

NOTICES OF FINAL RULEMAKING

The Administrative Procedure Act requires the publication of the final rules of the state's agencies. Final rules are those which have appeared in the *Register* first as proposed rules and have been through the formal rulemaking process including approval by the Governor's Regulatory Review Council or the Attorney General. The Secretary of State shall publish the notice along with the Preamble and the full text in the next available issue of the *Register* after the final rules have been submitted for filing and publication.

NOTICE OF FINAL RULEMAKING

TITLE 12. NATURAL RESOURCES

CHAPTER 1. RADIATION REGULATORY AGENCY

Editor's Note: The following Notice of Final Rulemaking was reviewed per Executive Order 2012-03 as issued by Governor Brewer. (See the text of the executive order on page 417.) The Governor's Office authorized the notice to proceed through the rulemaking process on July 18, 2013.

[R14-01]

PREAMBLE

<u>1. Article, Part, or Section Affected (as applicable)</u>	<u>Rulemaking Action</u>
R12-1-102	Amend
R12-1-303	Amend
R12-1-304	Amend
R12-1-306	Amend
R12-1-308	Amend
R12-1-311	Amend
R12-1-313	Amend
R12-1-320	Amend
Exhibit B	Amend
Exhibit D	Amend
R12-1-408	Amend
R12-1-434	Amend
R12-1-438	Amend
R12-1-438.01	New Section
R12-1-439	Amend
R12-1-446	Amend
Appendix B	Amend
R12-1-703	Amend
R12-1-705	Amend
R12-1-710	Amend
R12-1-711	Amend
R12-1-712	Amend
R12-1-713	Amend
R12-1-717	Amend
R12-1-719	Amend
R12-1-720	Amend
R12-1-721	Amend
R12-1-723	Amend
R12-1-727	Amend
R12-1-728	Amend
R12-1-744	Amend
Exhibit A	Amend
R12-1-1004	Amend

2. Citations to the agency's statutory rulemaking authority to include the authorizing statute (general) and the implementing statute (specific):

Authorizing statute: A.R.S. § 30-654(B)(5)

Implementing statutes: A.R.S. §§ 30-651, 30-654, 30-657, 30-671(B), 30-672, 30-673, 30-681, 30-687, 30-688, and 30-689.

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3. The effective date of the rule:

March 8, 2014

4. Citations to all related notices published in the Register as specified in R1-1-409(A) that pertain to the record of the proposed rule:

Notice of Rulemaking Docket Opening: 19 A.A.R. 1992, August 2, 2013

Notice of Proposed Rulemaking: 19 A.A.R. 2642, August 30, 2013

5. The agency's contact person who can answer questions about the rulemaking:

Name: Jerry W. Perkins
Address: Arizona Radiation Regulatory Agency
4814 S. 40th St.
Phoenix, AZ 85040
Telephone: (602) 255-4845, ext. 272
Fax: (602) 437-0705
E-mail: jperkins@azrra.gov
Website: www.azrra.gov

6. An agency's justification and reason why a rule should be made, amended, repealed or renumbered, to include an explanation about the rulemaking:

This rulemaking package amends several rules to ensure that Arizona radiation compliance remains compatible with the Nuclear Regulatory Commission regulations. This compatibility is a requirement under Arizona's agreement state status. Arizona has entered into an agreement with the NRC that gives the state the authority to license and inspect byproduct, source, and special nuclear materials used or possessed within the state's borders since 1967 as a portion of the existing radiation protection program adopted by the state. This allows Arizona to retain local jurisdiction without duplication of effort in a continuing effort to protect the health and safety of the public. In addition, A.R.S. § 30-654(B)(6) requires the Agency to be as nearly as possible in conformity with the regulations of the NRC.

7. A reference to any study relevant to the rule that the agency reviewed and proposes either to rely on or not to rely on in its evaluation of or justification for the rule, where the public may obtain or review each study, all data underlying each study, and any analysis of each study and other supporting material:

None

8. A showing of good cause why the rulemaking is necessary to promote a statewide interest if the rulemaking will diminish a previous grant of authority of a political subdivision of this state:

Not applicable

9. A summary of the economic, small business, and consumer impact:

There is little or minimal economic impact from any of the proposed rules in this rulemaking. Currently all licensees and registrants pay an annual fee which covers the administrative cost and inspection fees for each facility registration number. This package has no fee increase or new requirements that would markedly change the way businesses operate with radiation safety concerns in mind. The amendments in this rulemaking brings the Arizona Regulatory program closer to federal regulations in accordance with the Agreement State document signed by the state Governor on March 30, 1967. No new FTEs were needed for this rulemaking package so additional notice was not sent to the Joint Legislative Budget Committee (JLBC).

10. A description of any changes between the proposed rulemaking, to include supplemental notices, and the final rulemaking:

Several grammatical, clarifying, and formatting changes were made to the proposed rules following the suggestions presented by the U.S. Nuclear Regulatory Commission in a written comments letter dated August 14, 2013. R12-1-711, Exhibit A: Group 100, R12-1-719, Exhibit A: Group 200, R12-1-721, R12-1-723, R12-1-727, and R12-1-744 were corrected to include "NRC" in the referencing equivalent requirements as well as clarifying specific subsections referred to within the rule. A typographical correction to a cross-reference was made to the definition of "Authorized user" in R12-1-102. In addition, incorporations of 10 CFR 101, 101, and 103 required removal as the 2013 code of federal regulations no longer included these regulations. The second alphabetical listing for Radiation Safety officer (RSO) was struck as it was a duplicate of the language in the second portion of the first listing of the definition.

Original language in R12-1-303 and R12-1-306 was inaccurately noticed in the proposed rules and corrected as it did not include language modifications that were already final but had not yet been included in the Administrative Code by the Secretary of State's Office when the rulemaking was first being drafted for comments. In addition, the change on R12-1-310 was a typographical mistake that did not change the rule and was not needed. R12-1-408 title in the rule was modified to match the existing title in the table of contents as well as the title used in 10 FCR 20.1201. In several rules the abbreviated term "Commission" was replaced by NRC for clarity.

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R12-1-311(G) incorrectly proposed removing incorporated material in favor of training already listed in the rules. However, the intent was to all additional entities to manufacture radioactive medications so the incorporated material was not removed and an additional incorporation was included. In addition, a definition for “FDA” was included in Article one to match the one listed in Article 14. The cross-reference in R12-1-703(C)(2) was corrected.

11. An agency’s summary of the public or stakeholder comments made about the rulemaking and the agencies response to the comments:

Agency received 12 written comments that were presented and discussed by the Radiation Regulatory Hearing Board from the U.S. Nuclear Regulatory Commission. The first comment requested that Arizona adopt language in the rules to allow a consortium to apply for a positron radioactive drug production license. This was originally considered a significant change from the proposed rulemaking, however, the original incorporated material was retained and adjustment to not restrict previously approved entities was made. The use of state specific language instead of incorporation will be made in a further rulemaking package. The second and fourth comments requested changes to the definitions of “Preceptor” and training requirements for a radiation safety officer. No change was made as this was previously completed in rulemaking package 0072, however the Secretary of State’s version of the code was several years behind at the time that the staff of the NRC was reviewing the rules in Arizona and they did not notice the published registers that showed these changes. Comment number three addressed a needed correction to a cross reference typo in the definition of “Authorized user” and this correction was made. Comments number five through twelve clarified the cross-reference section in the specific training rules R12-1-711, Exhibit A: Group 100, R12-1-719, Exhibit A: Group 200, R12-1-721, R12-1-723, R12-1-727, and R12-1-744 as well as the need to include “NRC” in the verbiage related to equivalent regulations. These corrections were all made with the Approval of the Radiation Hearing Board. Two members of the Agency staff were observing the proceeding and were listed as “Public Members” in the transcript by the court reporter. The Agency staff also acknowledged agreement with the rules modifications as recorded in the public record.

12. All agencies shall list other matters prescribed by statute applicable to the specific agency or to any specific rule or class of rules. Additionally, an agency subject to Council review under A.R.S. §§ 41-1052 and 41-1055 shall respond to the following questions:

a. Whether the rule requires a permit, whether a general permit is used and if not, the reasons why a general permit is not used:

The Agency believes that it is exempt from A.R.S. § 41-1037 due to paragraph (A)(3) as the issuance of a general permit would not meet the statutory requirement of A.R.S. § 30-656 which allows Arizona to be an Agreement State and compatibility of licensing is one of the requirements of the agreement. The agency also believes that it is exempt from A.R.S. § 41-1037 due to paragraph (A)(2) as the issuance of an alternative type of permit is authorized under the statutory requirement of A.R.S. § 30-672 to protect the public health and safety.

b. Whether a federal law is applicable to the subject of the rule, whether the rule is more stringent than federal law and if so, citation to the statutory authority to exceed the requirements of federal law:

The rule amendments are compatible with existing federal regulations and are not more stringent except for those types of radiation protection use whose regulation is authorized by Arizona statute that are not in the jurisdiction of an equivalent federal regulating body.

c. Whether a person submitted an analysis to the agency that compares the rule’s impact of the competitiveness of business in this state to the impact on business in other states:

No analysis has been completed as the regulated community must be in compliance with either federal regulations (if not under a state jurisdiction) or agreement state rules.

Other matters prescribed by statute applicable to the specific agency or to any specific rule or class of rules:

The Arizona Radiation Regulatory Hearing Board (ARRHB) is required to “review and approve rules and substantive policy statements as defined in A.R.S. § 41-1001 adopted by the agency.” A.R.S. § 30-655(D). After reviewing the rules and requested changes during a public meeting, the ARRHB approved the rules on October 3, 2013.

13. A list of any incorporated by reference material as specified in A.R.S. § 41-1028 and its location in the rules:

<u>Rule</u>	<u>Incorporated Material</u>
R12-1-102	
“A ₁ ”	10 CFR 71, Appendix A
“A ₂ ”	10 CFR 71, Appendix A
“Certifiable cabinet x-ray system”	21 CFR 1020.40
“Certified cabinet x-ray system”	21 CFR 1010.2 and 21 CFR 1020.40
“Generally applicable environmental radiation standards”	40 CFR 190 and 191
“Major processor”	10 CFR 71.4
“Nuclear waste”	49 CFR 173.403
“Regulations of the U.S. Department of Transportation”	49 CFR 107, and 171 through 180

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“Special form radioactive material”	10 CFR 71.75
R12-1-304(A)(1)	10 CFR 30.3
R12-1-306(B)(1)	10 CFR 31.5(b), (c), and (d)
R12-1-306(B)(4)(g)	10 CFR 110
R12-1-306(D)(1)	10 CFR 32.57 or 10 CFR 70.39
R12-1-306(E)(3)	10 CFR 32.21
R12-1-306(I)(3)	10 CFR part 110
R12-1-308(G)	10 CFR 32.210(c)
R12-1-308(G)(1)(a)	10 CFR 32.210(c)
R12-1-311(A)(1)(f)	10 CFR 31.5(c)(13)(i)
R12-1-311(A)(4)(b)(i)	10 CFR 32.52
R12-1-311(B)(2)	10 CFR 32.53 through 32.56
R12-1-311(C)(2)	10 CFR 32.57, 32.58, 32.59, and 70.39
R12-1-311(F)(2)	10 CFR 32.61 and 32.62
R12-1-311(G)	10 CFR 32.32(j) and 32.72
R12-1-311(I)	10 CFR 32.74
R12-1-311(K)	10 CFR 32.201
R12-1-439	10 CFR 20 Appendix G and 10 CFR 20.2006
R12-1-723(B)	10 CFR 35.392
R12-1-723(C)	10 CFR 35.394
R12-1-723(D)	10 CFR 35.396
R12-1-727(B)	10 CFR 35.491

14. Whether the rule was previously made, amended or repealed as an emergency rule. If so, cite the notice published in the Register as specified in R1-1-409(A). Also, the agency shall state where the text was changed between the emergency and the final rulemaking packages:

Not applicable

15. The full text of the rules follows:

TITLE 12. NATURAL RESOURCES

CHAPTER 1. RADIATION REGULATORY AGENCY

ARTICLE 1. GENERAL PROVISIONS

Section
R12-1-102. Definitions

ARTICLE 3. RADIOACTIVE MATERIAL LICENSING

Section
R12-1-303. Radioactive Material Other Than Source Material; Exemptions
R12-1-304. License Types
R12-1-306. General License - Radioactive Material Other Than Source Material
R12-1-308. Filing Application for Specific Licenses
R12-1-311. Special Requirements for a Specific License to Manufacture, Assemble, Repair, or Distribute Commodities, Products, or Devices that Contain Radioactive Material
R12-1-313. Specific Terms and Conditions
R12-1-320. Reciprocal Recognition of Licenses
Exhibit B. Exempt Quantities
Exhibit D. Radioactive Material Quantities Requiring Consideration for an Emergency Plan (R12-1-322)

ARTICLE 4. STANDARDS FOR PROTECTION AGAINST IONIZING RADIATION

Section
R12-1-408. Occupational Dose Limits for Adults
R12-1-434. General Requirements for Waste Disposal
R12-1-438. Disposal of Specific Wastes
R12-1-438.01 Disposal of Certain Radioactive Material
R12-1-439. Transfer for Disposal and Manifests
R12-1-446. Notifications and Reports to Individuals

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Appendix B. Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sanitary Sewerage

ARTICLE 7. MEDICAL USES OF RADIOACTIVE MATERIAL

Section

- R12-1-703. License for Medical Use of Radioactive Material
- R12-1-705. Authority and Responsibilities for the Radiation Protection Program
- R12-1-710. Radiation Safety Officer Training
- R12-1-711. Authorized Medical Physicist Training
- R12-1-712. Authorized Nuclear Pharmacist Training
- R12-1-713. Determination of Prescribed Dosages, and Possession, Use, and Calibration of Instruments
- R12-1-717. Release of Individuals Containing Radioactive Material or Implants Containing Radioactive Material
- R12-1-719. Training for Uptake, Dilution, and Excretion Studies
- R12-1-720. Permissible Molybdenum-99, Strontium-82, and Strontium-85 Concentrations
- R12-1-721. Training for Imaging and Localization Studies Not Requiring a Written Directive
- R12-1-723. Training for Use of Unsealed Radioactive Material Requiring a Written Directive, Including Treatment of Hyperthyroidism, and Treatment of Thyroid Carcinoma
- R12-1-727. Training for Use of Manual Brachytherapy Sources and Training for the Use of Strontium-90 Sources for Treatment of Ophthalmic Disease
- R12-1-728. Training for Use of Sealed Sources for Diagnosis
- R12-1-744. Training for Use of Remote Afterloader Units, Teletherapy Units, and Gamma Stereotactic Radiosurgery Units
- Exhibit A. Medical Use Groups

ARTICLE 10. NOTICES, INSTRUCTIONS, AND REPORTS TO IONIZING RADIATION WORKERS; INSPECTIONS

Section

- R12-1-1004. Notifications and Reports to Individuals

ARTICLE 1. GENERAL PROVISIONS

R12-1-102. Definitions

Terms defined in A.R.S. § 30-651 have the same meanings when used in this Chapter, unless the context otherwise requires. Additional subject-specific definitions are used in other Articles.

“A1” means the maximum activity of special form radioactive material permitted in a type A package. These values are either listed in 10 CFR 71, Appendix A, Table A-1, or may be derived in accordance with the procedures prescribed in 10 CFR 71, Appendix A, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

“A2” means the maximum activity of radioactive material, other than special form radioactive material, low specific activity (LSA) material, and surface contaminated object (SCO) material, permitted in a Type A package. These values are either listed in 10 CFR 71, Appendix A, Table A-1, or may be derived in accordance with the procedure prescribed in 10 CFR 71, Appendix A, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

“Absorbed dose” No change

“Accelerator” No change

“Accelerator produced material” No change

“Act” No change

“Activity” No change

“Adult” No change

“Agency,” or “ARRA” No change

“Agreement State” No change

“Airborne radioactive material” No change

“Airborne radioactivity area” No change

“ALARA” No change

“Analytical x-ray equipment” No change

“Analytical x-ray system” No change

“Annual” No change

“Authorized medical physicist” means an individual who meets the requirements in R12-1-711; or is identified as an authorized medical physicist or teletherapy physicist on:

A specific medical use license issued by the Agency, NRC, or another Agreement State;

A medical use permit issued by a NRC master material licensee;

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A permit issued by an Agency, NRC, or another Agreement State broad scope medical use licensee; or

A permit issued by a NRC master material license broad scope medical use permittee.

“Authorized nuclear pharmacist” means a pharmacist who meets the requirements in R12-1-712; or is identified as an authorized nuclear pharmacist on:

A specific license issued by an Agency, NRC, or another Agreement State that authorizes medical use or the practice of nuclear pharmacy;

A permit issued by a NRC master material licensee that authorizes medical use or the practice of nuclear pharmacy;

A permit issued by an Agency, NRC, or another Agreement State broad scope medical use licensee that authorizes medical use or the practice of nuclear pharmacy; or

A permit issued by a NRC master material license broad scope medical use permittee that authorizes medical use or the practice of nuclear pharmacy; or

Is identified as an authorized nuclear pharmacist by a commercial nuclear pharmacy that has been authorized to identify authorized nuclear pharmacists; or

Is designated as an authorized nuclear pharmacist in accordance with R12-1-311(G).

“Authorized user” means a physician, dentist, or podiatrist who meets the requirements in R12-1-719, R12-1-723, R12-1-727, R12-1-728, or R12-1-744; or is identified as an authorized user on:

An Agency, NRC, or another Agreement State license that authorizes the medical use of radioactive material;

A permit issued by a NRC master material licensee that is authorized to permit the medical use of radioactive material;

A permit issued by an Agency, NRC, or another Agreement State specific licensee of broad scope that is authorized to permit the medical use of radioactive material; or

A permit issued by a NRC master material license broad scope permittee that is authorized to permit the medical use of radioactive material.

“Background radiation” No change

“Becquerel” No change

“Bioassay” No change

“Brachytherapy” No change

“Byproduct material” means:

Any radioactive material, except special nuclear material, yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material; and

The tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material content, including discrete surface wastes resulting from uranium or thorium solution extraction processes. Underground ore bodies depleted by these solution extraction operations do not constitute “byproduct material” within this definition;

Any discrete source of radium-226 that is produced, extracted, or converted after extraction, for use for a commercial, medical, or research activity; or any material that, has been made radioactive by use of a particle accelerator; and is produced, extracted, or converted after extraction, for use for a commercial, medical, or research activity; and

Any discrete source of naturally occurring radioactive material, other than source material, that the NRC, in consultation with the Administrator of the Environmental Protection Agency, the Secretary of Energy, the Secretary of Homeland Security, and the head of any other appropriate federal agency, determines would pose a threat similar to the threat posed by a discrete source of radium-226 to the public health and safety or the common defense and security and; before, on, or after August 8, 2005, is extracted or converted after extraction for use in a commercial, medical, or research activity.

“Calendar quarter” No change

“Calibration” No change

“Certifiable cabinet x-ray system” means an existing uncertified x-ray system that meets or has been modified to meet the certification requirements specified in 21 CFR 1020.40, revised April 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

“Certified cabinet x-ray system” means an x-ray system that has been certified in accordance with 21 CFR 1010.2, as being manufactured and assembled on or after April 10, 1975, in accordance with the provisions of 21 CFR 1020.40, both sections revised April 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

“CFR” No change

“Chelating agent” No change

“Civil penalty” No change

“Collective dose” No change

“Committed dose equivalent” No change

“Committed effective dose equivalent” No change

“Consortium” means an association of medical use licensees and a PET radionuclide production facility in the same geo-

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graphical area that jointly own or share in the operation and maintenance cost of the PET radionuclide production facility that produces PET radionuclides for use in producing radioactive drugs within the consortium for noncommercial distributions among its associated members for medical use. The PET radionuclide production facility within the consortium must be located at an educational institution or a federal facility or a medical facility.

“Curie” No change

“Current license or registration” No change

“Deep-dose equivalent” No change

“Depleted uranium” No change

“Discrete source” means a radionuclide that has been processed so that its concentration within a material has been purposely increased for use for commercial, medical, or research activities.

“Dose” No change

“Dose equivalent” No change

“Dose limits” No change

“Dosimeter” No change

“Effective dose equivalent” No change

“Effluent release” No change

“Embryo/fetus” No change

“Enclosed beam x-ray system” No change

“Enclosed radiography” No change

“Entrance or access point” No change

“Exhibit” No change

“Explosive material” No change

“Exposure” No change

“Exposure rate” No change

“External dose” No change

“Extremity” No change

“Fail-safe characteristics” No change

“FDA” means the United States Food and Drug Administration

“Field radiography” No change

“Field station” No change

“Former U.S. Atomic Energy Commission (AEC) or U.S. Nuclear Regulatory Commission (NRC) licensed facilities” No change

“Generally applicable environmental radiation standards” means standards issued by the U.S. Environmental Protection Agency (EPA), 40 CFR 190 and 191, revised July 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101, under the authority of the Atomic Energy Act of 1954, as amended, that impose limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material. This incorporated material contains no future editions or amendments.

“Gray” No change

“Hazardous waste” No change

“Healing arts” No change

“Health care institution” No change

“High radiation area” No change

“Human use” No change

“Impound” No change

“Individual” No change

“Individual monitoring” No change

“Individual monitoring device” No change

“Individual monitoring equipment” No change

“Industrial radiography” No change

“Injection tool” No change

“Inspection” No change

“Interlock” No change

“Internal dose” No change

“Irradiate” No change

“Laser” No change

“Lens dose equivalent” No change

“License” No change

“Licensed material” No change

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“Licensed practitioner” No change

“Licensee” No change

“Licensing State” No change

“Limits” No change

“Local components” No change

“Logging supervisor” No change

“Logging tool” No change

“Lost or missing licensed or registered source of radiation” No change

“Low-level waste” No change

“Major processor” means a user processing, handling, or manufacturing radioactive material exceeding Type A quantities as unsealed sources or material or exceeding four times Type B quantities as sealed sources but does not include nuclear medicine programs, universities, industrial radiographers, or small industrial programs. Type A and B quantities are defined in 10 CFR 71.4, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

“Medical dose” No change

“Member of the public” No change

“MeV” No change

“Mineral logging” No change

“Minor” No change

“Monitoring” No change

“Multiplier” No change

“NARM” No change

“Normal operating procedures” No change

“Natural radioactivity” No change

“NRC” No change

“Nuclear waste” means any highway route controlled quantity (defined in 49 CFR 173.403, revised October 1, ~~2007~~ 2012, incorporated by reference, and available under R12-1-101; this incorporated material contains no future editions or amendments) of source, byproduct, or special nuclear material required to be in NRC-approved packaging while transported to, through, or across state boundaries to a disposal site, or to a collection point for transport to a disposal site. Additional requirements associated with transportation of radioactive material can be found in Article 15.

“Occupational dose” No change

“Open beam system” No change

“Package” No change

“Particle accelerator” No change

“Permanent radiographic installation” No change

“Personnel dosimeter” No change

“Personnel monitoring equipment” No change

“Personal supervision” No change

“PET” (See Positron Emission Tomography (PET))

“Pharmacist” No change

“Physician” No change

“Positron Emission Tomography (PET)” means an imaging technique using radionuclides to produce high resolution images of the body’s biological functions.

“Positron Emission Tomography radionuclide production facility” means a facility operating a cyclotron or accelerator for the purpose of producing PET radionuclides.

“Preceptor” No change

“Primary beam” No change

“Public dose” No change

“Pyrophoric liquid” No change

“Pyrophoric solid” No change

“Qualified expert” No change

“Quality Factor” No change

“Quarter” No change

“Rad” No change

“Radiation” No change

“Radiation area” No change

“Radiation dose” No change

“Radiation machine” No change

“Radiation Safety Officer” (RSO) means the individual and who for license conditions:

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Meets the requirements of R12-1-407, and for a medical license meets the training requirements of R12-1-710 in 10 CFR 35.50(a) or (e)(1) and 10 CFR 35.59, (revised January 1, 2010, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.); or is identified as a Radiation Safety Officer on a specific medical use license issued by the Agency, NRC or an, or another Agreement State; or a medical use permit issued by a NRC master material licensee;

Or, who meets the requirements in R12-1-512 on a specific industrial license issued by the Agency, NRC, or another Agreement State; or an industrial use permit issued by a NRC master material licensee:

Or, who, for registration conditions, is designated by the registrant as the individual who has the knowledge, authority, and responsibility to apply appropriate radiation protection principles to ensure radiation safety and compliance with the Act, this Chapter and any registration conditions.

~~“Radiation safety officer” (RSO) means the individual designated by the licensee or registrant who has the knowledge, authority, and responsibility to apply appropriate radiation protection principles to ensure radiation safety and compliance with the Act, this Chapter and any license, or registration conditions.~~

“Radioactive marker” No change

“Radioactive material” No change

“Radioactivity” No change

“Radiographer” No change

“Radiographer’s assistant” No change

“Registrant” No change

“Registration” No change

“Regulations of the U.S. Department of Transportation” means the federal regulations in 49 CFR 107, 171 through 180, revised October 1, 2007 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

“Rem” No change

“Research and Development” No change

“Restricted area” No change

“Roentgen” No change

“Safety system” No change

“Sealed source” No change

“Sealed Source and Device Registry” No change

“Shallow dose equivalent” No change

“Shielded position” No change

“Sievert” No change

“Site boundary” No change

“Source changer” No change

“Source holder” No change

“Source material” No change

“Source material milling” No change

“Source of radiation” or “source” No change

“Special form radioactive material” means radioactive material that satisfies all of the following conditions:

It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;

The piece or capsule has at least one dimension not less than 5 millimeters (0.2 inch); and

It satisfies the test requirements specified in 10 CFR 71.75, revised January 1, 2008 2013, incorporated by reference, available under R12-1-101. This incorporated material contains no future editions or amendments. A special form encapsulation designed in accordance with the U.S. Nuclear Regulatory Commission requirements in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. A special form encapsulation constructed after June 30, 1985, shall meet requirements of this definition applicable at the time of its construction.

“Special nuclear material in quantities not sufficient to form a critical mass” No change

“Storage area” No change

“Storage container” No change

“Subsurface tracer study” No change

“Survey” No change

“TEDE” No change

“Teletherapy” No change

“Temporary job site” No change

“Test” No change

“These rules” No change

~~“Total Effective Dose Equivalent” (TEDE) means total effective dose equivalent, the sum of the deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures. the sum of the effective dose~~

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equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

- “Total Organ Dose Equivalent” No change
- “Unrefined and unprocessed ore” No change
- “Unrestricted area” No change
- “U.S. Department of Energy” No change
- “Very high radiation area” No change
- “Waste” No change
- “Waste handling licensees” No change
- “Week” No change
- “Well-bore” No change
- “Well-logging” No change
- “Whole body” No change
- “Wireline” No change
- “Wireline service operation” No change
- “Worker” No change
- “WL” No change
- “WLM” No change
- “Workload” No change
- “Year” No change

ARTICLE 3. RADIOACTIVE MATERIAL LICENSING

R12-1-303. Radioactive Material Other Than Source Material; Exemptions

- A. No change
 - 1. No change
 - 2. This Section shall not be deemed to authorize the import of ~~byproduct~~ radioactive material or products containing ~~byproduct~~ radioactive material.
 - 3. A manufacturer, processor, or producer of a product or material is exempt from the requirements for a license issued under R12-1-311(A) or the requirements of this Article to the extent that this person transfers ~~byproduct~~ radioactive material contained in a product or material in concentrations not in excess of those specified in Exhibit A of this Article and introduced into the product or material by a licensee holding a specific license issued by the ~~Commission~~ NRC expressly authorizing such introduction. This exemption does not apply to the transfer of ~~byproduct~~ radioactive material contained in any food, beverage, cosmetic, drug, or other commodity or product designed for ingestion or inhalation by, or application to, a human being.
 - 4. No change
- B. No change
 - 1. No change
 - a. No change
 - i. No change
 - ii. No change
 - iii. 555 megabecquerels (15 millicuries) of tritium per dial (bezels when used shall be ~~are~~ considered part of the dial),
 - iv. No change
 - v. No change
 - vi. 2.22 megabecquerels (60 microcuries) of promethium-147 per watch dial or 4.44 MBq (120 microcuries) of promethium-147 per other timepiece dial (bezels, when used, shall be ~~are~~ considered part of the dial),
 - vii. No change
 - (1) No change
 - (2) No change
 - (3) No change
 - viii. 37 kBq (1 microcurie) of radium-226 ~~in time pieces~~ per timepiece in intact timepieces manufactured prior to ~~October 1, 1978~~ November 30, 2007;
 - b. Static elimination devices which contain, as a sealed source or sources, radioactive material consisting of a total of not more than 18.5 MBq (500 µCi) of polonium-210 per device.
 - i. Ion generating tubes designed for ionization of air that contain, as a sealed source or sources, radioactive material consisting of a total of not more than 18.5 MBq (500 µCi) of polonium-210 per device or of a total of not more than 1.85 GBq (50 mCi) of hydrogen-3 (tritium) per device.
 - ii. Such devices authorized before October 23, 2012 for use under the general license then provided in R12-1-306 and equivalent regulations of the NRC or Agreement State and manufactured, tested, and labeled by the manufacturer in accordance with the specifications contained in a specific license issued by the NRC.

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- ~~b-c.~~ Balances of precision containing not more than 37 megabecquerels (1 millicurie) of tritium per balance or not more than 18.5 megabecquerels (0.5 millicurie) of tritium per balance part manufactured before December 17, 2007;
 - ~~e-d.~~ Marine compasses containing not more than 27.75 gigabecquerels (750 millicuries) of tritium gas and other marine navigational instruments containing not more than 9.25 gigabecquerels (250 millicuries) of tritium gas manufactured before December 17, 2007;
 - ~~e.~~ Ionization chamber smoke detectors containing not more than 37 kBq (1 microcurie) of americium-241 per detector in the form of a foil and designed to protect life and property from fires;
 - ~~d-f.~~ Electron tubes: Provided that each tube does not contain more than one of the following specified quantities of radioactive material:
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
 - vi. No change
 - vii. And provided further, that the level of radiation due to radioactive material contained in each electron tube does not exceed 10 μ Gy (1 millirad) per hour at 1 centimeter from any surface when measured through 7 milligrams per square centimeter of absorber. The term "electron tubes" includes spark gap tubes, power tubes, gas tubes, including glow lamps, receiving tubes, microwave tubes, indicator tubes, pick-up tubes, radiation detection tubes, and any other completely sealed tube that is designed to conduct or control electrical current;
 - ~~e-g.~~ Ionizing radiation measuring instruments containing, for purposes of internal calibration or standardization, one or more sources of radioactive material provided that:
 - i. No change
 - ii. No change
 - iii. No change
 - ~~h.~~ Any person who desires to apply radioactive material to, or to incorporate radioactive material into, the products exempted in subsection (B)(1)(a), or who desires to initially transfer for sale or distribution such products containing radioactive material, should apply for a specific license pursuant to R-12-311 of this Article, which license states that the product may be distributed by the licensee to persons exempt from the rules pursuant R12-1-303 (A)(1).
 - ~~f.~~ Ionization chamber smoke detectors containing not more than 1 microcurie ([micro]Ci) of americium-241 per detector in the form of a foil and designed to protect life and property from fires.
2. No change
- a. No change
 - b. No change
3. No change
- a. Except for persons who manufacture, process, initially transfer for sale or distribution, or produce gas and aerosol detectors containing radioactive material, a person is exempt from this Chapter if the person receives, possesses, uses, transfers, owns, or acquires radioactive material in gas and aerosol detectors designed to protect life or property from fires and airborne hazards, provided that detectors containing radioactive material shall be manufactured, imported, or transferred according to a specific license issued by the U.S. Nuclear Regulatory Commission and described in 10 CFR 32.26, or equivalent regulations of an Agreement or Licensing State, this exemption also covers gas and aerosol detectors manufactured or distributed before November 30, 2007 in accordance with a specific license issued by the U.S. Nuclear Regulatory Commission, or equivalent regulations of an Agreement or Licensing State and the license authorizes the transfer of the detectors to persons who are exempt from regulatory requirements.
 - b. No change
- C. No change
- 1. No change
 - 2. No change
 - 3. No change
 - 4. No change
 - 5. No change
 - 6. Any person, who possesses ~~by product~~ radioactive material received or acquired before September 25, 1971, under the general license issued under R12-1-311(A) of this Article or similar general license of an Agreement State or the NRC, is exempt from the requirements for a license issued under R12-1-311(A) of this Article to the extent that this person possesses, uses, transfers, or owns ~~by product~~ radioactive material.

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7. No person may, for purposes of producing an increased radiation level, combine quantities of ~~byproduct~~ radioactive material covered by the exemption described in subsection (C)(6) so that the aggregate quantity exceeds the limits set forth in Exhibit B, except for ~~byproduct~~ radioactive material combined within a device placed in use before May 3, 1999, or as otherwise permitted by the rules in this Section.

R12-1-304. License Types

- A.** Activities requiring license. Except as provided in 10 CFR 30.3 (revised January 1, 2013, incorporated by reference, and available under R12-1-101; this incorporated material contains no future editions or amendments) this Section and for persons exempt as provided in R12-1-302 and R12-1-303 of this Article, no person shall manufacture, produce, transfer, receive, acquire, own, possess, or use byproduct material except as authorized in a specific or general license issued in accordance with the regulations in this chapter and in accordance with 10 CFR 30.3.
- B.** Licenses for radioactive materials are of two types: general and specific.
 1. No change
 2. No change

R12-1-306. General License - Radioactive Material Other Than Source Material

- A.** No change
 1. No change
 2. No change
- B.** Certain measuring, gauging or controlling devices and certain devices for producing light or an ionized atmosphere.
 1. This subsection grants a general license ~~that authorizes to~~ a commercial or industrial firm; a research, educational or medical institution; an individual conducting business; or a state or local government agency to receive, acquire, possess, use, or transfer radioactive material contained in devices designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere, according to the provisions of 10 CFR 31.5(b), (c), and (d), (Revised January 1, ~~2010~~ 2013, incorporated by reference, and available under R12-1-101. The incorporated material contains no future editions or amendments.); ~~contained in devices designed and manufactured for the purpose of detecting, measuring, gauging or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere.;~~
 2. No change
 3. No change
 - a. No change
 - b. No change
 - c. An equivalent specific license issued by a State with rules or regulations comparable to this Section.
 4. A person who acquires, receives, possesses, uses, or transfers radioactive material in a device licensed under subsection (B)(1) or through a transfer made under subsection (B)(4)(h), shall:
 - a. Ensure that all labels and safety statements affixed to a device at the time of receipt and bearing a statement that removal of the label is prohibited are maintained and not removed, and comply with all instructions and precautions on the labels.
 - b. No change
 - i. A general licensee need not test a device that contains only krypton for leakage of radioactive material; and
 - ii. A general licensee need not test a device for leakage of radioactive material if the device contains only tritium, not more than 3.7 ~~Mbq~~ megabecquerels (100 microcuries) of other beta and/or gamma emitting material, or 370 ~~kBq~~ kilobecquerels (10 microcuries) of alpha emitting material, or the device is held in storage, in the original shipping container, before initial installation.
 - c. No change
 - i. No change
 - ii. No change
 - d. No change
 - e. Immediately suspend operation of a device if there is a failure of, or damage to, or any indication of a possible failure of or damage to, the shielding of the radioactive material or the on-off mechanism or indicator, or upon the detection of 185 ~~Becquerel~~ becquerel (0.005 microcurie) or more of removable radioactive material.
 - i. No change
 - ii. No change
 - iii. No change
 - f. No change
 - g. Not export a device that contains radioactive material except in accordance with 10 CFR 110, ~~revised January 1, 2010,~~ revised January 1, 2013 incorporated by reference, and available under R12-1-101. The incorporated material contains no future editions or amendments.
 - h. No change

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- i. No change
 - i. No change
 - ii. No change
 - iii. No change
- j. No change
- k. No change
 - i. No change
 - ii. No change
- l. No change
- m. No change
- n. No change
- o. No change
- p. No change
- q. No change
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
 - vi. No change
- r. No change
- s. No change
- 5. No change
- 6. No change
- 7. No change
- C. No change
 - 1. No change
 - 2. No change
 - a. No change
 - b. No change
 - c. No change
 - d. No change
 - e. No change
- D. No change
 - 1. This subsection grants a general license for calibration or reference sources that have been manufactured according to the specifications contained in a specific license issued to the manufacturer or importer of the sources by the U.S. Nuclear Regulatory Commission under 10 CFR 32.57 or 10 CFR 70.39. This general license also governs calibration or reference sources that have been manufactured according to specifications contained in a specific license issued to the manufacturer by the Agency, an Agreement State, or a Licensing State, according to licensing requirements equivalent to those contained in 10 CFR 32.57 or 10 CFR 70.39, ~~revised January 1, 2010~~, revised January 1, 2013, incorporated by reference, and available under R12-1-101. The incorporated material contains no future editions or amendments.
 - 2. No change
 - a. No change
 - b. No change
 - i. No change
 - ii. No change
 - c. No change
 - d. No change
 - e. No change
 - 3. No change
 - 4. No change
- E. No change
 - 1. No change
 - 2. No change
 - 3. A physician who desires to manufacture, prepare, process, produce, package, repackage, or transfer carbon-14 urea capsules for commercial distribution shall obtain a specific license from the Agency, issued according to the requirements in 10 CFR 32.21, (Revised January 1, ~~2010~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.)

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4. No change
- F.** No change
 1. No change
 - a. No change
 - b. No change
 - c. No change
 - d. No change
 - e. No change
 - f. No change
 - g. No change
 2. No change
 - a. No change
 - b. No change
 3. No change
 - a. No change
 - b. No change
 - c. No change
 - d. No change
 - e. No change
 - f. Package or prepackage a unit bearing a durable, clearly visible label: identifying the radioactive contents as to chemical form and radionuclide, and indicating that the amount of radioactivity does not exceed 0.37 megabecquerel (10 microcuries) of iodine-131, iodine-125, selenium-75, or carbon-14; 1.85 megabecquerels (50 microcuries) of hydrogen-3 (tritium); or 0.74 megabecquerel (20 microcuries) of iron-59; or Mock Iodine-125 in units not exceeding 1.85 kilobecquerels (0.05 microcurie) of iodine-129 and 0.185 kilobecquerel (0.005 microcurie) of americium-241 each; or cobalt-57 in units not exceeding 0.37 megabecquerel (10 microcuries).
 - g. Package to display the radiation caution symbol and the words, "Caution, Radioactive Material", and "Not for Internal or External Use in Humans or Animals."
 4. No change
 - a. No change
 - b. No change
 - i. No change
 - ii. No change
 5. No change
 - a. No change
 - b. No change
 6. No change
- G.** No change
 1. No change
 2. No change
 3. No change
 4. No change
 5. No change
- H.** This subsection grants a general license that authorizes a person to acquire, receive, possess, use, or transfer, in accordance with the provisions of subsections (I) and (J), radium-226 contained in the following products manufactured prior to November 30, 2007.
 1. Antiquities originally intended for use by the general public. For the purposes of this paragraph, antiquities mean products originally intended for use by the general public and distributed in the late 19th and early 20th centuries, such as radium emanator jars, revigators, radium water jars, radon generators, refrigerator cards, radium bath salts, and healing pads.
 2. Intact timepieces containing greater than 0.037 megabecquerel (1 microcurie), nonintact timepieces, and timepiece hands and dials no longer installed in timepieces.
 3. Luminous items installed in air, marine, or land vehicles.
 4. All other luminous products, provided that no more than 100 items are used or stored at the same location at any one time.
 5. Small radium sources containing no more than 0.037 megabecquerel (1 microcurie) of radium-226. For the purposes of this paragraph, "small radium sources" means discrete survey instrument check sources, sources contained in radiation measuring instruments, sources used in educational demonstrations (such as cloud chambers and spinthariscopes), electron tubes, lightning rods, ionization sources, static eliminators, or as designated by the NRC.
- I.** Persons who acquire, receive, possess, use, or transfer byproduct material under the general license issued in subsection

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(H) are exempt from the provisions 12 A.A.C. 1, Articles 1, 3, 4, 7, 10, 12, and 15 and A.R.S. §§ 30-654(B)(13), 30-657(A) and (B), 30-681, and 30-685 through 30-689, to the extent that the receipt, possession, use, or transfer of byproduct material is within the terms of the general license; provided, however, that this exemption shall not be deemed to apply to any such person specifically licensed under this chapter. Any person who acquires, receives, possesses, uses, or transfers byproduct material in accordance with the general license in subsection (H):

1. Shall notify the Agency should there be any indication of possible damage to the product so that it appears it could result in a loss of the radioactive material. A report containing a brief description of the event, and the remedial action taken, must be furnished to the Agency within 30 days.
2. Shall not abandon products containing radium-226. The product, and any radioactive material from the product, may only be disposed of according to Article 4 or by transfer to a person authorized by a specific license to receive the radium-226 in the product or as otherwise approved by the Agency.
3. Shall not export products containing radium-226 except in accordance with 10 CFR 110 revised January 1, 2013, incorporated by reference, and available under R12-1-101. The incorporated material contains no future editions or amendments.
4. Shall dispose of products containing radium-226 at a disposal facility authorized to dispose of radioactive material in accordance with any federal or state solid or hazardous waste law, including the Solid Waste Disposal Act, as authorized under the Energy Policy Act of 2005, by transfer to a person authorized to receive radium-226 by a specific license issued under Article 3, equivalent regulations of an Agreement State, or the NRC.
5. Shall respond to written requests from the Agency to provide information relating to the general license within 30 calendar days of the date of the request, or other time specified in the request. If the general licensee cannot provide the requested information within the allotted time, it shall, within that same time period, request a longer period to supply the information by providing the Agency Director a written justification for the request.

J. The general license in subsection (H) does not authorize the manufacture, assembly, disassembly, repair, or import of products containing radium-226, except that timepieces may be disassembled and repaired.

R12-1-308. Filing Application for Specific Licenses

- A. No change
- B. No change
- C. No change
- D. No change
- E. No change
- F. No change
- G. Except as provided in subsections (G)(1), (2), and (3), an application for a specific license to use byproduct material in the form of a sealed source or in a device that contains the sealed source must either identify the source or device by manufacturer and model number as registered with the Agency, NRC, or with an Agreement State, or, for a source or a device containing radium-226 or accelerator-produced radioactive material, with the Agency, NRC, or an Agreement State under 10 CFR 32.210(c) revised January 1, 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.
 1. For sources or devices manufactured before October 23, 2012, that are not licensed under R12-1-306, R12-1-310, R12-1-311 or registered with the NRC or with an Agreement State, and for which the applicant is unable to provide all categories of information specified in 10 CFR 32.210(c) the application must include:
 - a. All available information identified in 10 CFR 32.210(c) concerning the source, and, if applicable, the device; and
 - b. Sufficient additional information to demonstrate that there is reasonable assurance that the radiation safety properties of the source or device are adequate to protect health and minimize danger to life and property. Such information must include a description of the source or device, a description of radiation safety features, the intended use and associated operating experience, and the results of a recent leak test.
 2. For sealed sources and devices allowed to be distributed without registration of safety information, the applicant may supply only the manufacturer, model number, and radionuclide and quantity.
 3. If it is not feasible to identify each sealed source and device individually, the applicant may propose constraints on the number and type of sealed sources and devices to be used and the conditions under which they will be used, in lieu of identifying each sealed source and device.

R12-1-311. Special Requirements for a Specific License to Manufacture, Assemble, Repair, or Distribute Commodities, Products, or Devices that Contain Radioactive Material

- A. No change
 1. No change
 - a. No change
 - b. No change
 - i. No change

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- ii. No change
 - iii. No change
 - (1) No change
 - (2) No change
 - (3) No change
 - c. No change
 - i. No change
 - ii. No change
 - iii. No change
 - d. No change
 - e. No change
 - f. Each device meets the criteria in 10 CFR 31.5(c)(13)(i) (revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments) and bears a permanent (e.g., embossed, etched, stamped, or engraved) label affixed to the source housing, if separable, or the device if the source housing is not separable, that includes the words, "Caution-Radioactive Material," and, if practicable, the radiation symbol described in R12-1-428.
2. No Change
- a. No change
 - b. No change
 - c. No change
 - d. No change
 - e. No change
 - f. No change
 - g. No change
 - h. No change
 - i. No change
 - j. No change
3. No change
4. No change
- a. No change
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
 - b. No change
 - i. Report on a quarterly basis to the responsible Agreement State or NRC all transfers of devices to persons for use under a general license in accordance with 10 CFR 32.52, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.
 - ii. No change
 - iii. No change
5. No change
- a. No change
 - b. No change
 - c. No change
 - d. No change
6. No change
7. No change
8. No change
- a. No change
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
 - b. No change
 - c. No change
 - i. No change

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- ii. No change
- iii. No change
- iv. No change
- d. No change
- e. No change
- f. No change
- g. No change
- 9. No change
- B.** No change
 - 1. No change
 - 2. The requirements of 10 CFR 32.53 through 32.56 and ~~32.101~~, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.
- C.** The Agency shall grant a specific license to manufacture or initially transfer calibration or reference sources that contain americium-241, radium-226, or plutonium for distribution to persons generally licensed under R12-1-306(D) if the applicant satisfies:
 - 1. No change
 - 2. The requirements of 10 CFR 32.57, 32.58, 32.59, ~~32.102~~, and 70.39, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.
- D.** No change
 - 1. No change
 - 2. No change
 - a. No change
 - b. No change
- E.** No change
 - 1. No change
 - 2. No change
 - a. No change
 - b. No change
 - c. No change
 - d. No change
 - e. No change
 - f. No change
 - g. No change
 - 3. No change
 - a. No change
 - b. No change
 - 4. No change
 - a. No change
 - b. No change
 - 5. No change
- F.** No change
 - 1. No change
 - 2. The criteria of 10 CFR 32.61, and 32.62, ~~and 32.103~~, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.
- G.** The Agency shall grant a specific license to manufacture, prepare, or transfer for commercial distribution radioactive drugs that contain radioactive material for use by a person authorized in accordance with Article 7 of this Chapter, if the applicant meets all of the requirements in 10 CFR 30.32(j) or 10 CFR 32.72, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1- 101. This incorporated material contains no future editions or amendments.
 - 1. Authorization under this Section to produce Positron Emission Tomography (PET) radioactive drugs for noncommercial transfer to medical use licensees in its consortium does not relieve the licensee from complying with applicable FDA, other federal, and state requirements governing radioactive drugs.
 - 2. Each licensee authorized under this Section to produce PET radioactive drugs for noncommercial transfer to medical use licensees in its consortium shall:
 - a. Satisfy the labeling requirements in R12-1-431 for each PET radioactive drug transport radiation shield and each syringe, vial, or other container used to hold a PET radioactive drug intended for noncommercial distribution to members of its consortium.
 - b. Possess and use instrumentation to measure the radioactivity of the PET radioactive drugs intended for noncommercial distribution to members of its consortium and meet the procedural, radioactivity measurement, instrument test, instrument check, and instrument adjustment requirements in R12-1-449.

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3. A licensee that is a pharmacy authorized under this Section to produce PET radioactive drugs for noncommercial transfer to medical use licensees in its consortium shall require that any individual who prepares PET radioactive drugs be an:
 - a. Authorized nuclear pharmacist that meets the requirements in § R12-1-712, or
 - b. Individual under the supervision of an authorized nuclear pharmacist as specified in R12-1-706.
4. A pharmacy, authorized under this Section to produce PET radioactive drugs for noncommercial transfer to medical use licensees in its consortium that allows an individual to work as an authorized nuclear pharmacist, shall meet the requirements of R12-1-712.

H. No change

1. No change
2. No change
 - a. No change
 - b. No change
3. No change
4. No change
5. No change
 - a. No change
 - b. No change

I. The Agency shall grant a specific license to manufacture and distribute sources and devices that contain radioactive material to a person licensed in accordance with Article 7 of this Chapter for use as a calibration, transmission, or reference source or for medical purposes, if the applicant meets all of the requirements in 10 CFR 32.74, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.

J. No change

1. No change
 - a. No change
 - b. No change
 - c. No change
2. No change
3. No change
4. No change
 - a. No change
 - b. No change
 - i. No change
 - ii. No change
 - c. No change
 - d. No change
 - e. No change
 - f. No change
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
 - vi. No change

K. No change

1. Serialize the sources in accordance with 10 CFR 32.201, revised January 1, ~~2008~~ 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments; and
2. No change

R12-1-313. Specific Terms and Conditions

A. No change

B. No change

C. No change

D. No change

1. No change
 - a. No change
 - b. No change
 - c. No change
2. No change

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- a. No change
- b. No change
- c. No change

E. Each licensee preparing technetium-99m radiopharmaceuticals from molybdenum-99/technetium-99m generators or rubidium-82 from strontium-82/rubidium-82 generators shall test the generator eluates for molybdenum-99 breakthrough or strontium-82 and strontium-85 contamination, respectively, in accordance with R12-1-720. The licensee shall record the results of each test and retain each record for 3 years after the record is made.

R12-1-320. Reciprocal Recognition of Licenses

A. No change

- 1. The license does not limit the activity to ~~specified~~ specific installations or locations;
- 2. ~~The out-of-state licensee notifies the Agency in writing at least three days before engaging in the licensed activity. Following the first notification, application, and payment of fees, the licensee shall notify the agency three days prior to entering the state and prior to each non-consecutive visit while reciprocity remains in effect. The notification shall indicate the location, period, and type of proposed possession and use within the State, and be accompanied by a copy of the pertinent licensing document. If, for a specific case, the three-day period would impose an undue hardship on the out-of-state licensee, the licensee may, upon application to the Agency, obtain permission to proceed sooner. The Agency may waive the requirement for filing additional written notifications during the remainder of the calendar year, following receipt of the initial notification from a person engaging in activities under the general license provided in this Section;~~
- 3. The out-of-state licensee complies with all applicable statutes, now or hereafter in effect, ~~and~~ rules, and orders of the Agency and with all the terms and conditions of the license, except those terms and conditions inconsistent with applicable statutes, ~~and~~ rules and orders of the Agency;
- 4. The out-of-state licensee supplies any other information the Agency requests; and
- 5. No change
 - a. No change
 - b. No change

B. No change

- 1. No change
- 2. No change
- 3. No change
- 4. No change

C. No change

D. No change

E. No change

- 1. No change
- 2. No change

F. No change

Exhibit B. Exempt Quantities

Material Microcuries	
Antimony-122 (Sb-122)	100
Antimony-124 (Sb-124)	10
Antimony-125 (Sb-125)	10
Arsenic-73 (As-73)	100
Arsenic-74 (As-74)	10
Arsenic-76 (As-76)	10
Arsenic-77 (As-77)	100
Barium-131 (Ba-131)	10
Barium-133 (Ba-133)	10
Barium-140 (Ba-140)	10
Bismuth-210 (Bi-210)	1
Bromine-82 (Br-82)	10
Cadmium-109 (Cd-109)	10
Cadmium-115m (Cd-115m)	10
Cadmium-115 (Cd-115)	100
Calcium-45 (Ca-45)	10
Calcium-47 (Ca-47)	10
Carbon-14 (C-14)	100
Cerium-141 (Ce-141)	100
Cerium-143 (Ce-143)	100

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Cerium-144 (Ce-144)	1
Cesium-129 (Cs-129)	100
Cesium-131 (Cs-131)	1,000
Cesium-134m (Cs-134m)	100
Cesium-134 (Cs-134)	1
Cesium-135 (Cs-135)	10
Cesium-136 (Cs-136)	10
Cesium-137 (Cs-137)	10
Chlorine-36 (Cl-36)	10
Chlorine-38 (Cl-38)	10
Chromium-51 (Cr-51)	1,000
Cobalt-57 (Co-57)	100
Cobalt-58m (Co-58m)	10
Cobalt-58 (Co-58)	10
Cobalt-60 (Co-60)	1
Copper-64 (Cu-64)	100
Dysprosium-165 (Dy-165)	10
Dysprosium-166 (Dy-166)	100
Erbium-169 (Er-169)	100
Erbium-171 (Er-171)	100
Europium-152 (Eu-152) (9.2 h)	100
Europium-152 (Eu-152) (13 yr)	1
Europium-154 (Eu-154)	1
Europium-155 (Eu-155)	10
Fluorine-18 (F-18)	1,000
Gadolinium-153 (Gd-153)	10
Gadolinium-159 (Gd-159)	100
Gallium-67 (Ga-67)	100
Gallium-72 (Ga-72)	10
<u>Germanium-68 (Ge-68)</u>	<u>10</u>
Germanium-71 (Ge-71)	100
Gold-195 (Au-195)	10
Gold-198 (Au-198)	100
Gold-199 (Au-199)	100
Hafnium-181 (Hf-181)	10
Holmium-166 (Ho-166)	100
Hydrogen-3 (H-3)	1,000
<u>Indium-111 (In-111)</u>	<u>100</u>
Indium-113m (In-113m)	100
Indium-114m (In-114m)	10
Indium-115m (In-115m)	100
Indium-115 (In-115)	10
Iodine-123 (I-123)	100
Iodine-125 (I-125)	1
Iodine-126 (I-126)	1
Iodine-129 (I-129)	0.1
Iodine-131 (I-131)	1
Iodine-132 (I-132)	10
Iodine-133 (I-133)	1
Iodine-134 (I-134)	10
Iodine-135 (I-135)	10
Iridium-192 (Ir-192)	10
Iridium-194 (Ir-194)	100
Iron-52 (Fe-52)	10
Iron-55 (Fe-55)	100
Iron-59 (Fe-59)	10
Krypton-85 (Kr-85)	100
Krypton-87 (Kr-87)	10
Lanthanum-140 (La-140)	10

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Lutetium-177 (Lu-177)	100
Manganese-52 (Mn-52)	10
Manganese-54 (Mn-54)	10
Manganese-56 (Mn-56)	10
Mercury-197m (Hg-197m)	100
Mercury-197 (Hg-197)	100
Mercury-203 (Hg-203)	10
Molybdenum-99 (Mo-99)	100
Neodymium-147 (Nd-147)	100
Neodymium-149 (Nd-149)	100
Nickel-59 (Ni-59)	100
Nickel-63 (Ni-63)	10
Nickel-65 (Ni-65)	100
Niobium-93m (Nb-93m)	10
Niobium-95 (Nb-95)	10
Niobium-97 (Nb-97)	10
Osmium-185 (Os-185)	10
Osmium-191m (Os-191m)	100
Osmium-191(Os-191)	100
Osmium-193 (Os-193)	100
Palladium-103 (Pd-103)	100
Palladium-109 (Pd-109)	100
Phosphorus-32 (P-32)	10
Platinum-191 (Pt-191)	100
Platinum-193m (Pt-193m)	100
Platinum-193 (Pt-193)	100
Platinum-197m (Pt-197m)	100
Platinum-197 (Pt-197)	100
Polonium-210 (Po-210)	0.1
Potassium-42 (K-42)	10
Potassium-43 (K-43)	10
Praseodymium-142 (Pr-142)	100
Praseodymium-143 (Pr-143)	100
Promethium-147 (Pm-147)	10
Promethium-149 (Pm-149)	10
Rhenium-186 (Re-186)	100
Rhenium-188 (Re-188)	100
Rhodium-103m (Rh-103m)	100
Rhodium-105 (Rh-105)	100
Rubidium-81 (Rb-81)	10
Rubidium-86 (Rb-86)	10
Rubidium-87 (Rb-87)	10
Ruthenium-97 (Ru-97)	100
Ruthenium-103 (Ru-103)	10
Ruthenium-105 (Ru-105)	10
Ruthenium-106 (Ru-106)	1
Samarium-151 (Sm-151)	10
Samarium-153 (Sm-153)	100
Scandium-46 (Sc-46)	10
Scandium-47 (Sc-47)	100
Scandium-48 (Sc-48)	10
Selenium-75 (Se-75)	10
Silicon-31 (Si-31)	100
Silver-105 (Ag-105)	10
Silver-110m (Ag-110m)	1
Silver-111 (Ag-111)	100
Sodium-22 (Na-22)	10
Sodium-24 (Na-24)	10
Strontium-85 (Sr-85)	10

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Strontium-89 (Sr-89)	1
Strontium-90 (Sr-90)	0.1
Strontium-91 (Sr-91)	10
Strontium-92 (Sr-92)	10
Sulfur-35 (S-35)	100
Tantalum-182 (Ta-182)	10
Technetium-96 (Tc-96)	10
Technetium-97m (Tc-97m)	100
Technetium-97 (Tc-97)	100
Technetium-99m (Tc-99m)	100
Technetium-99 (Tc-99)	10
Tellurium-125m (Te-125m)	10
Tellurium-127m (Te-127m)	10
Tellurium-127 (Te-127)	100
Tellurium-129m (Te-129m)	10
Tellurium-129 (Te-129)	100
Tellurium-131m (Te-131m)	10
Tellurium-132 (Te-132)	10
Terbium-160 (Tb-160)	10
Thallium-200 (Tl-200)	100
Thallium-201 (Tl-201)	100
Thallium-202 (Tl-202)	100
Thallium-204 (Tl-204)	10
Thulium-170 (Tm-170)	10
Thulium-171 (Tm-171)	10
Tin-113 (Sn-113)	10
Tin-125 (Sn-125)	10
Tungsten-181 (W-181)	10
Tungsten-185 (W-185)	10
Tungsten-187 (W-187)	100
Vanadium-43 (V-48)	10
Xenon-131m (Xe-131m)	1,000
Xenon-133 (Xe-133)	100
Xenon-135 (Xe-135)	100
Ytterbium-175 (Yb-175)	100
Yttrium-87 (Y-87)	10
Yttrium-88 (Y-88)	10
Yttrium-90 (Y-90)	10
Yttrium-91 (Y-91)	10
Yttrium-92 (Y-92)	100
Yttrium-93 (Y-93)	100
Zinc-65 (Zn-65)	10
Zinc-69m (Zn-69m)	100
Zinc-69 (Zn-69)	1,000
Zirconium-93 (Zr-93)	10
Zirconium-95 (Zr-95)	10
Zirconium-97 (Zr-97)	10
Any radionuclide material not listed above other than alpha-emitting radioactive material	0.1

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Exhibit D. Radioactive Material Quantities Requiring Consideration for an Emergency Plan (R12-1-322)

<u>Radioactive Material</u>	<u>Release Fraction</u>	<u>Quantity (Ci)</u>
Actinium-228	0.001	4,000
Americium-241	.001	2
Americium-242	.001	2
Americium-243	.001	2
Antimony-124	.01	4,000
Antimony-126	.01	6,000
Barium-133	.01	10,000
Barium-140	.01	30,000
Bismuth-207	.01	5,000
Bismuth-210	.01	600
Cadmium-109	.01	1,000
Cadmium-113	.01	80
Calcium-45	.01	20,000
Californium-252	.001	9 (20 mg)
Carbon-14 (Non CO)	.01	50,000
Cerium-141	.01	10,000
Cerium-144	.01	300
Cesium-134	.01	2,000
Cesium-137	.01	3,000
Chlorine-36	.5	100
Chromium-51	.01	300,000
Cobalt-60	.001	5,000
Copper-64	.01	200,000
Curium-242	.001	60
Curium-243	.001	3
Curium-244	.001	4
Curium-245	.001	2
Europium-152	.01	500
Europium-154	.01	400
Europium-155	.01	3,000
Gadolinium-153	.01	5,000
Germanium-68	.01	2,000
Gold-198	.01	30,000
Hafnium-172	.01	400
Hafnium-181	.01	7,000
Holmium-166m	.01	100
Hydrogen-3	.5	20,000
Indium-114m	.01	1,000
Iodine-125	.5	10
Iodine-131	.5	10
Iridium-192	.001	40,000
Iron-55	.01	40,000
Iron-59	.01	7,000
Krypton-85	1.0	6,000,000
Lead-210	.01	8
Manganese-56	.01	60,000
Mercury-203	.01	10,000
Molybdenum-99	.01	30,000
Neptunium-237	.001	2
Nickel-63	.01	20,000
Niobium-94	.01	300
Phosphorus-32	.5	100
Phosphorus-33	.5	1,000
Polonium-210	.01	10
Potassium-42	.01	9,000
Promethium-145	.01	4,000
Promethium-147	.01	4,000
<u>Radium-226</u>	<u>.001</u>	<u>100</u>
Ruthenium-106	.01	200
Samarium-151	.01	4,000
Scandium-46	.01	3,000
Selenium-75	.01	10,000

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Silver-110m	.01	1,000
Sodium-22	.01	9,000
Sodium-24	.01	10,000
Strontium-89	.01	3,000
Strontium-90	.01	90
Sulfur-35	.5	900
Technetium-99	.01	10,000
Technetium-99m	.01	400,000
Tellurium-127m	.01	5,000
Tellurium-129m	.01	5,000
Terbium-160	.01	4,000
Thulium-170	.01	4,000
Tin-113	.01	10,000
Tin-123	.01	3,000
Tin-126	.01	1,000
Titanium-44	.01	100
Vanadium-48	.01	7,000
Xenon-133	1.0	900,000
Yttrium-91	.01	2,000
Zinc-65	.01	5,000
Zirconium-93	.01	400
Zirconium-95	.01	5,000
Any other beta-gamma emitter	.01	10,000
Mixed fission products	.01	1,000
Mixed corrosion products	.01	10,000
Contaminated equipment beta-gamma	.001	10,000
Irradiated material, any form other than solid non- combustible	.01	1,000
Irradiated material, solid noncombustible	.001	10,000
Mixed radioactive waste, beta-gamma	.01	1,000
Packaged mixed waste, beta gamma	.001	10,000
Any other alpha emitter	.001	2
Contaminated equipment, alpha	.0001	20
Packaged waste, alpha	.0001	20

Combinations of radioactive materials listed above:

For combinations of radioactive materials, consideration of the need for an emergency plan is required if the sum of the ratios of the quantity of each radioactive material authorized to the quantity listed for that material in Exhibit D exceeds 1.

NOTE: Waste packaged in Type B containers does not require an emergency plan.

ARTICLE 4. STANDARDS FOR PROTECTION AGAINST IONIZING RADIATION

R12-1-408. Occupational Dose ~~Amounts~~ Limits for Adults

- A.** No change
 - 1. No change
 - a. No change
 - b. No change
 - 2. No change
 - a. No change
 - b. No change
- B.** No change
- C.** No change
 - 1. No change
 - 2. If a protective apron is worn and monitoring is conducted as specified in R12-1-419(B)(6), the effective dose equivalent for external radiation shall be determined as follows:
 - a. No change
 - b. No change
 - 3. 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 Agency. The assigned deep-dose equivalent shall be determined for

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the part of the body that receives the highest exposure. The assigned shallow-dose equivalent is the dose averaged over the contiguous 10 square centimeters of skin that receives 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.

- D. No change
- E. No change
- F. No change

R12-1-434. General Requirements for Waste Disposal

- A. No change
 - 1. No change
 - 2. By decay in storage, according to ~~subsection (C)~~ R12-1-438(C)
 - 3. No change
 - 4. As authorized according to R12-1-435, R12-1-436, R12-1-437, ~~or~~ R12-1-438, or R12-1-438.01;
- B. No change
 - 1. No change
 - 2. No change
 - 3. No change
 - 4. No change
 - 5. No change

R12-1-438. Disposal of Specific Wastes

- A. No change
 - 1. No change
 - 2. No change
 - 3. No change
- B. No change
- C. A licensee ~~is authorized to~~ may hold radioactive material with a physical half-life of less than or equal to 120 days ~~or less~~ for decay in storage before disposal without regard to its radioactivity in ordinary trash, and is exempt from the requirements of R12-1-434, provided:
 - 1. The licensee monitors the ~~container~~ of radioactive material at the surface before disposal ~~to~~ and ~~determine~~ determines that its radioactivity cannot be distinguished from the background radiation level with an appropriate radiation detection survey meter set on its most sensitive scale and with no interposed shielding; and
 - 2. No change
- D. No change

R12-1-438.01 Disposal of Certain Radioactive Material

- A. Licensed material as defined in the definition of radioactive material in R12-1-102 may be disposed of in accordance with this Article, 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 by the Agency, must meet the requirements of R12-1-439.
- B. A licensee may dispose of radioactive material, as defined in the definition of radioactive material in R12-1-102, at a disposal facility authorized to dispose of such material in accordance with any federal or state solid or hazardous waste law, including the Solid Waste Disposal Act, as authorized under the Energy Policy Act of 2005.

R12-1-439. Transfer for Disposal and Manifests

- A. Any licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility (for purposes of this rule "land disposal facility" means the land, buildings, structures, and equipment that are intended to be used for the disposal of radioactive waste. A geologic repository is not a land disposal facility) shall comply with 10 CFR 20.2006 and 10 CFR 20 Appendix G, 2003 edition, published January 1, 2003, by the Office of the Federal Register, National Archives and Records Administration, Washington, D.C. 20408 which is incorporated by reference and on file with the Agency. This incorporation by reference contains no future editions or amendments. published January 1, 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.
- B. No change

R12-1-446. Notifications and Reports to Individuals

- A. No change
- B. In addition to the reporting requirements in R12-1-444 and R12-1-445, each licensee or registrant shall notify the individual exposed to radiation or radioactive material. The notice to the exposed individual shall be provided no later than the date the report is submitted to the Agency and shall comply with R12-1-1004(A).

Appendix 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. 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, nonstochastic 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 R12-1-403. The nonstochastic ALIs were derived to avoid nonstochastic 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 shall 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 nonstochastic 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 nonstochastic ALIs, will ensure that nonstochastic 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 nonstochastic 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, $\Sigma (\text{intake (in } \mu\text{Ci) of each radionuclide} / ALI_{ns}) \leq 1.0$. 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 ≤ 1.0 .

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.

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:

$$DAC = ALI(\text{in } \mu\text{Ci}) / (2000 \text{ hours per working year} \times 60 \text{ minutes/hour} \times 2 \times 10^4 \text{ ml per minute}) = [ALI / 2.4 \times 10^9] \mu\text{Ci/ml},$$

where 2×10^4 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 shall be treated by the general method appropriate for mixtures.

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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 R12-1-407. 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 R12-1-415. 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 nonstochastic limits has not been included in deriving the air and water effluent concentration limits because nonstochastic effects are presumed not to occur at or below the dose levels established for individual members of the public. For radionuclides, where the nonstochastic 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 they were in earlier versions of Appendix A of Article 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 2.4×10^9 , 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 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, that is 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 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 R12-1-435. 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 rem.

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LIST OF ELEMENTS

<u>Name</u>	<u>Symbol</u>	<u>Atomic Number</u>
Actinium	Ac	89
Aluminum	Al	13
Americium	Am	95
Antimony	Sb	51
Argon	Ar	18
Arsenic	As	33
Astatine	At	85
Barium	Ba	56
Berkelium	Bk	97
Beryllium	Be	4
Bismuth	Bi	83
Bromine	Br	35
Cadmium	Cd	48
Calcium	Ca	20
Californium	Cf	98
Carbon	C	6
Cerium	Ce	58
Cesium	Cs	55
Chlorine	Cl	17
Chromium	Cr	24
Cobalt	Co	27
Copper	Cu	29
Curium	Cm	96
Dysprosium	Dy	66
Einsteinium	Es	99
Erbium	Er	68
Europium	Eu	63
Fermium	Fm	100
Fluorine	F	9
Francium	Fr	87
Gadolinium	Gd	64
Gallium	Ga	31
Germanium	Ge	32
Gold	Au	79
Hafnium	Hf	72
Holmium	Ho	67
Hydrogen	H	1
Indium	In	49
Iodine	I	53
Iridium	Ir	77
Iron	Fe	26
Krypton	Kr	36
Lanthanum	La	57
Lead	Pb	82
Lutetium	Lu	71
Magnesium	Mg	12
Manganese	Mn	25
Mendelevium	Md	101
Mercury	Hg	80
Molybdenum	Mo	42
Neodymium	Nd	60
Neptunium	Np	93
Nickel	Ni	28
Niobium	Nb	41
<u>Nitrogen</u>	<u>N</u>	<u>7</u>
Osmium	Os	76
<u>Oxygen</u>	<u>O</u>	<u>8</u>
Palladium	Pd	46
Phosphorus	P	15
Platinum	Pt	78
Plutonium	Pu	94

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Polonium	Po	84
Potassium	K	19
Praseodymium	Pr	59
Promethium	Pm	61
Protactinium	Pa	91
Radium	Ra	88
Radon	Rn	86
Rhenium	Re	75
Rhodium	Rh	45
Rubidium	Rb	37
Ruthenium	Ru	44
Samarium	Sm	62
Scandium	Sc	21
Selenium	Se	34
Silicon	Si	14
Silver	Ag	47
Sodium	Na	11
Strontium	Sr	38
Sulfur	S	16
Tantalum	Ta	73
Technetium	Tc	43
Tellurium	Te	52
Terbium	Tb	65
Thallium	Tl	81
Thorium	Th	90
Thulium	Tm	69
Tin	Sn	50
Titanium	Ti	22
Tungsten	W	74
Uranium	U	92
Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation	Col.3 DAC	Col. 1 Air	Col.2 Water	Monthly Average Concentration ($\mu\text{Ci/ml}$)
			ALI (μCi)	ALI (μCi)	($\mu\text{Ci/ml}$)	($\mu\text{Ci/ml}$)	($\mu\text{Ci/ml}$)	
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
		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	2E+2	1E-7	3E-10	-	-
		LLI wall						

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion	Col. 2 Inhalation ALI	Col.3 DAC	Col. 1 Air	Col.2 Water	Monthly Average Concentration
			ALI (µCi)	ALI (µCi)	(µCi/ml)	(µCi/ml)	(µCi/ml)	
			(3E+3)	-	-	-	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	2E+4	7E-6	2E-8	-	-
		LLI wall	(8E+3)	-	-	-	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	-	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	4E+4	2E-5	6E-8	-	-
		St wall	(3E+4)	-	-	-3E-4	3E-3	-
		W, see ³⁶ Cl	-	5E+4	2E-5	6E-8	-	-
17	Chlorine-39 ²	D, see ³⁶ Cl	2E+4	5E+4	2E-5	7E-8	-	-
		St wall	(4E+4)	-	-	-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
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

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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 watt (5E+4)	1E+5	5E-5	2E-7	-	7E-4	7E-3

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col.2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
20	Calcium-41	W, all compounds	3E+3 Bone surf (4E+3)	4E+3 Bone surf (4E+3)	2E-6	-	-	6E-4
20	Calcium-45	W, all compounds	2E+3	8E+2	4E-7	5E-9	6E-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 LLI wall (3E+3)	3E+3	1E-6	4E-9	-	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, SrTiO	-	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 (3E+4)	8E+4	3E-5	1E-7	-	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	-	-	-
		W, see ⁴⁷ V	-	2E+4	8E-6	2E-8	1E-3	1E-2
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	-	-

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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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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		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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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		St wall	(3E+4)	-	-	-	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	7E+4	3E-5	9E-8	-	-
		St wall	(3E+4)	-	-	-	3E-4	3E-3

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

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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	9E+4	4E-5	1E-7	-	-
		St wait (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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Table II		Table III
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Col. 1	Col. 2	
			Air (μCi/ml)	Water (μCi/ml)				
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

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		W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	-	-
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

**Table I
Occupational Values**

**Table II
Effluent Concentrations**

**Table III
Releases to Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Table II		Table III
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	

		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

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		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
		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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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			(3E+4)	-	-	-	4E-4	4E-3
37	Rubidium-89 ²	D, all compounds	4E+4	1E+5	6E-5	2E-7	-	-
			St wall					
			(6E+4)	-	-	-	9E-4	9E-3
38	Strontium-80 ²	D, all soluble compounds except SrTiO	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
		Y, all insoluble compounds and SrTiO	-	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	Bone surf				
			(4E+1)	(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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Col. 1 Col.2		Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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

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		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-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
	halides, and nitrates	W, oxides, hydroxides,	-	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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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			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	-	-
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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Col. 1	Col.2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC DAC (μCi/ml)	Air Air (μCi/ml)	Water Water (μCi/ml)	

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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	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-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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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
43	Technetium-104 ²	W, see ^{93m} Tc	-	4E+5	2E-4	5E-7	-	-
		D, see ^{93m} Tc	2E+4	7E+4	3E-5	1E-7	-	-
43	Technetium-104 ²		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	-	-
44	Ruthenium-106	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	-	-

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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col.3	Col. 1	Col. 2	Monthly Average Concentration (µCi/ml)
			Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	
		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	-	-
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	2E+5	8E-5	3E-7	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col.3	Col. 1	Col. 2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
			St Wall (6E+4)	-	-	-	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	2E+0 Kidneys	1E-9	-	-	-

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			(4E+1)	(4E+0)	-	5E-12	5E-7	5E-6
		W, see ¹⁰⁴ Cd	-	8E+0 Kidneys	4E-9	-	-	-
			-	(1E+1)	-	2E-11	-	-
		Y, see ¹⁰⁴ Cd	-	1E+1	5E-9	2E-11	-	-
48	Cadmium-113	D, see ¹⁰⁴ Cd	2E+1 Kidneys	2E+0 Kidneys	9E-10	-	-	-
			(3E+1)	(3E+0)	-	5E-12	4E-7	4E-6
		W, see ¹⁰⁴ Cd	-	8E+0 Kidneys	3E-9	-	-	-
			-	(1E+1)	-	2E-11	-	-
		Y, see ¹⁰⁴ Cd	-	1E+1	6E-9	2E-11	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
48	Cadmium-115m	D, see ¹⁰⁴ Cd	3E+2	5E+1 Kidneys	2E-8	-	4E-6	4E-5
			-	(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 LLI wall	1E+3	6E-7	2E-9	-	-
			(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

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	-	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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
49	Indium-119m ²	D, see ¹⁰⁹ In	4E+4	1E+5	5E-5	2E-7	-	-
			St wall (5E+4)	-	-	-	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	1E+3	5E-7	2E-9	-	-
			LLI wall (2E+3)	-	-	-	3E-5	3E-4
		W, see ¹¹⁰ Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-117m	D, see ¹¹⁰ Sn	2E+3	1E+3	5E-7	-	-	-
			LLI wall (2E+3)	Bone surf (2E+3)	-	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	2E+3	1E-6	3E-9	-	-
			LLI wall (4E+3)	-	-	-	6E-5	6E-4
		W, see ¹¹⁰ Sn	-	1E+3	4E-7	1E-9	-	-
50	Tin-121m	D, see ¹¹⁰ Sn	3E+3	9E+2	4E-7	1E-9	-	-
			LLI wall					

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			(4E+3)	-	-	-	5E-5	5E-4
		W, see ¹¹⁰ Sn	-	5E+2	2E-7	8E-10	-	-
50	Tin-121	D, see ¹¹⁰ Sn	6E+3	2E+4	6E-6	2E-8	-	-
		LLI wall (6E+3)	-	-	-	-	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	6E+2	3E-7	9E-10	-	-
		LLI wall (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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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		W, see ¹¹⁵ Sb	-	5E+5	2E-4	7E-7	-	-
51	Antimony-120	D, see ¹¹⁵ Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
	(5.76 d)	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
		W, see ¹¹⁵ Sb	-	5E+2	2E-7	7E-10	-	-
51	Antimony-126m ²	D, see ¹¹⁵ Sb	5E+4	2E+5	8E-5	3E-7	-	-
			St wall (7E+4)	-	-	-	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	2E+3	9E-7	3E-9	-	-
			LLI wall (8E+2)	-	-	-	1E-5	1E-4
		W, see ¹¹⁵ Sb	7E+2	9E+2	4E-7	1E-9	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Occupational Values			Effluent Concentrations		Monthly Average Concentration (μCi/ml)
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	
51	Antimony-128 ² (10.4 min)	D, see ¹¹⁵ Sb	8E+4	4E+5	2E-4	5E-7	-	-
			St wall (1E+5)	-	-	-	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	2E+4	1E-5	-	-	-
			Thyroid (2E+4)	Thyroid (4E+4)	-	6E-8	2E-4	2E-3
		W, see ¹¹⁵ Sb	-	2E+4	1E-5	-	-	-
			-	Thyroid (4E+4)	-	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

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		W, oxides, hydroxides, and nitrates	-	3E+4	1E-5	4E-8	-	-
52	Tellurium-121m	D, see ¹¹⁶ Te	5E+2	2E+2	8E-8	-	-	-
			Bone surf (7E+2)	Bone surf (4E+2)	-	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	2E+2	9E-8	-	-	-
			Bone surf (1E+3)	Bone surf (5E+2)	-	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	2E+2	8E-8	-	-	-
			Bone surf (1E+3)	Bone surf (5E+2)	-	7E-10	2E-5	2E-4
		W, see ¹¹⁶ Te	-	4E+2	2E-7	-	-	-
			-	Bone surf (1E+3)	-	2E-9	-	-
52	Tellurium-125m	D, see ¹¹⁶ Te	1E+3	4E+2	2E-7	-	-	-
			Bone surf (1E+3)	Bone surf (1E+3)	-	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	1E-7	-	9E-6	9E-5
			-	Bone surf (4E+2)	-	6E-10	-	-
		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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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	4E+2	2E-7	-	-	-
			Thyroid (6E+2)	Thyroid (1E+3)	-	2E-9	8E-6	8E-5
		W, see ¹¹⁶ Te	-	4E+2	2E-7	-	-	-
			-	Thyroid (9E+2)	-	1E-9	-	-
52	Tellurium-131 ²	D, see ¹¹⁶ Te	3E+3	5E+3	2E-6	-	-	-
			Thyroid (6E+3)	Thyroid (1E+4)	-	2E-8	8E-5	8E-4
		W, see ¹¹⁶ Te	-	5E+3	2E-6	-	-	-
			-	Thyroid	-	-	-	-

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			-	(1E+4)	-	2E-8	-	-
52	Tellurium-132	D, see ¹¹⁶ Te	2E+2	2E+2	9E-8	-	-	-
			Thyroid	Thyroid				
			(7E+2)	(8E+2)	-	1E-9	9E-6	9E-5
		W, see ¹¹⁶ Te	-	2E+2	9E-8	-	-	-
				Thyroid				
			-	(6E+2)	-	9E-10	-	-
52	Tellurium-133m ²	D, see ¹¹⁶ Te	3E+3	5E+3	2E-6	-	-	-
			Thyroid	Thyroid				
			(6E+3)	(1E+4)	-	2E-8	9E-5	9E-4
		W, see ¹¹⁶ Te	-	5E+3	2E-6	-	-	-
				Thyroid				
			-	(1E+4)	-	2E-8	-	-
52	Tellurium-133 ²	D, see ¹¹⁶ Te	1E+4	2E+4	9E-6	-	-	-
			Thyroid	Thyroid				
			(3E+4)	(6E+4)	-	8E-8	4E-4	4E-3
		W, see ¹¹⁶ Te	-	2E+4	9E-6	-	-	-
				Thyroid				
			-	(6E+4)	-	8E-8	-	-
52	Tellurium-134 ²	D, see ¹¹⁶ Te	2E+4	2E+4	1E-5	-	-	-
			Thyroid	Thyroid				
			(2E+4)	(5E+4)	-	7E-8	3E-4	3E-3
		W, see ¹¹⁶ Te	-	2E+4	1E-5	-	-	-
				Thyroid				
			-	(5E+4)	-	7E-8	-	-
53	Iodine-120m ²	D, all compounds	1E+4	2E+4	9E-6	3E-8	-	-
			Thyroid					
			(1E+4)	-	-	-	2E-4	2E-3
53	Iodine-120 ²	D, all compounds	4E+3	9E+3	4E-6	-	-	-
			Thyroid	Thyroid				
			(8E+3)	(1E+4)	-	2E-8	1E-4	1E-3

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col.2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
53	Iodine-121	D, all compounds	1E+4	2E+4	8E-6	-	-	-
			Thyroid	Thyroid				
			(3E+4)	(5E+4)	-	7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	3E+3	6E+3	3E-6	-	-	-
			Thyroid	Thyroid				
			(1E+4)	(2E+4)	-	2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	5E+1	8E+1	3E-8	-	-	-
			Thyroid	Thyroid				
			(2E+2)	(3E+2)	-	4E-10	2E-6	2E-5
53	Iodine-125	D, all compounds	4E+1	6E+1	3E-8	-	-	-
			Thyroid	Thyroid				
			(1E+2)	(2E+2)	-	3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	2E+1	4E+1	1E-8	-	-	-
			Thyroid	Thyroid				

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			(7E+1)	(1E+2)	-	2E-10	1E-6	1E-5
53	Iodine-128 ²	D, all compounds	4E+4	1E+5	5E-5	2E-7	-	-
			St wall					
			(6E+4)			-	8E-4	8E-3
53	Iodine-129	D, all compounds	5E+0	9E+0	4E-9	-	-	-
			Thyroid	Thyroid				
			(2E+1)	(3E+1)	-	4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	4E+2	7E+2	3E-7	-	-	-
			Thyroid	Thyroid				
			(1E+3)	(2E+3)	-	3E-9	2E-5	2E-4
53	Iodine-131	D, all compounds	3E+1	5E+1	2E-8	-	-	-
			Thyroid	Thyroid				
			(9E+1)	(2E+2)	-	2E-10	1E-6	1E-5
53	Iodine-132m ²	D, all compounds	4E+3	8E+3	4E-6	-	-	-
			Thyroid	Thyroid				
			(1E+4)	(2E+4)	-	3E-8	1E-4	1E-3
53	Iodine-132	D, all compounds	4E+3	8E+3	3E-6	-	-	-
			Thyroid	Thyroid				
			(9E+3)	(1E+4)	-	2E-8	1E-4	1E-3
53	Iodine-133	D, all compounds	1E+2	3E+2	1E-7	-	-	-
			Thyroid	Thyroid				
			(5E+2)	(9E+2)	-	1E-9	7E-6	7E-5
53	Iodine-134 ²	D, all compounds	2E+4	5E+4	2E-5	6E-8	-	-
			Thyroid					
			(3E+4)	-	-	-	4E-4	4E-3
53	Iodine-135	D, all compounds	8E+2	2E+3	7E-7	-	-	-
			Thyroid	Thyroid				
			(3E+3)	(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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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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
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, oxides and hydroxides	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
			-	2E+5	7E-5	2E-7	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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			-	(7E+1)	-	1E-10	-	-
		W, see ¹³¹ La	-	3E+2	1E-7	-	-	-
				Liver				
			-	(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	-	-
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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col.2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
58	Cerium-144	W, see ¹³⁴ Ce	2E+2	3E+1	1E-8	4E-11	-	-
			LLI wall					
			(3E+2)	-	-	-	3E-6	3E-5

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		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-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	-	-
		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	-	-
		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	-	-
		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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Col. 1	Col.2	Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	

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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, 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	-	-
0			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

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col.2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
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)	4E2 Bone surf (6E-2)	1E-11 -	- 9E-14	- 3E-7	- 3E-6
62	Samarium-147	W, all compounds	2E+1 Bone surf (3E+1)	4E2 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 Bone surf -	9E+1 (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

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		W, see ¹⁴⁵ Gd	-	4E+3	1E-6	5E-9	-	-
			Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col.2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
64	Gadolinium-148	D, see ¹⁴⁵ Gd	1E+1 Bone surf (2E+1)	8E+3 Bone surf (2E+2)	3E-12 -	- 2E-14	- 3E-7	- 3E-6
		W, see ¹⁴⁵ Gd	-	3E-2 Bone surf (6E-2)	1E-11 -	- 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 (6E+2)	2E-7 -	- 9E-10	9E-5 -	9E-4 -
		W, see ¹⁴⁵ Gd	-	1E+3	5E-7	2E-9	-	-
64	Gadolinium-152	D, see ¹⁴⁵ Gd	2E+1 Bone surf (3E+1)	1E-2 Bone surf (2E-2)	4E-12 -	- 3E-14	- 4E-7	- 4E-6
		W, see ¹⁴⁵ Gd	-	4E-2 Bone surf (8E-2)	2E-11 -	- 1E-13	- -	- -
64	Gadolinium-153	D, see ¹⁴⁵ Gd	5E+3	1E+2 Bone surf (2E+2)	6E-8 -	- 3E-10	6E-5 -	6E-4 -
		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 (5E+4)	3E+2 Bone surf (6E+2)	1E-7 -	- 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	-	-

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			(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

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

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69	Thulium-172	W, all compounds	7E+2 LLI wall (8E+2)	1E+3	5E-7	2E-9	-	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 St wall (9E+4)	3E+5	1E-4	4E-7	-	1E-3	1E-2

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

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		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-1	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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				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		

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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		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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Col. 2 Inhalation ALI (μ Ci)	Col.3 DAC (μ Ci/ml)	Col. 1 Air (μ Ci/ml)	Col.2 Water (μ Ci/ml)	
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

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74	Tungsten-185	D, all compounds	2E+3 LLI wall (3E+3)	7E+3	3E-6	9E-9	-	4E-5	4E-4
74	Tungsten-187	D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-5	3E-4
74	Tungsten-188	D, all compounds	4E+2 LLI wall (5E+2)	1E+3	5E-7	2E-9	-	7E-6	7E-5
75	Rhenium-177 ²	D, all compounds except those given for W	9E+4 St wall (1E+5)	3E+5	1E-4	4E-7	-	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 St wall (1E+5)	3E+5	1E-4	4E-7	-	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-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-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-5	2E-4
		W, see ¹⁷⁷ Re	-	2E+3	9E-7	3E-9	-	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Col. 1 Col. 2		Monthly Average Concentration (μCi/ml)
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Air (μCi/ml)	Water (μCi/ml)	
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 St wall (2E+3)	2E+3 St wall (2E+3)	7E-7	-	3E-9	2E-5
		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 St wall	8E+5	4E-4	-	8E-3	8E-2
		W, see ¹⁷⁷ Re	-	(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	-	-

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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-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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Table II		Table III
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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						

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		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
		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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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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
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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Col. 1 Col.2		Monthly Average Concentration (µCi/ml)
			Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	
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	-	-

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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	-	-
79	Gold-200m	Y, see ¹⁹³ Au	-	4E+3	2E-6	5E-9	-	-
		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	-	-
79	Gold-200 ²	Y, see ¹⁹³ Au	-	2E+4	1E-6	3E-9	-	-
		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	-	-
79	Gold-201 ²	Y, see ¹⁹³ Au	-	7E+4	3E-5	1E-7	-	-
		D, see ¹⁹³ Au	7E+4	2E+5	9E-5	3E-7	-	-
			St wall (9E+4)	-	-	-	1E-3	1E-2
80	Mercury-193m	W, see ¹⁹³ Au	-	2E+5	1E-4	3E-7	-	-
		Y, see ¹⁹³ Au	-	2E+5	9E-5	3E-7	-	-
		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
80	Mercury-193	W, oxides, hydroxides, halides, nitrates, and sulfides	-	8E+3	3E-6	1E-8	-	-
		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	-	-
		Vapor	-	4E+3	2E-6	6E-9	-	-
80	Mercury-195m	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	-	-
		Vapor	-	3E+4	1E-5	4E-8	-	-
		Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
80	Mercury-195	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	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μ Ci)	Col. 2 Inhalation ALI (μ Ci)	Col.3 DAC (μ Ci/ml)	Col. 1 Air (μ Ci/ml)	Col.2 Water (μ Ci/ml)	Monthly Average Concentration (μ Ci/ml)
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	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	6E1	2E1	1E-10	-	-	-

Bone surf Bone surf

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC ($\mu\text{Ci/ml}$)	Col. 1 Air ($\mu\text{Ci/ml}$)	Col.2 Water ($\mu\text{Ci/ml}$)	Monthly Average Concentration ($\mu\text{Ci/ml}$)
			(1E+0)	(4E-1)	-	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 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	-	-

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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	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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	9E-9	3E-11	-	-
			(or 12 working level months)			(or 1.0 working level)		
86	Radon-222	With daughters removed	-	1E+4	4E-6	1E-8	-	-
		With daughters present	-	1E+2	3E-8	1E-10	-	-
			(or 4 working level months)			(or 0.33 working level)		
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	7E-1	3E-10	9E-13	-	-
			Bone surf (9E+0)	-	-	-	1E-7	1E-6
88	Radium-224	W, all compounds	8E+0	2E+0	7E-10	2E-12	-	-
			Bone surf (2E+1)	-	-	-	2E-7	2E-6
88	Radium-225	W, all compounds	8E+0	7E-1	3E-10	9E-13	-	-
			Bone surf (2E+1)	-	-	-	2E-7	2E-6
88	Radium-226	W, all compounds	2E+0	6E-1	3E-10	9E-13	-	-
			Bone surf (5E+0)	-	-	-	6E-8	6E-7
88	Radium-227 ²	W, all compounds	2E+4	1E+4	6E-6	-	-	-
			Bone surf (2E+4)	Bone surf (2E+4)	-	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E+0	1E+0	5E-10	2E-12	-	-
			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	-	-

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Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1	Col. 2	Col.3	Col. 1	Col. 2	Monthly Average Concentration (µCi/ml)
			Oral Ingestion ALI (µCi)	Inhalation ALI (µCi)	DAC (µCi/ml)	Air (µCi/ml)	Water (µCi/ml)	
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 -	-	3E-5	2E-11 -
		W see ²²⁴ Ac	-	4E+1 Bone surf (6E+1)	2E-8 -	-	-	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 St wall (5E+3)	2E+2 -	6E-8 -	2E-10 -	-	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 Bone surf (1E+1)	1E-2 Bone surf (2E-2)	4E-12 -	-	-	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 Bone surf (1E+0)	9E-4 Bone surf (2E-3)	4E-13 -	-	-	3E-15 2E-8 2E-7
		Y, see ²²⁶ Th	-	2E-3 Bone surf (3E-3)	1E-12 -	-	-	4E-15- -

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90	Thorium-230	W, see ²²⁶ Th	4E+0	6E-3	3E-12	-	-	-
			Bone surf (9E+0)	Bone surf (2E-2)	-	2E-14	1E-6	7E-7
		Y, see ²²⁶ Th	-	2E-2	6E-12	-	-	-
				Bone surf (2E-2)	-	3E-14	-	-
90	Thorium-231	W, see ²²⁸ Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
		Y, see ²²⁸ Th	-	6E+3	3E-6	9E-9	-	-

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
90	Thorium-232	W, see ²²⁸ Th	7E-1	1E-3	5E-13	-	-	-
			Bone surf (2E+0)	Bone surf (3E-3)	-	4E-15	3E-8	3E-7
		Y, see ²²⁸ Th	-	3E-3	1E-12	-	-	-
				Bone surf (4E-3)	-	6E-15	-	-
90	Thorium-234	W, see ²²⁸ Th	3E+2	2E+2	8E-8	3E-10	-	-
			LLI wall (4E+2)	-	-	-	5E-6	5E-5
		Y, see ²²⁸ 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	-	-
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	-	-

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			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, UOF, UO(NO)	4E+0	4E-1	2E-10	-	-	-
			Bone surf (6E+0)	Bone surf (6E-1)	-	8E-13	8E-8	8E-7
		W, UO, UF, UCI	-	4E-1	1E-10	5E-13	-	-
		Y, UO, UO	-	3E-1	1E-10	4E-13	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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			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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col. 2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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-24	-	-
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
93	Neptunium-238	W, all compounds	1E+3	6E+1	3E-8	-	2E-5	2E-4
			-	Bone surf (2E+2)	-	2E-10	-	-
93	Neptunium-239	W, all compounds	2E+3	2E+3	9E-7	3E-9	-	-
			LLI wall (2E+3)	-	-	-	2E-5	2E-4

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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	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
		Y, PuO	-	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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Col. 1	Col. 2	Col.3	Table II		Table III
			Oral Ingestion ALI (μCi)	Inhalation ALI (μCi)	DAC (μCi/ml)	Col. 1	Col. 2	
						Air (μCi/ml)	Water (μCi/ml)	
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)	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)	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)	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)	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	-	-	-

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			Bone surf (2E+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-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

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

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96	Curium-242	W, all compounds	- 3E+1	(4E+1) 3E-1	- 1E-10	5E-11 -	- -	- -
			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
Releases to
Sewers**

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

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			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	-	-

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

Atomic No.	Radionuclide	Class	Table I Occupational Values			Table II Effluent Concentrations		Table III Releases to Sewers
			Col. 1 Oral Ingestion ALI (μCi)	Col. 2 Inhalation ALI (μCi)	Col.3 DAC (μCi/ml)	Col. 1 Air (μCi/ml)	Col.2 Water (μCi/ml)	Monthly Average Concentration (μCi/ml)
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
99	Einsteinium-254	W, all compounds	8E+0	7E-2	3E-11	-	-	-
			Bone surf (2E+1)	Bone surf (1E-1)	-	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

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100	Fermium-257	W, all compounds	2E+1 Bone surf (4E+1)	2E-1 Bone surf (2E-1)	7E-11	-	-	-
101	Mendelevium-257	W, all compounds	7E+3	8E+1	4E-8	-	3E-13	5E-7
				Bone surf (9E+1)	-	1E-10	-	-
101	Mendelevium-258	W, all compounds	3E+1 Bone surf (5E+1)	2E-1 Bone surf (3E-1)	1E-10	-	-	-
-	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

**Table I
Occupational Values**

**Table II
Effluent
Concentrations**

**Table III
Releases to
Sewers**

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

	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
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FOOTNOTES:

¹ No change

² No change

³ No change

NOTE:

1. No change

2. No change

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

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 - - -

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

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,

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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. No change						
4. No change						

ARTICLE 7. MEDICAL USES OF RADIOACTIVE MATERIAL

R12-1-703. License for Medical Use of Radioactive Material

- A.** No change
 - 1. No change
 - 2. No change
 - 3. No change
- B.** No change
 - 1. No change
 - a. No change
 - b. No change
 - c. No change
 - d. No change
 - 2. No change
 - a. No change
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - b. No change
 - c. No change
- C.** No change
 - 1. The Agency shall approve an application for a specific license under subsections (A) or (B), for any medical use or uses of radioactive material specified in Groups 100 through ~~600~~ 1,000, in Exhibit A of this Article, for all of the materials within each group requested in the application if:
 - a. No change
 - b. No change
 - c. The applicant's radiation detection and measuring instrumentation is adequate for conducting the procedures involved in the authorized uses selected from Group 100 through Group ~~600~~ 1,000; and
 - d. The applicant's radiation safety operating procedures are adequate for handling and disposal of the radioactive material involved in the authorized uses selected from Group 100 through Group ~~600~~ 1,000.
 - 2. Any licensee who is authorized to use radioactive material:
 - a. In unsealed form under Groups 100, 200, ~~or~~ 300 or 1,000 listed in Exhibit A of this Article, shall do so using radiopharmaceuticals prepared in accordance with R12-1-311~~(J)~~(I); or
 - b. In sealed source form under Groups 400, 500, ~~or~~ 600, or 1,000 listed in Exhibit A of this Article, shall do so using sealed sources that have been manufactured and distributed in accordance with R12-1-311~~(L)~~(K);
 - c. In any form under group 1,000 listed in Exhibit A of this Article, shall do so using sealed and unsealed sources

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that have been manufactured and distributed in accordance with the specific license issued by the Agency.

3. No change

D. No change

R12-1-705. Authority and Responsibilities for the Radiation Protection Program

A. No change

B. Licensees that are authorized for two or more different types of uses of radioactive material listed in Groups 300, 400, ~~and 600, and 1,000~~, or two or more types of units under group 600 or 1,000, shall establish a Radiation Safety Committee (RSC) to oversee all uses of radioactive material permitted by the license. At a minimum, the RSC shall include an authorized user of each type of use permitted by the license, the RSO, a representative of the nursing service, and a representative of management who is neither an authorized user nor a RSO.

C. No change

D. No change

R12-1-710. Radiation Safety Officer Training

A. No change

1. No change

a. No change

i. No change

ii. No change

iii. No change

b. No change

i. No change

ii. No change

(1) No change

(2) No change

iii. No change

2. No change

a. No change

i. No change

ii. No change

iii. No change

iv. No change

v. No change

b. No change

i. No change

ii. No change

iii. Securing and controlling ~~byproduct~~ radioactive material;

iv. Using administrative controls to avoid mistakes in the administration of ~~byproduct~~ radioactive material;

v. No change

vi. Using emergency procedures to control ~~byproduct~~ radioactive material; and

vii. Disposing of ~~byproduct~~ radioactive material; or

c. No change

3. No change

B. No change

1. No change

2. No change

C. No change

D. Individuals who, under subsection (B), need not comply with training requirements described in this Section may serve as preceptors for, and supervisors of, applicants seeking authorization on Agency licenses for the same uses for which these individuals are authorized.

R12-1-711. Authorized Medical Physicist Training

A. No change

1. Is certified by a specialty board whose certification process includes all of the training and experience requirements in subsection ~~(A)(2) and (A)(3)(b) and (A)(3)(c)~~ and whose certification has been recognized by the Agency, NRC or an Agreement State; or

2. Training requirements.

a. ~~Holds a master's or doctor's degree in physics, biophysics, radiological physics, medical physics, or health physics and has completed one year of fulltime training in therapeutic radiological physics and an additional year of full-time work experience under the supervision of an authorized medical physicist at a medical institution that~~

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- ~~includes the physics tasks associated with the sealed source radiation therapy procedures regulated in this Article; and~~
- a. Hold a master's or doctor's degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university;
 - b. Have 2 years of full-time practical training and/or supervised experience in medical physics:
 - i. Under the supervision of a medical physicist who is certified in medical physics by a specialty board recognized by the NRC or an Agreement State; or
 - ii. In clinical radiation facilities providing high-energy, external beam therapy (photons and electrons with energies greater than or equal to 1 million electron volts) and brachytherapy services under the direction of physicians who meet the requirements for authorized users in R12-1-710, R12-1-719, R12-1-721, R12-1-723, R12-1-727, R12-1-728, or R12-1-744; and
 - c. Pass an examination, administered by diplomates of the specialty board, that assesses knowledge and competence in clinical radiation therapy, radiation safety, calibration, quality assurance, and treatment planning for external beam therapy, brachytherapy, and stereotactic radiosurgery; or
3. Training requirements alternative.
- a. Holds a master's or doctor's degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university; and has completed 1 year of full-time training in medical physics and an additional year of fulltime work experience under the supervision of an individual who meets the requirements for an authorized medical physicist for the type(s) of use for which the individual is seeking authorization. This training and work experience must be conducted in clinical radiation facilities that provide high-energy, external beam therapy (photons and electrons with energies greater than or equal to 1 million electron volts) and brachytherapy services and must include:
 - i. Performing sealed source leak tests and inventories;
 - ii. Performing decay corrections;
 - iii. Performing full calibration and periodic spot checks of external beam treatment units, stereotactic radiosurgery units, and remote afterloading units as applicable; and
 - iv. Conducting radiation surveys around external beam treatment units, stereotactic radiosurgery units, and remote afterloading units as applicable; and
 - b. Has obtained written attestation that the individual has satisfactorily completed the requirements in subsection (A)(3)(c) and (A)(2)(a) and (A)(2)(b) and (A)(3)(c), or (A)(3)(a) and (A)(3)(c); and has achieved a level of competency sufficient to function independently as an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status. The written attestation must be signed by a preceptor authorized medical physicist who meets the requirements in section, or equivalent Agreement State requirements for an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status; and
 - c. Has training for the type(s) of use for which authorization is sought that includes hands-on device operation, safety procedures, clinical use, and the operation of a treatment planning system. This training requirement may be satisfied by satisfactorily completing either a training program provided by the vendor or by training supervised by an authorized medical physicist authorized for the type(s) of use for which the individual is seeking authorization.
 - b. ~~Has obtained written certification that the individual has satisfactorily completed the requirements in subsection (A)(2)(a) and has achieved a level of competency sufficient to function independently as an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status. The written certification shall be signed by a preceptor authorized medical physicist who meets the requirements in this Section or equivalent NRC or Agreement State requirements for an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status.~~
- B. No change
C. No change
D. Individuals who, under subsection (B), need not comply with training requirements described in this Section may serve as preceptors for, and supervisors of, applicants seeking authorization on Agency licenses for the same uses for which these individuals are authorized.

R12-1-712. Authorized Nuclear Pharmacist Training

- A. A licensee shall require the authorized nuclear pharmacist to be a pharmacist who:
1. Is certified as a nuclear pharmacist by a specialty board whose certification process ~~includes all of the requirements in subsection (2) and whose certification~~ has been recognized by the Agency, NRC, or an Agreement State; ~~or~~ To have its certification process recognized, a specialty board shall require all candidates for certification to:
 - a. Have graduated from a pharmacy program accredited by the American Council on Pharmaceutical Education (ACPE) or have passed the Foreign Pharmacy Graduate Examination Committee (FPGEC) examination;

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- b. Hold a current, active license to practice pharmacy in Arizona;
 - c. Provide evidence of having acquired at least 4000 hours of training/experience in nuclear pharmacy practice. Academic training may be substituted for no more than 2000 hours of the required training and experience; and
 - d. Pass an examination in nuclear pharmacy administered by diplomates of the specialty board, that assesses knowledge and competency in procurement, compounding, quality assurance, dispensing, distribution, health and safety, radiation safety, provision of information and consultation, monitoring patient outcomes, research and development; or
2. No change
- a. ~~Didactic~~ 200 hours of classroom and laboratory training in the following areas:
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
 - b. No change
 - i. No change
 - ii. No change
 - iii. No change
 - iv. No change
 - v. No change
3. Has obtained written ~~certification~~ attestation, signed by a preceptor authorized nuclear pharmacist, that the individual has satisfactorily completed the requirements in subsection (A)(2) and has achieved a level of competency sufficient to function independently as an authorized nuclear pharmacist.
- B.** No change
- C.** No change
- D.** Individuals who, under subsection (B), need not comply with training requirements described in this Section may serve as preceptors for, and supervisors of, applicants seeking authorization on Agency licenses for the same uses for which these individuals are authorized.

R12-1-713. Determination of Prescribed Dosages, and Possession, Use, and Calibration of Instruments

- A.** No change
- B.** No change
- 1. No change
 - 2. No change
 - a. No change
 - b. An Agency, NRC, or Agreement State licensee for use in research in accordance with a Radioactive Drug Research Committee-approved protocol or an Investigational New Drug (IND) protocol accepted by FDA-~~or~~;
 - c. A PET radioactive drug producer licensed under R12-1-311 or equivalent NRC or Agreement State requirements.
- C.** No change
- 1. No change
 - 2. No change
 - 3. No change
- D.** No change
- E.** No change
- F.** No change
- G.** No change
- 1. No change
 - a. No change
 - b. No change
 - c. No change
 - d. No change
 - e. No change
 - f. No change
 - 2. No change
 - 3. No change
- H.** No change
- 1. No change
 - 2. No change
 - 3. No change

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- I. No change
- J. No change

R12-1-717. Release of Individuals Containing Radioactive Material or Implants Containing Radioactive Material

- A. A licensee may authorize the release from its control of any individual who has been administered unsealed radioactive material or implants containing radioactive material, if the total effective dose equivalent to any other individual from exposure to the released individual is not likely to exceed 5 ~~mSv~~ millisieverts (0.5 rem).
- B. A licensee shall provide the released individual, or the individual's parent or guardian, with instructions, including written instructions, on actions recommended to maintain doses to other individuals as low as is reasonably achievable if the total effective dose equivalent to any other individual is likely to exceed 1 ~~mSv~~ millisievert (0.1 rem). If the total effective dose equivalent to a nursing infant or child could exceed 1 ~~mSv~~ millisievert (0.1 rem) assuming there were no interruption of breast-feeding, the instructions shall also include:
 - 1. No change
 - 2. No change
- C. No change

R12-1-719. Training for Uptake, Dilution, and Excretion Studies

- A. Except as provided in R12-1-710, ~~each licensee shall require an authorized user of unsealed radioactive material for the uses authorized under Group 100 to be a physician who has completed the training requirements in 10 CFR 35.190, January 1, 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~ the licensee shall require an authorized user of unsealed radioactive material for the uses authorized under Group 100 to be a physician who:
 - 1. Is certified by a medical specialty board whose certification process has been recognized by the NRC or an Agreement State and who meets the requirements in subsection (A)(3). To have its certification process recognized, a specialty board shall require all candidates for certification to:
 - a. Complete 60 hours of training and experience in basic radionuclide handling techniques and radiation safety applicable to the medical use of unsealed radioactive material for uptake, dilution, and excretion studies as described in subsection (A)(3); and
 - b. Pass an examination, administered by diplomates of the specialty board, that assesses knowledge and competence in radiation safety, radionuclide handling, and quality control; or
 - 2. Is an authorized user under R12-1-721, R12-1-723, NRC, or equivalent Agreement State requirements; or
 - 3. Has completed 60 hours of training and experience, including a minimum of 8 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material for uptake, dilution, and excretion studies. The training and experience must include:
 - a. Classroom and laboratory training in the following areas:
 - i. Radiation physics and instrumentation;
 - ii. Radiation protection;
 - iii. Mathematics pertaining to the use and measurement of radioactivity;
 - iv. Chemistry of radioactive material for medical use; and
 - v. Radiation biology; and
 - b. Work experience, under the supervision of an authorized user who meets the requirements in this Article, NRC, or equivalent Agreement State requirements, involving:
 - i. Ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;
 - ii. Performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;
 - iii. Calculating, measuring, and safely preparing patient or human research subject dosages;
 - iv. Using administrative controls to prevent a medical event involving the use of unsealed radioactive material;
 - v. Using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and
 - vi. Administering dosages of radioactive drugs to patients or human research subjects; and
 - c. Has obtained written attestation, signed by a preceptor authorized user who meets the requirements who meets the requirements of R12-1-710, R12-1-719, R12-1-721, or R12-1-723, NRC, or equivalent Agreement State requirements; that the individual has satisfactorily completed the requirements in subsection (A)(1) or (A)(3) and has achieved a level of competency sufficient to function independently as an authorized user for the medical uses authorized under Exhibit A of this Article.
- B. No change
- C. Individuals who, under R12-1-710(B), need not comply with training requirements described in this Section may serve as preceptors for, and supervisors of, applicants seeking authorization on Agency licenses for the same uses for which these

individuals are authorized.

R12-1-720. Permissible Molybdenum-99, Strontium-82, and Strontium-85 Concentrations

- A. A licensee may not administer to humans a radiopharmaceutical that contains more than 0.15 kilobecquerel of molybdenum-99 per megabecquerel of technetium-99m (0.15 microcurie of molybdenum-99 per millicurie of technetium-99m) or more than 0.02 kilobecquerel of strontium-82 per megabecquerel of rubidium-82 chloride injection (0.02 microcurie of strontium-82 per millicurie of rubidium-82 chloride); or more than 0.2 kilobecquerel of strontium-85 per megabecquerel of rubidium-82 chloride injection (0.2 microcurie of strontium-85 per millicurie of rubidium-82).
- B. No change
- C. A licensee that uses a strontium-82/rubidium-82 generator for preparing a rubidium-82 radiopharmaceutical shall, before the first patient use of the day, measure the concentration of radionuclides strontium-82 and strontium-85 to demonstrate compliance with subsection (A).
- ~~C.~~ D. A licensee shall maintain a record of each molybdenum-99 concentration measurement or strontium-82 and strontium-85 concentrations measurements for three years following completion of the measurement.

R12-1-721. Training for Imaging and Localization Studies Not Requiring a Written Directive

- A. ~~Except as provided in R12-1-710, a licensee shall require an authorized user of unsealed radioactive material for the uses authorized under Group 200 to be a physician who has completed the training requirements in 10 CFR 35.290, January 1, 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments: the licensee shall require an authorized user of unsealed radioactive material for the uses authorized under Group 200 to be a physician who:~~
 - 1. Is certified by a medical specialty board whose certification process has been recognized by the NRC or an Agreement State and who meets the requirements in subsection (A)(3). To have its certification process recognized, a specialty board shall require all candidates for certification to:
 - a. Complete 700 hours of training and experience in basic radionuclide handling techniques and radiation safety applicable to the medical use of unsealed radioactive material for imaging and localization studies as described in subsection (3); and
 - b. Pass an examination, administered by diplomates of the specialty board, that assesses knowledge and competence in radiation safety, radionuclide handling, and quality control; or
 - 2. Is an authorized user under this Chapter and R12-1-723, NRC, or equivalent Agreement State requirements; or
 - 3. Has completed 700 hours of training and experience, including a minimum of 80 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material for imaging and localization studies. The training and experience must include:
 - a. Classroom and laboratory training in the following areas:
 - i. Radiation physics and instrumentation;
 - ii. Radiation protection;
 - iii. Mathematics pertaining to the use and measurement of radioactivity;
 - iv. Chemistry of radioactive material for medical use; and
 - v. Radiation biology; and
 - b. Work experience, under the supervision of an authorized user who meets the requirements in R12-1-710, R12-1-721, or R12-1-723 and R12-1-721(A)(3)(b)(vii), NRC, or equivalent Agreement State requirements, involving:
 - i. Ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;
 - ii. Performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;
 - iii. Calculating, measuring, and safely preparing patient or human research subject dosages;
 - iv. Using administrative controls to prevent a medical event involving the use of unsealed radioactive material;
 - v. Using procedures to contain spilled radioactive material safely and using proper decontamination procedures; and
 - vi. Administering dosages of radioactive drugs to patients or human research subjects; and
 - vii. Eluting generator systems appropriate for preparation of radioactive drugs for imaging and localization studies, measuring and testing the elate for radionuclide purity, and processing the elate with reagent kits to prepare labeled radioactive drugs; and
 - c. Has obtained written attestation, signed by a preceptor authorized user who meets the requirements as an authorized user for Exhibit A group 200 nuclides, NRC, or equivalent Agreement State requirements, that the individual has satisfactorily completed the requirements in subsection (A)(1) or (A)(3) and has achieved a level of competency sufficient to function independently as an authorized user for the medical uses authorized under Exhibit A of this Article.
- ~~B. An authorized user candidate who is a cardiologist is limited to nuclear cardiology if the candidate is unable to provide~~

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~~proof that he or she has participated in 700 hours of training and experience, required in 10 CFR 35.290(e).~~

~~E.B.~~ The training and experience shall have been obtained within the seven years preceding the date of application or the individual shall have had related continuing education and experience since the required training and experience was completed.

R12-1-723. Training for Use of Unsealed Radioactive Material Requiring a Written Directive, Including Treatment of Hyperthyroidism, and Treatment of Thyroid Carcinoma

A. ~~Except as provided in R12-1-710, a licensee shall require an authorized user of unsealed radioactive material for the uses authorized under Group 300 to be a physician who has completed the training requirements in 10 CFR 35.390, January 1, 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments; the licensee shall require an authorized user of unsealed radioactive material for the uses authorized under Group 300 to be a physician who:~~

1. Is certified by a medical specialty board whose certification process has been recognized by the NRC or an Agreement State and who meets the requirements in subsection (A)(2). To have its certification process recognized, a specialty board shall require all candidates for certification to:

- a. Successfully complete residency training in a radiation therapy or nuclear medicine training program or a program in a related medical specialty. These residency training programs must include 700 hours of training and experience as described in (A)(2). Eligible training programs must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Committee on Post-Graduate Training of the American Osteopathic Association; and
- b. Pass an examination, administered by diplomates of the specialty board, which tests knowledge and competence in radiation safety, radionuclide handling, and quality assurance, and clinical use of unsealed radioactive material for which a written directive is required; or

2. Has completed 700 hours of training and experience, including a minimum of 200 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material requiring a written directive. The training and experience must include:

- a. Classroom and laboratory training in the following areas:
 - i. Radiation physics and instrumentation;
 - ii. Radiation protection;
 - iii. Mathematics pertaining to the use and measurement of radioactivity;
 - iv. Chemistry of radioactive material for medical use; and
 - v. Radiation biology; and
- b. Work experience, under the supervision of an authorized user who meets the requirements in this Article, NRC, or equivalent Agreement State requirements, involving:
 - i. Ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;
 - ii. Performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;
 - iii. Calculating, measuring, and safely preparing patient or human research subject dosages;
 - iv. Using administrative controls to prevent a medical event involving the use of unsealed radioactive material;
 - v. Using procedures to contain spilled radioactive material safely and using proper decontamination procedures;
 - vi. Administering dosages of radioactive drugs to patients or human research subjects involving a minimum of three cases in each of the following categories for which the individual is requesting authorized user status:
 - (1) Oral administration of less than or equal to 1.22 gigabecquerels (33 millicuries) of sodium iodide I-131, for which a written directive is required (Experience with at least 3 cases in Category (A)(2)(b)(vi)(2) also satisfies this requirement);
 - (2) Oral administration of greater than 1.22 gigabecquerels (33 millicuries) of sodium iodide I-131;
 - (3) Parenteral administration of any beta emitter, or a photon-emitting radionuclide with a photon energy less than 150 keV, for which a written directive is required; and/or
 - (4) Parenteral administration of any other radionuclide, for which a written directive is required; and

c. Has obtained written attestation, signed by a preceptor authorized user who meets the requirements as an authorized user for Exhibit A group 300 nuclides, NRC, or equivalent Agreement State requirements, that the individual has satisfactorily completed the requirements in subsection (A)(1) or (A)(2) and has achieved a level of competency sufficient to function independently as an authorized user for the medical uses authorized under Exhibit A of this Article. The written attestation must be signed by a preceptor authorized user who meets the requirements in this Section, NRC, or equivalent Agreement State requirements. The preceptor authorized user, who meets the requirements in subsection (B) must have experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status.

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- B. ~~Except as provided in R12-1-710, a licensee shall require an authorized user of iodine-131 for the treatment of hyperthyroidism for the oral administration of sodium iodide I-131 requiring a written directive in quantities less than or equal to 1.22 gigabecquerels (33 millicuries) to be a physician who has completed the training requirements in 10 CFR 35.392, January 1, 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments. 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~
- C. ~~Except as provided in R12-1-710, a licensee shall require an authorized user of iodine-131 for the treatment of thyroid carcinoma for the oral administration of sodium iodide I-131 requiring a written directive in quantities greater than 1.22 gigabecquerels (33 millicuries) to be a physician who has completed the training requirements in 10 CFR 35.394, January 1, 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments. 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~
- D. ~~Except as provided in R12-1-710, a licensee shall require an authorized user for the parenteral administration of unsealed radioactive material requiring a written directive to be a physician who has completed the training requirements in 10 CFR 35.396, January 1, 2013, incorporated by reference, and available under R12-1-101. This incorporated material contains no future editions or amendments.~~
- ~~D.E.~~ The training and experience shall have been obtained within the seven years preceding the date of application or the individual shall have had related continuing education and experience since the required training and experience was completed.

R12-1-727. Training for Use of Manual Brachytherapy Sources and Training for the Use of Strontium-90 Sources for Treatment of Ophthalmic Disease

- A. ~~Except as provided in R12-1-710, a licensee shall require an authorized user of a manual brachytherapy source for the uses authorized under Group 400 to be a physician who has completed the training requirements in 10 CFR 35.490, January 1, 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~ the licensee shall require an authorized user of a manual brachytherapy source for the uses authorized under this Article to be a physician who:
1. ~~Is certified by a medical specialty board whose certification process has been recognized by the NRC or an Agreement State and who meets the requirements in subsection (A)(2). To have its certification process recognized, a specialty board shall require all candidates for certification to:~~
 - a. ~~Successfully complete a minimum of 3 years of residency training in a radiation oncology program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Committee on Post-Graduate Training of the American Osteopathic Association; and~~
 - b. ~~Pass an examination, administered by diplomates of the specialty board, that tests knowledge and competence in radiation safety, radionuclide handling, treatment planning, quality assurance, and clinical use of manual brachytherapy; or~~
 2. ~~Has completed a structured educational program in basic radionuclide handling techniques applicable to the use of manual brachytherapy sources that includes:~~
 - a. ~~200 hours of classroom and laboratory training in the following areas:~~
 - i. ~~Radiation physics and instrumentation;~~
 - ii. ~~Radiation protection;~~
 - iii. ~~Mathematics pertaining to the use and measurement of radioactivity;~~
 - iv. ~~Radiation biology; and~~
 - b. ~~500 hours of work experience, under the supervision of an authorized user who meets the requirements in this Section, or equivalent NRC or Agreement State requirements at a medical institution, involving:~~
 - i. ~~Ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;~~
 - ii. ~~Checking survey meters for proper operation;~~
 - iii. ~~Preparing, implanting, and removing brachytherapy sources;~~
 - iv. ~~Maintaining running inventories of material on hand;~~
 - v. ~~Using administrative controls to prevent a medical event involving the use of radioactive material;~~
 - vi. ~~Using emergency procedures to control radioactive material; and~~
 - c. ~~Has completed 3 years of supervised clinical experience in radiation oncology, under an authorized user who meets the requirements in this Section, or equivalent Agreement State requirements, as part of a formal training program approved by the Residency Review Committee for Radiation Oncology of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Committee on~~

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Postdoctoral Training of the American Osteopathic Association. This experience may be obtained concurrently with the supervised work experience required by subsection (A)(2)(b); and

- d. Has obtained written attestation, signed by a preceptor authorized user who meets the requirements in this Section, NRC, or equivalent Agreement State requirements, that the individual has satisfactorily completed the requirements in subsection (A)(1) or (A)(2) and has achieved a level of competency sufficient to function independently as an authorized user of manual brachytherapy sources for the medical uses authorized under Exhibit A of this Article.
- B. Except as provided in R12-1-710, a licensee shall require an authorized user of strontium-90 for ophthalmic radiotherapy to be a physician who has completed the training requirements in 10 CFR 35.491, January 1, ~~2013~~, incorporated by reference, and available under R12-1-101. ~~This incorporated material contains no future editions or amendments. 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~
- C. No change

R12-1-728. Training for Use of Sealed Sources for Diagnosis

- A. Except as provided in R12-1-710, the licensee shall require the authorized user of a diagnostic sealed source for use in a device authorized under Group 500 to be a physician, dentist, or podiatrist who ~~has completed the training requirements in 10 CFR 35.590, January 1, 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~ Is certified by a medical specialty board whose certification process has been recognized by the NRC or an Agreement State and who meets the requirements in subsections (A)(1) and (2); or
 1. Has completed 8 hours of classroom and laboratory training in basic radionuclide handling techniques specifically applicable to the use of the device. The training must include:
 - a. Radiation physics and instrumentation;
 - b. Radiation protection;
 - c. Mathematics pertaining to the use and measurement of radioactivity;
 - d. Radiation biology; and
 2. Has completed training in the use of the device for the uses requested.
- B. No change

R12-1-744. Training for Use of Remote Afterloader Units, Teletherapy Units, and Gamma Stereotactic Radiosurgery Units

- A. Except as provided in R12-1-710, a licensee shall require an authorized user of a sealed source for a use authorized under Group 600 to be a physician who ~~has completed the training requirements in 10 CFR 35.690, January 1, 2006, which is incorporated by reference, published by the Office of the Federal Register, National Archives and Records Administration, Washington, DC 20408, and on file with the Agency. This incorporation by reference contains no future editions or amendments.~~
 1. Is certified by a medical specialty board whose certification process has been recognized by the NRC or an Agreement State and who meets the requirements in subsection (A)(2). To have its certification process recognized, a specialty board shall require all candidates to:
 - a. Successfully complete a minimum of 3 years of residency training in a radiation therapy program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Committee on Post-Graduate Training of the American Osteopathic Association; and
 - b. Pass an examination, administered by diplomates of the specialty board, which tests knowledge and competence in radiation safety, radionuclide handling, treatment planning, quality assurance, and clinical use of stereotactic radiosurgery, remote afterloaders and external beam therapy; or
 2. Has completed a structured educational program in basic radionuclide techniques applicable to the use of a sealed source in a therapeutic medical unit that includes:
 - a. 200 hours of classroom and laboratory training in the following areas:
 - i. Radiation physics and instrumentation;
 - ii. Radiation protection;
 - iii. Mathematics pertaining to the use and measurement of radioactivity;
 - iv. Chemistry of radioactive material for medical use; and
 - v. Radiation biology; and
 - b. 500 hours of work experience, under the supervision of an authorized user who meets the requirements in this Section, or equivalent Agreement State or NRC requirements at a medical institution, involving:
 - i. Reviewing full calibration measurements and periodic spot-checks;

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- ii. Preparing treatment plans and calculating treatment doses and times;
- iii. Using administrative controls to prevent a medical event involving the use of radioactive material;
- iv. Implementing emergency procedures to be followed in the event of the abnormal operation of the medical unit or console;
- v. Checking and using survey meters; and
- vi. Selecting the proper dose and how it is to be administered; and
- c. Has completed 3 years of supervised clinical experience in radiation therapy, under an authorized user who meets the requirements in this Section, or equivalent Agreement State or NRC requirements, as part of a formal training program approved by the Residency Review Committee for Radiation Oncology of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Committee on Postdoctoral Training of the American Osteopathic Association. This experience may be obtained concurrently with the supervised work experience required by subsection (A)(2)(b); and
- d. Has obtained written attestation that the individual has satisfactorily completed the requirements in subsection (A)(1) or (A)(2), and has achieved a level of competency sufficient to function independently as an authorized user of each type of therapeutic medical unit for which the individual is requesting authorized user status. The written attestation must be signed by a preceptor authorized user who meets the requirements in this Section, or equivalent Agreement State or NRC requirements for an authorized user for each type of therapeutic medical unit for which the individual is requesting authorized user status; and.
- e. Has received training in device operation, safety procedures, and clinical use for the type(s) of use for which authorization is sought. This training requirement may be satisfied by satisfactory completion of a training program provided by the vendor for new users or by receiving training supervised by an authorized user or authorized medical physicist, as appropriate, who is authorized for the type(s) of use for which the individual is seeking authorization.

B. No change

Exhibit A. Medical Use Groups

Group 100

Included is the use of any unsealed radioactive material for use in uptake, dilution, or excretion studies and not requiring a written directive: The radioactive material in this group shall be:

1. Obtained from a manufacturer or preparer licensed under R12-1-703(C)(2)(a), or equivalent NRC or Agreement State requirements; or
2. Obtained from a PET radioactive drug producer licensed under R12-1-703 or equivalent NRC or an Agreement State license excluding production of PET radionuclides prepared Prepared by an authorized nuclear pharmacist who meets the requirements in R12-1-712, a physician who is an authorized user and who meets the requirements specified in R12-1-721, or R12-1-723 and R12-1-721(A)(3)(b)(vii), or an individual under the supervision of either as specified in R12-1-706; or
3. ~~And if~~ If a research protocol:
 - a. Obtained from and prepared by an Agreement State or NRC licensee for use in ~~basic~~ research in accordance with a Radioactive Drug Research Committee- approved protocol or an Investigational New Drug (IND) protocol accepted by FDA; or
 - b. Prepared by the licensee for use in ~~basic~~ research in accordance with a Radioactive Drug Research Committee- approved application or an Investigational New Drug (IND) protocol accepted by FDA.

Group 200

Included is the use of any unsealed radioactive material for use in imaging and localization not requiring a written directive. PET radiopharmaceuticals may be used if the licensee meets the requirements in R12-1-716. The radioactive material in this group shall be:

1. Obtained from a manufacturer or preparer licensed under R12-1-703(C)(2)(a), or equivalent NRC or Agreement State requirements; or
2. Obtained from a PET radioactive drug producer licensed under R12-1-703 or equivalent NRC or an Agreement State license excluding production of PET radionuclides prepared Prepared by an authorized nuclear pharmacist who meets the requirements in R12-1-712, a physician who is an authorized user and who meets the requirements specified in R12-1-721 or R12-1-723 and R12-1-721(A)(3)(b)(vii), or an individual under the supervision of either as specified in R12-1-706; or
3. ~~And if~~ If a research protocol:
 - a. Obtained from and prepared by an Agreement State or NRC licensee for use in ~~basic~~ research in accordance with a Radioactive Drug Research Committee- approved application or an Investigational New Drug (IND) protocol accepted by FDA; or
 - b. Prepared by the licensee for use in ~~basic~~ research in accordance with a Radioactive Drug Research Committee- approved application or an Investigational New Drug (IND) protocol accepted by FDA.

Group 300

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Included is the use of any unsealed radioactive material for medical use (radiopharmaceutical) for which a written directive is required. The radioactive material in this group shall be:

1. Obtained from a manufacturer or preparer licensed under R12-1-703(C)(2)(a) or equivalent NRC or Agreement State requirements; or
2. Obtained from a PET radioactive drug producer licensed under R12-1-703 or equivalent NRC or an Agreement State license excluding production of PET radionuclides prepared Prepared by an authorized nuclear pharmacist who meets the requirements in R12-1-712, a physician who is an authorized user and who meets the requirements specified in R12-1-721 or R12-1-723, or an individual under the supervision of either as specified in R12-1-706; or
3. ~~And if~~ If a research protocol:
 - a. Obtained from and prepared by an Agreement State or NRC licensee for use in research in accordance with an Investigational New Drug (IND) protocol accepted by FDA; or
 - b. Prepared by the licensee for use in ~~basic~~ research in accordance with an Investigational New Drug (IND) protocol accepted by FDA.

Group 400 No change

1. No change
2. No change

Group 500 No change

Group 600 No change

1. No change
2. No change

Group 1000

A licensee may use radioactive material or a radiation source approved for medical use which is not specifically addressed in R12-1-309(A)(4) if:

1. The applicant or licensee has submitted the information required by this Article; and
2. The applicant or licensee has received written approval from the Agency in a license or license amendment and uses the material in accordance with the rules and specific conditions the Agency considers necessary for the medical use of the material.

ARTICLE 10. NOTICES, INSTRUCTIONS, AND REPORTS TO IONIZING RADIATION WORKERS; INSPECTIONS

R12-1-1004. Notifications and Reports to Individuals

- A. No change
- B. Each licensee or registrant shall make dose information available to workers as shown in records maintained by the licensee or registrant under the provisions of Article 4. Each licensee or registrant shall provide annual notification of exposure to radiation or radioactive material for each worker, as shown in records maintained by the licensee or registrant under R12-1-419 ~~(E)(D)~~ if:-
 1. The individual's occupational dose exceeds 1 mSv (100 mrem) TEDE or 1 mSv (100 mrem) to any individual organ or tissue; or
 2. The individual requests his or her annual dose report.
- C. No change
- D. No change