3E-2	1E-11	5E-14	-	-
98	Californium-253	W, see ^{244}Cf	2E+2	2E+0	8E-10	3E-12	-	-
			Bone surf (4E+2)	-	-	-	5E-6	5E-5
		Y, see ^{244}Cf	-	2E+0	7E-10	2E-12	-	-
98	Californium-254	W, see ^{244}Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
		Y, see ^{244}Cf	-	2E-2	7E-12	2E-14	-	-
99	Einsteinium-250	W, all compounds	4E+4	5E+2	2E-7	-	6E-4	6E-3
			-	Bone surf (1E+3)	-	2E-9	-	-
99	Einsteinium-251	W, all compounds	7E+3	9E+2	4E-7	-	1E-4	1E-3
			-	Bone surf (1E+3)	-	2E-9	-	-
99	Einsteinium-253	W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
99	Einsteinium-254m	W, all compounds	3E+2	1E+1	4E-9	1E-11	-	-
			LLI wall (3E+2)	-	-	-	4E-6	4E-5

Atomic No.	Radionuclide	Class	Table 1 Occupational Values Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col. 3 Inhalation DAC (μCi/ml)	Table II Effluent Concentrations Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Table III release to Sewers Monthly Average Concentration (μCi/ml)
99	Einsteinium-254	W, all compounds	8E+0 Bone surf (2E+1)	7E-2 Bone surf (1E-1)	3E-11 -	- 2E-13	- 2E-7	- 2E-6
100	Fermium-252	W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	2E+1 Bone surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11 -	- 3E-13	- 5E-7	- 5E-6
101	Mendelevium-257	W, all compounds	7E+3 -	8E+1 Bone surf (9E+1)	4E-8 -	- 1E-10	1E-4 -	1E-3 -
101	Mendelevium-258	W, all compounds	3E+1 Bone surf (5E+1)	2E-1 Bone surf (3E-1)	1E-10 -	- 5E-13	- 6E-7	- 6E-6
-	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	Submersion[1]	-	2E+2	1E-7	1E-9	-	-
-	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		-	2E-1	1E-10	1E-12	1E-8	1E-7
-	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known		-	4E-4	2E-13	1E-15	2E-9	2E-8

FOOTNOTES:

[1]"Submersion" means that values given are for submersion in a hemispherical semi-infinite cloud of airborne material.

[2]These radionuclides have radiological half-lives of less than 2 hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do NOT include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 μCi/ml for the listed DAC to account for the submersion dose prospectively, but should use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits. (See180 NAC 4-007.)

[3]For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor (see180 NAC 4-004, item 5). If the percent by weight (enrichment) of U-235 is not greater than 5, the concentration value for a 40-hour workweek 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 8E-3 (SA) μCi-hr/ml, where

		Table I Occupational Values			Table II Effluent Concentrations		Table III release to Sewers
		Col. 1 Oral Ingestion	Col. 2 Inhalation	Col. 3	Col. 1	Col. 2	
Atomic No.	Radionuclide Class	ALI (μCi)	ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	Monthly Average Concentration (μCi/ml)

SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, shall be:

SA = 3.6E-7 curies/gram U U-depleted

SA = $[0.4 + 0.38 (\text{enrichment}) + 0.0034 (\text{enrichment})^2] E-6$, enrichment ≥ 0.72

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

NOTE:

1. If the identity of each radionuclide in a mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture shall be the most restrictive DAC of any radionuclide in the mixture.

2. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in this appendix are not present in the mixture, the inhalation ALI, DAC, and effluent and sewage concentrations for the mixture are the lowest values specified in this appendix for any radionuclide that is not known to be absent from the mixture; or

+If it is known that Ac-227-D and Cm-250-W are not present	-	7E-4	3E-13	-	-	-
If, in addition, it is known that Ac-227-W,Y, Th-229-W,Y, Th-230-W, Th-232-W,Y, Pa-231-W,Y, Np-237-W, Pu-239-W, Pu-240-W, Pu-242-W, Am-241-W, Am-242m-W, Am-243-W, Cm-245-W, Cm-246-W, Cm-247-W, Cm-248-W, Bk-247-W, Cf-249-W, and Cf-251-W are not present	-	7E-3	3E-12	-	-	-
If, in addition, it is known that Sm-146-W, Sm-147-W, Gd-148-D,W, Gd-152-D,W, Th-228-W,Y, Th-230-Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y, U-238-Y, Np-236-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-Y, Pu-240-Y, Pu-242-Y, Pu-244-W,Y, Cm-243-W, Cm-244-W, Cf-248-W, Cf-249-Y, Cf-250-W,Y, Cf-251-Y, Cf-252-W,Y, and Cf-254-W,Y are not present	-	7E-2	3E-11	-	-	-
If, in addition, it is known that Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-Y, Es-254-W, Fm-257-W, and Md-258-W are not present	-	7E-1	3E-10	-	-	-
If, in addition, it is known that Si-32-Y, Ti-44-Y, Fe-60-D, Sr-90-Y, Zr-93-D, Cd-113m-D, Cd-113-D, In-115-D,W, La-138-D, Lu-176-W, Hf-178m-D,W, Hf-182-D,W, Bi-210m-D, Ra-224-W, Ra-228-W, Ac-226-D,W,Y, Pa-230-W,Y, U-233-D,W, U-234-D,W, U-235-D,W, U-236-D,W, U-238-D,W, Pu-241-Y, Bk-249-W, Cf-253-W,Y, and Es-253-W are not present	-	7E+0	3E-9	-	-	-
If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th-232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present-	-	-	1E-14	-	-	
If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236-Y,						

Atomic No.	Radionuclide	Class	Table I Occupational Values: Col. 1 Oral Ingestion ALI (μCi)	Table I Occupational Values: Inhalation Col. 2 ALI (μCi)	Table I Occupational Values: Inhalation Col. 3 DAC (μCi/ml)	Table II Effluent Concentrations: Col. 1 Air (μCi/ml)	Table II Effluent Concentrations: Col. 2 Water (μCi/ml)	Table III release to Sewers: Monthly Average Concentration (μCi/ml)
	U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240-W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y are not present		-	-	-	1E-13	-	-
	If, in addition, it is known that Sm-147-W, Gd-152-W, Pb-210-D, Bi-210m-W, Po-210-D,W, Ra-223-W, Ra-225-W, Ra-226-W, Ac-225-D,W,Y, Th-227-W,Y, U-230-D,W,Y, U-232-D,W, U-Nat-W, Pu-241-W, Cm-240-W, Cm-242-W, Cf-248-W,Y, Es-254-W, Fm-257-W, and Md-258-W are not present		-	-	-	1E-12	-	-
	If, in addition it is known that Fe-60, Sr-90, Cd-113m, Cd-113, In-115, I-129, Cs-134, Sm-145, Sm-147, Gd-148, Gd-152, Hg-194 (organic), Bi-210m, Ra-223, Ra-224, Ra-225, Ac-225, Th-228, Th-230, U-233, U-234, U-235, U-236, U-238, U-Nat, Cm-242, Cf-248, Es-254, Fm-257, and Md-258 are not present		-	-	-	-	1E-6	1E-5

3. If a mixture of radionuclides consists of uranium and its daughters in ore dust (10 μm AMAD particle distribution assumed) prior to chemical separation of the uranium from the ore, the following values may be used for the DAC of the mixture: 6E-11 μCi of gross alpha activity from uranium-238, uranium-234, thorium-230, and radium-226 per milliliter of air; 3E-11 μCi of natural uranium per milliliter of air; or 45 micrograms of natural uranium per cubic meter of air.

4. If the identity and concentration of each radionuclide in a mixture are known, the limiting values should be derived as follows: determine, for each radionuclide in the mixture, the ratio between the concentration present in the mixture and the concentration otherwise established in 180 NAC Appendix 4-B for the specific radionuclide when not in a mixture. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., "unity").

   Example: If radionuclides "A," "B," and "C" are present in concentrations CA, CB, and CC, and if the applicable DACs are DAC_A, DAC_B, and DAC_C, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} \leq 1$$

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Hydrogen-3	1,000	Manganese-56	1,000
Beryllium-7	1,000	Iron-52	100
Beryllium-10	1	Iron-55	100
Carbon-11	1,000	Iron-59	10
Carbon-14	100	Iron-60	1
Fluorine-18	1,000	Cobalt-55	100
Sodium-22	10	Cobalt-56	10
Sodium-24	100	Cobalt-57	100
Magnesium-28	100	Cobalt-58m	1,000
Aluminum-26	10	Cobalt-58	100
Silicon-31	1,000	Cobalt-60m	1,000
Silicon-32	1	Cobalt-60	1
Phosphorus-32	10	Cobalt-61	1,000
Phosphorus-33	100	Cobalt-62m	1,000
Sulfur-35	100	Nickel-56	100
Chlorine-36	10	Nickel-57	100
Chlorine-38	1,000	Nickel-59	100
Chlorine-39	1,000	Nickel-63	100
Argon-39	1,000	Nickel-65	1,000
Argon-41	1,000	Nickel-66	10
Potassium-40	100	Copper-60	1,000
Potassium-42	1,000	Copper-61	1,000
Potassium-43	1,000	Copper-64	1,000
Potassium-44	1,000	Copper-67	1,000
Potassium-45	1,000	Zinc-62	100
Calcium-41	100	Zinc-63	1,000
Calcium-45	100	Zinc-65	10
Calcium-47	100	Zinc-69m	100
Scandium-43	1,000	Zinc-69	1,000
Scandium-44m	100	Zinc-71m	1,000
Scandium-44	100	Zinc-72	100
Scandium-46	10	Gallium-65	1,000
Scandium-47	100	Gallium-66	100
Scandium-48	100	Gallium-67	1,000
Scandium-49	1,000	Gallium-68	1,000
Titanium-44	1	Gallium-70	1,000
Titanium-45	1,000	Gallium-72	100
Vanadium-47	1,000	Gallium-73	1,000
Vanadium-48	100	Germanium-66	1,000
Vanadium-49	1,000	Germanium-67	1,000
Chromium-48	1,000	Germanium-68	10
Chromium-49	1,000	Germanium-69	1,000
Chromium-51	1,000	Germanium-71	1,000
Manganese-51	1,000	Germanium-75	1,000
Manganese-52m	1,000	Germanium-77	1,000
Manganese-52	100	Germanium-78	1,000
Manganese-53	1,000	Arsenic-69	1,000
Manganese-54	100	Arsenic-70	1,000

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Arsenic-71	100	Strontium-85m	1,000
Arsenic-72	100	Strontium-85	100
Arsenic-73	100	Strontium-87m	1,000
Arsenic-74	100	Strontium-89	10
Arsenic-76	100	Strontium-90	0.1
Arsenic-77	100	Strontium-91	100
Arsenic-78	1,000	Strontium-92	100
Selenium-70	1,000	Yttrium-86m	1,000
Selenium-73m	1,000	Yttrium-86	100
Selenium-73	100	Yttrium-87	100
Selenium-75	100	Yttrium-88	10
Selenium-79	100	Yttrium-90m	1,000
Selenium-81m	1,000	Yttrium-90	10
Selenium-81	1,000	Yttrium-91m	1,000
Selenium-83	1,000	Yttrium-91	10
Bromine-74m	1,000	Yttrium-92	100
Bromine-74	1,000	Yttrium-93	100
Bromine-75	1,000	Yttrium-94	1,000
Bromine-76	100	Yttrium-95	1,000
Bromine-77	1,000	Zirconium-86	100
Bromine-80m	1,000	Zirconium-88	10
Bromine-80	1,000	Zirconium-89	10
Bromine-82	100	Zirconium-93	1
Bromine-83	1,000	Zirconium-95	10
Bromine-84	1,000	Zirconium-97	100
Krypton-74	1,000	Niobium-88	1,000
Krypton-76	1,000	Niobium-89 (66 min)	1,000
Krypton-77	1,000	Niobium-89 (122 min)	1,000
Krypton-79	1,000	Niobium-90	100
Krypton-81	1,000	Niobium-93m	10
Krypton-83m	1,000	Niobium-94	1
Krypton-85m	1,000	Niobium-95m	100
Krypton-85	1,000	Niobium-95	100
Krypton-87	1,000	Niobium-96	100
Krypton-88	1,000	Niobium-97	1,000
Rubidium-79	1,000	Niobium-98	1,000
Rubidium-81m	1,000	Molybdenum-90	100
Rubidium-81	1,000	Molybdenum-93m	100
Rubidium-82m	1,000	Molybdenum-93	10
Rubidium-83	100	Molybdenum-99	100
Rubidium-84	100	Molybdenum-101	1,000
Rubidium-86	100	Technetium-93m	1,000
Rubidium-87	100	Technetium-93	1,000
Rubidium-88	1,000	Technetium-94m	1,000
Rubidium-89	1,000	Technetium-94	1,000
Strontium-80	100	Technetium-96m	1,000
Strontium-81	1,000	Technetium-96	100
Strontium-83	100	Technetium-97m	100

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Technetium-97	1,000	Indium-109	1,000
Technetium-98	10	Indium-110 (69.1m)	1,000
Technetium-99m	1,000	Indium-110 (4.9h)	1,000
Technetium-99	100	Indium-111	100
Technetium-101	1,000	Indium-112	1,000
Technetium-104	1,000	Indium-113m	1,000
Ruthenium-94	1,000	Indium-114m	10
Ruthenium-97	1,000	Indium-115m	1,000
Ruthenium-103	100	Indium-115	100
Ruthenium-105	1,000	Indium-116m	1,000
Ruthenium-106	1	Indium-117m	1,000
Rhodium-99m	1,000	Indium-117	1,000
Rhodium-99	100	Indium-119m	1,000
Rhodium-100	100	Tin-110	100
Rhodium-101m	1,000	Tin-111	1,000
Rhodium-101	10	Tin-113	100
Rhodium-102m	10	Tin-117m	100
Rhodium-102	10	Tin-119m	100
Rhodium-103m	1,000	Tin-121m	100
Rhodium-105	100	Tin-121	1,000
Rhodium-106m	1,000	Tin-123m	1,000
Rhodium-107	1,000	Tin-123	10
Palladium-100	100	Tin-125	10
Palladium-101	1,000	Tin-126	10
Palladium-103	100	Tin-127	1,000
Palladium-107	10	Tin-128	1,000
Palladium-109	100	Antimony-115	1,000
Silver-102	1,000	Antimony-116m	1,000
Silver-103	1,000	Antimony-116	1,000
Silver-104m	1,000	Antimony-117	1,000
Silver-104	1,000	Antimony-118m	1,000
Silver-105	100	Antimony-119	1,000
Silver-106m	100	Antimony-120 (16min.)	1,000
Silver-106	1,000	Antimony-120 (5.76d)	100
Silver-108m	1	Antimony-122	100
Silver-110m	10	Antimony-124m	1,000
Silver-111	100	Antimony-124	10
Silver-112	100	Antimony-125	100
Silver-115	1,000	Antimony-126m	1,000
Cadmium-104	1,000	Antimony-126	100
Cadmium-107	1,000	Antimony-127	100
Cadmium-109	1	Antimony-128 (10.4min.)	1,000
Cadmium-113m	0.1	Antimony-128 (9.01h)	100
Cadmium-113	100	Antimony-129	100
Cadmium-115m	10	Antimony-130	1,000
Cadmium-115	100	Antimony-131	1,000
Cadmium-117m	1,000	Tellurium-116	1,000
Cadmium-117	1,000	Tellurium-121m	10

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Tellurium-121	100	Cesium-132	100
Tellurium-123m	10	Cesium-134m	1,000
Tellurium-123	100	Cesium-134	10
Tellurium-125m	10	Cesium-135m	1,000
Tellurium-127m	10	Cesium-135	100
Tellurium-127	1,000	Cesium-136	10
Tellurium-129m	10	Cesium-137	10
Tellurium-129	1,000	Cesium-138	1,000
Tellurium-131m	10	Barium-126	1,000
Tellurium-131	100	Barium-128	100
Tellurium-132	10	Barium-131m	1,000
Tellurium-133m	100	Barium-131	100
Tellurium-133	1,000	Barium-133m	100
Tellurium-134	1,000	Barium-133	100
Iodine-120m	1,000	Barium-135m	100
Iodine-120	100	Barium-139	1,000
Iodine-121	1,000	Barium-140	100
Iodine-123	100	Barium-141	1,000
Iodine-124	10	Barium-142	1,000
Iodine-125	1	Lanthanum-131	1,000
Iodine-126	1	Lanthanum-132	100
Iodine-128	1,000	Lanthanum-135	1,000
Iodine-129	1	Lanthanum-137	10
Iodine-130	10	Lanthanum-138	100
Iodine-131	1	Lanthanum-140	100
Iodine-132m	100	Lanthanum-141	100
Iodine-132	100	Lanthanum-142	1,000
Iodine-133	10	Lanthanum-143	1,000
Iodine-134	1,000	Cerium-134	100
Iodine-135	100	Cerium-135	100
Xenon-120	1,000	Cerium-137m	100
Xenon-121	1,000	Cerium-137	1,000
Xenon-122	1,000	Cerium-139	100
Xenon-123	1,000	Cerium-141	100
Xenon-125	1,000	Cerium-143	100
Xenon-127	1,000	Cerium-144	1
Xenon-129m	1,000	Praseodymium-136	1,000
Xenon-131m	1,000	Praseodymium-137	1,000
Xenon-133m	1,000	Praseodymium-138m	1,000
Xenon-133	1,000	Praseodymium-139	1,000
Xenon-135m	1,000	Praseodymium-142m	1,000
Xenon-135	1,000	Praseodymium-142	100
Xenon-138	1,000	Praseodymium-143	100
Cesium-125	1,000	Praseodymium-144	1,000
Cesium-127	1,000	Praseodymium-145	100
Cesium-129	1,000	Praseodymium-147	1,000
Cesium-130	1,000	Neodymium-136	1,000
Cesium-131	1,000	Neodymium-138	100

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Neodymium-139m	1,000	Gadolinium-153	10
Neodymium-139	1,000	Gadolinium-159	100
Neodymium-141	1,000	Terbium-147	1,000
Neodymium-147	100	Terbium-149	100
Neodymium-149	1,000	Terbium-150	1,000
Neodymium-151	1,000	Terbium-151	100
Promethium-141	1,000	Terbium-153	1,000
Promethium-143	100	Terbium-154	100
Promethium-144	10	Terbium-155	1,000
Promethium-145	10	Terbium-156m (5.0h)	1,000
Promethium-146	1	Terbium-156m (24.4h)	1,000
Promethium-147	10	Terbium-156	100
Promethium-148m	10	Terbium-157	10
Promethium-148	10	Terbium-158	1
Promethium-149	100	Terbium-160	10
Promethium-150	1,000	Terbium-161	100
Promethium-151	100	Dysprosium-155	1,000
Samarium-141m	1,000	Dysprosium-157	1,000
Samarium-141	1,000	Dysprosium-159	100
Samarium-142	1,000	Dysprosium-165	1,000
Samarium-145	100	Dysprosium-166	100
Samarium-146	1	Holmium-155	1,000
Samarium-147	100	Holmium-157	1,000
Samarium-151	10	Holmium-159	1,000
Samarium-153	100	Holmium-161	1,000
Samarium-155	1,000	Holmium-162m	1,000
Samarium-156	1,000	Holmium-162	1,000
Europium-145	100	Holmium-164m	1,000
Europium-146	100	Holmium-164	1,000
Europium-147	100	Holmium-166m	1
Europium-148	10	Holmium-166	100
Europium-149	100	Holmium-167	1,000
Europium-150 (12.62h)	100	Erbium-161	1,000
Europium-150 (34.2y)	1	Erbium-165	1,000
Europium-152m	100	Erbium-169	100
Europium-152	1	Erbium-171	100
Europium-154	1	Erbium-172	100
Europium-155	10	Thulium-162	1,000
Europium-156	100	Thulium-166	100
Europium-157	100	Thulium-167	100
Europium-158	1,000	Thulium-170	10
Gadolinium-145	1,000	Thulium-171	10
Gadolinium-146	10	Thulium-172	100
Gadolinium-147	100	Thulium-173	100
Gadolinium-148	0.001	Thulium-175	1,000
Gadolinium-149	100	Ytterbium-162	1,000
Gadolinium-151	10	Ytterbium-166	100
Gadolinium-152	100	Ytterbium-167	1,000

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Ytterbium-169	100	Tungsten-177	1,000
Ytterbium-175	100	Tungsten-178	1,000
Ytterbium-177	1,000	Tungsten-179	1,000
Ytterbium-178	1,000	Tungsten-181	1,000
Lutetium-169	100	Tungsten-185	100
Lutetium-170	100	Tungsten-187	100
Lutetium-171	100	Tungsten-188	10
Lutetium-172	100	Rhenium-177	1,000
Lutetium-173	10	Rhenium-178	1,000
Lutetium-174m	10	Rhenium-181	1,000
Lutetium-174	10	Rhenium-182 (12.7h)	1,000
Lutetium-176m	1,000	Rhenium-182 (64.0h)	100
Lutetium-176	100	Rhenium-184m	10
Lutetium-177m	10	Rhenium-184	100
Lutetium-177	100	Rhenium-186m	10
Lutetium-178m	1,000	Rhenium-186	100
Lutetium-178	1,000	Rhenium-187	1,000
Lutetium-179	1,000	Rhenium-188m	1,000
Hafnium-170	100	Rhenium-188	100
Hafnium-172	1	Rhenium-189	100
Hafnium-173	1,000	Osmium-180	1,000
Hafnium-175	100	Osmium-181	1,000
Hafnium-177m	1,000	Osmium-182	100
Hafnium-178m	0.1	Osmium-185	100
Hafnium-179m	10	Osmium-189m	1,000
Hafnium-180m	1,000	Osmium-191m	1,000
Hafnium-181	10	Osmium-191	100
Hafnium-182m	1,000	Osmium-193	100
Hafnium-182	0.1	Osmium-194	1
Hafnium-183	1,000	Iridium-182	1,000
Hafnium-184	100	Iridium-184	1,000
Tantalum-172	1,000	Iridium-185	1,000
Tantalum-173	1,000	Iridium-186	100
Tantalum-174	1,000	Iridium-187	1,000
Tantalum-175	1,000	Iridium-188	100
Tantalum-176	100	Iridium-189	100
Tantalum-177	1,000	Iridium-190m	1,000
Tantalum-178	1,000	Iridium-190	100
Tantalum-179	100	Iridium-192 (73.8d)	1
Tantalum-180m	1,000	Iridium-192m (1.4min.)	10
Tantalum-180	100	Iridium-194m	10
Tantalum-182m	1,000	Iridium-194	100
Tantalum-182	10	Iridium-195m	1,000
Tantalum-183	100	Iridium-195	1,000
Tantalum-184	100	Platinum-186	1,000
Tantalum-185	1,000	Platinum-188	100
Tantalum-186	1,000	Platinum-189	1,000
Tungsten-176	1,000	Platinum-191	100

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Platinum-193m	100	Lead-212	1
Platinum-193	1,000	Lead-214	100
Platinum-195m	100	Bismuth-200	1,000
Platinum-197m	1,000	Bismuth-201	1,000
Platinum-197	100	Bismuth-202	1,000
Platinum-199	1,000	Bismuth-203	100
Platinum-200	100	Bismuth-205	100
Gold-193	1,000	Bismuth-206	100
Gold-194	100	Bismuth-207	10
Gold-195	10	Bismuth-210m	0.1
Gold-198m	100	Bismuth-210	1
Gold-198	100	Bismuth-212	10
Gold-199	100	Bismuth-213	10
Gold-200m	100	Bismuth-214	100
Gold-200	1,000	Polonium-203	1,000
Gold-201	1,000	Polonium-205	1,000
Mercury-193m	100	Polonium-207	1,000
Mercury-193	1,000	Polonium-210	0.1
Mercury-194	1	Astatine-207	100
Mercury-195m	100	Astatine-211	10
Mercury-195	1,000	Radon-220	1
Mercury-197m	100	Radon-222	1
Mercury-197	1,000	Francium-222	100
Mercury-199m	1,000	Francium-223	100
Mercury-203	100	Radium-223	0.1
Thallium-194m	1,000	Radium-224	0.1
Thallium-194	1,000	Radium-225	0.1
Thallium-195	1,000	Radium-226	0.1
Thallium-197	1,000	Radium-227	1,000
Thallium-198m	1,000	Radium-228	0.1
Thallium-198	1,000	Actinium-224	1
Thallium-199	1,000	Actinium-225	0.01
Thallium-200	1,000	Actinium-226	0.1
Thallium-201	1,000	Actinium-227	0.001
Thallium-202	100	Actinium-228	1
Thallium-204	100	Thorium-226	10
Lead-195m	1,000	Thorium-227	0.01
Lead-198	1,000	Thorium-228	0.001
Lead-199	1,000	Thorium-229	0.001
Lead-200	100	Thorium-230	0.001
Lead-201	1,000	Thorium-231	100
Lead-202m	1,000	Thorium-232	100
Lead-202	10	Thorium-234	10
Lead-203	1,000	Thorium-natural	100
Lead-205	100	Protactinium-227	10
Lead-209	1,000	Protactinium-228	1
Lead-210	0.01	Protactinium-230	0.1
Lead-211	100	Protactinium-231	0.001

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*
Protactinium-232	1	Americium-246m	1,000
Protactinium-233	100	Americium-246	1,000
Protactinium-234	100	Curium-238	100
Uranium-230	0.01	Curium-240	0.1
Uranium-231	100	Curium-241	1
Uranium-232	0.001	Curium-242	0.01
Uranium-233	0.001	Curium-243	0.001
Uranium-234	0.001	Curium-244	0.001
Uranium-235	0.001	Curium-245	0.001
Uranium-236	0.001	Curium-246	0.001
Uranium-237	100	Curium-247	0.001
Uranium-238	100	Curium-248	0.001
Uranium-239	1,000	Curium-249	1,000
Uranium-240	100	Berkelium-245	100
Uranium-natural	100	Berkelium-246	100
Neptunium-232	100	Berkelium-247	0.001
Neptunium-233	1,000	Berkelium-249	0.1
Neptunium-234	100	Berkelium-250	10
Neptunium-235	100	Californium-244	100
Neptunium-236 (1.15×10^5y)	0.001	Californium-246	1
Neptunium-236 (22.5h)	1	Californium-248	0.01
Neptunium-237	0.001	Californium-249	0.001
Neptunium-238	10	Californium-250	0.001
Neptunium-239	100	Californium-251	0.001
Neptunium-240	1,000	Californium-252	0.001
Plutonium-234	10	Californium-253	0.1
Plutonium-235	1,000	Californium-254	0.001
Plutonium-236	0.001	Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.001
Plutonium-237	100	Einsteinium-250	100
Plutonium-238	0.001	Einsteinium-251	100
Plutonium-239	0.001	Einsteinium-253	0.1
Plutonium-240	0.001	Einsteinium-254m	1
Plutonium-241	0.01	Einsteinium-254	0.01
Plutonium-242	0.001	Fermium-252	1
Plutonium-243	1,000	Fermium-253	1
Plutonium-244	0.001	Fermium-254	10
Plutonium-245	100	Fermium-255	1
Americium-237	1,000	Fermium-257	0.01
Americium-238	100	Mendelevium-257	10
Americium-239	1,000	Mendelevium-258	0.01
Americium-240	100	Any radionuclide other than alpha-emitting radionuclides not listed above, or mixtures of beta- emitters of unknown composition	0.01
Americium-241	0.001		
Americium-242m	0.001		
Americium-242	10		
Americium-243	0.001		
Americium-244m	100		
Americium-244	10		
Americium-245	1,000		

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-C

QUANTITIES[1] MATERIAL REQUIRING LABELING

Radionuclide	Quantity (μCi)*	Radionuclide	Quantity (μCi)*

[1]The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in Table I, Columns 1 and 2, of Appendix 004-B to Section 004, rounding to the nearest factor of 10, and constraining the values listed between 37 Bq and 37 MBq (0.001 and 1,000 μCi). Values of 3.7 MBq (100 μCi) have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years, except rhenium, 37 MBq (1,000 μCi), to take into account their low specific activity.

NOTE: For purposes of 180 NAC 4-32.05, 4-035.01 and 4-055.01, item 1 where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" -- that is, unity.

*To convert μCi to kBq, multiply the μCi value by 37.

APPENDIX 4-D

REQUIREMENTS FOR TRANSFERS OF LOW-LEVEL RADIOACTIVE WASTE INTENDED FOR DISPOSAL AT LICENSED DISPOSAL FACILITIES AND MANIFESTS

Section I. - Manifest.

A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste disposal facility must prepare a Manifest reflecting information requested on the following forms, U.S. Nuclear Regulatory Commission (U.S. NRC) U.S. NRC 540, (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper) and U.S. Form NRC 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description) and if necessary, on Agency Form NRC 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation). U.S. NRC 540 and U.S. NRC 540A must be completed and must physically accompany the pertinent low-level radioactive waste shipment. Upon agreement between shipper and consignee, U.S. Forms U.S. NRC 541 and U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms. Licensees are not required by the Agency to comply with the manifesting requirements of this section when they ship:

(a) Low-Level Waste for processing and expect its return (that is, for storage under their license) prior to disposal at a licensed land disposal facility;

(b) Low-Level Waste that is being returned to the licensee who is the "waste generator" or "generator," as defined in this section; or

(c) Radioactively contaminated material to a "waste processor" that becomes the processor's "residual waste".

For guidance in completing these forms, refer to the instructions that accompany the forms. Copies of manifests required by this appendix may be legible carbon copies, photocopies, or computer printouts that reproduce the data in the format of the uniform manifest.

Forms U.S. NRC 540, U.S. NRC 541, U.S. NRC 541A and U.S. NRC 542 and U.S. NRC 542A and the accompanying instructions, in hard copy, may be obtained from

Department of Health and Human Services
Division of Public Health, Radiological Health
301 Centennial Mall South
P.O. Box 95026
Lincoln, Nebraska 68509-5026

This appendix includes information requirements of the Department of Transportation, as codified in 49 CFR part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency regulations, as codified in 40 CFR parts 259, 261 or elsewhere, is not addressed in this section, and must be provided on the required EPA forms. However, the required EPA forms must accompany the Uniform Low-Level Radioactive Waste Manifest required by this section.

As used in this appendix, the following definitions apply:

"Chelating agent" has the same meaning as that given in 180 NAC 1-002.

"Chemical description" means a description of the principal chemical characteristics of a low-level radioactive waste.

"Computer-readable medium" means that the Agency's computer can transfer the information from the medium into its memory.

"Consignee" means the designated receiver of the shipment of low-level radioactive waste.

"Decontamination facility" means a facility operating under an Agency, U.S. Nuclear Regulatory Commission or Agreement State or license whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and, for purposes of this section, is not considered to be a consignee for low-level waste shipments.

"Disposal container" means a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility (also see "high integrity container"). Note that for some shipments, the disposal container may be the transport package.

"EPA identification number" means the number received by a transporter following application to the Administrator of EPA as required by 40 CFR part 263.

"Generator" means a licensee operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license who (1) is a waste generator as defined in this part, or (2) is the licensee to whom waste can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (e.g., waste generated as a result of decontamination or recycle activities).

"High integrity container (HIC)" means a container commonly designed to meet the structural stability requirements of Appendix 180 NAC 4 E, Section II, and to meet Department of Transportation requirements for a Type A package.

U.S. NRC Forms 540, 540A, 541, 541A, 542, and 542A are Forms referenced in this appendix. Licensees need not use originals of these U.S. NRC Forms as long as any substitute forms are equivalent to the original document in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, U.S. NRC Forms 541 (and 541A) and U.S. NRC Forms 542 and (542A) may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

"Package" means the assembly of components necessary to ensure compliance with the packaging requirements of DOT regulations, together with its radioactive contents, as presented for transport.

"Physical description" means the items called for on Form U.S. NRC 541 to describe a low-level radioactive waste.

"Residual waste" means low-level radioactive waste resulting from processing or decontamination activities that cannot be easily separated into distinct batches attributable to specific waste generators. This waste is attributable to the processor or decontamination facility, as applicable.

"Shipper" means the licensed entity (i.e., the waste generator, waste collector, or waste processor) who offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

"Shipping paper" means U.S. NRC 540 and, if required Form U.S. NRC 540A, which includes the information required by DOT in 49 CFR part 172.

"Source material" has the same meaning as that given in180 NAC 1-002.

"Special nuclear material" has the same meaning as that given in180 NAC 1-002.

"Uniform Low-Level Radioactive Waste Manifest" or "Uniform Manifest" means the combination of U.S. NRC Forms 540, 541, and if necessary, 542, and their respective continuation sheets as needed, or equivalent.

"Waste collector" means an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to collect and consolidate waste generated by others, and to transfer this waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed disposal facility.

"Waste description" means the physical, chemical and radiological description of a low-level radioactive waste as called for on Form U.S. NRC 541.

"Waste generator" means an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, who (1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use, and (2) transfers this material or component to a licensed disposal facility or to a licensed waste collector or processor for handling or treatment prior to disposal. A licensee performing processing or decontamination services may be a "waste generator" if the transfer of low-level radioactive waste from its facility is defined as "residual waste."

"Waste processor" means an entity, operating under a Department, U.S. Nuclear Regulatory Commission or Agreement State license, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others prior to eventual transfer of waste to a licensed low-level radioactive waste disposal facility.

"Waste type" means a waste within a disposal container having a unique physical description that is, a specific waste descriptor code or description; or a waste absorbed on or solidified in a specifically defined media).

INFORMATION REQUIREMENTS

A. General Information

The shipper of the low-level radioactive waste must provide the following information on the uniform manifest:

1. The name, facility address, and telephone number of the licensee shipping the waste;
2. An explicit declaration indicting whether the shipper is acting as a waste generator, collector, processor, or a combination of these identifiers for purposes of the manifested shipment; and
3. The name, address, and telephone number, or the name and EPA identification number for the carrier transporting the waste.

B. Shipment Information

The shipper of the radioactive waste must provide the following information regarding the waste shipment on the uniform manifest:

1. The date of the waste shipment;
2. The total number of packages/disposal containers;
3. The total disposal volume and disposal weight in the shipment;
4. The total radionuclide activity in the shipment.
5. The activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and
6. The total masses of U-233, U-235, and plutonium in the form of special nuclear material, and the total mass of uranium and thorium in the form of source material.

C. Disposal Container and Waste Information

The shipper of the radioactive waste must provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

1. An alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;
2. A physical description of the disposal container, including the manufacturer and model of any high integrity container;
3. The volume displaced by the disposal container;
4. The gross weight of the disposal container, including the waste;
5. For waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;
6. A physical and chemical description of the waste;
7. The total weight percentage of chelating agent for any waste containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;
8. The approximate volume of waste within a container;
9. The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;
10. The identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material. For discrete waste types (that is, activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides associated with a disposal container must be reported;
11. The total radioactivity within each container; and
12. For wastes consigned to a disposal facility, the classification of the waste pursuant to Appendix 4-E, Section I. Waste not meeting the structural stability requirements of Appendix 4-E, Section II(b) must be identified.

D. Uncontainerized Waste Information

The shipper of the radioactive waste must provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

1. The approximate volume and weight of the waste;
2. A physical and chemical description of the waste;
3. The total weight percentage of chelating agent if the chelating agent exceeds 0.1% by weight, plus the identity of the principal chelating agent;
4. For waste consigned to a disposal facility, the classification of the waste pursuant to Appendix 180 NAC 4-E, Section I. Waste not meeting the structural stability requirements of Appendix 180 NAC 4-E, Section II(b) must be identified.
5. The identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material; and
6. For wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

E. Multi-Generator Disposal Container Information

This section applies to disposal containers enclosing mixtures of waste originating from different generators. (Note: The origin of the low-level waste resulting from a processor's activities may be attributable to one or more "generators" (including "waste generators") as defined in this section). It also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.

1. For homogeneous mixtures of waste, such as incinerator ash, provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.

2. For heterogeneous mixtures of waste, such as the combined products from a large compactor, identify each generator contributing waste to the disposal container, and, for discrete waste types (that is activated materials, contaminated equipment, mechanical filters, sealed source/devices, and wastes in solidification/stabilization media), the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, provide the following:

   (a) The volume of waste within the disposal container;

   (b) A physical and chemical description of the waste, including the solidification agent, if any;

   (c) The total weight percentage of chelating agents for any disposal container containing more than 0.1% chelating agent by weight, plus the identity of the principal chelating agent;

   (d) The sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements in Appendix 180 NAC 4-E, Section II(b); and

   (e) Radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in the form of special nuclear material, and the masses of uranium and thorium in the form of source material if contained in the waste.

Section II - Certification

An authorized representative of the waste generator, processor, or collector must certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation and the Department. A collector in signing the certification is certifying that nothing has been done to the collected waste which would invalidate the waste generator's certification.

Section III - Control and Tracking

A. Any licensee who transfers radioactive waste to a land disposal facility or a licensed waste collector must comply with the requirements in A.1 through 9 of this section. Any licensee who transfers waste to a licensed waste processor for waste treatment or repackaging of A.4 through 9 of this section. A licensee shall:

   1. Prepare all wastes so that the waste is classified according to Appendix 180 NAC 4-E, Section I and meets waste characteristics requirements in, Appendix 180 NAC 4-E, Section II.
   2. Label each disposal container (or transport package if potential radiation hazards preclude labeling of the individual disposal container) of waste to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, in accordance with Appendix 180 NAC 4-E, Section I.
   3. Conduct a quality assurance program to assure compliance with Appendix 180 NAC 4-E, Section I and Section II (the program must include management evaluation of audits);
   4. Prepare the Department Uniform Low-Level Radioactive Waste Manifest as required by this appendix;
   5. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;

6. Include Forms U.S. NRC 540 and U.S. NRC 540A, if required, with the shipment regardless of the option in Paragraph A.5 of this section;.
7. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3. This includes those manifests and documents required under the standards for protection against radiation in effect prior to May 30, 1994; and
8. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by Appendix 180 NAC 4-D.
9. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix, conduct an investigation in accordance with Paragraph E of this appendix.

B. Any waste collector licensee who handles only prepackaged waste must:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of Form U.S. NRC 540.
2. Prepare a new manifest to reflect consolidated shipments that meet the requirements of this appendix. The waste collector must ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;
3. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) Receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
4. Include Forms U.S. NRC 540 and NRC 540A, if required, with the shipment regardless of the option chosen in Paragraph B.3 of this section;
5. Retain a copy of the manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by180 NAC 3, and retain information from generator manifest until the license is terminated. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994; and
6. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt;
7. For any shipments or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
8. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

C. Any licensed waste processor who treats or repackages waste must:

1. Acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of Form U.S. NRC 540;
2. Prepare a new manifest that meets the requirements of this appendix. Preparation of the new manifest reflects that the processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest must identify the waste generators, the preprocessed waste volume, and other information as required in Section I.E. of this appendix;
3. Prepare all wastes so that the waste is classified according to Appendix 18- NAC 4-E, Section I, of Appendix 180 NAC 4-D and meets the waste characteristics requirements in Appendix 180 NAC 4-E, Section II;
4. Label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, in accordance with Appendix 180 NAC 4-E, Section I and Section III;

5. Conduct a quality assurance program to assure compliance with Appendix 180 NAC 4- E, Section I and II (the program must include management evaluation of audits);
6. Forward a copy or electronically transfer the Uniform Low-Level Radioactive Waste Manifest to the intended consignee so that either: (i) receipt of the manifest precedes the low-level waste shipment or (ii) the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee. Using both (i) and (ii) is also acceptable;
7. Include Forms U.S. NRC 540 and NRC 540A, if required, with the shipment regardless of the option chosen in Paragraph C.6 of this section;
8. Retain copies of the original manifests and new manifests and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3. This includes those manifests and documents of acknowledgment of receipt required under the standards for protection against radiation in effect prior to May 30, 1994; and
9. Retain a copy of or electronically store the Uniform Low-Level Radioactive Waste Manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required by 180 NAC 3;
10. For any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this appendix, conduct an investigation in accordance with Paragraph E of this appendix; and
11. Notify the shipper and the Department when any shipment, or any part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

D. The land disposal facility operator must:

1. Acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of Form U.S. NRC 540 to the shipper. The shipper to be notified is the licensee who last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the Uniform Low-Level Radioactive Waste Manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating that discrepancy.
2. Maintain copies of all completed manifests or equivalent documentation until the license is terminated. This includes those manifests or equivalent documents required under the standards for protection against radiation in effect prior to May 30, 1994.
3. Notify the shipper and the Department when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

E. Any shipments or part of a shipment for which acknowledgment is not received within the times set forth in this section must:

1. Be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and
2. Be traced and reported. The investigation must include tracing the shipment and filing a report with the Department. Each licensee who conducts a trace investigation must file a written report with the Department within two weeks of completion of the investigation.

APPENDIX 4-E

CLASSIFICATION AND CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE WASTE

I. Classification of Radioactive Waste for Land Disposal

a) Considerations. Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

b) Classes of waste.

1) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in Section II. (a). If Class A waste also meets the stability requirements set forth in Section II. (b), it is not necessary to segregate the waste for disposal.

2) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in Section II.

3) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in Section II.

c) Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table I, classification must be determined as follows:

1) If the concentration does not exceed 0.1 times the value in Table I, the waste is Class A.

2) If the concentration exceeds 0.1 times the value in Table I, but does not exceed the value in Table I, the waste is Class C.

3) If the concentration exceeds the value in Table I, the waste is not generally acceptable for near surface disposal.

4) For wastes containing mixtures of radionuclides listed in Table I, the total concentration must be determined by the sum of fractions rule described in Section I. (g).

APPENDIX 4-E

Table I		
	Concentration	
Radionuclide	curie/cubic meter[a]	nanocurie/gram[b]
C-14	8	
C-14 in activated metal	80	
Ni-59 in activated metal	220	
Nb-94 in activated metal	0.2	
Tc-99	3	
I-129	0.08	
Alpha emitting transuranic radionuclides with half-life greater than five years		100
Pu-241		3,500
Cm-242		20,000
Ra-226		100
[a]To convert the Ci/m^3 values to gigabecquerel (Gbq) per cubic meter, multiply the Ci/m^3 value by 37.		
[b]To convert the nCi/g values to becquerel (Bq) per gram, multiply the nCi/g value by 37.		

d) Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table I classification must be determined based on the concentrations shown in Table II. However, as specified in Section I. (f), if radioactive waste does not contain any nuclides listed in either Table I or II, it is Class A.

1) If the concentration does not exceed the value in Column 1, the waste is Class A.

2) If the concentration exceeds the value in Column 1 but does not exceed the value in Column 2, the waste is Class B.

3) If the concentration exceeds the value in Column 2 but does not exceed the value in Column 3, the waste is Class C.

4) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

5) For wastes containing mixtures of the radionuclides listed in Table II, the total concentration must be determined by the sum of fractions rule described in Section I. (g).

Table II			
	Concentration, curie/cubic meter*		
Radionuclide	Column 1	Column 2	Column 3
Total of all radionuclides with less than 5-year half-life	700	-----	-----
H-3	40	-----	-----
Co-60	700	-----	-----
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Cs-137	1	44	4600

*DEPARTMENT NOTE: To convert the Ci/m^3 value to gigabecquerel (Gbq) per cubic meter, multiply the Ci/m^3 value by 37. There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table II determine the waste to be Class C independent of these radionuclides.

e) Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains a mixture of radionuclides, some of which are listed in Table I and some of which are listed in Table II, classification must be determined as follows:

1) If the concentration of a radionuclide listed in Table I is less than 0.1 times the value listed in Table I, the class must be that determined by the concentration of radionuclides listed in Table II.

2) If the concentration of a radionuclide listed in Table I exceeds 0.1 times the value listed in Table I, but does not exceed the value in Table I, the waste must be Class C, provided the concentration of radionuclides listed in Table II does not exceed the value shown in Column 3 of Table II.

f) Classification of wastes with radionuclides other than those listed in Tables I and II. If the waste does not contain any radionuclides listed in either Table I or II, it is Class A.

g) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each radionuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0 if the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 1.85 TBq/m^3 (50 Ci/m^3) and Cs-137 in a concentration of 814 GBq/m^3 (22 Ci/m^3). Since the concentrations both exceed the values in Column 1, Table II, they must be compared to Column 2 values. For Sr-90 fraction, 50/150 = 0.33., for Cs-137 fraction, 22/44 = 0.5; the sum of the fractions = 0.83. Since the sum is less than 1.0, the waste is Class B.

h) Determination of concentrations in wastes. The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as becquerel (nanocurie) per gram.

II. Radioactive Waste Characteristics

a) The following are minimum requirements for all classes of waste and are intended to facilitate handling and provide protection of health and safety of personnel at the disposal site.

1) Wastes must be packaged in conformance with the conditions of the license issued to the site operator to which the waste will be shipped. Where the conditions of the site license are more restrictive than the provisions of 180 NAC 4, the site license conditions shall govern.

2) Wastes must not be packaged for disposal in cardboard or fiberboard boxes.

3) Liquid waste must be packaged in sufficient absorbent material to absorb twice the volume of the liquid.

4) Solid waste containing liquid must contain as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.

5) Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

6) Waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes harmful to persons transporting, handling, or disposing of the waste. This does not apply to radioactive gaseous waste packaged in accordance with Section II.(a)(8).

7) Waste must not be pyrophoric. Pyrophoric materials contained in wastes must be treated, prepared, and packaged to be nonflammable.[1]

8) Wastes in a gaseous form shall be packaged at an absolute pressure that does not exceed 1.5 atmospheres at 20°C. Total activity must not exceed 3.7 TBq (100 Ci) per container.

9) Wastes containing hazardous, biological, pathogenic, or infectious material must be treated to reduce to the maximum extent practicable the potential hazard from the non-radiological materials.

b) The following requirements are intended to provide stability of the waste. Stability is intended to ensure that the waste does not degrade and affect overall stability of the site through slumping, collapse, or other failure of the disposal unit and thereby lead to water infiltration. Stability is also a factor in limiting exposure to an inadvertent intruder, since it provides a recognizable and nondispersible waste.

1) Waste must have structural stability. A structurally stable waste form will generally maintain its physical dimensions and its form, under the expected disposal conditions such as weight of overburden and compaction equipment, the presence of moisture, and microbial activity, and

[1]See 180 NAC 1-002 for definition of pyrophoric.

internal factors such as radiation effects and chemical changes. Structural stability can be provided by the waste form itself, processing the waste to a stable form, or placing the waste in a disposal container or structure that provides stability after disposal.

2) Notwithstanding the provisions in Section II. (a)(3) and (4), liquid wastes, or wastes containing liquid, must be converted into a form that contains as little free-standing and non-corrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container designed to ensure stability, or 0.5% of the volume of the waste for waste processed to a stable form.

3) Void spaces within the waste and between the waste and its package must be reduced to the extent practicable.

III. Labeling

Each package of waste must be clearly labeled to identify whether it is Class A, Class B, or Class C waste, in accordance with Section I.

APPENDIX 4-F

QUANTITIES FOR USE WITH DECOMMISSIONING

(To convert μCi to kBq, multiply the μCi value by 37.)

Material	Microcurie
Americium-241	0.01
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
Florine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100
Gold-198	100
Gold-199	100
Hafnium-181	10

APPENDIX 4-F

QUANTITIES FOR USE WITH DECOMMISSIONING

(To convert μCi to kBq, multiply the μCi value by 37.)

Material	Microcurie
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
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	0.01
Polonium-210	0.1

APPENDIX 4-F

QUANTITIES FOR USE WITH DECOMMISSIONING

(To convert μCi to kBq, multiply the μCi value by 37.)

Material	Microcurie
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
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-22	1
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulfur-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

APPENDIX 4-F

QUANTITIES FOR USE WITH DECOMMISSIONING

(To convert μCi to kBq, multiply the μCi value by 37.)

Material	Microcurie
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	0.01
Uranium-234	0.01
Uranium-235	0.01
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
Any alpha emitting radionuclide not listed above or Mixtures of alpha emitters of unknown composition	0.1
Any radionuclide other than alpha emitting Radionuclides, not listed above or mixtures of Beta emitters of unknown composition	0.1

NOTE: 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" -- that is, unity.

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

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

APPENDIX 4-G

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY

(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
F-18	3E-1	8
Si-31	1E-2	3E+3
Na-24	9E-4	2E-2
P-32	2	5E+1
P-33	10	3E+2
S-35	9	2E+2
Ar-41	3E-1	8
K-42	2E-2	5E-1
Ca-45	4	1E+2
Ca-47	2E-2	5E-1
Sc-46	2E-3	5E-2
Cr-51	6E-1	2E+1
Fe-59	5E-3	1E-1
Co-57	6E-2	2
Co-58	1E-2	3E-1
Zn-65	7E-3	2E-1
Ga-67	3E-1	8
Se-75	5E-2	1
Br-82	2E-3	5E-2
Rb-86	4E-2	1
Sr-85	2E-2	5E-1
Sr-89	8	2E+2
Y-90	4	1E+2
Y-91	4E-1	10
Zr-95	8E-3	2E-1
Nb-95	8E-3	2E-1
Mo-99	5E-2	1

APPENDIX 4-G

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY

(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
Tc-99m	1	3E+1
Rh-106	1	3E+1
Ag-110m	2E-3	5E-2
Cd-115m	2E-1	5
In-111	9E-2	2
In-113m	9	2E+2
Sn-113	6E-2	2
Sn-119	2E+1	5E+2
Sb-124	2E-3	5E-2
Te-129	2E-1	5
I-123	4E-1	1E+1
I-125	7E-1	2E+1
I-131	4E-2	1
I-133	2E-2	5E-1
Xe-127	8E-2	2
Xe-133	1	3E+1
Ba-140	2E-3	5E-2
La-140	2E-3	5E-2
Ce-141	4E-1	1E+1
Ce-144	1E-3	3E-2
Pr-143	6	2E+2
Nd-147	7E-2	2
Yb-169	6E-2	2
Ir-192	1E-2	3E-1
Au-198	3E-2	8E-1
Hg-197	8E-1	2E+1
Tl-201	4E-1	1E+1

APPENDIX 4-G

CONCENTRATION AND ACTIVITY LIMITS OF NUCLIDES FOR DISPOSAL IN A CITY OR COUNTY LANDFILL DISPOSAL FACILITY

(For use in 180 NAC 4-038)

Nuclides	Concentration Limits (Ci/m^3)	Annual Generator Disposal Limit (Ci/yr)
Hg-203	1E-1	3

NOTE: In any case where there is a mixture in waste of more than one radionuclide, the limiting values for purposes of this Appendix must be determined as follows:

For each radionuclide in the mixture, calculate the ratio between the quantity present in the mixture and the limit established in Appendix 004-G 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").

Examples: If radionuclides a, b, and c are present in concentrations C_a, C_b, and C_c, and if the applicable concentrations are CL_a, CL_b, and CL_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$(C_a/CL_a) + (C_b/CL_b) + (C_c/CL_c) \leq 1$$

If the total curies for radionuclides a, b, and c are represented A_a, A_b, and A_c, and the annual curie limit for each radionuclide is AL_a, AL_b, and AL_c, then the generator is limited to the following:

$$(A_a/AL_a) + (A_b/AL_b) + (A_c/AL_c) \leq 1$$

APPENDIX 4-H

NATIONALLY TRACKED SOURCE THRESHOLDS

The Terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The curie values are provided for practical usefulness only and are rounded after conversion.

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Actinium-227	20	540	0.2	5.4
Americium-241	60	1,600	0.6	16
Americium-241/Be	60	1,600	0.6	16
Californium-252	20	540	0.2	5.4
Cobalt-60	30	810	0.3	8.1
Curium-244	50	1,400	0.5	14
Cesium-137	100	2,700	1.0	27
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,200	0.8	22
Plutonium-238	60	1,600	0.6	16
Plutonium-239/Be	60	1,600	0.6	16
Polonium-210	60	1,600	0.6	16
Promethium-147	40,000	1,100,000	400	11,000
Radium-226	40	1,100	0.4	11
Selenium-75	200	5,400	2	54
Strontium-90	1,000	27,000	10	270
Thorium-228	20	540	0.2	5.4
Thorium-229	20	540	0.2	5.4
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81

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~~Nebraska Department of Health and Human Services, Radiological Health~~

~~CUMULATIVE OCCUPATIONAL EXPOSURE HISTORY~~

~~NRH-1~~
~~EFFECTIVE DATE November 28, 2016~~

~~1. NAME (LAST, FIRST, MIDDLE INITIAL)~~			~~2. IDENTIFICATION NUMBER~~		~~3. ID TYPE~~	~~4. SEX~~ ~~MALE~~ ☐ ~~FEMALE~~ ☐	~~5. DATE OF BIRTH~~
~~6. MONITORING PERIOD~~		~~7. LICENSEE OR REGISTRANT NAME~~		~~8. LICENSE OR REGISTRATION NUMBER~~		~~9.~~ ~~RECORD~~ ☐ ~~ESTIMATE~~ ☐ ~~NO RECORD~~ ☐	~~10.~~ ~~ROUTINE~~ ☐ ~~PSE~~ ☐
~~11. DDE~~	~~12. LDE~~	~~13. SDE, WB~~	~~14. SDE, ME~~	~~15. CEDE~~	~~16. CDE~~	~~17. TEDE~~	~~18. TODE~~
~~6. MONITORING PERIOD~~		~~7. LICENSEE OR REGISTRANT NAME~~		~~8. LICENSE OR REGISTRATION NUMBER~~		~~9.~~ ~~RECORD~~ ☐ ~~ESTIMATE~~ ☐ ~~NO RECORD~~ ☐	~~10.~~ ~~ROUTINE~~ ☐ ~~PSE~~ ☐
~~11. DDE~~	~~12. LDE~~	~~13. SDE, WB~~	~~14. SDE, ME~~	~~15. CEDE~~	~~16. CDE~~	~~17. TEDE~~	~~18. TODE~~
~~6. MONITORING PERIOD~~		~~7. LICENSEE OR REGISTRANT NAME~~		~~8. LICENSE OR REGISTRATION NUMBER~~		~~9.~~ ~~RECORD~~ ☐ ~~ESTIMATE~~ ☐ ~~NO RECORD~~ ☐	~~10.~~ ~~ROUTINE~~ ☐ ~~PSE~~ ☐
~~11. DDE~~	~~12. LDE~~	~~13. SDE, WB~~	~~14. SDE, ME~~	~~15. CEDE~~	~~16. CDE~~	~~17. TEDE~~	~~18. TODE~~
~~6. MONITORING PERIOD~~		~~7. LICENSEE OR REGISTRANT NAME~~		~~8. LICENSE OR REGISTRATION NUMBER~~		~~9.~~ ~~RECORD~~ ☐ ~~ESTIMATE~~ ☐ ~~NO RECORD~~ ☐	~~10.~~ ~~ROUTINE~~ ☐ ~~PSE~~ ☐
~~11. DDE~~	~~12. LDE~~	~~13. SDE, WB~~	~~14. SDE, ME~~	~~15. CEDE~~	~~16. CDE~~	~~17. TEDE~~	~~18. TODE~~
~~6. MONITORING PERIOD~~		~~7. LICENSEE OR REGISTRANT NAME~~		~~8. LICENSE OR REGISTRATION NUMBER~~		~~9.~~ ~~RECORD~~ ☐ ~~ESTIMATE~~ ☐ ~~NO RECORD~~ ☐	~~10.~~ ~~ROUTINE~~ ☐ ~~PSE~~ ☐
~~11. DDE~~	~~12. LDE~~	~~13. SDE, WB~~	~~14. SDE, ME~~	~~15. CEDE~~	~~16. CDE~~	~~17. TEDE~~	~~18. TODE~~
~~6. MONITORING PERIOD~~		~~7. LICENSEE OR REGISTRANT NAME~~		~~8. LICENSE OR REGISTRATION NUMBER~~		~~9.~~ ~~RECORD~~ ☐ ~~ESTIMATE~~ ☐ ~~NO RECORD~~ ☐	~~10.~~ ~~ROUTINE~~ ☐ ~~PSE~~ ☐
~~11. DDE~~	~~12. LDE~~	~~13. SDE, WB~~	~~14. SDE, ME~~	~~15. CEDE~~	~~16. CDE~~	~~17. TEDE~~	~~18. TODE~~
~~19. SIGNATURE OF MONITORED INDIVIDUAL~~		~~20. DATE SIGNED~~	~~21. CERTIFYING ORGANIZATION~~		~~22. SIGNATURE OF DESIGNEE~~		~~23. DATE SIGNED~~

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRH-1

(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee, registrant, or facility not licensed by the Department that provided monitoring.

8. Enter the Department license or registration number or numbers.

9. Place an "X" in Record, Estimate, or No Record. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee or registrant intends to assign the record dose on the basis of TLD results that are not yet available.

10. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee should sum them and report the total of all PSEs.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE).

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ.

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the monitored individual. The signature of the monitored individual on this form indicates that the information contained on the form is complete and correct to the best of his or her knowledge.

20. Enter the date this form was signed by the monitored individual.

21. [OPTIONAL] Enter the name of the licensee, registrant or facility not licensed by the Department, providing monitoring for exposure to radiation (such as a DOE facility) or the employer if the individual is not employed by the licensee or registrant and the employer chooses to maintain exposure records for its employees.

22. [OPTIONAL] Signature of the person designated to represent the licensee, registrant or employer entered in item 21. The licensee, registrant or employer who chooses to countersign the form should have on file documentation of all the information on the Department Form Y being signed.

23. [OPTIONAL] Enter the date this form was signed by the designated representative.

Nebraska Department of Health and Human Services, Radiological Health

NRH 2
EFFECTIVE DATE November 28, 2016

OCCUPATIONAL EXPOSURE RECORD FOR A MONITORING PERIOD

1. NAME (LAST, FIRST, MIDDLE INITIAL)	2. IDENTIFICATION NUMBER	3. ID TYPE	4. SEX MALE_____ FEMALE_____	5. DATE OF BIRTH

6. MONITORING PERIOD	7. LICENSEE OR REGISTRANT NAME	8. LICENSE OR REGISTRATION NUMBER(S)	9A.		9B.	
				RECORD		ROUTINE
				ESTIMATE		PSE

INTAKES

10A. RADIONUCLIDE	10B. CLASS	10C. MODE	10D. INTAKE IN ΦCi

DOSES (in rem)

DEEP DOSE EQUIVALENT (DDE)	11.
EYE DOSE EQUIVALENT TO THE LENS OF THE EYE (LDE)	12.
SHALLOW DOSE EQUIVALENT, WHOLE BODY (SDE,WB)	13.
SHALLOW DOSE EQUIVALENT, MAX EXTREMITY (SDE,ME)	14.
COMMITTED EFFECTIVE DOSE EQUIVALENT(CEDE)	15.
COMMITTED DOSE EQUIVALENT, MAXIMALLY EXPOSED ORGAN (CDE)	16.
TOTAL EFFECTIVE DOSE EQUIVALENT (BLOCKS 11+15) (TEDE)	17.
TOTAL ORGAN DOSE EQUIVALENT, MAX ORGAN (BLOCKS 11+16) (TODE)	18.

19. COMMENTS

20. SIGNATURE -- LICENSEE OR REGISTRANT	21. DATE PREPARED

INSTRUCTIONS AND ADDITIONAL INFORMATION PERTINENT TO THE COMPLETION OF NRH-2

(All doses should be stated in rems)

1. Type or print the full name of the monitored individual in the order of last name (include "Jr," "Sr," "III," etc.), first name, middle initial (if applicable).

2. Enter the individual's identification number, including punctuation. This number should be the 9-digit social security number if at all possible. If the individual has no social security number, enter the number from another official identification such as a passport or work permit.

3. Enter the code for the type of identification used as shown below:

CODE	ID TYPE
SSN	U.S. Social Security Number
PPN	Passport Number
CSI	Canadian Social Insurance Number
WPN	Work Permit Number
IND	INDEX Identification Number
OTH	Other

4. Check the box that denotes the sex of the individual being monitored.

5. Enter the date of birth of the individual being monitored in the format MM/DD/YY.

6. Enter the monitoring period for which this report is filed. The format should be MM/DD/YY - MM/DD/YY.

7. Enter the name of the licensee or registrant.

8. Enter the Department license or registration number or numbers.

9A. Place an "X" in Record or Estimate. Choose "Record" if the dose data listed represent a final determination of the dose received to the best of the licensee's or registrant's knowledge. Choose "Estimate" only if the listed dose data are preliminary and will be superseded by a final determination resulting in a subsequent report. An example of such an instance would be dose data based on self-reading dosimeter results and the licensee intends to assign the record dose on the basis of TLD results that are not yet available.

9B. Place an "X" in either Routine or PSE. Choose "Routine" if the data represent the results of monitoring for routine exposures. Choose "PSE" if the listed dose data represents the results of monitoring of planned special exposures received during the monitoring period. If more than one PSE was received in a single year, the licensee or registrant should sum them and report the total of all PSEs.

10A. Enter the symbol for each radionuclide that resulted in an internal exposure recorded for the individual, using the format "Xx-###x," for instance, Cs-137 or Tc-99m.

10B. Enter the lung clearance class as listed in Appendix B to Part D (D, W, Y, V, or O for other) for all intakes by inhalation.

10C. Enter the mode of intake. For inhalation, enter "H." For absorption through the skin, enter "B." For oral ingestion, enter "G." For injection, enter "J."

10D. Enter the intake of each radionuclide in ΦCi.

11. Enter the deep dose equivalent (DDE) to the whole body.

12. Enter the eye dose equivalent (LDE) recorded for the lens of the eye.

13. Enter the shallow dose equivalent recorded for the skin of the whole body (SDE,WB).

14. Enter the shallow dose equivalent recorded for the skin of the extremity receiving the maximum dose (SDE,ME).

15. Enter the committed effective dose equivalent (CEDE) or "NR" for "Not Required" or "NC" for "Not Calculated".

16. Enter the committed dose equivalent (CDE) recorded for the maximally exposed organ or "NR" for "Not Required" or "NC" for "Not Calculated".

17. Enter the total effective dose equivalent (TEDE). The TEDE is the sum of items 11 and 15.

18. Enter the total organ dose equivalent (TODE) for the maximally exposed organ. The TODE is the sum of items 11 and 16.

19. Signature of the person designated to represent the licensee or registrant.

20. Enter the date this form was prepared.

21. COMMENTS.
In the space provided, enter additional information that might be needed to determine compliance with limits. An example might be to enter the note that the SDE,ME was the result of exposure from a discrete hot particle. Another possibility would be to indicate that an overexposed report has been sent to the Department in reference to the exposure report.