

CHAPTER 28
RADIATION PROTECTION PROGRAMS

Authority

N.J.S.A. 26:2D-1 et seq., specifically 26:2D-7,
 26:2D-9, 26:2D-21 and 26:2D-76.

Source and Effective Date

R.2005 d.239, effective June 21, 2005.
 See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

Chapter Expiration Date

Chapter 28, Radiation Protection Programs, expires on June 21, 2010.

Chapter Historical Note

Chapter 28, Bureau of Radiation Protection, was filed and became effective prior to September 1, 1969.

Subchapter 19, Excessive Exposure to Ionizing Radiation, was adopted as R.1972 d.102, effective July 17, 1972. See: 4 N.J.R. 4(c).

Subchapter 25, Radiation Laboratory Fee Schedule, was adopted as R.1978 d.47, effective February 8, 1978. See: 9 N.J.R. 560(a), 10 N.J.R. 101(b).

Subchapter 24, Nuclear Medicine Technology, was adopted as R.1978 d.101, effective March 20, 1978. See: 9 N.J.R. 213(b), 10 N.J.R. 146(c).

Subchapter 21, Analytical X-Ray Installations, was adopted as R.1979 d.64, effective May 1, 1979. See: 10 N.J.R. 321(a), 11 N.J.R. 123(a).

Subchapter 41, Mercury Vapor Lamps, was adopted as R.1981 d.464, effective December 7, 1981. See: 13 N.J.R. 9(b), 13 N.J.R. 887(c).

Subchapter 1, General Provisions, and Subchapter 2, Use of Sources of Radiation and Special Exemptions, were repealed and Subchapter 1, General Provisions, and Subchapter 2, Use of Sources of Ionizing Radiation and Special Exemptions, were adopted as new rules by R.1983 d.592, effective December 19, 1983. See: 15 N.J.R. 391(a), 15 N.J.R. 2160(a).

Subchapter 42, Radio Frequency Radiation, was adopted as R.1984 d.337, effective August 6, 1984. See: 16 N.J.R. 7(a), 16 N.J.R. 2120(a).

Pursuant to Executive Order No. 66(1978), Subchapter 21, Analytical X-Ray Installations, was readopted as R.1984 d.353, effective August 6, 1984. See: 16 N.J.R. 1310(a), 16 N.J.R. 2276(a).

Subchapter 19, Medical Exposure to Ionizing Radiation by Radiologic Technologists, was adopted as R.1984 d.349, effective August 20, 1984. See: 16 N.J.R. 797(a), 16 N.J.R. 2271(a).

Pursuant to Executive Order No. 66(1978), Subchapter 24, Nuclear Medicine Technology, expired February 14, 1985.

Subchapter 24, Nuclear Medicine Technology, was adopted as new rules by R.1985 d.140, effective March 18, 1985. See: 17 N.J.R. 22(a), 17 N.J.R. 699(a).

Pursuant to Executive Order No. 66(1978), Subchapter 12, Transportation, was readopted as R.1985 d.387, effective August 5, 1985. See: 17 N.J.R. 1369(a), 17 N.J.R. 1884(a).

Subchapter 14, Therapeutic Installations, was repealed and Subchapter 14, Therapeutic Installations, was adopted as new rules by R.1987 d.258, effective July 6, 1987. See: 18 N.J.R. 1157(a), 19 N.J.R. 1196(c).

Subchapter 3, Registration: Radiation Protection Fee Schedule, was repealed and Subchapter 3, Registration of Ionizing Radiation-Producing Machines and Radioactive Materials, was adopted as new rules by R.1987 d.485, effective November 16, 1987. See: 19 N.J.R. 836(a), 19 N.J.R. 2167(a).

Subchapter 4, Licensing, was repealed and Subchapter 4, Licensing of Naturally Occurring and Accelerator Produced Radioactive Materials, was adopted as new rules by R.1987 d.483, effective November 16, 1987. See: 19 N.J.R. 1041(a), 19 N.J.R. 2171(a).

Subchapter 5, Controlled Areas, was repealed and Subchapter 5, Controlled Areas, was adopted as new rules by R.1987 d.484, effective November 16, 1987. See: 19 N.J.R. 839(a), 19 N.J.R. 2180(a).

Subchapter 25, Radiation Laboratory Fee Schedule, was repealed and Subchapter 25, Radiation Laboratory Fee Schedule, was adopted as new rules by R.1989 d.349, effective July 3, 1989. See: 21 N.J.R. 826(a), 21 N.J.R. 1904(a).

Pursuant to Executive Order No. 66(1978), Chapter 28, Bureau of Radiation Protection, was readopted as R.1990 d.427, effective July 30, 1990. See: 22 N.J.R. 890(a), 22 N.J.R. 2570(a).

Subchapter 16, Dental Radiographic Installations, was adopted as R.1990 d.538, effective November 5, 1990. See: 22 N.J.R. 894(a), 22 N.J.R. 3367(a).

Subchapter 27, Certification of Radon Testers and Mitigators, was adopted as R.1990 d.559, effective November 19, 1990 (operative January 13, 1991). See: 21 N.J.R. 3369(a), 22 N.J.R. 3516(a).

Subchapter 20, Particle Accelerators for Industrial and Research Use, was adopted as R.1992 d.52, effective February 3, 1992. See: 23 N.J.R. 1401(c), 24 N.J.R. 416(a).

Subchapter 15, Medical Diagnostic X-Ray Installations, was repealed and Subchapter 15, Medical Diagnostic X-Ray Installations, was adopted as new rules by R.1993 d.510, effective October 18, 1993. See: 25 N.J.R. 7(a), 25 N.J.R. 1039(a), 25 N.J.R. 4770(a), 25 N.J.R. 5148(a).

Subchapter 48, Fees for the Registration of Nonionizing Radiation Producing Sources, was adopted as R.1995 d.6, effective January 3, 1995. See: 25 N.J.R. 5422(a), 26 N.J.R. 793(b), 27 N.J.R. 99(a).

Pursuant to Executive Order No. 66(1978), Chapter 28, Bureau of Radiation Protection, was readopted as R.1995 d.457, effective July 28, 1995, and Subchapter 12, Transportation, was repealed by R.1995 d.457, effective August 21, 1995. See: 26 N.J.R. 4942(a), 27 N.J.R. 3157(b).

Pursuant to Executive Order No. 66(1978), Chapter 28, Radiation Protection Programs, was readopted as R.2000 d.120, effective February 25, 2000, and Subchapter 25, Radiation Laboratory Fee Schedule, was repealed by R.2000 d.120, effective March 20, 2000. See: 31 N.J.R. 3007(a), 32 N.J.R. 1016(a).

Subchapter 24, Nuclear Medicine Technology, was repealed and Subchapter 24, Nuclear Medicine Technology, was adopted as new rules by R.2000 d.171, effective April 17, 2000. See: 31 N.J.R. 3012(a), 32 N.J.R. 1388(a).

Subchapter 12, Remediation Standards for Radioactive Materials, was adopted as R.2000 d.314, effective August 7, 2000. See: 31 N.J.R. 1723(a), 32 N.J.R. 2866(a).

Subchapter 22, Quality Assurance Programs for Medical Diagnostic X-ray Installations, was adopted as R.2001 d.37, effective January 16, 2001. See: 32 N.J.R. 1459(a), 33 N.J.R. 292(b).

Chapter 28, Radiation Protection Programs, was readopted as R.2005 d.239, effective June 21, 2005. See: Source and Effective Date. See, also, section annotations.

Subchapter 19, Medical Exposure to Ionizing Radiation by Radiologic Technologists, was repealed and Subchapter 19, Radiologic Technology, was adopted as new rules by R.2008 d.234, effective August 18, 2008. See: 39 N.J.R. 4024(a), 40 N.J.R. 4790(b).

Chapter 28, Radiation Protection Programs, was amended by R.2008 d.281, effective September 15, 2008, operative upon publication of notice in the New Jersey Register by the Department of Environmental Protection that the U.S. Nuclear Regulatory Commission and the State of New Jersey have entered into an Agreement for the State to regulate source, certain special nuclear, and by-product material. See: 40 N.J.R. 2309(a), 40 N.J.R. 5196(b).

CHAPTER TABLE OF CONTENTS

SUBCHAPTER 1. GENERAL PROVISIONS

- 7:28-1.1 Purpose and scope
- 7:28-1.2 Construction
- 7:28-1.3 Practice where rules do not govern
- 7:28-1.4 Definitions
- 7:28-1.5 Communications

SUBCHAPTER 2. USE OF SOURCES OF IONIZING RADIATION AND SPECIAL EXEMPTIONS

- 7:28-2.1 Authorized use of sources of ionizing radiation
- 7:28-2.2 Supervision
- 7:28-2.3 Instruction
- 7:28-2.4 Unattended radiation sources
- 7:28-2.5 Protective devices, systems or mechanisms
- 7:28-2.6 Intentional human irradiation
- 7:28-2.7 Exemptions for prevention or control of diseases
- 7:28-2.8 Special exemptions
- 7:28-2.9 Prohibited use
- 7:28-2.10 Emergency precautions
- 7:28-2.11 Inspections
- 7:28-2.12 Tests

SUBCHAPTER 3. REGISTRATION OF IONIZING RADIATION-PRODUCING MACHINES AND RADIOACTIVE MATERIALS

- 7:28-3.1 Registration for possession of ionizing radiation-producing machines and radioactive by-product material, source material and special nuclear material
- 7:28-3.2 Exemptions from registration for possession of ionizing radiation-producing machines and radioactive by-product material, source material and special nuclear material
- 7:28-3.3 Registration of ionizing radiation-producing machines
- 7:28-3.4 Temporary registration of ionizing radiation-producing machines
- 7:28-3.5 Registration of radioactive by-product material, source material and special nuclear material
- 7:28-3.6 Transfer of registration for possession of radioactive by-product material, source material, special nuclear material and ionizing radiation-producing machines
- 7:28-3.7 Amendments to registration of ionizing radiation-producing machines
- 7:28-3.8 Amendments to registration of radioactive by-product material, source material or special nuclear material
- 7:28-3.9 Sale, installation, relocation or disposal of ionizing radiation-producing machines
- 7:28-3.10 Denial of an application for registration, and suspension, modification, or revocation of registration of ionizing radiation-producing machines, radioactive by-product material, source material or special nuclear material
- 7:28-3.11 Table of radioactive materials and quantities exempt from registration
- 7:28-3.12 Application and annual registration renewal fees for ionizing-radiation-producing machines
- 7:28-3.13 Fees for registration of radioactive by-product material, source material and special nuclear material

SUBCHAPTER 4. LICENSING OF NATURALLY OCCURRING OR ACCELERATOR PRODUCED RADIOACTIVE MATERIALS

- 7:28-4.1 Scope and general provisions
- 7:28-4.2 Recognition of licenses from other jurisdictions
- 7:28-4.3 Exemption from requirement for a State license for manufacture, production, transfer, distribution or arrangement of distribution, sale, lease, receipt, acquisition, ownership, possession or use of all naturally occurring or accelerator produced radioactive materials

- 7:28-4.4 Types of licenses for manufacture, production, transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of all naturally occurring or accelerator produced radioactive materials
- 7:28-4.5 General licenses for the transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of naturally occurring or accelerator produced radioactive materials and certain devices and equipment
- 7:28-4.6 Application for and renewal of specific State licenses for manufacture, transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of naturally occurring or accelerator produced radioactive materials
- 7:28-4.7 General requirements for approval of an application for an initial specific State license or renewal of a specific State license for use of naturally occurring or accelerator produced materials
- 7:28-4.8 Special requirements for approval of an application for an initial specific State license or renewal of a specific State license for use of naturally occurring or accelerator produced radioactive materials
- 7:28-4.9 Terms and conditions of general and specific State licenses
- 7:28-4.10 Expiration of specific State license
- 7:28-4.11 Status of specific State licenses pending renewal
- 7:28-4.12 Amendment of a specific State license at request of licensee
- 7:28-4.13 Records
- 7:28-4.14 Inspections
- 7:28-4.15 Tests
- 7:28-4.16 Modification, revocation, suspension, and termination of general and specific State licenses
- 7:28-4.17 Requests for an adjudicatory hearing
- 7:28-4.18 Requirements governing requests for stay of the effective date of the Department decision for which an adjudicatory hearing is requested
- 7:28-4.19 Specific State license fee schedule for the manufacture, production, transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of naturally occurring or accelerator produced radioactive material
- 7:28-4.20 Confidentiality claims
- 7:28-4.21 Access to information; non-disclosure
- 7:28-4.22 Confidentiality determinations
- 7:28-4.23 Substantive criteria for use in confidentiality determinations
- 7:28-4.24 Disclosure of confidential information to other public agencies
- 7:28-4.25 Disclosure by consent
- 7:28-4.26 Disclosure based on imminent and substantial danger
- 7:28-4.27 Security procedures
- 7:28-4.28 Wrongful access or disclosure; penalties

SUBCHAPTER 5. CONTROLLED AREAS

- 7:28-5.1 Areas which must be controlled
- 7:28-5.2 Limitations on controlled areas
- 7:28-5.3 Precautionary procedures
- 7:28-5.4 Termination of controlled areas

SUBCHAPTER 6. DOSE LIMITS

- 7:28-6.1 Exposure of individuals in controlled areas
- 7:28-6.2 Dose limits for individual members of the public
- 7:28-6.3 Concentrations in effluents from controlled areas
- 7:28-6.4 Exposures in the event of radiation incidents or emergencies
- 7:28-6.5 Average concentrations
- 7:28-6.6 Dose equivalent to an embryo/fetus

RADIATION PROTECTION PROGRAMS

SUBCHAPTER 7. RADIATION SURVEYS AND PERSONNEL MONITORING

- 7:28-7.1 Surveys inside controlled areas
- 7:28-7.2 Surveys outside controlled areas
- 7:28-7.3 Statement in lieu of actual survey
- 7:28-7.4 Use of personnel-monitoring equipment
- 7:28-7.5 Requirements for bio-assays

SUBCHAPTER 8. RECORDS

- 7:28-8.1 Personnel-monitoring records
- 7:28-8.2 Records of surveys
- 7:28-8.3 Records of radioactive materials
- 7:28-8.4 Records of sealed source testing
- 7:28-8.5 Records from discontinued installations

SUBCHAPTER 9. RADIOACTIVE CONTAMINATION CONTROL

- 7:28-9.1 General precautions
- 7:28-9.2 Personnel and material contamination
- 7:28-9.3 Decontamination of premises
- 7:28-9.4 Sealed source testing

SUBCHAPTER 10. LABELING, POSTING, AND CONTROLS

- 7:28-10.1 General requirement
- 7:28-10.2 Radiation areas
- 7:28-10.3 High radiation areas
- 7:28-10.4 Airborne radioactivity areas
- 7:28-10.5 Areas containing radioactive materials
- 7:28-10.6 Labeling of equipment and containers
- 7:28-10.7 Removal of signs and labels
- 7:28-10.8 Exceptions from posting and labeling requirements
- 7:28-10.9 Quantities of radioactive materials that require labeling and posting

SUBCHAPTER 11. DISPOSAL OF RADIOACTIVE MATERIALS

- 7:28-11.1 General requirements
- 7:28-11.2 Disposal by release into sanitary sewer systems
- 7:28-11.3 Disposal by discharges into the air, ground waters or surface waters
- 7:28-11.4 Disposal by burial in the soil
- 7:28-11.5 Disposal by transfer to a radioisotope disposal service
- 7:28-11.6 Disposal by incineration
- 7:28-11.7 Disposal by a specially approved method
- 7:28-11.8 Unauthorized removal

APPENDIX

SUBCHAPTER 12. REMEDIATION STANDARDS FOR RADIOACTIVE MATERIALS

- 7:28-12.1 Purpose and scope
- 7:28-12.2 Applicability
- 7:28-12.3 Definitions
- 7:28-12.4 General requirements
- 7:28-12.5 Sampling, surveying and laboratory requirements
- 7:28-12.6 Remedial action selection
- 7:28-12.7 Remedial action requirements
- 7:28-12.8 Radiation dose standards applicable to remediation of radioactive contamination of all real property
- 7:28-12.9 Minimum remediation standards for radionuclide contamination of soil
- 7:28-12.10 Petition for alternative remediation standards for radioactive contamination
- 7:28-12.11 Requirements pertaining to engineering or institutional controls
- 7:28-12.12 Requirements pertaining to a change in land use
- 7:28-12.13 Requirements pertaining to the final status survey

APPENDIX A

APPENDIX B

SUBCHAPTER 13. REPORTS OF THEFTS AND RADIATION INCIDENTS

- 7:28-13.1 Reports of theft or loss
- 7:28-13.2 Reportable radiation incidents

SUBCHAPTER 14. THERAPEUTIC INSTALLATIONS

- 7:28-14.1 Scope
- 7:28-14.2 Definitions
- 7:28-14.3 Therapeutic x-ray systems with energies less than one MeV
- 7:28-14.4 Therapeutic x-ray and therapeutic accelerator installations with energies of one MeV and above

SUBCHAPTER 15. MEDICAL DIAGNOSTIC X-RAY INSTALLATIONS

- 7:28-15.1 Scope
- 7:28-15.2 Definitions
- 7:28-15.3 General requirements for radiographic installations
- 7:28-15.4 Mammography radiographic installations
- 7:28-15.5 Medical fluoroscopic x-ray systems
- 7:28-15.6 Radiation therapy simulators
- 7:28-15.7 Computed tomography equipment
- 7:28-15.8 Medical cabinet x-ray systems
- 7:28-15.9 Individual radiation safety
- 7:28-15.10 Structural shielding and radiation safety surveys
- 7:28-15.11 Prohibited installations
- 7:28-15.12 X-ray bone densitometer equipment
- 7:28-15.13 Severability

SUBCHAPTER 16. DENTAL RADIOGRAPHIC INSTALLATIONS

- 7:28-16.1 Scope
- 7:28-16.2 Definitions
- 7:28-16.3 Dental radiographic equipment
- 7:28-16.4 Multiple dental radiographic tube installations
- 7:28-16.5 Cephalometric radiographic installations
- 7:28-16.6 Panoramic radiographic installations
- 7:28-16.7 Structural shielding
- 7:28-16.8 Radiation safety surveys
- 7:28-16.9 Operating criteria
- 7:28-16.10 Operating procedures

SUBCHAPTER 17. INDUSTRIAL AND NONMEDICAL RADIOGRAPHY

- 7:28-17.1 Scope
- 7:28-17.2 Definitions
- 7:28-17.3 Registration and licensing requirements
- 7:28-17.4 Equipment control
- 7:28-17.5 Personal radiation safety requirements for radiographers
- 7:28-17.6 Precautionary procedures in radiographic operations
- 7:28-17.7 Cabinet x-rays systems
- 7:28-17.8 Shielded room radiography

SUBCHAPTER 18. MAJOR NUCLEAR FACILITIES

- 7:28-18.1 Scope
- 7:28-18.2 Facility description and required monitoring program
- 7:28-18.3 Operation
- 7:28-18.4 Emergency plans
- 7:28-18.5 Radiation incidents

SUBCHAPTER 19. RADIOLOGIC TECHNOLOGY

- 7:28-19.1 Purpose, scope and applicability
- 7:28-19.2 Definitions

- 7:28-19.3 General provisions
- 7:28-19.4 Scopes of practice
- 7:28-19.5 Unethical conduct
- 7:28-19.6 Requirements of applicants for the licensing examination
- 7:28-19.7 Requirements of applicants for licensure
- 7:28-19.8 Temporary, conditional and restricted licenses
- 7:28-19.9 License expiration, reissuance and renewal
- 7:28-19.10 Fees
- 7:28-19.11 Minimum requirements for admission to a school of radiologic technology
- 7:28-19.12 Requirements for students engaging in the scope of practice of radiologic technology
- 7:28-19.13 Requirements for schools of radiologic technology
- 7:28-19.14 School of radiologic technology: process for approval; provisional approval; probationary approval; termination of approval and other general provisions
- 7:28-19.15 List of approved schools
- 7:28-19.16 Radiologist assistants – schools and practice
- 7:28-19.17 Procedures for requesting and conducting adjudicatory hearings
- 7:28-19.18 Severability

SUBCHAPTER 20. PARTICLE ACCELERATORS FOR INDUSTRIAL AND RESEARCH USE

- 7:28-20.1 Scope
- 7:28-20.2 Definitions
- 7:28-20.3 Registration requirements
- 7:28-20.4 General requirements for a particle accelerator facility
- 7:28-20.5 Use of particle accelerators on humans
- 7:28-20.6 Training program on the safe use of each particle accelerator
- 7:28-20.7 Shielding design and radiation area survey requirements for a particle accelerator
- 7:28-20.8 Particle accelerator controls and interlock systems
- 7:28-20.9 Warning devices
- 7:28-20.10 Operating procedures
- 7:28-20.11 Radiation area and personnel monitoring requirements
- 7:28-20.12 Ventilation systems
- 7:28-20.13 Electron microscopes

SUBCHAPTER 21. ANALYTICAL X-RAY INSTALLATIONS

- 7:28-21.1 Scope
- 7:28-21.2 Definitions
- 7:28-21.3 General equipment requirements
- 7:28-21.4 Additional equipment requirements for open beam x-ray systems
- 7:28-21.5 Additional equipment requirements for enclosed beam X-ray systems
- 7:28-21.6 Operating procedures
- 7:28-21.7 Analytical x-ray equipment with a high voltage supply that cannot operate at potentials above 16 kilovolts

SUBCHAPTER 22. QUALITY ASSURANCE PROGRAMS FOR MEDICAL DIAGNOSTIC X-RAY INSTALLATIONS

- 7:28-22.1 Purpose, scope and applicability
- 7:28-22.2 Definitions
- 7:28-22.3 General provisions
- 7:28-22.4 Quality assurance program manual
- 7:28-22.5 Quality assurance program for medical diagnostic radiographic equipment
- 7:28-22.6 Quality assurance program for medical diagnostic fluoroscopic equipment
- 7:28-22.7 Quality assurance program for diagnostic computed tomography equipment
- 7:28-22.8 Medical Physicist's Radiographic QC Survey
- 7:28-22.9 Medical Physicist's Fluoroscopic QC Survey
- 7:28-22.10 Medical Physicist's Computed Tomography QC Survey
- 7:28-22.11 Quality assurance for x-ray bone densitometer equipment

- 7:28-22.12 Qualifications of medical physicists and medical physicist assistants
- 7:28-22.13 Certification and decertification of qualified medical physicists and qualified medical physicist assistants
- 7:28-22.14 Compliance schedule
- 7:28-22.15 Severability

SUBCHAPTER 23. (RESERVED)

SUBCHAPTER 24. NUCLEAR MEDICINE TECHNOLOGY

- 7:28-24.1 Purpose, scope and applicability
- 7:28-24.2 Definitions
- 7:28-24.3 General provisions
- 7:28-24.4 Examination for licensure of nuclear medicine technologists
- 7:28-24.5 Nuclear medicine technologist licenses
- 7:28-24.6 Temporary, conditional and restricted licenses
- 7:28-24.7 License expiration and license renewal
- 7:28-24.8 Fees
- 7:28-24.9 Examination application or license application denial, license revocation and suspension
- 7:28-24.10 School of nuclear medicine technology: standards for approval
- 7:28-24.11 School of nuclear medicine technology: process for approval; provisional approval; probationary approval; withdraw of approval and other general provisions
- 7:28-24.12 List of approved schools

SUBCHAPTERS 25 THROUGH 26. (RESERVED)

SUBCHAPTER 27. CERTIFICATION OF RADON TESTERS AND MITIGATORS

- 7:28-27.1 Scope
- 7:28-27.2 Definitions
- 7:28-27.3 General provisions
- 7:28-27.4 Signatories
- 7:28-27.5 Certification requirements for radon measurement business
- 7:28-27.6 Application requirements for a radon measurement business
- 7:28-27.7 Certification requirements for a radon mitigation business
- 7:28-27.8 Application requirements for radon mitigation business
- 7:28-27.9 Certification requirements for radon measurement specialists
- 7:28-27.10 Application requirements for radon measurement specialists
- 7:28-27.11 Provisional certification of radon measurement specialists
- 7:28-27.12 Certification requirements for radon measurement technicians
- 7:28-27.13 Application requirements for radon measurement technician
- 7:28-27.14 Provisional certification of radon measurement technician
- 7:28-27.15 Certification requirements for radon mitigation specialists
- 7:28-27.16 Application requirements for radon mitigation specialists
- 7:28-27.17 Provisional certification of radon mitigation specialists
- 7:28-27.18 Certification requirements for radon mitigation technicians
- 7:28-27.19 Application requirements for radon mitigation technicians
- 7:28-27.20 Provisional certification of radon mitigation technicians
- 7:28-27.21 Recordkeeping requirements for a certified radon measurement business or a certified radon mitigation business
- 7:28-27.22 Renewal of certification
- 7:28-27.23 Reciprocity
- 7:28-27.24 Inspections

RADIATION PROTECTION PROGRAMS

- 7:28-27.25 Denial, suspension, or revocation of a certification
- 7:28-27.26 Criminal penalties
- 7:28-27.27 Request for adjudicatory hearing
- 7:28-27.28 Reporting requirements
- 7:28-27.29 Liability of certified radon measurement or radon mitigation business for actions of employees
- 7:28-27.30 Fees
- 7:28-27.31 Exemptions
- 7:28-27.32 Examinations
- 7:28-27.33 Elements of quality assurance plans
- 7:28-27.34 Minimum requirements for radiological safety plans
- 7:28-27.35 Temporary certification

SUBCHAPTERS 28 THROUGH 40. (RESERVED)

SUBCHAPTER 41. MERCURY VAPOR LAMPS

- 7:28-41.1 Purpose and scope
- 7:28-41.2 Definitions
- 7:28-41.3 General requirements for indoor installations
- 7:28-41.4 General requirements for outdoor installations

SUBCHAPTER 42. RADIO FREQUENCY RADIATION

- 7:28-42.1 Scope
- 7:28-42.2 Purpose
- 7:28-42.3 Radio Frequency Protection Guides (RFPG)
- 7:28-42.4 Radio Frequency Protection Guides (RFPG) for whole body exposure

SUBCHAPTERS 43 THROUGH 47. (RESERVED)

SUBCHAPTER 48. FEES FOR THE REGISTRATION OF
NONIONIZING RADIATION PRODUCING
SOURCES

- 7:28-48.1 Scope, purpose and general provisions
 7:28-48.2 Definitions
 7:28-48.3 Registration of a nonionizing radiation producing source
 7:28-48.4 Amendments to the registration of a nonionizing radiation producing source
 7:28-48.5 Radiation Assessment Document
 7:28-48.6 Amendments to Radiation Assessment Documents
 7:28-48.7 Initial registration fee and annual renewal fee for nonionizing radiation-producing sources
 7:28-48.8 Sale of a nonionizing radiation producing source or transfer of a controlling interest; termination of registration upon sale of nonionizing radiation producing source or upon transfer of controlling interest
 7:28-48.9 Disposal of a nonionizing radiation producing source
 7:28-48.10 Exemption from registration and payment of initial registration fee and annual renewal fee

SUBCHAPTER 1. GENERAL PROVISIONS

7:28-1.1 Purpose and scope

(a) The purpose of this chapter is to prohibit and prevent the use or presence of unnecessary radiation in such manner as to be, or tend to be, injurious or dangerous to the health of the people or the industrial or agriculture potentials of the State, or to the ecology of the State and its wildlife.

(b) Unless otherwise provided by statute, or codes, rules or regulations promulgated by the Commission on Radiation Protection, this chapter shall constitute the rules of the Department of Environmental Protection, and shall govern all persons installing, using, handling, transporting or storing sources of radiation.

Amended by R.2000 d.120, effective March 20, 2000.
 See: 31 N.J.R. 3007(a), 32 N.J.R. 1016(a).

In (b), substituted a reference to the Radiation Protection Programs for a reference to the Bureau of Radiation Protection.
 Amended by R.2005 d.239, effective July 18, 2005.
 See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

Deleted a reference to Radiation Protection Programs.

7:28-1.2 Construction

These rules shall be liberally construed to permit the Department and its various agencies to discharge their statutory functions.

Amended by R.2000 d.120, effective March 20, 2000.
 See: 31 N.J.R. 3007(a), 32 N.J.R. 1016(a).

Substituted a reference to the Radiation Protection Programs for a reference to the Bureau of Radiation Protection.
 Amended by R.2005 d.239, effective July 18, 2005.
 See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

Deleted a reference to Radiation Protection Programs.

7:28-1.3 Practice where rules do not govern

The Commission may rescind, amend or expand these rules from time to time, in accordance with N.J.S.A. 26:2D-7, Chapter 116, Public Laws of 1958, as amended.

7:28-1.4 Definitions

The following words and terms, when used in this chapter, shall have the following meanings unless the context clearly indicates otherwise. Additional words and terms, applicable to a specific subchapter only, will be found in that subchapter.

(a) General Terms:

“Absorbed dose” means the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest. The special unit for absorbed dose is the rad. (See “Rad” under (b) below.)

“Act” means the New Jersey Radiation Protection Act, Chapter 116, Public Laws of New Jersey 1958, as amended, cited as N.J.S.A. 26:2D-1 et seq.

“Agreement state” means any state with which the United States Nuclear Regulatory Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, as amended.

“ALARA” means “as low as is reasonably achievable”, taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of radiation in the public interest.

“Area” means a bounded space such as a room, floor, building, plant or any designated geographical entity having physical or imaginary boundaries.

“Average dose rate” means an integrated or accumulated dose of radiation divided by the time over which the integration or accumulation took place or by a specified length of time.

“Background radiation” means radiation from cosmic sources; naturally occurring radioactive material, including radon (except as a decay product of source, special nuclear material, or technologically enhanced naturally occurring radioactive material); and global fallout as it exists in the environment from the testing of nuclear explosive devices or from past nuclear accidents such as Chernobyl that contribute to background radiation and are not under the control of the State licensee or licensee. “Background radiation” does not include radiation from source, byproduct, or special nuclear materials regulated by the U.S. Nuclear Regulatory Commission or from naturally occurring or accelerator produced radioactive materials regulated by the State.

"Calendar quarter" means not less than 12 consecutive weeks nor more than 14 consecutive weeks. The first calendar quarter of each year shall begin in January and subsequent calendar quarters shall be so arranged that no day in any year is omitted from inclusion within a calendar quarter. For purposes of this chapter, no State licensee, licensee, radioactive materials registrant or registrant shall change the method observed by him of determining calendar quarters except at the beginning of a calendar year.

"Commission" means the New Jersey Commission on Radiation Protection.

"Controlled area" means any area to which the access, occupancy and activity of those within are subject to control and supervision for the purpose of radiation protection.

"Dead-man switch" means a switch which can be kept closed only when the operator applies continuous pressure.

"Department" means the New Jersey Department of Environmental Protection.

"Dose equivalent" means a numerical quantity that expresses on a common scale for all ionizing radiation, a measure of the postulated effect on a given organ. It is defined as the absorbed dose in rads times certain modifying factors. The unit of dose is the Rem. (See "Rem" under (b) below).

"Dose rate" means dose per unit time.

"Emergency exposure" means an exposure to radiation of an emergency worker during rescue or other emergency operations.

"Emergency worker" means a member of the owner's staff or of a public voluntary or governmental agency engaged in safety or other emergency operations.

"Exemption" means the administrative relief from the requirements of a substantive rule.

"Healing art" means the practice of any branch of medicine or surgery, any method of diagnosis of human ailment, disease, pain, injury, deformity, mental or physical condition.

"Inspection" means an official examination or observation including but not limited to tests, surveys, and monitoring to determine compliance with rules, regulations, orders, requirements and conditions of the Department.

"Installation" means a radiation source, with its associated equipment, and the area in which it is housed.

"Instructed individual" means an individual who has received appropriate instructions as to the safe means and methods of performing work with or near radiation sources.

"Ionizing radiation" means any form of radiation which has the capability of ionizing the medium through which it is passing.

"Maximum permissible dose" means the maximum dose to which the body or a particular part of the body of a person shall be permitted to be exposed continuously or intermittently in a stated period of time.

"Nonionizing radiation" means any form of radiation which does not have the capability of ionizing the medium through which it is passing.

"Occupational dose" means the dose received by an individual in the course of employment in which the individual's assigned duties involve exposure to radiation from a machine source or to radioactive material from State licensed and unlicensed sources of radiation, whether in the possession of the State licensee, licensee or other person. Occupational dose does not include dose received from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with Federal regulations found in Title 10 Code of Federal Regulations, Part 35, section 75, or as a member of the public.

"Owner" means a person who has title to a radiation source or who possesses a radiation source as a lessee, bailee or pursuant to the terms of a license issued by the Department, by a Federal agency, or by any other state.

"Person" includes an individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, municipality, any state, or other legal entity; and any legal successor, representative agent, or agency of the foregoing.

"Personnel-monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received; for example, film badges, pocket chambers, pocket dosimeters, and thermoluminescent dosimeters.

"Qualified individual" means an individual suited by training and experience to perform dependable radiation surveys and to determine the degree of radiation hazard.

"Radiation" includes any or all of the following: electromagnetic radiation including radiofrequency, microwave, infrared, visible, ultraviolet, x-ray, or gamma ray; sonic, infrasonic, or ultrasonic waves; and particle radiation including alphas, betas, high energy electrons, neutrons, protons, and other atomic or nuclear particles.

"Radiation area" means an area which is accessible to a worker and in which there exists ionizing radiation at such levels that a major portion of the body would receive in any one hour a dose equivalent in excess of five millirems or in any workweek a dose equivalent in excess of 100 millirems; or levels of nonionizing radiation which exceed the maximum permissible levels of such radiation as specified in the rules and standards established by the Commission.

“Research and development” means theoretical analysis, exploration, or experimentation; or the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental production and testing of models, devices, equipment, materials and processes. “Research and development” does not include the internal or external administration of radioactive material, or of radiation, to human beings.

“Shielding” means any material introduced into the path of radiation to reduce the radiation level.

“Source of radiation” means a material, equipment or machine emitting or capable of emitting radiation.

“State” means the State of New Jersey.

“State license” means a license issued by the Department. See also “License” under (b) below.

“State licensee” means a person who is required to obtain a license from the Department pursuant to this chapter.

“Survey” means evaluation for a specific set of conditions or actual or potential radiation or contamination levels by or under the supervision of a qualified individual.

“Unnecessary radiation” means the use of nonionizing or ionizing radiation in such a manner as to be, or tend to be, injurious or dangerous to the health of the people or the industrial or agricultural potentials of the State, as defined in the Radiation Protection Act.

“User” means any individual who personally utilizes or manipulates a source of radiation.

(b) Ionizing radiation terms:

“Adult” means an individual 18 or more years of age.

“Airborne-radioactivity area” means an area accessible to workers, in which airborne radioactive materials are present in concentrations such that the values at any time are in excess of the respective values stated in N.J.A.C. 7:28-6.5(a) (Average concentrations) Column B, or prorated values if more than one isotope is present; or values if averaged over the hours of occupancy in any week are in excess of 25 percent of the respective foregoing values.

“Beam-monitoring device” means a device in the useful beam to indicate the relative output of a radiation-producing machine.

“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.

“Collective dose” means the sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation.

“Committed dose equivalent” ($H_{T,50}$) means the dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

“Committed effective dose equivalent” ($H_{E,50}$) means the sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \sum w_T H_{T,50}$).

“Contamination” means radioactive contamination.

“Curie” means that amount of a specific radionuclide which disintegrates at the rate of 37 billion atoms per second.

i. The new International System of Units replaces “curie” with the “becquerel”, which means that amount of a specific radionuclide which disintegrates at the rate

of one atom per second. One curie equals 3.7×10^{10} becquerel.

“Declared pregnant woman” means a woman who has voluntarily informed the State licensee, radioactive materials registrant or registrant, in writing, of her pregnancy and the estimated date of conception. The declaration remains in effect until the declared pregnant woman withdraws the declaration in writing, or is no longer pregnant.

“Deep-dose equivalent” (H_d), which applies to external whole-body exposure, means the dose equivalent at a tissue depth of one cm ($1,000 \text{ mg/cm}^2$).

“Diagnostic-type protective tube housing” means x-ray tube housing so constructed that the leakage radiation at a distance of one meter from the target cannot exceed 100 milliroentgen in one hour when the tube is operated at any of its specified ratings.

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

“Effective dose equivalent” (H_E) means the sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighting factors (w_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum w_T H_T$).

“High radiation area” means an area which is accessible to workers and in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirem.

“Human use” means the deliberate internal and external administration of radiation or radioactive material to human beings.

“Ionizing radiation-producing machine” means a machine or device capable of generating radiation, such as x-ray producing machines, particle accelerators, high-voltage rectifiers, high-voltage projection equipment, electron microscopes and other types of high-voltage machines.

“Leakage radiation” means all radiation coming from within an ionizing radiation-producing machine except the useful beam.

“License”, except where otherwise specified, means a license issued by the United States Nuclear Regulatory Commission or any state for possession and use of radioactive material. See also “State license” under (a) above.

“Licensee” means a person who is required to obtain a license from the U.S. Nuclear Regulatory Commission or any state other than New Jersey.

“Medical radiographer” means any individual who, under the supervision of a licensed practitioner, uses medical radiographic equipment on human beings for diagnostic or therapeutic purposes.

“Member of the public” means any individual except when that individual is receiving an occupational dose.

“Minor” means an individual less than 18 years of age.

“Monitoring” means a periodic or continuous determination of ionizing radiation levels or of radioactive contamination.

“NARM” means any naturally occurring or accelerator produced radioactive material.

“NORM” means any naturally occurring radioactive material.

“Protective barrier” means a barrier of radiation-absorbing material used to reduce radiation exposure. The types of protective barriers are as follows:

1. “Primary protective barrier” means the material, excluding filters, intercepting the useful beam for protection purposes to reduce the radiation exposure so that it does not exceed two millirems per hour;
2. “Secondary protective barrier” means a barrier sufficient to attenuate the stray radiation to reduce radiation exposure so that it does not exceed two millirems per hour.

“Public dose” means the dose received by a member of the public from exposure to radiation from a machine source or to radioactive material released by a State licensee, or to any other source of radiation under the control of a licensee. Public dose does not include occupational dose or doses received from background radiation, from any medical administration the patient has received, or from exposure to individuals administered radioactive material and released in accordance with Federal regulations found in 10 CFR 35, section 75.

“Rad” means the dose corresponding to the absorption of 100 ergs per gram: a measure of the dose of any radiation to body tissues in terms of the energy absorbed per unit mass of the tissue.

- i. The new International System of Units replaces the “rad” with the “gray”, which means the dose corresponding to the absorption of one joule per kilogram. One rad equals 1×10^{-2} gray.

“Radioactive material” means a natural or artificially produced substance, solid, liquid or gas which emits ionizing radiation spontaneously.

“Radioactive materials registrant” means a person who is required to register radioactive by-product material, source material or special nuclear material with the Department pursuant to this chapter.

“Radiographer” means any individual who is in attendance at a site where ionizing radiation sources are being used and who uses or supervises their use in industrial radiographic operations and who is responsible to the owner for assuring compliance with the requirements of this chapter.

“Radiographer’s assistant” means any individual who, under the personal supervision of a radiographer, uses sources of ionizing radiation including ionizing radiation-producing machines, radiographic-exposure devices, sealed sources or related handling tools, or survey instruments in industrial radiography.

“Radiographic-exposure device” means any instrument containing a sealed source fastened or contained therein which the sealed source or shielding thereof may be moved or otherwise changed from a shielded to unshielded position for purposes of making a radiographic exposure.

“Radiography” means the examination of humans or animals, or of the structure of materials by non-destructive methods, utilizing sealed sources or ionizing radiation-producing machines. This term is not intended to apply to techniques such as electron microscopy or x-ray diffraction.

“Reference man” means a hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. These characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

“Registrant” means a person who is required to register a machine source of radiation with the Department pursuant to this chapter.

“Rem” means a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one rad of x-rays. For the purpose of this chapter, any of the following are considered to be equivalent to a dose of one rem:

- i. A dose of one rad due to x, gamma, or beta radiation;
- ii. A dose of 0.1 rad due to neutrons or high-energy protons;
- iii. A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye.

(1) The new International System of Units replaces the "rem" with the "sievert", which means a measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of one gray of x-rays. One rem equals 1×10^{-2} sievert.

(2) If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in ii above, one rem of neutron radiation may, for purposes of this chapter, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

Neutron energy (MeV)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutron/cm ²)	Average flu.: to deliver 100 millirem in 40 hours (neutrons/cm ² per sec.)
Thermal	970×10^6	670
0.001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10	24×10^6	17
10 to 30	14×10^6	10

"Residual" means a solid waste that consists of the accumulated solids and associated liquids which are by-products of a physical, chemical, biological, or mechanical process or any other process designed to treat wastewater or any other discharges subject to regulation under the New Jersey Water Pollution Control Act, N.J.S.A. 58:10A-1 et seq., as amended. For purposes of this chapter, residual includes, but is not limited to, marketable residual product, sludge and sewage sludge. Residual excludes screened vegetative waste and grit and screenings. The terms used in this definition shall have the same meaning as those in N.J.A.C. 7:14A-1.2.

"Roentgen" means the quantity of x or gamma radiation such that the associated corpuscular emission per .001293 grams of air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign.

"Sanitary sewer system" means any device or system used in the storage and treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature which is owned by a State or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a sanitary sewer system providing treatment. A synonym for sanitary sewer system is publicly owned treatment works (POTW).

"Sealed source" means a radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

"Secondary protective barrier" means a barrier intended to attenuate ionizing radiation (other than the useful beam) to the required degree.

"Shielded position" means the location within the radiographic-exposure device or storage container which by manufacturer's design, is the proper location for storage of the sealed source.

"Source material" means uranium or thorium, or any combination thereof, in any physical or chemical form, or ores which contain by weight $\frac{1}{20}$ of one percent (0.05 percent) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material.

"Special nuclear material in quantities not sufficient to form a critical mass" means uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; U-233 in quantities not exceeding 200 grams; plutonium (Pu) in quantities not exceeding 200 grams; or any combination of them in accordance with the following formula: for each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all the kinds of special nuclear material in combination shall not exceed "1", that is, unity as illustrated in the following example:

175 grams Contained	50 grams	50 grams	
U-235 350	+ U-233 200	+ Pu 200	= 1

"Stochastic effects" means health effects that occur randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be linear function of dose without threshold. Hereditary effects and cancer incidence are examples of stochastic effects.

"Storage container" means a device in which radioactive materials or sources are transported or stored.

"Technologically enhanced naturally occurring radioactive materials" or "TENORM" means any naturally occurring radioactive materials whose radionuclide concentrations or potential for human exposure have been increased by any human activities.

"Total effective dose equivalent" (TEDE) means the sum of the deep-dose equivalent (for external exposures) and the

committed effective dose equivalent (for internal exposures).

"Total filtration" means the filtration produced by all materials inserted in the useful beam including the materials comprising the tube and its housing, any measured devices in the beam which act as a filter, and any material purposely placed in the beam as filters.

"Unrefined and unprocessed ore" means ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

"Unrestricted area" means an area, access to which is neither limited nor controlled by the State licensee or registrant.

"Useful beam" means that part of the radiation beam which passes through the window, aperture cone or other collimating device of the tube housing.

"Very high radiation area" means an area, accessible to individuals, in which radiation levels from radiation sources external to the body could result in an individual receiving an absorbed dose in excess of 500 rads (five grays) in one hour at one meter from a radiation source or one meter from any surface that the radiation penetrates. Note that at very high doses received at high dose rates, units of absorbed dose (for example, rads and grays) are appropriate, rather than units of dose equivalent (for example, rems and sieverts).

"Water treatment facility" means an entity that applies a treatment device to drinking water for the purpose of reducing contaminants. The entity may be a community water system or non-community water system as defined by the EPA in 40 CFR 141.

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

Organ Dose Weighting Factors

Organ or Tissue	w_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone surfaces	0.03
Remainder	0.30 ^a
Whole Body	1.00 ^b

^a 0.30 results from 0.06 for each of 5 "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

^b For the purpose of weighting the external whole body dose (for adding it to the internal dose), a single weighting factor, $w_T = 1.0$, has been specified.

"X-ray tube" means an electron tube which is designed for the conversion of electrical energy into x-ray energy.

(c) Non-ionizing radiation terms:

"Electric field strength" means a field vector quantity that represents the force on an infinitesimal unit positive test charge at a point divided by that charge. The electric field strength is expressed in units of volts per meter (V/m).

"Far field" means a region associated with a radiating source or structure in which the field per unit solid angle is constant. In this region, the field has a predominantly plane wave character, that is, locally very uniform distributions of electric field strength and magnetic field strength in planes perpendicular to the direction of propagation. Generally, the far field region begins several wavelengths distant from the source.

"Fixed radio frequency device" means a device operating at a specific location for a period of 30 days or more.

"Magnetic field strength" means a field vector that is equal to the product of the magnetic flux density and the reciprocal of the permeability. Magnetic field strength is expressed in units of amperes per meter (A/m).

"Microwave oven" means an oven which is designed to heat, cook or dry food through the applications of radio frequency electromagnetic energy, and which is designed to operate at a frequency of 916 MHz or 2.45 GHz.

"Near field" means a region near a radiating source or structure in which the electric and magnetic fields do not have a substantially plane wave character, but vary considerably from point to point. The extent of the near field is only vaguely defined and depends on several factors the most important of which is the size of the radiating structure with respect to the wavelength of the emitted electromagnetic energy. In general, this distance extends to at least five wavelengths from the radiating device.

"Power density" means the rate of energy transported into a small sphere divided by the cross-sectional area of that sphere. Power density is expressed in units of watts per meter squared (W/m^2), or for convenience milliwatts per centimeter squared (mW/cm^2).

"Power density, plane wave equivalent" means a quantity that is associated with any electromagnetic wave that is equal in magnitude to the power density of a plane wave that has the same electric or magnetic field strength.

“Radiating device” means the antenna, leakage port, or any other part of a device that emits radio frequency electromagnetic energy.

“Radio frequency” means the frequency range of 300 kilohertz (kHz) to 100 gigahertz (GHz).

“Radio frequency device” means any stationary device, machine, equipment or installation which is capable of generating a radio frequency electromagnetic field. This does not include devices which are marketed as consumer products, including, but not limited to citizens band radios, remote controlled toys, remote controlled garage door openers, mobile radio transmitter under authorization of the Federal Communications Commission or any other device specifically exempted by the Commission on Radiation Protection as not presenting a potential hazard or harm to a worker or the public.

“Radio frequency protection guide (RFPG)” means the mean squared electric field strength, the mean squared magnetic field strength, and the equivalent plane wave power density which shall not be exceeded. The RFPG is an upper limit of exposure. Exposure to levels slightly in excess of the RFPG is not harmful, however, such exposure is not desirable. In all cases the exposure shall be reduced to values that are as low as reasonably achievable.

“Specific absorption rate (SAR)” means the time derivative of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ).

$$\text{SAR} = \frac{dW}{dt \, dm} \quad \frac{dW}{dt \, \rho dV}$$

The specific absorption rate is expressed in units of watts per kilogram (W/kg). In view of the proliferation of terms for describing the electromagnetic radiation conditions in biological materials and the discipline oriented interpretation of these terms, it is recommended that the name “specific absorption rate” be used for the quantity defined here, rather than such a name as “absorbed power density per unit mass”.

Amended by R.1984 d.337, effective August 6, 1984.
See: 16 N.J.R. 7(a), 16 N.J.R. 2120(a).

“Fixed radio frequency device” added.
Amended by R.1985 d.502, effective October 7, 1985.
See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

Added definitions “shielded position” and “x-ray tube” in (b).
Amended by R.1992 d.52, effective February 3, 1992.
See: 23 N.J.R. 1401(c), 24 N.J.R. 416(a).

Added definitions “registrant” and “protective barrier”; deleted old definitions for “primary and secondary barriers” and replaced with new definitions.

Administrative Correction.
See: 25 N.J.R. 5665(a).

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote the section.

Authority

N.J.S.A. 13:1D-1 et seq., and specifically N.J.S.A. 26:2D-1 et seq.

7:28-1.5 Communications

(a) Communications concerning this chapter, or matters relating to radiation protection, may be addressed to the New Jersey Department of Environmental Protection, Radiation Protection and Release Prevention Element, PO Box 415, Trenton, New Jersey 08625-0415. The physical location of the office is 25 Arctic Parkway, Ewing, New Jersey 08638.

(b) All emergency notification of incidents involving sources of radiation in this State shall be immediately reported to either one of the following agencies:

1. Radiation Protection and Release Prevention Element
New Jersey Department of Environmental Protection
25 Arctic Parkway
Ewing, NJ 08638
Telephone: (609) 984-5462
Hours: 8:00 A.M. to 5:00 P.M. daily, except Saturday, Sunday, and Holidays
After hours and weekends: (609) 292-7172 or toll free: 1 (877) 927-6337 (1 (877) WARN-DEP)
2. Communications Officer
New Jersey State Police Office of Emergency Management
West Trenton, NJ 08628
Telephone: 609-882-2000
Hours: 24 hours, seven days.

Amended by R.2000 d.120, effective March 20, 2000.
See: 31 N.J.R. 3007(a), 32 N.J.R. 1016(a).

Rewrote the section.

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

Rewrote the section.

SUBCHAPTER 2. USE OF SOURCES OF IONIZING RADIATION AND SPECIAL EXEMPTIONS

7:28-2.1 Authorized use of sources of ionizing radiation

(a) No person shall manufacture, use, operate, receive, possess, dispose, transfer, distribute or arrange for the distribution, sell, lease, install, transport or store sources of ionizing radiation in a manner other than prescribed in this chapter.

(b) No person shall cause, suffer, allow or permit any person to manufacture, use, operate, receive, possess, dispose, transfer, distribute or arrange for the distribution, sell, lease, install, transport or store sources of ionizing radiation in a manner other than prescribed in this chapter.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Inserted references to manufacture, distribution, sales, and leasing of sources of ionizing radiation throughout.

7:28-2.2 Supervision

(a) All sources of radiation, except those specifically exempted by other sections of this chapter, shall be under the supervision of at least one person who has demonstrated to the Department, or to any agency recognized by the Department, that the person's training and experience satisfies the Department requirements in the following areas of radiation protection:

1. Principles and practices of radiation protection;
2. X-ray and/or radioactivity measurements and monitoring techniques and instruments;
3. Mathematics and calculations basic to the use of radiation;
4. Biological effects of radiation; and
5. Any additional information, qualifications or experience as may be required by the Department.

(b) Any person applying to the Department for a State license, registration or certificate pursuant to this chapter, shall include in his application the name of at least one person who has satisfied the requirements of (a) above.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-2.3 Instruction

(a) All persons working in or frequenting the vicinity of radiation-producing machines or radioactive material shall be instructed in the operation and/or use of the sources of radiation and the function and need of any applicable safeguards for the sources of radiation, in accordance with preestablished procedures that have been documented and are on file for review and inspection.

(b) All visitors to controlled areas shall be instructed or escorted to prevent unnecessary exposure to radiation. See N.J.A.C. 7:28-7.4(a)4 (Use of personnel monitoring equipment for visitors).

7:28-2.4 Unattended radiation sources

No person shall cause, suffer, allow or permit any source of radiation to remain unattended and accessible to unauthorized use.

7:28-2.5 Protective devices, systems or mechanisms

(a) No person shall operate a radiation-producing machine or utilize radioactive material whenever shielding for the source of radiation permits levels of radiation that exceed or have the potential to exceed the radiation limits specified in N.J.A.C. 7:28-6.2 (Radiation levels outside controlled areas).

(b) No person shall operate a radiation-producing machine or utilize radioactive material whenever any device, system or mechanism designed for the protection against radiation required by this chapter has not been installed or is operating improperly.

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

7:28-2.6 Intentional human irradiation

(a) Only persons licensed or otherwise permitted by law shall arrange for irradiation, application or administration of radiation to a human being or any part thereof, for the purpose of medical diagnosis or treatment.

(b) No provision in N.J.A.C. 7:28 regarding the treatment of human beings in the healing arts is intended to conflict with, supplant or supersede any requirement of the Medical Practices Act of New Jersey.

7:28-2.7 Exemptions for prevention or control of diseases

Rules contained in N.J.A.C. 7:28-6 or 7 and 7:28-13.2 (Reportable radiation incidents) shall not apply insofar as they relate to the intentional exposure of human beings to radiation for the purpose of diagnosis, treatment or investigation for the prevention or control of disease.

7:28-2.8 Special exemptions

The Department, upon application and a showing of hardship or compelling need, with the approval of the Commission, may grant an exemption from any requirement of these rules should it determine that such exemption will not result in any exposure to radiation in excess of the limits permitted by N.J.A.C. 7:28-6, Dose Limits.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Substituted ", Dose Limits" for "Permissible Dose Rates, Radiation Levels and Concentrations" following the N.J.A.C. reference.

7:28-2.9 Prohibited use

- (a) Hand-held fluoroscopic screens shall not be used.
- (b) Shoe-fitting fluoroscopic devices shall not be used.

7:28-2.10 Emergency precautions

(a) All owners of radioactive materials shall make a study of potential radiation hazards which may arise from radiation incidents, theft of radioactive materials, fires, floods, windstorms and other disasters within and near the installation with regard to the protection of the following:

1. Tenants and employees;
2. Emergency workers;
3. General public; and
4. Fire fighters and police.

(b) Such studies shall be made for radioactive materials on hand and shall be made in advance of the receipt of additional radioactive materials.

(c) An emergency operational plan, prepared from these studies, shall inform all persons concerned of their duties and responsibilities. This plan shall be made available to the Department on request.

7:28-2.11 Inspections

(a) All persons shall afford the Department an opportunity to inspect any source of radiation and the operation associated with the source of radiation as well as the facilities and premises where the source of radiation is being used or stored.

(b) Upon request of the Department all persons shall make available for inspection by the Department records kept pursuant to the rules in N.J.A.C. 7:28.

7:28-2.12 Tests

Upon request of the Department, all persons shall perform, and/or permit the Department to perform if it so desires, such tests as the Department deems appropriate or necessary for the administration of this chapter.

SUBCHAPTER 3. REGISTRATION OF IONIZING RADIATION-PRODUCING MACHINES AND RADIOACTIVE MATERIALS

7:28-3.1 Registration for possession of ionizing radiation-producing machines and radioactive by-product material, source material and special nuclear material

(a) Any person, manufacturer, dealer or State, county or local government shall register with the Department all radioactive by-product material, source material, special nuclear material and every ionizing radiation-producing machine possessed within the State of New Jersey except as exempted by N.J.A.C. 7:28-3.2.

(b) Any person, manufacturer, dealer or State, county or local government shall apply for such registration within 30 days after taking possession, custody or control of radioactive by-product material, source material, special nuclear material and ionizing radiation-producing machines on forms available from the Department.

(c) Any person, manufacturer, dealer or State, county or local government shall retain a copy of the registration at the facility for inspection by employees and the Department.

7:28-3.2 Exemptions from registration for possession of ionizing radiation-producing machines and radioactive by-product material, source material and special nuclear material

(a) Ionizing radiation-producing machines not being used in such a manner as to produce radiation, such as equip-

ment in storage or on display, are exempt from registration. Machines that are operated while on display must meet the requirements of N.J.A.C. 7:28-3.1.

(b) Electrical equipment that is not primarily intended to produce radiation and that does not produce radiation greater than 0.5 millirem per hour at any readily accessible point five centimeters from its surface is exempt from registration. Production-testing facilities for such equipment shall not be exempt if any individual might receive a radiation dose exceeding the limits established in N.J.A.C. 7:28-6.2.

(c) Ionizing radiation-producing machines possessed, stored or used by agencies of the United States Government are exempt from registration.

(d) Those radioactive materials covered in specific and general state licenses issued by the Department in accordance with N.J.A.C. 7:28-4 are exempt from registration.

(e) Those radioactive materials contained in devices which are covered under general license issued by the United States Nuclear Regulatory Commission or have been granted an exemption from licensing requirements by the United States Nuclear Regulatory Commission are exempt from registration.

(f) Quantities of radioactive material equal to or less than those listed in N.J.A.C. 7:28-3.11 are exempt from registration requirements provided that no individual user of radioactive material shall have more than 10 such quantities of any material or materials at any one time.

7:28-3.3 Registration of ionizing radiation-producing machines

(a) Registration of ionizing radiation-producing machines shall pertain to each x-ray tube and its accompanying transformer, generator and control panel. If more than one x-ray tube operates off the same control panel, a separate registration is required for each tube.

(b) All registrations issued for ionizing radiation-producing machines shall expire on May 19 of each renewal year or shall expire one year from the date of initial application as determined by the Department. Registrations are renewable by the registrant for a period of one year upon payment of the fee provided in N.J.A.C. 7:28-3.12.

(c) Applications for new registrations for ionizing radiation producing machines will be accepted throughout the calendar year. The annual registration fee set forth in N.J.A.C. 7:28-3.12 shall be either prorated from the date the registration is issued until its expiration date on May 19 following the date of application, except that the Department may issue a registration for an additional year when an application is initially filed during the last three months of the registration year, or shall be assessed in full from the

date of application until its expiration date one year later as determined by the Department.

7:28-3.4 Temporary registration of ionizing radiation-producing machines

(a) Any person, manufacturer, dealer or State, county or local government having temporary possession, custody or control of any ionizing radiation-producing machine for the purpose of replacing a registered machine that is out of service for a period longer than 60 days or for evaluation prior to purchase for a period longer than 60 days shall obtain a registration for temporary possession, custody or control of said machine.

(b) Application for temporary registration shall be submitted, on forms available from the Department, within 30 days after taking temporary possession, custody or control. No registration fee will be charged if the period of temporary possession, custody or control does not exceed 60 days. If the period exceeds 60 days, the annual registration fee for said machine set forth in N.J.A.C. 7:28-3.12 will be charged as of the date of application for the temporary registration.

(c) Within 30 days after relinquishment of temporary possession, custody or control of an ionizing radiation-producing machine, the registrant shall notify the Department in writing to terminate the temporary registration. The Department shall continue to charge a registration fee until a written notice of termination is received from the registrant.

7:28-3.5 Registration of radioactive by-product material, source material and special nuclear material

(a) Any person having within his possession, custody or control any radioactive by-product material, source material or special nuclear material pursuant to a specific license issued by the United States Nuclear Regulatory Commission shall apply for and obtain a registration for possession, custody or control of the specified type(s) and amount(s) of such material as authorized by the license issued by the Nuclear Regulatory Commission. Application forms for the registration of radioactive material are available from the Department. When submitting an application, the applicant shall attach to the application a copy of the license issued by the Nuclear Regulatory Commission.

(b) A radioactive materials registrant does not have to apply for a new or amended registration for receipt of each shipment of a type of radioactive material for which it has a valid current registration provided that the total amount of such type of radioactive material in the radioactive materials registrant's possession, custody or control does not exceed the amount authorized in its registration for such type of material.

(c) Fees in the amounts indicated in N.J.A.C. 7:28-3.13 shall be paid for each initial registration application, each registration amendment and each annual registration renewal.

(d) Any registration issued for radioactive materials pursuant to this subchapter shall be valid for so long as the license issued by the United States Nuclear Regulatory Commission is in full force and effect.

Amended by R.1991 d.417, effective August 5, 1991.

See: 22 N.J.R. 3300(a), 23 N.J.R. 2362(a).

(a) Added specific to a "specific" license; (c) deleted old text pertaining to fees and added new.

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

In (b), inserted "radioactive materials" preceding reference to registrant throughout.

7:28-3.6 Transfer of registration for possession of radioactive by-product material, source material, special nuclear material and ionizing radiation-producing machines

Registrations for possession of radioactive by-product material, source material, special nuclear material and ionizing radiation-producing machines are not transferable.

7:28-3.7 Amendments to registration of ionizing radiation-producing machines

(a) A registrant must notify the Department in writing within 30 days after any change in the following information on the application for registration of an ionizing radiation-producing machine:

1. Trade name;
2. X-ray tube capacity;
3. Type of housing;
4. Generator power;
5. Owner;
6. Co-owner;
7. Location of machine including address (number, street, city, zip code, county) and room number;
8. Machine category;
9. Manufacturer;
10. Control panel model number; and
11. Control console serial number.

7:28-3.8 Amendments to registration of radioactive by-product material, source material or special nuclear material

A radioactive materials registrant shall notify the Department in writing within 30 days after any change in the license issued by the Nuclear Regulatory Commission for possession, custody or control of any type of radioactive by-product material, source material or special nuclear material when there is a change in the type and/or quantity of such material or when there is a change in the designated licensed user(s) or radiation safety officer.

Amended by R.2005 d.156, effective May 16, 2005.
 See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
 Inserted "radioactive materials" preceding "registrant".

7:28-3.9 Sale, installation, relocation or disposal of ionizing radiation-producing machines

(a) Whenever a manufacturer or dealer sells, installs, relocates or disposes of an ionizing radiation-producing machine, said manufacturer, agent or dealer shall give written notification thereof to the Department within 30 days of such sale, installation, relocation or disposal. Said notification shall include the manufacturer, model and serial number of each component, name and address of the new owner(s), address of the relocated machine or details of the final disposition of the machine. Notification shall be submitted on a form available from the Department. The Department may accept the current form used by the United States Food and Drug Administration for Report of Assembly of a Diagnostic X-ray System if the Department determines that the information is complete and accurate.

(b) Whenever an owner sells, relocates or disposes of an ionizing radiation-producing machine, said owner shall:

1. Give written notification to the Department on forms available from the Department within 30 days of such sale, relocation or disposal;
2. Include the New Jersey registration number, manufacturer, model and serial number of each component;
3. Include the name and address of the new owner(s); and
4. Include the address of the relocated machine, or details of the final disposition of the machine; and
5. Be responsible for all fees until the written notification is received by the Department.

7:28-3.10 Denial of an application for registration, and suspension, modification, or revocation of registration of ionizing radiation-producing machines, radioactive by-product material, source material or special nuclear material

(a) The Department, in addition to any penalties authorized by the Act, may deny an application for registration or suspend, modify or revoke a registration of ionizing radiation-producing machines, radioactive by-product material, source material or special nuclear material by reason of amendments to the Act, adoption of rules, orders issued by the Department pursuant to said Act or if the applicant, radioactive materials registrant or registrant:

1. Fails to comply with any provisions of the Act or any rules promulgated pursuant thereto including the timely payment of registration fees;
2. Falsifies or makes misleading statements in the application for registration;

3. Falsifies or makes misleading statements in any documents which were utilized to obtain a registration;
4. Alters registration documents;
5. Falsifies required records;
6. Aids, abets, combines with, or conspires with any person for any purpose which will evade or be in violation of the provisions of the Act or any rules promulgated pursuant thereto; or
7. Allows a registration to be used by any person for any purpose which will evade or be in violation of the provisions of the Act or any rules promulgated pursuant thereto.

(b) Except as provided in N.J.S.A. 26:2D-12 in cases of emergency, no registration shall be denied, modified, suspended or revoked prior to a hearing conducted by the Office of Administrative Law pursuant to N.J.S.A. 52:14B-1 et seq., the Administrative Procedure Act, and N.J.A.C. 1:1-1 et seq., the Uniform Administrative Practice Rules, on the basis of a Notice of Intent filed by the Department stating the grounds for denial, suspension, modification or revocation of a registration.

(c) The Department may terminate a registration upon request submitted by the radioactive materials registrant or registrant to the Department in writing.

Amended by R.2005 d.156, effective May 16, 2005.
 See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Inserted a reference to a radioactive materials registrant in (a) and (c).

7:28-3.11 Table of radioactive materials and quantities exempt from registration

(a) The following radioactive materials, in quantities less than or equal to those specified below, are exempt from registration:

Radioactive Material	Column A Not as a sealed source (microcuries)	Column B As a sealed source (microcuries)
Antimony (Sb 124)	1	10
Arsenic 76 (As 76)	10	10
Arsenic 77 (As 77)	10	10
Barium 140 + Lanthanum 140 (Ba 140 + La 140)	1	10
Beryllium (Be 7)	50	50
Cadmium 109 + Silver 109 (Cd 109 + Ag 109)	10	10
Calcium 45 (Ca 45)	10	10
Carbon 14 (C 14)	50	50
Cerium 144 + Praseodymium 144 (Ce 144 + Pr 144)	1	10
Cesium 137 + Barium 137 (Ce 137 + Ba 137)	1	10
Chlorine 36 (Cl 36)	1	10
Chromium 51 (Cr 51)	50	50
Cobalt 60 (Co 60)	1	10
Copper 64 (Cu 64)	50	50

Radioactive Material	Column A Not as a sealed source (microcuries)	Column B As a sealed source (microcuries)
Europium 154 (Eu 154)	1	10
Fluorine 18 (F 18)	50	50
Gallium 72 (Ga 72)	10	10
Germanium 71 (Ge 71)	50	50
Gold 198 (Au 198)	10	10
Gold 199 (Au 199)	10	10
Hydrogen 3 (Tritium H 3)	250	250
Indium 114 (In 114)	1	10
Iodine 131 (I 131)	10	10
Iridium 192 (Ir 192)	10	10
Iron 55 (Fe 55)	50	50
Iron 59 (Fe 59)	1	10
Lanthanum 140 (La 140)	10	10
Manganese 52 (Mn 52)	1	10
Manganese 56 (Mn 56)	50	50
Molybdenum 99 (Mo 99)	10	10
Nickel 59 (Ni 59)	1	10
Nickel 63 (Ni 63)	1	10
Niobium 95 (Nb 95)	10	10
Palladium 109 (Pd 109)	10	10
Palladium 103 + Rhodium 103 (Pd 103 + Rh 103)	50	50
Phosphorus 32 (P 32)	10	10
Polonium 210 (Po 210)	0.1	1
Potassium 42 (K 42)	10	10
Praseodymium 143 (Pr 143)	10	10
Promethium 147 (Pm 147)	10	10
Rhenium 186 (Re 186)	10	10
Rhodium 105 (Rh 105)	10	10
Rubidium 86 (Rb 86)	10	10
Ruthenium 106 + Rhodium 106 (Ru 106 + Rh 106)	1	10
Samarium 153 (Sm 153)	10	10
Scandium 46 (Sc 46)	1	10
Silver 105 (Ag 105)	1	10
Silver 111 (Ag 111)	10	10
Sodium 22 (Na 22)	10	10
Sodium 24 (Na 24)	10	10
Strontium 89 (Sr 89)	1	10
Strontium 90 + Yttrium 90 (Sr 90 + Y 90)	0.1	1
Sulfur 35 (S 35)	50	50
Tantalum 182 (Ta 182)	10	10
Technetium 96 (Tc 96)	1	10
Technetium 99 (Tc 99)	1	10
Tellurium 127 (Te 127)	10	10
Tellurium 129 (Te 129)	1	10
Thallium 204 (Tl 204)	50	50
Tin 113 (Sn 113)	10	10
Tungsten 185 (W 185)	10	10
Vanadium 48 (V 48)	1	10
Yttrium 90 (Y 90)	1	10
Yttrium 91 (Y 91)	1	10
Zinc 65 (Zn 65)	10	10
Beta and/or Gamma emitting ra- dioactive material not listed above	1	10

7:28-3.12 Application and annual registration renewal fees for ionizing-radiation-producing machines

(a) On initial registration of each x-ray tube, each registrant shall pay an application fee of \$40.00 plus the prorated portion of the applicable annual registration renewal fee set forth in (b), (c), (d) or (e) below for the remainder of the first year of registration.

(b) Each registrant of an ionizing-radiation-producing machine used in a dental facility shall pay:

1. The initial application and registration fees for each x-ray tube pursuant to (a) above, and
2. In each year after the expiration of the first year of registration established pursuant to (f) below, the annual registration renewal fee per x-ray tube as follows:

DENTAL FACILITIES

Machine Category and Description	Annual Registration Renewal Fee Per X-Ray Tube
01D Dental Machine	\$92

(c) Each registrant of an ionizing-radiation-producing machine used in a hospital facility shall pay:

1. The initial application and registration fees for each X-ray tube pursuant to (a) above; and
2. In each year after the expiration of the first year of registration establish pursuant to (f) below, the annual registration renewal fee per X-ray tube follows:

HOSPITAL FACILITIES

Machine Category and Description	Annual Registration Renewal Fee Per X-Ray Tube
01H Dental Machine	\$140.00
02H Fixed Medical Radiographic Machine	208.00
03H Mobile Medical Radiographic Machine	208.00
31H Portable Medical Radiographic Machine (hand carried)	208.00
06H Motor Vehicle Mounted Medical Radiographic Machine	208.00
04H Fixed Medical Fluoroscopic Machine	163.00
05H Mobile Medical Fluoroscopic Machine	163.00
32H Portable Medical Fluoroscopic Machine (hand carried)	163.00
33H Motor Vehicle Mounted Medical Fluoroscopic Machine	163.00
07H Fixed Medical Radiographic Fluoroscopic Machine	253.00
08H Mobile Medical Radiographic Fluoroscopic Machine	253.00
34H Portable Medical Radiographic Fluoroscopic Machine (hand carried)	253.00

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

Machine Category and Description	Annual Registration Renewal Fee Per X-Ray Tube
35H Motor Vehicle Mounted Medical Radiographic Fluoroscopic Machine	253.00
09H CT Scan Machine	163.00
10H Mammography Machine	298.00
36H Motor Vehicle Mounted Mammography Machine	298.00
37H Mobile Mammography Machine	298.00
44H MQSA Mammography Machine	73.00
45H MQSA Motor Vehicle Mounted Mammography Machine	73.00
46H MQSA Mobile Mammography Machine	73.00
11H Medical Therapeutic Machine 60 kVp	253.00
12H Medical Therapeutic Machine 61 kVp to 999 kVp	253.00
14H Medical Therapeutic Machine 1 MeV and above	343.00
30H Radiation Therapy Simulator Machine	208.00
38H Biomedical (non-human) Research Machine	140.00
21H Electron Microscope Machine	140.00
22H Cabinet X-ray Machine	140.00
28H Bone Densitometer Machine	118.00

Machine Category and Description	Annual Registration Renewal Fee Per X-Ray Tube
07N Fixed Medical Radiographic Fluoroscopic Machine	163.00
08N Mobile Medical Radiographic Fluoroscopic Machine	163.00
34N Portable Medical Radiographic Fluoroscopic Machine (hand carried)	163.00
35N Motor Vehicle Mounted Medical Radiographic Fluoroscopic Machine	163.00
09N CT Scan Machine	118.00
10N Mammography Machine	298.00
36N Motor Vehicle Mounted Mammography Machine	298.00
37N Mobile Mammography Machine	298.00
44N MQSA Mammography Machine	73.00
45N MQSA Motor Vehicle Mounted Mammography Machine	73.00
46N MQSA Mobile Mammography Machine	73.00
11N Medical Therapeutic Machine ≤60 kVp	118.00
12N Medical Therapeutic Machine >61 kVp to 999 kVp	253.00
14N Medical Therapeutic Machine 1 MeV and above	343.00
30N Radiation Therapy Simulator Machine	208.00
38N Biomedical (non-Human) Research Machine	140.00
17N Industrial/Research Radiography Machine	151.00
39N Portable Industrial Radiography Machine	151.00
40N Shielded Room Radiography Machine	151.00
18N Electron Beam Welder/Furnace Machine	129.00
19N Analytical X-ray Machine ≤16 kVp	118.00
20N Analytical X-ray Machine >16 kVp	118.00
21N Electron Microscope Machine	106.00
22N Cabinet X-ray Machine	106.00
23N X-ray Baggage Machine	106.00
24N Particle Accelerator Machine (non-medical use) ≤30 kVp	196.00
25N Particle Accelerator Machine (non-medical use) >30 kVp	185.00
28N Bone Densitometer Machine	95.00
41N Machine not specifically listed above, ≤50 kVp	118.00
42N Machine not specifically listed above, 51 kVp to 999 kVp	118.00
43N Machine not specifically listed above, 1 MeV and above	140.00

(d) Each registrant of an ionizing-radiation-producing machine used in a non-hospital facility (including but not limited to doctors' offices, medical facilities, industrial facilities, schools, and government facilities) shall pay:

1. The initial application and registration fees for each X-ray tube pursuant to (a) above; and
2. In each year after the expiration of the first year of registration established pursuant to (f) below, the annual registration renewal fee per X-ray tube as follows:

NON-HOSPITAL FACILITIES

Machine Category and Description	Annual Registration Renewal Fee Per X-Ray Tube
01N Dental Machine	\$106.00
02N Fixed Medical Radiographic Machine	140.00
03N Mobile Medical Radiographic Machine	140.00
31N Portable Medical Radiographic Machine (hand carried)	140.00
06N Motor Vehicle Mounted Medical Radiographic Machine	140.00
04N Fixed Medical Fluoroscopic Machine	118.00
05N Mobile Medical Fluoroscopic Machine	118.00
32N Portable Medical Fluoroscopic Machine (hand carried)	118.00
33N Motor Vehicle Mounted Medical Fluoroscopic Machine	118.00

(e) Each registrant of an ionizing-radiation-producing machine used in a veterinary facility shall pay:

1. The initial application and registration fees for each X-ray tube pursuant to (a) above, and

2. In each year after the expiration of the first year of registration established pursuant to (f) below, the annual registration renewal fee per X-ray tube as follows:

VETERINARY FACILITIES

Machine Source Category and Description	Annual Registration Renewal Fee Per X-Ray Tube
01V Dental Machine	\$ 86.00
02V Fixed Medical Radiographic Machine	100.00
03V Mobile Medical Radiographic Machine	100.00
31V Portable Medical Radiographic Machine (hand carried)	100.00
04V Fixed Medical Fluoroscopic Machine	91.00
05V Mobile Medical Fluoroscopic Machine	91.00
32V Portable Medical Fluoroscopic Machine (hand carried)	91.00
07V Fixed medical Radiographic Fluoroscopic Machine	109.00
08V Mobile Medical Radiographic Fluoroscopic Machine	109.00

(f) The expiration date of each year of registration shall be specified by the Department on the billing invoice sent to each registrant. The registration expiration date shall be based on the first letter of the registrant name as follows:

1. For a registrant whose name begins with A through F, the registration expiration date shall be August 31 of each calendar year;
2. For a registrant whose name begins with G through L, the registration expiration date shall be September 30 of each calendar year;
3. For a registrant whose name begins with M through R, the registration expiration date shall be October 31 of each calendar year; and
4. For a registrant whose name begins with S through Z, the registration expiration date shall be November 30 of each calendar year.

(g) Each registrant shall pay the initial registration application fee and annual registration renewal fee within 60 days of the date of the invoice billing issued by the Department. Any fee payment postmarked or handcarried to the Department after the invoice due date will be subject to a \$25.00 per month late charge. If necessary, the Department will issue a second invoice. Late charges must be paid within 30 days of the second invoice. If a registrant fails to pay a fee by the original invoice due date, the registration of the ionizing-radiation-producing machine shall be deemed expired.

(h) When two or more X-ray tubes are operated from the same generator, the registrant shall pay an application fee and an annual registration renewal fee for each tube.

(i) Each registrant shall make payment only by check or money order made payable to "Treasurer, State of New Jersey." Each payment shall be accompanied by the invoice issued by the Department and shall be submitted to the address specified on the invoice: Department of Treasury, Division of Revenue, PO Box 417, Trenton, New Jersey 08646-0417.

(j) An application fee will not be charged for any machine registered pursuant to the Radiation Protection Code prior to November 16, 1987. However, the registrant shall pay the applicable annual registration renewal fee for any such machine.

Amended by R.1990 d.400, effective August 6, 1990.
See: 22 N.J.R. 1653(a), 22 N.J.R. 2302(a), 22 N.J.R. 2830(a).
Fees increased.

Repeal and New Rule, R.1995 d.49, effective January 17, 1995.
See: 26 N.J.R. 3797(a), 27 N.J.R. 336(a).

Formerly "Fees for initial registration application and annual registration of ionizing radiation-producing machines".

Amended by R.1999 d.369, effective October 18, 1999.
See: 31 N.J.R. 1130(a), 31 N.J.R. 3087(c).

In (c)2 and (d)2, inserted references to MQSA Mammography Machines, MQSA Motor Vehicle Mounted Mammography Machines and MQSA Mobile Mammography Machines.

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

In (i), amended the address.

7:28-3.13 Fees for registration of radioactive by-product material, source material and special nuclear material

(a) Fees for initial registration, annual registration renewal and each registration amendment for possession, custody or control of radioactive by-product material, source material and special nuclear material as provided below shall be paid in full by the radioactive materials registrant.

1. Initial Registration Fee: \$250.00;
2. Annual Registration Renewal: \$165.00;
3. Each Amendment to Registration: \$165.00.

(b) Payment for each initial registration shall be made only by check or money order payable to "Treasurer, State of New Jersey" and shall be submitted with each initial registration application to the Department.

(c) Annual registration renewal fees payable to "Treasurer, State of New Jersey" shall be submitted to the Department annually no later than August 1 of each year.

(d) In the event that registration renewal fees are paid later than 30 days after August 1, a delinquency fee equal to one-half of the annual registration fee will be imposed. Failure to pay a registration renewal fee, including any accrued delinquency fees for longer than 90 days after August 1 shall constitute grounds for suspension or revocation of the registration pursuant to N.J.A.C. 7:28-3.10.

(e) Registration amendment fees shall be submitted with the amended registration.

(f) The initial registration fee, the annual renewal fee and registration amendment fee shall be mailed to:

State of New Jersey
Department of Treasury
Division of Revenue
PO Box 417
Trenton, New Jersey 08646-0417

(g) The registration year shall be July 1 of each year to June 30 of the following year.

(h) Fees submitted to the Department are non-refundable.

New Rule, R.1991 d.417, effective August 5, 1991.

See: 23 N.J.R. 3300(a), 23 N.J.R. 2362(a).

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote (a); in (d), substituted "registration" for "license" following "annual" in the first sentence; added (h).

Amended by R.2005 d.239, effective July 18, 2005.

See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

In (f), amended the address.

SUBCHAPTER 4. LICENSING OF NATURALLY OCCURRING OR ACCELERATOR PRODUCED RADIOACTIVE MATERIALS

7:28-4.1 Scope and general provisions

(a) This subchapter shall apply to persons who manufacture, produce, transfer, distribute or arrange for the distribution, sell, lease, receive, acquire, own, possess or use any naturally occurring or accelerator produced radioactive materials, including TENORM, in this State.

(b) No person shall manufacture, produce, transfer, distribute or arrange for the distribution, sell, lease, receive, acquire, own, possess or use any naturally occurring or accelerator produced radioactive materials, including TENORM, in this State unless authorized by a specific State license issued by the Department as provided by N.J.A.C. 7:28-4.7 and 4.8, a general State license as provided in N.J.A.C. 7:28-4.5, or an exemption as provided in N.J.A.C. 7:28-4.3. Excepted from this provision are byproduct, source and special nuclear materials.

(c) A person who sells, transfers, distributes or arranges for the distribution of a device containing naturally occurring or accelerator produced radioactive materials manufactured by another person, but which is sold, transferred or distributed under its own name, shall obtain a State license in accordance with this subchapter.

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote the section.

7:28-4.2 Recognition of licenses from other jurisdictions

(a) Any person who possesses a specific license or equivalent licensing document issued by a Federal agency or any other state may, pursuant to such document, transport, receive, possess, or use the radioactive materials specified in such license within this State for a period not in excess of 20 days in any period of 12 consecutive months without obtaining a specific license from the Department provided that:

1. The license does not limit the activity to specified installations or locations;
2. The licensee notifies the Department in writing at least two days prior to the time that such radioactive material is brought into this State. Such notification shall indicate the location, period, and type of proposed possession and use within this State, and shall be accompanied by a copy of the pertinent licensing document. If in a specific case the two-day period would impose an undue hardship on the user, he may, upon application to the Department, obtain permission to proceed sooner;
3. The licensee complies with all the terms and conditions of the license;
4. The licensee provides such other information as the Department may request; and

(b) The Department may withdraw, limit or qualify its acceptance of such licenses issued by another agency, or any product distributed pursuant to such licensing documents, upon determining that such action is necessary in order to prevent undue hazard to public health and safety or property.

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

In (b), substituted "product" for "produce" preceding "distributed".

7:28-4.3 Exemption from requirement for a State license for manufacture, production, transfer, distribution or arrangement of distribution, sale, lease, receipt, acquisition, ownership, possession or use of all naturally occurring or accelerator produced radioactive materials

(a) A person shall be exempt from the requirement to obtain a State license for the following activities:

1. The person is a plant or laboratory owned by or operated on behalf of a Federal agency;
2. The person is a common or contract carrier and is transporting or storing radioactive materials covered by N.J.A.C. 7:28-4.7 in the regular course of carriage for another, or storage incident thereto;
3. The person manufactures, produces, receives, possesses, uses, transfers, distributes or arranges for the

distribution, sells, leases, owns or acquires products or materials containing naturally occurring or accelerator produced radioactive materials in concentrations not in excess of those exempted in N.J.A.C. 7:28-4.3(b);

4. The person manufactures, receives, possesses, uses, transfers, distributes or arranges for the distribution, sells, leases, owns or acquires luminous timepieces or parts thereof containing radium. However, any person who desires to apply radium to luminous timepieces or parts thereof is not exempt and must obtain a specific State license;

5. The person owns or possesses naturally occurring radioactive materials, occurring in natural abundance and which are not technologically enhanced naturally occurring radioactive materials, whether intentionally or unintentionally;

6. The person who receives, owns, possesses, uses, processes, transfers, distributes, arranges for the distribution, sells or leases technologically enhanced naturally occurring radioactive materials (TENORM) if the TENORM contain any combination of Radium-226 and Radium-228 at concentrations less than five pCi/g (185 Bq/kg) (dry weight) above background and less than the quantity listed in (c) below;

7. The person owns property where radon gas is being expelled to the outside atmosphere as part of a radon remediation system installed in accordance with the provisions of N.J.A.C. 7:28-27;

8. The person owns a sanitary sewer system where residuals are present which may contain TENORM from the separation of liquids and solids which is the outcome of normal operations of the sanitary sewer system;

9. The person is involved with the distribution, including custom blending, possession, and use of fertilizers containing TENORM; and

10. The person owns property where residual contamination remaining at the site was remediated under the Radiation Protection Act (N.J.S.A. 26:2D-1 et seq.) and/or the other authorities listed in the Soil Remediation Standards at N.J.A.C. 7:28-12.2(a). Such residual concentrations may be greater than the limits specified in (a)6 above, but be under restricted conditions imposed by the Department (such as engineering and institutional controls), and meet the dose criteria specified in N.J.A.C. 7:28-12.8(a).

(b) The following concentrations of NARM, including TENORM, when obtained from naturally occurring materials or when produced by an accelerator are exempt from the requirements for a State license:

Exempt Concentrations

Element (nuclide)	Column 1	Column 2
	Gas concentration (uCi/ml)	Liq. & solid concentration (uCi/ml)****
Argon (Ar-37)	1×10^{-3}	—
Arsenic (As-73)	—	5×10^{-3}
(As-74)	—	5×10^{-4}
Barium (Ba-131)	—	2×10^{-3}
Beryllium (Be-7)	—	2×10^{-2}
Bismuth (Bi-206)	—	4×10^{-4}
(Bi-207)*	—	2×10^{-4}
Cadmium (Cd-109)	—	2×10^{-3}
Chromium (Cr-51)	—	2×10^{-2}
Cobalt (Co-56)*	—	1.2×10^{-4}
(Co-57)	—	5×10^{-3}
(Co-58)	—	1×10^{-3}
Dysprosium (Dy-159)*	—	4×10^{-3}
Fluorine (F-18)	2×10^{-6}	8×10^{-3}
Gallium (Ga-67)*	—	2×10^{-3}
Germanium (Ge-68)*	—	1.2×10^{-3}
(Ge-71)	—	2×10^{-2}
Gold (Au-196)	—	2×10^{-3}
(Au-199)	—	2×10^{-3}
Indium (In-111)*	—	1.2×10^{-3}
(In-113m)	—	1×10^{-2}
Iodine (I-123)*	4×10^{-7}	2×10^{-3}
(I-124)*	8×10^{-9}	4×10^{-5}
Iridium (Ir-190)	—	2×10^{-3}
(Ir-192)	—	4×10^{-4}
Iron (Fe-55)	—	8×10^{-3}
Krypton (Kr-85m)	1×10^{-6}	—
Lead (Pb-201)*	—	2×10^{-3}
(Pb-203)	—	4×10^{-3}
(Pb-210)*	—	2×10^{-7}
Manganese (Mn-52)	—	3×10^{-4}
(Mn-54)	—	1×10^{-3}
Mercury (Hg-197m)	—	2×10^{-3}
(Hg-197)	—	3×10^{-3}
Neptunium (Np-237)*	—	4×10^{-7}
Palladium (Pd-103)	—	3×10^{-3}
Platinum (Pt-191)	—	1×10^{-3}
(Pt-193m)	—	1×10^{-2}
(Pt-197m)	—	1×10^{-2}
Radium (Ra-226)*	—	1.2×10^{-6}
(Ra-228)	—	4×10^{-11}
Rhenium (Re-183)	—	6×10^{-3}
Rubidium (Rb-81)*	—	1×10^{-2}
(Rb-83)*	—	1.8×10^{-4}
(Rb-84)*	—	1.4×10^{-4}
Ruthenium (Ru-97)	—	4×10^{-4}
Samarium (Sm-153)	—	8×10^{-4}
Scandium (Sc-48)	—	3×10^{-4}
Silver (Ag-105)	—	1×10^{-3}
(Ag-111)	—	4×10^{-4}
Sodium (Na-22)*	—	1.2×10^{-4}
Tantalum (Ta-179)*	—	6×10^{-3}
Technetium (Tc-96)	—	1×10^{-3}
Thallium (Tl-200)	—	4×10^{-3}
(Tl-201)	—	3×10^{-3}
(Tl-202)	—	1×10^{-3}
**Thorium (Th-228)*	—	4×10^{-6}
(Th-230)*	—	2×10^{-6}
(Th-232)*	—	6×10^{-7}
(Th-234)*	—	1×10^{-4}
Thulium (Tm-170)	—	5×10^{-4}
Tungsten (Wolfram) (W-181)	—	4×10^{-3}

Element (nuclide)	Column 1 Gas concentration (uCi/ml)	Column 2 Liq. & solid concentration (uCi/ml)****
**Uranium (U-234)*	—	6 x 10 ⁻⁶
(U-235)*	—	6 x 10 ⁻⁶
(U-238)*	—	6 x 10 ⁻⁶
Vanadium (V-48)	—	3 x 10 ⁻⁴
Yttrium (Y-88)*	—	2 x 10 ⁻⁴
(Y-92)	—	6 x 10 ⁻⁴
Zinc (Zn-69m)	—	7 x 10 ⁻⁴
Any other beta/gamma emitter with half-life < 3 years	1 x 10 ⁻¹⁰	1 x 10 ⁻⁶

The values for those NARM nuclides, including TENORM, that are followed by a single asterisk() are based upon multiplying 20 times the most restrictive release concentrations specified in 10 CFR 20 Appendix B, Table 2, Columns 1 (air) and 2 (water).

**These concentrations do not apply to source material as defined by the NRC for thorium and uranium.

***uCi/g for solids

1. Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the concentrations in this section, the value given is that of the parent isotope and takes into account the radioactivity of the daughters.

2. For purposes of N.J.A.C. 7:28-4.3(a)3, where a combination of isotopes is involved, the limit for the combination shall be computed as follows:

i. Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in this section for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (unity).

Example:

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt concentration of Isotope B}} \leq 1$$

(c) If a person manufactures, produces, transfers, distributes or arranges for the distribution, sells, leases, receives, acquires, owns, possesses or uses NARM, including TENORM, in quantities less than those listed in N.J.A.C. 7:28-4.5(c), they are exempt from the requirement for a license.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote the section.

7:28-4.4 Types of licenses for manufacture, production, transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of all naturally occurring or accelerator produced radioactive materials

(a) General State licenses described in N.J.A.C. 7:28-4.5 are effective without the filing of an application with the

Department or the issuance of licensing documents to particular persons.

(b) Specific State licenses are issued to named persons upon application filed pursuant to the requirements of this subchapter.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-4.5 General licenses for the transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of naturally occurring or accelerator produced radioactive materials and certain devices and equipment

(a) Any person who uses, transfers, distributes or arranges for the distribution, sells, leases, receives, acquires, owns or possesses the following devices and equipment incorporating naturally occurring or accelerator produced radioactive material, when manufactured, tested and labeled by the manufacturer in accordance with the specifications contained in a specific license issued by the Department, or a specific license of a Federal agency or any other state, shall be deemed to have a general State license:

1. Devices designed for use as static eliminators and which contain, as a sealed source or sources, radioactive material consisting of a total of not more than 500 microcuries of Polonium 210 or 50 microcuries of Radium 226 per device;

2. Spark gap tubes and electronic tubes which contain radioactive material consisting of not more than one microcurie of Radium per tube;

3. Devices designed for ionizing of air and which contain, as a sealed source or sources, radioactive material consisting of a total of not more than 500 microcuries of Polonium 210 or 50 microcuries of Radium 226 per device.

(b) The devices described in (a) above shall not be transferred, abandoned or disposed of except by transfer to a person duly authorized to receive such device by a specific State license issued by the Department, a Federal agency, or any other state.

(c) The following quantities of radioactive substances, when obtained from naturally occurring materials or when produced by an accelerator, are generally licensed provided that no person shall at any one time possess or use more than a total of 10 such quantities:

Radioactive Material	Column A Not as a Sealed Source (microcuries)	Column B As a Sealed Source (microcuries)
Beryllium (Be-7)	50	50
Bismuth 207 (Bi-207)	1	10
Cadmium 109-Silver 109 (Cd 109 + Ag 109)	10	10

	Column A Not as a Sealed Source (microcuries)	Column B As a Sealed Source (microcuries)
Radioactive Material		
Cerium 141 (Ce-141)	1	10
Chromium 51 (Cr-51)	50	50
Cobalt 57 (Co-57)	20	20
Germanium 68 (Ge-68)	1	10
Iron 55 (Fe-55)	50	50
Manganese 52 (Mn-52)	1	10
Polonium 210 (Po-210)	0.1	1
Radium and daughters	0.1	1
Sodium 22 (Na-22)	10	10
Vanadium 48 (V-48)	1	10
Zinc 65 (Zn-65)	10	10
Beta and/or gamma emitting radioactive material not list- ed above	1	10

(d) There are no generally licensed quantities for alpha-emitting materials other than those set forth in N.J.A.C. 7:28-4.5(c).

(e) Any person who owns, receives, acquires, possesses or uses radioactive material when contained in a device 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, when such devices are manufactured in accordance with the specifications contained in a specific license authorizing distribution under a general license issued to the supplier by the Department, a Federal agency, or any other state, is deemed to have a general State license, provided that:

1. The device is labeled in accordance with the provisions of the specific license which authorizes the distribution of the devices;
2. The device bears a label containing the following or a substantially similar statement:

“This device contains radioactive material and has been manufactured for distribution as a generally licensed device pursuant to

(identify appropriate section of the rules)

(name of licensing agency and state)

License No. _____ by _____ (name of supplier)

This device shall not be transferred, abandoned or disposed of except by transfer to a person duly authorized to receive such device by a specific license issued by the Department, a Federal agency, or any other state.

Removal of this label is prohibited.”; and

3. The devices requiring special installation shall be installed on the premises of the general licensee by a person authorized to install the devices under a specific license issued to the installer by the Department, a Federal agency, or any other state.

(f) Persons who transfer, distribute or arrange for the distribution, sell, lease, receive, acquire, own, possess or use items and quantities of radioactive materials set forth in N.J.A.C. 7:28-4.5(a) and (c) pursuant to a general State license shall not:

1. Effect an increase in the radioactivity of such scheduled items or quantities by adding other radioactive material thereto, by combining radioactive material from two or more such items or quantities, or by altering them in any other manner so as to increase the rate of radiation emission;

2. Administer or direct the administration of the scheduled items or quantities or any part thereof to a human being, either externally or internally, for any purpose, including, but not limited to, diagnostic, therapeutic and research purposes;

3. Add or direct the addition of the scheduled items or quantities or any part thereof to any food, beverage, cosmetic, drug or other product designed for ingestion or inhalation by, or application to, a human being; or

4. Include the scheduled items or quantities or any part thereof in any device, instrument, apparatus, including component parts and accessories intended for use in diagnosis, treatment or prevention of disease in human beings or animals or otherwise intended to affect the structure or any function of the body of human beings or animals.

(g) Persons who receive, acquire, possess or use a device pursuant to a general license specified in N.J.A.C. 7:28-4.5(a):

1. Shall not transfer, abandon or dispose of the device except by transfer to a person duly authorized to receive such device by a specific license issued by the Department, a Federal agency, or any other state;

2. Shall assure that all labels affixed to the device at the time of receipt and bearing the statement, “Removal of this label is prohibited”, are maintained thereon and shall comply with the instructions contained in such labels;

3. Shall have the device tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at intervals not to exceed six months except that devices containing only tritium need not be tested for any purpose and devices containing only krypton need not be tested for leakage;

4. Shall have the tests required by N.J.A.C. 7:28-4.5(g)3 and all other services involving the radioactive material, its shielding and containment, performed by the supplier or other person duly authorized by a specific license issued by the Department, a Federal agency, or any other state to manufacture, install or service such devices;

5. Shall maintain records of all tests performed on the devices as required under N.J.A.C. 7:28-4.5(g)3, including the dates and results of the tests and the names and addresses of the persons conducting the tests;

6. Upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the

shielding or containment of the radioactive material or the on-off mechanism or indicator, shall immediately suspend operation of the device until it has been either:

i. Repaired by a supplier, manufacturer, or other person holding a specific license issued by the Department, a Federal agency, or any other state to manufacture, install or service such devices; or

ii. Disposed of by transfer to a person holding a specific license issued by the Department, a Federal agency, or any other state to receive the radioactive material contained in the device; and

7. Shall be exempt from the requirements of this subchapter, except the provisions of N.J.A.C. 7:28-4.4(a), 4.9, 4.14, 4.18, 8.2, 8.4, and 13.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
Rewrote the section.

7:28-4.6 Application for and renewal of specific State licenses for manufacture, transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of naturally occurring or accelerator produced radioactive materials

(a) Upon approval of an initial or renewal application, a specific State license may be issued by the Department for a period of five years commencing on the date the license is issued.

(b) Application for specific State licenses and renewals shall be filed with the Department, on forms available from the Department.

(c) All applications shall contain the following signature and certification:

1. "I certify under penalty of law that the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties for submitting false, inaccurate or incomplete information, including fines and/or imprisonment."

2. The certification shall be signed by the highest ranking corporate, partnership, or governmental officer or official at the facility or the individual for which or for whom the specific State license is requested.

(d) An application for a specific State license may include a request for a State license authorizing one or more activities.

(e) Subject to the provisions of N.J.A.C. 7:28-4.7 and 4.8, an application for a specific State license for any human use or uses of radioactive material specified in one or more of the Human Use activity Groups I to VI inclusive listed in N.J.A.C. 7:28-4.7(b) may be approved for all of the uses within the group or groups which include the use or uses specified in the application.

(f) Information included in the specific State license application will be incorporated in and made a part of the terms and conditions of such license by reference.

(g) All applicants for initial and renewal applications for specific State licenses shall complete the application in its entirety with no reference to previously filed documents. The Department may accept photocopies of previous relevant applications.

(h) No initial or renewal specific State licenses shall be issued unless the appropriate annual license fee required by N.J.A.C. 7:28-4.18 is paid.

(i) Except as provided in N.J.A.C. 7:28-4.20, applications and documents submitted to the Department will be made available for public inspection.

(j) Upon the request of the Department at any time after the filing of the original or renewal specific State license application, and before the expiration of the license, the applicant shall submit further information to enable the Department to determine whether the application should be granted or denied or whether a license should be modified or revoked.

(k) All applications for a State license or amendment shall be signed by the applicant or State licensee or a person duly authorized to act for and on his behalf.

(l) The Department may deny an application for a specific State license if the applicant:

1. Fails to comply with any provisions of the Act or any rules promulgated thereunder;
2. Falsifies or makes misleading statements in the application for license; or
3. Falsifies or makes misleading statements in any documents which were utilized to obtain a license.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-4.7 General requirements for approval of an application for an initial specific State license or renewal of a specific State license for use of naturally occurring or accelerator produced materials

(a) If the Department determines that an applicant meets the requirements of this subchapter and the Act, it may issue an initial specific State license or renew a specific State license for non-human use of radioactive materials provided:

1. The applicant is qualified by reason of training and experience to use the radioactive material for the purpose requested in such manner as to protect health, minimize danger to life or property and prevent unnecessary radiation;
2. The applicant's proposed equipment, facilities and procedures are adequate to protect health, minimize danger to life or property and prevent unnecessary radiation; and
3. The applicant satisfies special requirements as may be applicable in N.J.A.C. 7:28-4.8.

(b) If the Department determines that an applicant meets the requirements of this subchapter and the Act, it may issue an initial specific State license or renew a specific State

license for human use of radioactive materials for one or more of the following Human Use Groups of activities:

1. Group I: Use of prepared radiopharmaceuticals for certain diagnostic studies involving measurements of uptake, dilution and excretion. This group does not include imaging or localization studies;

2. Group II: Use of prepared radiopharmaceuticals for diagnostic imaging and localization studies;

3. Group III: Use of generators and reagent kits for the preparation and use of radiopharmaceuticals for certain diagnostic studies;

4. Group IV: Use of prepared radiopharmaceuticals for certain therapeutic uses that do not normally require hospitalization for purposes of radiation safety;

5. Group V: Use of prepared radiopharmaceuticals for certain therapeutic uses that normally require hospitalization for purposes of radiation safety; and

6. Group VI: Use of sources and devices containing radionuclides for certain medical uses.

(c) To qualify for an initial specific State license or renewal of a specific State license for human use of radioactive materials for any purpose described in Groups I through VI in (b) above, the applicant must demonstrate qualification by reason of training and experience to use the radioactive material for the purpose requested and in such manner as to protect health, minimize danger to life or property, and prevent unnecessary radiation, by satisfying the training and experience requirements for the appropriate Human Use Group of activities as follows:

1. The training and experience must have been obtained within a five year period preceding the date of the application for an initial or renewal specific State license or must be supplemented by continuing education or experience. The original training and experience should have been received in a formal residency program in an accredited medical institution. Each applicant's training and experience are examined on a case-by-case basis. If an applicant wishes to use radiopharmaceuticals but does not have the training and experience described, the applicant may submit an application listing specific qualifications and these will be considered by the Department.

2. To qualify as adequately trained to use or directly supervise the use of radioactive material listed in Human Use Groups I, II, and/or III, an applicant shall have all the training and experience specified in (c)2i, ii and iii below;

i. Two hundred hours training in basic radioisotope handling techniques applicable to the use of unsealed sources. This training shall consist of lectures, laboratory sessions, discussion groups, or supervised experience in a nuclear medicine laboratory (that is, on-the-job training in a formalized training program) in the following areas and for the specific hours of class, laboratory or clinical experience:

(1) Radiation physics and instrumentation (100 hours);

(2) Radiation protection (30 hours);

(3) Mathematics pertaining to the use and measurement of radioactivity (20 hours);

(4) Radiation biology (20 hours); and

(5) Radiopharmaceutical chemistry (30 hours);

ii. Five hundred hours of experience with the types and quantities of radioactive material for which the application is being made. For authorization of Human Use Group III (generators and reagent kits), this experience shall include personal participation in five elution procedures, including testing of eluate, and in five procedures to prepare radiopharmaceuticals from Human Use Group III reagent kits; and

iii. Five hundred hours of supervised clinical training in an institutional nuclear medicine program. The clinical training shall cover all appropriate types of diagnostic procedures and shall include:

(1) Supervise examination of patients to determine the suitability for radioisotope diagnosis and recommendation on dosage to be prescribed;

(2) Collaboration in calibration of the dose and the actual administration of the dose to the patient, including calculation of the radiation dose, related measurement, and plotting data;

(3) Follow-up of patients when required; and

(4) Study and discussion with preceptor of case histories to establish most appropriate diagnostic procedures, limitation, contraindication, etc.

3. The requirements specified in (c)2i, ii and iii above may be satisfied concurrently in a three month training program if all three areas are integrated into the program.

4. Certification by the American Board of Nuclear Medicine, or the American Board of Radiology in Diagnostic Radiology with Special Competence in Nuclear Radiology, will be accepted as evidence that an applicant has had adequate training and experience to use Human Use Groups I, II, and III as specified in (c)2i, ii and iii above.

5. An applicant who wishes to be authorized for only one or two specific diagnostic procedures shall have training in basic radioisotope handling techniques and clinical procedures commensurate with the procedures and quantities of radioactive material being requested. Such requests will be examined on a case-by-case basis by the Department.

6. To qualify as adequately trained to use or directly supervise the use of radioactive material listed in Groups IV and or V, an applicant shall have:

i. Eighty hours training in basic radioisotope handling techniques applicable to the use of unsealed sources for therapy procedures, consisting of lectures, laboratory sessions, discussion groups or supervised experience in the following areas and for the following specific hours:

- (1) Radiation physics and instrumentation (25 hours);
- (2) Radiation protection (25 hours);
- (3) Mathematics pertaining to the use and measurement of radioactivity (10 hours); and
- (4) Radiation biology (20 hours);

7. To qualify as adequately trained to use or directly supervise the use of radioactive material listed in Group VI an applicant shall have:

i. Two hundred hours training in basic radioisotope handling techniques applicable to the use of sealed sources for therapy procedures, consisting of lectures, laboratory sessions, discussion groups, or supervised experience in the following areas and for the following specified hours:

- (1) Radiation physics and instrumentation (110 hours);
- (2) Radiation protection (40 hours);
- (3) Mathematics pertaining to the use and measurements of radioactivity (25 hours); and
- (4) Radiation biology (25 hours);

ii. Five hundred hours experience with the types and quantities of radioactive material for which the application is made;

iii. Clinical training in Group VI procedures consisting of active practice in therapeutic radiology with a minimum of three years experience of which at least one year shall have been spent in a formal training program accredited by the Residency Review Committee of Radiology and the Liaison Committee on Graduate Medical Education; and

iv. Evidence of certification by the American Board of Radiology in Radiology or Therapeutic Radiology, certification as a British "Fellow of the Faculty of Radiology" (FFR) or "Fellow of the Royal College of Radiology" (FRCR), or Canadian certification from the Royal College of Physicians and Surgeons (RCPS) in therapeutic radiology may be submitted in lieu of the training required in (c)7i and iii above.

8. In addition to the training required by (c)7 above, an applicant for a specific State license for Human Use Group VI activities shall demonstrate that its proposed equipment, facilities and procedures are adequate to protect health, minimize danger to life or property and prevent unnecessary radiation; and

9. An applicant for a specific State license for Human Use Group VI activities shall satisfy special requirements as may be applicable in N.J.A.C. 7:28-4.8.

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

In (c), inserted "specific State" preceding "license" in 8 and 9.

7:28-4.8 Special requirements for approval of an application for an initial specific State license or renewal of a specific State license for use of naturally occurring or accelerator produced radioactive materials

(a) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued for human use of radioactive materials by an institution provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;

2. The applicant has appointed a medical isotopes committee to evaluate all proposals for research, diagnosis, and therapeutic use of radioactive material within that institution. Membership of the committee shall include one authorized user for each type of use permitted by the specific State license, the radiation safety officer, a representative of the nursing service, and a representative of management who is neither an authorized user nor a radiation safety officer;

3. The applicant possesses adequate facilities for the clinical care of patients;

4. The physician(s) designated on the application as the individual user(s) has considerable pertinent training and experience in the use, handling and administration of radioactive material and, where applicable, the clinical management of radioactive patients; and

5. If the application is for a specific State license to use unspecified quantities of multiple types of radioactive materials, the applicant's staff has had substantial pertinent experience in using a variety of radioactive materials for various human uses.

(b) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued for human use of radioactive materials by a physician or dentist provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;

2. The applicant has access to a hospital possessing adequate facilities to hospitalize and monitor the applicant's radioactive patient whenever it is advisable; and

3. The applicant has had extensive training and supervised experience in the proposed use, the handling and administration of radioisotopes and, where applicable, the clinical management of radioactive patients. The applicant shall furnish suitable evidence of such experience with his application. A statement from the institution where the applicant acquired the training and experience, indicating its amount and nature, may be submitted as evidence of such experience.

(c) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued for human use of a sealed source of radioactive materials provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;
2. The applicant or, if the application is made by an institution, the individual user(s) has specialized training in therapeutic use of the radioactive device considered or has experience equivalent to such training; and
3. The individual user is a physician or dentist.

(d) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued for use of multiple quantities or types of radioactive material in research and development provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;
2. The applicant's staff has had substantial training and experience with a variety of radioisotopes for various research and development uses;
3. The applicant has established an isotope committee, composed of a radiological safety officer, a representative of management and one or more persons trained or experienced in the safe use of radioactive materials, which will review and approve or disapprove proposals for use of radioactive materials in the advance of purchase of such materials; and
4. The applicant has appointed a radiological safety officer who shall be responsible for rendering advice and assistance on radiological safety.

(e) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued for use of multiple quantities or types of radioactive material in processing for distribution to other authorized persons provided:

1. The applicant satisfies the general requirements for approval of specific State license application in N.J.A.C. 7:28-4.7;

2. The applicant's staff has had training and experience in the processing and distribution of a variety of radioisotopes; and

3. The applicant has appointed a radiological safety officer who shall be responsible for rendering advice and assistance on radiological safety.

(f) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued to distribute certain devices to persons generally licensed under N.J.A.C. 7:28-4.5(a) and (e) provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;
2. The applicant submits sufficient information relating to the design, manufacturer prototype testing, quality control procedures, labeling, proposed uses and potential hazards of the device to provide reasonable assurance that:
 - i. The radioactive material contained in the device cannot be easily removed from the device;
 - ii. No person possessing, using, transporting or exposed to the device will receive a radiation dose to a major portion of his body in excess of 0.5 rem in any one year under ordinary circumstances of use;
 - iii. The device can be safely operated by persons not having training in radiological protection; and
 - iv. The radioactive material within the device would not be accessible to unauthorized persons; and
3. In describing the label or labels and contents thereon to be affixed to the device, the applicant shall separately indicate those instructions and precautions which are necessary to assure safe operation of the device. Such instructions and precautions shall be contained on labels as described in N.J.A.C. 7:28-4.5(e).

(g) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued for use of a sealed source or sources of radioactive materials in industrial and nonmedical radiography provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;
2. The applicant has an adequate program for training radiographers and radiographers' assistants and submits to the Department a schedule or description of such program which specifies the following:

- i. Initial training;
- ii. Periodic training;
- iii. On-the-job training;

iv. Means to be used by the specific State licensee to determine the radiographer's knowledge and understanding of and ability to comply with the requirements of this subchapter, the specific licensing requirements, and the operation and emergency instructions of the applicant; and

v. Means to be used by the specific State licensee to determine the radiographer's assistant's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant;

3. The applicant has established and submitted to the Department satisfactory written operating and emergency instructions as prescribed by N.J.A.C. 7:28-17;

4. The applicant will have an adequate internal inspection system, or other management control, providing assurance that the requirements of this chapter, the specific State license provisions, and the applicant's operating and emergency instructions are followed by radiographers and radiographers' assistants;

5. The applicant submits a description of its overall organizational structure pertaining to the radiography program, including specified delegation of authority and responsibility for operation of the program; and

6. The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources for possible leakage and contamination and submits to the Department a description of such procedures, including:

- i. Instrumentation to be used;
- ii. Method of performing test (for example, points on equipment from where wipe samples will be taken and method of obtaining the wipe sample); and
- iii. Pertinent experience of the person who will perform the test.

(h) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license will be issued to transfer, possess, or control products or materials containing exempt concentrations of radioactive material specified in N.J.A.C. 7:28-4.3(b) which the transferor has introduced into the product or material provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;

2. The applicant submits:

- i. A description of the product or material into which the radioactive material will be introduced;

ii. The intended use of the radioactive material and the product into which it is introduced;

iii. The method of introduction;

iv. The initial concentration of the radioactive material in the product or material;

v. The control methods to assure that no more than the specified concentration is introduced into the product or material;

vi. The estimated time interval between introduction and transfer of the product or material; and

vii. The estimated concentration of the radioisotope in the product or material at the time of proposed transfer by the applicant;

3. The applicant provides:

i. Reasonable assurance that the concentrations of the radioactive material at the time of transfer will not exceed the exempt concentrations listed in N.J.A.C. 7:28-4.3(b);

ii. That reconcentration of the radioactive material in concentrations exceeding those exempted under N.J.A.C. 7:28-4.3(b) is not likely;

iii. That the product or material is not likely to be inhaled or ingested; and

iv. That use of the lower concentration(s) is not feasible; and

4. Within 30 days subsequent to the end of the reporting period, each specific State licensee shall file an annual report with the Department describing kinds and quantities of products transferred, the concentration of radioactive material contained and the quantity of radioactive material transferred during the reporting period which shall be the 12-month period ending June 30 of each calendar year.

(i) If the Department determines that an applicant meets the requirements of this subchapter and the Act, an initial specific State license or renewal of a specific State license may be issued to distribute certain devices to persons specifically licensed under N.J.A.C. 7:28-4.7 provided:

1. The applicant satisfies the general requirements for approval of specific State license applications in N.J.A.C. 7:28-4.7;

2. The applicant submits sufficient information relating to the design, manufacture, prototype testing, quality control procedures, labeling, proposed uses and potential hazards of the device to provide reasonable assurance that:

i. The radioactive material contained in the device cannot be easily removed;

ii. The device can be safely operated by persons having trained in radiological protection; and

iii. The radioactive material within the device would not be accessible to unauthorized persons; and

3. Each device distributed as authorized by such specific State license is to bear a label containing the following or substantially similar statements:

- i. "Caution: Radioactive Materials";
- ii. The isotope name;
- iii. The isotope quantity and date; and
- iv. The following statement:

"This device contains radioactive material and has been manufactured for distribution as a specifically State licensed device pursuant to _____

(identify appropriate section of the regulation)

(name of licensing agency and state)

License No. _____ by _____(name of supplier)

Disposal of this device shall conform to the requirements listed in N.J.A.C. 7:28-4.5(g)6ii of the Radiation Protection Code. Removal of this label is prohibited."

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Inserted "specific State" preceding "license(e)" throughout.

7:28-4.9 Terms and conditions of general and specific State licenses

(a) Each State license issued pursuant to this subchapter shall be subject to all the provisions of the Act, now or hereafter in effect, and to this chapter and orders of the Department.

(b) No State license to possess or utilize radioactive material pursuant to this subchapter shall be transferred or assigned.

(c) Each person licensed by the Department pursuant to this subchapter shall confine his or her possession and use of radioactive material to the locations and purposes authorized by such State license, and shall not use or permit the use of radioactive materials contrary to the applicable requirements of this chapter. Persons licensed under the provisions of this subchapter may transfer radioactive material within the State only to the persons licensed to receive such material or as otherwise authorized by the Department in writing.

(d) The Department may incorporate in any State license at the time of issuance, or thereafter, all such additional requirements and conditions with respect to the State licensee's manufacture, distribution or arrangement for the distribution, sale, lease, receipt, possession, use, ownership or transfer of radioactive material as it deems appropriate or necessary in order to assure compliance with this chapter and the Act.

(e) Each State licensee authorized under N.J.A.C. 7:28-4.8(f) to distribute certain devices to generally licensed persons shall:

1. Report to the Department all transfers of such devices to persons in New Jersey generally licensed under N.J.A.C. 7:28-4.5(a) and (c). Such report shall identify each general licensee by name and address, the type and number of device(s) transferred, and the quantity and kind of radioactive material contained in each device. The report shall be submitted within 30 days after the end of each calendar quarter in which such a device is transferred to generally licensed persons; and

2. Furnish to each general licensee to whom such device is transferred a copy of N.J.A.C. 7:28-4.5(a), (e) and (g), 8.2 and 8.4.

(f) Each State licensee authorized under N.J.A.C. 7:28-4.8(i) to distribute certain devices to specifically licensed persons shall:

1. Report to the Department all transfers of such devices to persons in New Jersey specifically licensed under N.J.A.C. 7:28-4.7 and 4.8. Such report shall identify each specific licensee by name and address, the type and number of device(s) transferred, and the quantity and kind of radioactive material contained in each device. The report shall be submitted within 30 days after the end of each calendar quarter in which such a device is transferred to specifically licensed persons.

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Inserted "State" preceding "license(e)" in (b) and (e); rewrote (d).

7:28-4.10 Expiration of specific State license

Except as provided in N.J.A.C. 7:28-4.11, each specific State license shall expire at 12:01 A.M. of the day, in the month and year stated in the license.

7:28-4.11 Status of specific State licenses pending renewal

In any case in which a specific State licensee has filed a complete application in proper form for renewal of a specific State license not less than 30 days prior to expiration of the existing specific State license, such specific State license and all its existing conditions shall not expire until the Department has acted upon the application.

Amended by R.2005 d.156, effective .

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Inserted "specific State" preceding "license(e)" throughout.

7:28-4.12 Amendment of a specific State license at request of licensee

(a) Applications for amendment of a specific State license shall be filed in accordance with N.J.A.C. 7:28-4.6 and shall specify the amendment desired and the grounds for such amendment.

(b) The Department will evaluate only amendment applications submitted by personnel authorized by the State licensee.

(c) The applicant for an amended specific State license shall not engage in the activities for which an amendment has been requested until approval has been granted by the Department.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-4.13 Records

All persons licensed pursuant to this subchapter shall keep records in accordance with N.J.A.C. 7:28-8.

7:28-4.14 Inspections

(a) All State licensees shall allow the Department or its agents to inspect radioactive material and the facilities and premises where radioactive material is used or stored.

(b) No person shall prevent, prohibit, obstruct, hinder, delay or interfere with personnel of this Department or its agents in performing their duties.

(c) Upon request by the Department, or its agents, State licensees shall make available for inspection by the Department records kept pursuant to this chapter.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-4.15 Tests

(a) At the request of the Department or its agents, each State licensee shall perform, or allow the Department to perform if the Department so desires, such tests as the Department deems appropriate or necessary for the administration of this subchapter, including tests of the following:

1. Radioactive material;
2. Facilities where radioactive material is utilized or stored;
3. Radiation detection and monitoring instruments; and
4. Equipment and devices used in connection with the utilization or storage of radioactive material.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-4.16 Modification, revocation, suspension, and termination of general and specific State licenses

(a) Each general State license shall be subject to modification, suspension or revocation by reason of amendments to the Act, adoption of rules by the Commission or the Department, orders issued by the Department pursuant to authority of the Act, or for violation or failure to observe

any of the terms and provisions of the Act, State license or any rule of the Commission or the Department, or order of the Department.

(b) Each specific State license shall be subject to modification, suspension or revocation by reason of:

1. Amendments to the Act;
2. Adoption of rules by the Commission;
3. Orders issued by the Department pursuant to the authority of the Act;
4. Conditions revealed by the application for a specific State license or statement of fact or any report, records or inspection or other means which would warrant the Department to refuse to grant a specific State license on an original application;
5. Violation of or failure to observe any of the terms and provisions of the Act or the State license, or any rule of the Commission or Department or order of the Department;
6. Falsification or misleading statements in any State license application;
7. Alteration of State licensing document;
8. Falsification of required records; or
9. Failure to make timely payment of State licensing fees.

(c) If a specific State license is not to be renewed or if a State licensee requests a termination of its State license, the State licensee shall furnish to the Department, prior to the expiration date of the State license, close-out surveys, wipe tests and/or soil samples demonstrating that the facility meets the requirements of N.J.A.C. 7:28-12. The facility shall also provide a disposition certificate attesting to the disposal of radioactive material.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
Rewrote (c).

7:28-4.17 Requests for an adjudicatory hearing

(a) When the Department denies an initial application for or renewal of a specific State license, or determines to modify, revoke, suspend or terminate a general or specific State license, the Department shall send a notice of decision to the applicant or licensee by certified mail return receipt requested. The notice shall advise the applicant or licensee of the right to request a contested case hearing pursuant to the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq. and the New Jersey Uniform Administrative Procedure Rules, N.J.A.C. 1:1-1 et seq. The notice shall include the following information:

1. Where and whom hearing requests should be sent;

2. The deadline by which hearing requests must be submitted;
3. The information that is required to be in the hearing request under (c) below; and
4. The requirements for requesting a stay under N.J.A.C. 7:28-4.18.

(b) All requests for a contested case hearing must be received by the Department within 30 calendar days of the date upon which the notice of decision was received.

(c) All requests for a contested case hearing shall be submitted in writing to the Department, at Office of Legal Affairs, ATTENTION: Adjudicatory Hearing Requests, Department of Environmental Protection, CN 402, Trenton, New Jersey 08625-0402. The request shall contain:

1. The name, address and telephone number of the person making such request;
2. A statement of the legal authority and jurisdiction under which the request for a hearing is made;
3. A brief and clear statement of specific facts describing the Department decision appealed from as well as the nature and scope of the interest of the requestor in such decision; and
4. A statement of all facts alleged to be at issue and their relevance to the Department decision for which a hearing is requested. Any legal issues, associated with the alleged facts at issue, must also be included.

(d) The Department shall determine whether any request for a contested case hearing should be granted. In making such determination, the Department shall evaluate the request to determine whether a contested case, as defined by the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq., exists and whether there are issues of fact which, if assumed to be true, might change the Department's decision. Where only issues of law are raised by a request for a hearing, the request will be denied. Denial by the Department of a request for a contested case hearing shall constitute the final decision of the Department for the purposes of judicial appeal.

Administrative Change in (c).
See: 23 N.J.R. 3325(b).

7:28-4.18 Requirements governing requests for stay of the effective date of the Department decision for which an adjudicatory hearing is requested

(a) The Department may grant a stay of the effective date of a decision to deny, modify, revoke or suspend any State license. The applicant for such a stay must submit evidence that one of the following circumstances exist:

1. The granting of such stay is required as a constitutional or statutory right; or

2. The potential impact on public health, safety, welfare or the environment which might result from a decision to grant a stay is greatly outweighed by immediate, irreparable injury to the specific party requesting such stay.

(b) The decision to grant a contested case hearing request shall not automatically result in a stay of the Department action appealed from absent an express decision to stay such action by the Director. The burden shall be upon the party requesting a hearing to explicitly request a stay of action within the same document as well as to disclose reasons why such stay should be granted.

(c) Department decisions are effective, according to their terms, unless stayed by the Department in writing, upon receipt of written request pursuant to this section.

(d) Written requests for a stay of the effective date of the Department's decision must be made to the Department within 30 calendar days of the date upon which the notice of decision was received.

(e) Any stay that is granted by the Department shall be temporary and in no case shall it extend beyond the date of the Department's final decision of the contested case.

(f) Determinations made pursuant to this section shall be made in a writing mailed to the specific party making such request.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

7:28-4.19 Specific State license fee schedule for the manufacture, production, transfer, distribution or arrangement for distribution, sale, lease, receipt, acquisition, ownership, possession or use of naturally occurring or accelerator produced radioactive material

(a) The specific State license fee schedule is as follows:

<u>Category</u>	<u>Annual License Fee</u>
1. Radioactive materials license for Human Use Group I:	
i. Possession of material only;	\$350.00
ii. Administration of less than 10 doses per year;	\$500.00
iii. Administration of 10 through 49 doses per year;	\$650.00
iv. Administration of 50 or more doses per year.	\$850.00
2. Radioactive materials license for Human Use Group II:	
i. Possession of material only;	\$350.00
ii. Administration of less than 200 doses per year;	\$650.00
iii. Administration of between 200 and 1,499 doses per year;	\$1,300.00
iv. Administration of 1,500 or more doses per year.	\$2,000.00

<u>Category</u>	<u>Annual License Fee</u>
3. Radioactive materials license for Human Use Group III:	
i. Possession of material only;	\$350.00
ii. Administration of less than 200 doses per year;	\$350.00
iii. Administration of 200 through 999 doses per year;	\$650.00
iv. Administration of 1,000 or more doses per year.	\$850.00
4. Radioactive materials license for Human Use Group IV:	
i. Possession of material only;	\$350.00
ii. Administration of less than 10 doses per year;	\$500.00
iii. Administration of 10 through 49 doses per year;	\$650.00
iv. Administration of 50 or more doses per year.	\$850.00
5. Radioactive materials license for Human Use Group V:	
i. Possession of material only;	\$350.00
ii. Administration of less than 10 doses per year;	\$500.00
iii. Administration of 10 through 49 doses per year;	\$650.00
iv. Administration of 50 or more doses per year.	\$850.00
6. Radioactive materials license for Human Use Group VI:	
i. Possession of material only;	\$850.00
ii. Administration of less than 10 doses per year;	\$1,000.00
iii. Administration of 10 through 49 doses per year;	\$1,150.00
iv. Administration of 50 or more doses per year.	\$1,300.00
7. Radioactive material license for commercial manufacture, processing and/or distribution of radioactive materials for Human Use.	\$4,950.00
8. Radioactive materials license for commercial manufacture, processing and/or distribution of radioactive materials.	\$4,950.00
9. Radioactive materials license for radioactive materials as sealed sources used for calibration and quality control purposes with a possession limit of 10 mCi or less.	\$1,000.00
10. Radioactive materials license for radioactive materials, as sealed sources used for calibration and quality control purposes with a possession limit greater than 10 mCi.	\$1,650.00
11. Radioactive materials license for radioactive materials as sealed sources contained in devices used for analytical purposes with a possession limit of one mCi or less.	\$850.00
12. Radioactive materials license for radioactive materials, except radium-226, as sealed sources, contained in devices used for analytical purposes with a possession limit greater than one mCi but less than or equal to 300 mCi:	

<u>Category</u>	<u>Annual License Fee</u>
i. A government body, department, agency, authority, or any other unit of any state, Federal, county or local government using X-ray fluorescence devices for lead paint analysis	\$200.00
ii. All others	\$1,250.00
13. Radioactive materials license for radioactive materials, except radium-226, as sealed sources, contained in devices used for analytical purposes with a possession limit of greater than 300 mCi.	\$1,650.00
14. Radioactive materials license for radioactive radium-226, as sealed sources, contained in devices used for analytical purposes with possession limit greater than one mCi but less than or equal to 50 mCi.	\$1,650.00
15. Radioactive materials license for radioactive radium-226, as sealed sources, contained in devices used for analytical purposes with a possession limit greater than 50 mCi.	\$2,500.00
16. Radioactive materials license for radioactive materials as sealed sources for Non-Medical Industrial Radiography.	\$3,300.00
17. Radioactive materials license for radioactive materials not as sealed sources with a possession limit of 500 mCi or less.	\$2,500.00
18. Radioactive materials license for radioactive materials not as sealed sources with a possession limit of greater than 500 mCi.	\$3,300.00

(b) All State licensees shall pay the fees set forth in (a) above by check payable to "Treasurer, State of New Jersey" prior to August 1 of each year.

1. In the event that the fees are paid after August 1, a delinquency fee equal to one-half of the annual State license fee will be imposed. Failure to pay an annual State license fee including any accrued delinquency fees for longer than 90 days after August 1 shall constitute grounds for suspension or revocation of the State license pursuant to N.J.A.C. 7:28-4.16.

2. The annual State license fee shall be mailed to:

State of New Jersey
 Department of Environmental Protection
 Bureau of Revenue
 428 East State Street
 PO Box 420
 Trenton, New Jersey 08625-0420

(c) Facilities for which multiple State license categories apply shall be charged the sum of the fees for each of the applicable categories.

(d) The term "doses per year" when used in (a) above means the number of doses of radioactive materials within a

category that are administered during the period July 1 to June 30.

(e) The term "human use group" when used in (a) above includes the use of radioactive material for calibration and quality control procedures as well as the administration of radioactive materials to humans.

(f) Fees submitted to the Department are non-refundable.

Amended by R.1991 d.417, effective August 5, 1991.

See: 23 N.J.R. 3300(a), 23 N.J.R. 2362(a).

In (a), changed fees in all categories; substantial rewording in 1 through 8; added 9 through 18.

In (b), substituted old text with new text; added (b)1 and 2.

Added (c), (d), (e).

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote the section.

7:28-4.20 Confidentiality claims

(a) Any applicant required to submit any information pursuant to the Act or this chapter which in the applicant's opinion constitutes trade secrets, proprietary information or information related to national security, may assert a confidentiality claim by following the procedures set forth in this subchapter.

(b) Any applicant submitting any information to the Department and asserting a confidentiality claim covering any information contained therein shall submit two documents to the Department. One shall contain all the information required by the Act or this chapter including any information which the applicant alleges to be entitled to confidential treatment. The second shall be identical to the first except that it shall contain no information which the applicant alleges to be entitled to confidential treatment. The second can be a photocopy of the first, with the allegedly confidential material blacked out.

(c) The top of each page of the first submission containing the information which the applicant alleges to be entitled to confidential treatment shall display the heading "CONFIDENTIAL" in bold type, or stamp.

(d) All parts of the text of the first submission which the applicant alleges to be entitled to confidential treatment shall be underscored or highlighted in a clearly identifiable manner. This manner of marking confidential information shall be such that both the allegedly confidential information and the underscoring or highlighting is reproducible on photocopying machines.

(e) The first submission, containing the information which the applicant alleges to be entitled to confidential treatment, shall be sealed in an envelope which shall display the word "CONFIDENTIAL" in bold type or stamp on both sides. This envelope, together with the second, non-confidential submission (which may or may not be enclosed in a separate envelope, at the option of the applicant), shall be enclosed in another envelope for transmittal to the Department. The outer envelope shall bear no marking indicating the confidential nature of the contents.

(f) To ensure proper delivery, the complete package should be sent by certified mail, return receipt requested, or by other means which will allow verification of receipt. Ordinary mail may be used, but the Department will assume no responsibility for packages until they are actually received.

7:28-4.21 Access to information; non-disclosure

(a) Until such time as a final confidentiality determination has been made, access to any information for which a confidentiality claim has been made will be limited to Department employees whose activities necessitate such access and as provided at N.J.A.C. 7:28-4.24 and 4.26.

(b) No disclosure of information for which a confidentiality claim has been asserted shall be made to any other persons except as provided in this subchapter.

(c) Nothing in this section shall be construed as prohibiting the incorporation of confidential information into accumulations of data subject to disclosure as public records, provided that such disclosure is not in a form that would foreseeably allow persons, not otherwise having knowledge of such confidential information, to deduce from it the confidential information or the identity of the owner or operator who supplied it to the Department.

7:28-4.22 Confidentiality determinations

(a) Information for which a confidentiality claim has been asserted will be treated by the Department as entitled to confidential treatment, unless the Department determines that the information is not entitled to confidential treatment as provided in this section and N.J.A.C. 7:28-4.23.

(b) The Department shall act upon a confidentiality claim and determine whether information is or is not entitled to confidential treatment whenever the Department:

1. Receives a request under N.J.S.A. 47:1A-1 et seq. to inspect or copy such information; or
2. Desires to determine whether information in its possession is entitled to confidential treatment; or
3. Desires for any reason in the public interest to disclose the information to persons not authorized by this subchapter to have access to confidential information.

(c) The Department shall make the initial determination whether information is or is not entitled to confidential treatment.

1. If the Department determines that information is not entitled to confidential treatment, it shall so notify the applicant who submitted the information.
2. The notice required under this subsection shall be sent by certified mail, return receipt requested and shall state the reasons for the Department's initial determination.
3. An applicant who wishes to contest a determination by the Department shall, within 30 days of notification of the determination, submit evidence to support the applicant's contention that the Department's initial determination was incorrect. The evidence may include, but need not be limited to, a statement indicating:

- i. The period of time for which confidential treatment is desired by the applicant (for example, until a certain date, until the occurrence of a specified event, or permanently);
- ii. The measures taken by the applicant to guard against undesired disclosure of the information to others;
- iii. The extent to which the information has been disclosed to others, and the precautions taken in connection therewith; and

iv. The extent of which disclosure of the information would result in substantial damage to the applicant, including a description of the damage, an explanation of why the damage would be substantial, and an explanation of the causal relationship between disclosure and the damage.

4. Failure of an applicant to furnish timely comments or exceptions waives the applicant's confidentiality claim.

5. The applicant may assert a confidentiality claim to any information submitted to the Department by an applicant as part of its comments pursuant to (c)4 above.

6. The Department may extend the time limit for submitting comments pursuant to (c)4 above for good cause shown by the applicant and upon receipt of a request in writing.

(d) After receiving the evidence, the Department shall review its initial determination and make a final determination.

1. If, after review, the Department determines that the information is not entitled to confidential treatment, the Department shall so notify the applicant by certified mail, return receipt requested. The notice shall state the basis for the determination, that it constitutes final agency action concerning the confidentiality claim, and that the Department shall make the information available to the public on the 14th day following receipt by the applicant of the written notice.

2. If, after review, the determination is made that information is entitled to confidential treatment, the information shall not be disclosed, except as otherwise provided by this subchapter. The applicant shall be notified of the Department's determination by certified mail, return receipt requested. The notice shall state the basis for the determination and that it constitutes final agency action.

7:28-4.23 Substantive criteria for use in confidentiality determinations

(a) When the applicant satisfies each of the following substantive criteria, the Department shall determine that the information for which a confidentiality claim has been asserted is confidential:

1. The applicant has asserted a confidentiality claim which has not expired by its terms, been waived or withdrawn;
2. The applicant has shown that reasonable measures have been taken to protect the confidentiality of the information and that the applicant intends to continue to take such measures;
3. The information is not, and has not been, available or otherwise disclosed to other persons without the applicant's consent (other than by subpoena or by discovery based on a showing of special need in a judicial or quasi-

judicial proceeding, as long as the information has not become available to persons not involved in the proceeding);

4. No statute specifically requires disclosure of the information; and

5. The applicant has shown that disclosure of the information would be likely to cause substantial damage to its competitive position.

7:28-4.24 Disclosure of confidential information to other public agencies

(a) The Department may disclose confidential information to persons other than Department employees only as provided in this section or N.J.A.C. 7:28-4.25.

(b) The Department may disclose confidential information to any other State agency or to a Federal agency if:

1. The Department receives a written request for disclosure of the information from a duly authorized officer or employee of the other agency;

2. The request sets forth the official purpose for which the information is needed;

3. The Department notifies the other agency of the Department's determination that the information is entitled to confidential treatment, or of any unresolved confidentiality claim covering the information;

4. The other State or Federal agency has first furnished to the Department a written formal legal opinion from the agency's chief legal officer or counsel stating that under applicable law the agency has the authority to compel the person who submitted the information to the Department to disclose such information to the other agency; and

5. The other agency agrees not to disclose the information further unless:

i. The other agency has statutory authority both to compel production of the information and to make the proposed disclosure; or

ii. The other agency has obtained the consent of the affected owner or operator to the proposed disclosure; and

6. The other agency has adopted regulations or operates under statutory authority that will allow it to preserve confidential information from unauthorized disclosure.

(c) Except as otherwise provided at N.J.A.C. 7:28-4.25, the Department shall notify in writing the applicant who supplied the confidential information of:

1. Its disclosure to another agency;
2. The date on which disclosure was made;
3. The name of the agency to which disclosed; and

4. A description of the information disclosed.

7:28-4.25 Disclosure by consent

(a) The Department may disclose any confidential information to any person if it has obtained the written consent of the applicant to such disclosure.

(b) The giving of consent by an applicant to disclose shall not be deemed to waive a confidentiality claim with regard to further disclosures unless the authorized disclosure is of such a nature as to make the disclosed information accessible to the general public.

7:28-4.26 Disclosure based on imminent and substantial danger

(a) Upon a finding that disclosure of confidential information would serve to alleviate an imminent and substantial danger to public health and the environment, the Department may:

1. Prescribe and make known to the applicant such shorter comment period (N.J.A.C. 7:28-4.22(c)4), post-determination waiting period (N.J.A.C. 7:28-4.22(d)1), or both, as it finds necessary under the circumstances; or

2. Disclose confidential information to any person whose role in alleviating the danger to public health and the environment necessitates that disclosure. Any such disclosure shall be limited to information necessary to enable the person to whom it is disclosed to carry out the activities in alleviating the danger.

(b) Any disclosure made pursuant to this section shall not be deemed a waiver of a confidentiality claim, nor shall it of itself be grounds for any determination that information is no longer entitled to confidential treatment.

7:28-4.27 Security procedures

(a) Submissions to the Department pursuant to the Act and this chapter will be opened only by persons authorized by the Department engaged in administering the Act and this chapter.

(b) Only those Department employees whose activities necessitate access to information for which a confidentiality claim has been made, shall open any envelope which is marked "CONFIDENTIAL".

(c) All submissions entitled to confidential treatment as determined at N.J.A.C. 7:28-4.22 shall be stored by the Department only in locked cabinets.

(d) Any record made or maintained by Department employees which contains confidential information shall contain appropriate indicators identifying the confidential information.

7:28-4.28 Wrongful access or disclosure; penalties

(a) A person shall not disclose, seek access to, obtain or have possession of any confidential information obtained pursuant to the Act or this chapter, except as authorized by this subchapter.

(b) Every Department employee who has custody or possession of confidential information shall take appropriate measures to safeguard such information and to protect against its improper disclosure.

(c) A Department employee shall not disclose, or use for his or her private gain or advantage, any information which came into his or her possession, or to which he or she gained access, by virtue of his or her official position of employment or contractual relationship with the Department.

(d) If the Department finds that any person has violated provisions of this subchapter, it may:

1. Commence a civil action in Superior Court for a restraining order and an injunction barring that person from further disclosing confidential information.
2. Pursue any other remedy available by law.

(e) In addition to any other penalty that may be sought by the Department, violation of this subchapter by a Department employee shall constitute grounds for dismissal, suspension, fine or other adverse personnel action.

(f) Use of any of the remedies specified under this section shall not preclude the use of any other remedy.

SUBCHAPTER 5. CONTROLLED AREAS**7:28-5.1 Areas which must be controlled**

(a) Except as provided in (b) below, every area in which there is any reasonable possibility of an occupant receiving an exposure dose from radiation and radioactive material more than the dose specified in N.J.A.C. 7:28-6 for radiation levels outside a controlled area shall be set apart as a controlled area by any person having possession, custody or control of any ionizing radiation-producing machine and/or radioactive material.

(b) All outgoing or incoming shipments of radioactive material shall be transported in conformance with all pertinent U.S. Department of Transportation regulations.

Amended by R.2000 d.120, effective March 20, 2000.
See: 31 N.J.R. 3007(a), 32 N.J.R. 1016(a).
In (b), deleted N.J.A.C. reference.

7:28-5.2 Limitations on controlled areas

No area within controlled areas shall be used for residential quarters although a room or rooms in residential buildings may be set apart as a controlled area.

7:28-5.3 Precautionary procedures

(a) Any person having possession, custody or control of any ionizing radiation-producing machine and/or radioactive material shall comply with the following precautionary procedures:

1. Area surveys shall be performed in controlled areas and in adjacent areas to insure that exposure levels to individuals conform to N.J.A.C. 7:28-6. The surveys shall be performed in accordance with N.J.A.C. 7:28-7, Radiation Surveys and Personnel Monitoring.

2. Wipe tests shall be performed in areas where unsealed sources are routinely used to insure compliance with the requirements for radioactive contamination control in N.J.A.C. 7:28-9. The wipe tests shall be performed in accordance with N.J.A.C. 7:28-7.

3. Personnel surveys shall be performed and documented to insure compliance with N.J.A.C. 7:28-9.

4. All individuals entering a controlled area shall wear personnel monitoring equipment pursuant to the requirements for the use of personnel monitoring equipment in N.J.A.C. 7:28-7.

5. Proper and adequate instruction shall be given to all personnel working in controlled areas in the use of necessary safeguards and procedures, and they shall be supplied with such safety devices as may be required.

6. Adequate instructions or an escort shall be provided to all personnel frequenting or visiting controlled areas as shall be necessary to prevent unnecessary exposure.

7. The area shall be posted in accordance with N.J.A.C. 7:28-10.

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

In (a), substituted "Radiation Surveys and Personnel Monitoring" for "pertaining to Radiation survey and personnel monitoring" in 1.

7:28-5.4 Termination of controlled areas

Before an area where radioactive materials had been stored, utilized or generated can be reclassified as an uncontrolled area, surveys shall be performed and documented to ensure compliance with N.J.A.C. 7:28-6 for radiation levels outside of controlled areas. Wipe tests shall be performed and documented in areas where unsealed sources had been used or generated.

SUBCHAPTER 6. DOSE LIMITS**7:28-6.1 Exposure of individuals in controlled areas**

(a) Except as provided in (b) below, no individual in a controlled area shall receive in any period of one calendar quarter a dose in excess of the following specified limits:

1. Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads — 1½ Rems;
2. Hands and forearms; feet and ankles — 18¾ Rems;
3. Skin of whole body — 7½ Rems.
4. Doses received by human patients from intentional exposure to radiation for the purpose of diagnosis or therapy shall be excluded from the computations set forth in (a)1, 2 and 3 above.

(b) An individual in a controlled area may receive a dose to the whole body greater than that permitted under subsection (a) of this Section, provided:

1. During any calendar quarter the dose to the whole body shall not exceed three Rems;
2. The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed five (N-18) Rems where "N" equals the individual's age in years at his last birthday; and
3. The owner has determined the individual's accumulated occupational dose to the whole body on Form BRP-27, or on a clear and legible record containing all the information required in that form; and has otherwise complied with the requirements of subsection (c) of this Section. As used in this subsection "dose to the whole body" includes any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye; and
4. Doses received by human patients from intentional exposure to radiation for the purpose of diagnosis or therapy shall be excluded, in the computations set forth in paragraphs 1 and 2 of this subsection.

(c) The following requirements must be satisfied by owners who propose, pursuant to subsection (b) of this Section to permit individuals in a controlled area to receive exposure to radiation in excess of the limits specified in subsection (a) of this Section:

1. Before permitting any individual in a controlled area to receive exposure to radiation in excess of the limits specified in subsection (a) of this Section each owner shall:
 - i. Obtain a certificate on Form BRP-27, or on a clear and legible record containing all the information required in that form, signed by the individual showing each period of time after the individual attained the age of 18 in which the individual received, or may have received, an occupational dose of radiation; and
 - ii. Calculate on Form BRP-27, in accordance with the instructions, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under subsection (b) of this Section.

2. In the preparation of Form BRP-27, or on a clear and legible record containing all information required in that form, the owner shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. In any case where an owner is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Parts of body	Assumed exposure in rems for calendar quarters prior to Jan. 1, 1961	Assumed exposure in rems for calendar quarters beginning on or after Jan. 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye	3¾	1¾

3. If calculation of the individual's accumulated occupational dose for all periods prior to January 1, 1961, yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in subsection (b) of this Section, the excess may be disregarded. The owner shall retain and preserve records used in preparing Form BRP-27, or its equivalent, as specified in subsection (b)3 of this Section.

(d) For individuals within a controlled area, the radiation dose to tissues of the body from radioactive materials within the body shall be controlled by limiting the average rates at which such materials are taken into the body. Where the intake results from the occurrence of radioactive materials

in the air, the concentration of the radioisotopes in the air, averaged over any seven consecutive days, shall not be permitted to exceed the concentrations listed in Section 6.5(a) (Average concentrations) of this Chapter, Column B, or prorated values if more than one isotope is present. The limits given in Section 6.5(a) of this Chapter, Column B, are based upon exposure to the concentrations specified for 40 hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than 40, the limits specified in the table may be increased proportionately. In any such period, where the number of hours of exposure is greater than 40, the limits specified in the table shall be decreased proportionately.

(e) Except as authorized by the Department in writing, no allowance shall be made in subsection (d) of this Section or the use of protective clothing or equipment, or particle size.

1. The Department may authorize an owner to expose an individual in a controlled area to airborne concentrations in excess of the limits specified in Section 6.5(a) of this Chapter, Column B, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable and that the individual will not inhale concentrations in excess of the limits established in Section 6.5(a) of this Chapter, Column B. Each application under this paragraph shall include an analysis of particle size in the concentrations and a description of the methods used in determining the particle size.

2. The Department may authorize an owner to expose an individual in a controlled area to airborne concentrations in excess of the limits specified in Section 6.5(a) of this Chapter, Column B, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest, or absorb quantities of radioactive material in excess of those which might otherwise be permitted under this Chapter for individuals in controlled areas during a 40-hour week. Each application under this paragraph shall contain the following information:

- i. A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;
- ii. Procedures for the fitting, maintenance, and cleaning of the protective equipment;
- iii. Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each workweek. The proposed periods for use of the equipment by an individual shall not be of such duration as would discourage observance by the individual of the proposed procedures; and
- iv. The average concentrations present in the areas occupied by the individuals.

(f) The dose received by any individual under 18 years of age shall not exceed 10 percent of the limits established in (a) above nor shall such an individual be exposed to concentrations of radioactive material greater than those listed in N.J.A.C. 7:28-11 Appendix, Table 1, Column 1.

Amended by R.2005 d.156, effective may 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote (f).

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

In (a), substituted "below" for "of this section" in the introductory paragraph and designated the existing "Note" text as 4 and inserted "from the computations set forth in (a)1, 2, and 3 above" at the end.

Case Notes

Successors to radium processor which disposed waste product on property were absolute liable to subsequent purchaser of property for damages caused by gamma radiation and radon gas from radium tailings. *T & E Industries, Inc. v. Safety Light Corp.*, 227 N.J.Super. 228, 546 A.2d 570 (A.D.1988), certification granted 117 N.J. 118, 564 A.2d 848, certification granted 117 N.J. 119, 564 A.2d 848, affirmed as modified 123 N.J. 371, 587 A.2d 1249.

Processor is absolutely liable for damages resulting from processing of radium and disposal of its waste product. *T & E Industries, Inc. v. Safety Light Corp.*, 227 N.J.Super. 228, 546 A.2d 570 (A.D.1988), certification granted 117 N.J. 118, 564 A.2d 848, certification granted 117 N.J. 119, 564 A.2d 848, affirmed as modified 123 N.J. 371, 587 A.2d 1249.

Absolute liability for damages resulting from processing of radium and disposal of its waste product is not limited to situations in which processing and disposal interferes with rights of neighboring property owners. *T & E Industries, Inc. v. Safety Light Corp.*, 227 N.J.Super. 228, 546 A.2d 570 (A.D.1988), certification granted 117 N.J. 118, 564 A.2d 848, certification granted 117 N.J. 119, 564 A.2d 848, affirmed as modified 123 N.J. 371, 587 A.2d 1249.

Doctrine of caveat emptor is not defense to absolute liability claim by purchaser against prior landowner for damages unless purchaser knowingly accepts such burden. *T & E Industries, Inc. v. Safety Light Corp.*, 227 N.J.Super. 228, 546 A.2d 570 (A.D.1988), certification granted 117 N.J. 118, 564 A.2d 848, certification granted 117 N.J. 119, 564 A.2d 848, affirmed as modified 123 N.J. 371, 587 A.2d 1249.

7:28-6.2 Dose limits for individual members of the public

(a) Each State licensee or registrant shall conduct operations as follows:

1. The total effective dose equivalent to individual members of the public from the State licensed or registered operation does not exceed 0.1 rem (one millisievert (mSv)) in a year, exclusive of the dose contributions from background radiation, from any medical administration the individual has received, from exposure to individuals administered radioactive material and released in accordance with Federal regulations at 10 CFR 35.75, and from the State licensee's disposal of radioactive material into a sanitary sewer system in accordance with N.J.A.C. 7:28-11.2; and
2. The dose in any unrestricted area from external sources, exclusive of the dose contribution from patients administered radioactive materials and released in accordance with Federal regulations at 10 CFR 35.75, does not exceed 0.002 rem (0.02 millisievert) in any one hour.

(b) If the State licensee or registrant permits members of the public to have access to controlled areas, the limits for members of the public as set forth in (a) above continue to apply to those individuals.

(c) Notwithstanding (a)1 above, a State licensee may permit visitors to a patient who cannot be released under 10 CFR 35.75 to receive a radiation dose greater than 0.1 rem (one mSv) per year if:

1. The radiation dose received does not exceed 0.5 rem (five mSv) annually; and

2. The authorized user, as defined in 10 CFR 35.2, has determined before the visit that it is appropriate.

(d) A registrant or State licensee may apply to the Department, which may approve upon recommendation from the Commission, for authorization to conduct operations in such a manner that the annual dose received by an individual member of the public does not exceed 0.5 rem (five mSv). The registrant or State licensee shall include the following information in this application:

1. Demonstration of the need for and expected duration of operations in excess of the limit in (a) above;

2. A description of the registrant's or State licensee's program to assess and control dose within the 0.5 rem (five mSv) annual limit; and

3. The procedures to be followed to maintain the dose as low as is reasonably achievable.

(e) Transportation and packaging of radioactive materials must comply with all regulations of the U.S. Department of Transportation and all other agencies of the United States having jurisdiction.

(f) The Department may impose in a State license additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a State licensee may release in effluents (see N.J.A.C. 7:28-11 Appendix, Tables 1 and 2) in order to prevent exceedence of the collective dose.

Repeal and New Rule, R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
Section was "Radiation levels outside controlled areas".

7:28-6.3 Concentrations in effluents from controlled areas

Concentrations of radioactive materials in effluents from controlled areas shall meet the requirements of Sections 11.2 (Disposal by release into sanitary sewerage systems) and 11.3 (Disposal by discharges into the air, ground waters or surface waters) of this Chapter.

7:28-6.4 Exposures in the event of radiation incidents or emergencies

In the event of a radiation incident in which an employee or emergency worker receives more than the limits specified in subsection (a) of N.J.A.C. 7:28-6.1, Exposure of individuals in controlled areas, or in the event of emergency conditions in which immediate action required to minimize danger to life results in an employee or emergency worker receiving doses beyond the limits specified in subsection (a) of N.J.A.C. 7:28-6.1, Exposure of individuals in controlled areas, each employer shall take measures to limit additional exposures of his employees to an extent and for a period, which shall be subject to approval by the Department. All such doses shall be reported as required by N.J.A.C. 7:28-13, Reports of Thefts and Radiation Incidents, and shall be included in the records required by N.J.A.C. 7:28-8, Records.

Amended by R.2005 d.239, effective July 18, 2005.
See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).
Amended N.J.A.C. references throughout.

7:28-6.5 Average concentrations

(a) Maximum permissible average concentrations of radioactive materials in air and water shall be as follows:

Radionuclide		Occupational 40-hr. Week	
		Water uc/ml	Air uc/ml
Column		A	B
Actinium 227	(sol.)	6×10^{-5}	2×10^{-12}
	(insol.)	9×10^{-3}	3×10^{-11}
Actinium 228	(sol.)	3×10^{-3}	8×10^{-8}
	(insol.)	3×10^{-3}	2×10^{-8}
Americium 241	(sol.)	10^{-4}	6×10^{-12}
	(insol.)	8×10^{-4}	10^{-10}
Americium 242m	(sol.)	1×10^{-4}	6×10^{-12}
	(insol.)	3×10^{-3}	3×10^{-10}
Americium 242	(sol.)	4×10^{-3}	4×10^{-8}
	(insol.)	4×10^{-3}	5×10^{-8}
Americium 243	(sol.)	10^{-4}	6×10^{-12}
	(insol.)	8×10^{-4}	10^{-10}
Americium 244	(sol.)	1×10^{-1}	4×10^{-6}
	(insol.)	1×10^{-1}	2×10^{-5}
Antimony 122	(sol.)	8×10^{-4}	2×10^{-7}
	(insol.)	8×10^{-4}	10^{-7}
Antimony 124	(sol.)	7×10^{-4}	2×10^{-7}
	(insol.)	7×10^{-4}	2×10^{-8}
Antimony 125	(sol.)	3×10^{-3}	5×10^{-7}
	(insol.)	3×10^{-3}	3×10^{-8}
Argon 37	(imm.)	...	6×10^{-3}
Argon 41	(imm.)	...	2×10^{-6}
Arsenic 73	(sol.)	0.01	2×10^{-6}
	(insol.)	0.01	4×10^{-7}
Arsenic 74	(sol.)	2×10^{-3}	3×10^{-7}
	(insol.)	2×10^{-3}	10^{-7}
Arsenic 76	(sol.)	6×10^{-4}	10^{-7}
	(insol.)	6×10^{-4}	10^{-7}
Arsenic 77	(sol.)	2×10^{-3}	5×10^{-7}
	(insol.)	2×10^{-3}	4×10^{-7}
Astatine 211	(sol.)	5×10^{-5}	7×10^{-9}
	(insol.)	2×10^{-3}	3×10^{-8}
Barium 131	(sol.)	5×10^{-3}	10^{-6}
	(insol.)	5×10^{-3}	4×10^{-7}
Barium 140	(sol.)	8×10^{-4}	10^{-7}
	(insol.)	7×10^{-4}	4×10^{-8}
Berkelium 249	(sol.)	0.02	9×10^{-10}
	(insol.)	0.02	10^{-7}
Berkelium 250	(sol.)	6×10^{-3}	1×10^{-7}
	(insol.)	6×10^{-3}	1×10^{-6}
Beryllium 7	(sol.)	0.05	6×10^{-6}
	(insol.)	0.05	10^{-6}
Bismuth 206	(sol.)	10^{-3}	2×10^{-7}
	(insol.)	10^{-3}	10^{-7}
Bismuth 207	(sol.)	2×10^{-3}	2×10^{-7}
	(insol.)	2×10^{-3}	10^{-8}
Bismuth 210	(sol.)	10^{-3}	6×10^{-9}

Radionuclide		Occupational 40-hr. Week		Cobalt 58m	(sol.)	0.08	2x10 ⁻⁵
		Water uc/ml	Air uc/ml					(insol.)	0.06	9x10^{-6}
Column	A	B		Cobalt 58	(sol.)	4x10 ⁻³	8x10 ⁻⁷
Bismuth 212	(sol.) 0.01	10 ⁻⁷		(insol.)	3x10 ⁻³	5x10 ⁻⁸	
	(insol.) 0.01	2x10 ⁻⁷		Cobalt 60	(sol.)	10 ⁻³	3x10 ⁻⁷
Bromine 82	(sol.) 8x10 ⁻³	10 ⁻⁶		(insol.)	10 ⁻³	9x10 ⁻⁹	
	(insol.) 10 ⁻³	2x10 ⁻⁷		Copper 64	(sol.)	0.01	2x10 ⁻⁶
Cadmium 109	(sol.) 5x10 ⁻³	5x10 ⁻⁸		(insol.)	6x10 ⁻³	10 ⁻⁶	
	(insol.) 5x10 ⁻³	7x10 ⁻⁸		Curium 242	(sol.)	7x10 ⁻⁴	10 ⁻¹⁰
Cadmium 115m	(sol.) 7x10 ⁻⁴	4x10 ⁻⁸		(insol.)	7x10 ⁻⁴	2x10 ⁻¹⁰	
	(insol.) 7x10 ⁻⁴	4x10 ⁻⁴		Curium 243	(sol.)	10 ⁻⁴	6x10 ⁻¹²
Cadmium 115	(sol.) 10 ⁻³	2x10 ⁻⁷		(insol.)	7x10 ⁻⁴	10 ⁻¹⁰	
	(insol.) 10 ⁻³	2x10 ⁻⁷		Curium 244	(sol.)	2x10 ⁻⁴	9x10 ⁻¹²
Calcium 45	(sol.) 3x10 ⁻⁴	3x10 ⁻⁸		(insol.)	8x10 ⁻⁴	10 ⁻¹⁰	
	(insol.) 5x10 ⁻³	10 ⁻⁷		Curium 245	(sol.)	10 ⁻⁴	5x10 ⁻¹²
Calcium 47	(sol.) 10 ⁻³	2x10 ⁻⁷		(insol.)	8x10 ⁻⁴	10 ⁻¹⁰	
	(insol.) 10 ⁻³	2x10 ⁻⁷		Curium 246	(sol.)	10 ⁻⁴	5x10 ⁻¹²
Californium 249	(sol.) 10 ⁻⁴	2x10 ⁻¹²		(insol.)	8x10 ⁻⁴	10 ⁻¹⁰	
	(insol.) 7x10 ⁻⁴	10 ⁻¹⁰		Curium 247	(sol.)	1x10 ⁻⁴	5x10 ⁻¹²
Californium 250	(sol.) 4x10 ⁻⁴	5x10 ⁻¹²		(insol.)	6x10 ⁻⁴	1x10 ⁻¹⁰	
	(insol.) 7x10 ⁻⁴	10 ⁻¹⁰		Curium 248	(sol.)	1x10 ⁻⁵	6x10 ⁻¹³
Californium 251	(sol.) 1x10 ⁻⁴	2x10 ⁻¹²		(insol.)	4x10 ⁻⁵	1x10 ⁻¹¹	
	(insol.) 8x10 ⁻⁴	1x10 ⁻¹⁰		Curium 249	(sol.)	6x10 ⁻²	1x10 ⁻⁵
Californium 252	(sol.) 7x10 ⁻⁴	2x10 ⁻¹¹		(insol.)	6x10 ⁻²	1x10 ⁻⁵	
	(insol.) 7x10 ⁻⁴	10 ⁻¹⁰		Dysprosium 165	(sol.)	0.01	3x10 ⁻⁶
Californium 253	(sol.) 4x10 ⁻³	8x10 ⁻¹⁰		(insol.)	0.01	2x10 ⁻⁶	
	(insol.) 4x10 ⁻³	8x10 ⁻¹⁰		Dysprosium 166	(sol.)	10 ⁻³	2x10 ⁻⁷
Californium 254	(sol.) 4x10 ⁻⁶	5x10 ⁻¹²		(insol.)	10 ⁻³	2x10 ⁻⁷	
	(insol.) 4x10 ⁻⁶	5x10 ⁻¹²		Einsteinium 253	(sol.)	7x10 ⁻⁴	8x10 ⁻¹⁰
Carbon 14	(sol.) 0.02	4x10 ⁻⁶		(insol.)	7x10 ⁻⁴	6x10 ⁻¹⁰	
	(insol.) . . .	5x10 ⁻⁵		Einsteinium 254m	(sol.)	5x10 ⁻⁴	5x10 ⁻⁹
Cerium 141	(sol.) 3x10 ⁻³	4x10 ⁻⁷		(insol.)	5x10 ⁻⁴	6x10 ⁻⁹	
	(insol.) 3x10 ⁻³	2x10 ⁻⁷		Einsteinium 254	(sol.)	4x10 ⁻⁴	2x10 ⁻¹¹
Cerium 143	(sol.) 10 ⁻³	3x10 ⁻⁷		(insol.)	4x10 ⁻⁴	1x10 ⁻¹⁰	
	(insol.) 10 ⁻³	2x10 ⁻⁷		Einsteinium 255	(sol.)	8x10 ⁻⁴	5x10 ⁻¹⁰
Cerium 144	(sol.) 3x10 ⁻⁴	10 ⁻⁸		(insol.)	8x10 ⁻⁴	4x10 ⁻¹⁰	
	(insol.) 3x10 ⁻⁴	6x10 ⁻⁹		Erbium 169	(sol.)	3x10 ⁻³	6x10 ⁻⁷
Cesium 131	(sol.) 0.07	10 ⁻⁵		(insol.)	3x10 ⁻³	4x10 ⁻⁷	
	(insol.) 0.03	3x10 ⁻⁶		Erbium 171	(sol.)	3x10 ⁻³	7x10 ⁻⁷
Cesium 134m	(sol.) 0.2	4x10 ⁻⁵		(insol.)	3x10 ⁻³	6x10 ⁻⁷	
	(insol.) 0.03	6x10 ⁻⁶		Europium 152	(9.2 hr)		
Cesium 134	(sol.) 3x10 ⁻⁴	4x10 ⁻⁸		(sol.)	2x10 ⁻³	4x10 ⁻⁷	
	(insol.) 10 ⁻³	10 ⁻⁸		(insol.)	2x10 ⁻³	3x10 ⁻⁷	
Cesium 135	(sol.) 3x10 ⁻³	5x10 ⁻⁷		Europium 152	(13 yr.)		
	(insol.) 7x10 ⁻³	9x10 ⁻⁸		(sol.)	2x10 ⁻³	10 ⁻⁸	
Cesium 136	(sol.) 2x10 ⁻³	4x10 ⁻⁷		(insol.)	2x10 ⁻³	2x10 ⁻⁸	
	(insol.) 2x10 ⁻³	2x10 ⁻⁷		Europium 154	(sol.)	6x10 ⁻⁴	4x10 ⁻⁹
Cesium 137	(sol.) 4x10 ⁻⁴	6x10 ⁻⁸		(insol.)	6x10 ⁻⁴	7x10 ⁻⁹	
	(insol.) 10 ⁻³	10 ⁻⁸		Europium 155	(sol.)	6x10 ⁻³	9x10 ⁻⁸
Chlorine 36	(sol.) 2x10 ⁻³	4x10 ⁻⁷		(insol.)	6x10 ⁻³	7x10 ⁻⁸	
	(insol.) 2x10 ⁻³	2x10 ⁻⁸		Fermium 254	(sol.)	4x10 ⁻³	6x10 ⁻⁸
Chlorine 38	(sol.) 0.01	3x10 ⁻⁶		(insol.)	4x10 ⁻³	7x10 ⁻⁸	
	(insol.) 0.01	2x10 ⁻⁶		Fermium 255	(sol.)	1x10 ⁻³	2x10 ⁻⁸
Chromium 51	(sol.) 0.05	10 ⁻⁵		(insol.)	1x10 ⁻³	1x10 ⁻⁸	
	(insol.) 0.05	2x10 ⁻⁶		Fermium 256	(sol.)	3x10 ⁻⁵	3x10 ⁻⁹
Cobalt 57	(sol.) 0.02	3x10 ⁻⁶		(insol.)	3x10 ⁻⁵	2x10 ⁻⁹	
	(insol.) 0.01	2x10 ⁻⁷					

Radionuclide	Occupational 40-hr. Week		Radionuclide				
	Water uc/ml	Air uc/ml					
Column	A	B					
Fluorine 18	(sol) 0.02	5x10 ⁻⁶	Iron 55	(sol.)	0.02	9x10 ⁻⁷	
	(insol.) 0.01	3x10 ⁻⁶		(insol.)	0.07	10 ⁻⁶	
Gadolinium 153	(sol.) 6x10 ⁻³	2x10 ⁻⁷	Iron 59	(sol.)	2x10 ⁻³	10 ⁻⁷	
	(insol.) 6x10 ⁻³	9x10 ⁻⁸		(insol.)	2x103	5x10 ⁻⁸	
Gadolinium 159	(sol.) 2x10 ⁻³	5x10 ⁻⁷	Krypton 85m	(imm.)	...	6x10 ⁻⁶	
	(insol.) 2x10 ⁻³	4x10 ⁻⁷	Krypton 85	(imm.)	...	10 ⁻⁵	
Gallium 72	(sol.) 10 ⁻³	2x10 ⁻⁷	Krypton 87	(imm.)	...	10 ⁻⁶	
	(insol.) 10 ⁻³	2x10 ⁻⁷	Lanthanum 140	(sol)	7x10 ⁻⁴	2x10 ⁻⁷	
Germanium 71	(sol.) 0.05	10 ⁻⁵		(insol.)	7x10 ⁻⁴	10 ⁻⁷	
	(insol) 0.05	6x10 ⁻⁶	Lead 203	(sol)	0.01	3x10 ⁻⁶	
Gold 196	(sol) 5x10 ⁻³	10 ⁻⁶		(insol.)	0.01	2x10 ⁻⁶	
	(insol.) 4x10 ⁻³	6x10 ⁻⁷	Lead 210	(sol)	4x10 ⁻⁶	10 ⁻¹⁰	
Gold 198	(sol.) 2x10 ⁻³	3x10 ⁻⁷		(insol.)	5x10 ⁻³	2x10 ⁻¹⁰	
	(insol.) 10 ⁻³	2x10 ⁻⁷	Lead 212	(sol)	6x10 ⁻⁴	2x10 ⁻⁸	
Gold 199	(sol.) 5x10 ⁻³	10 ⁻⁶		(insol.)	5x10 ⁻⁴	2x10 ⁻⁸	
	(insol.) 4x10 ⁻³	8x10 ⁻⁷	Lutetium 177	(sol.)	3x10 ⁻³	6x10 ⁻⁷	
Hafnium 181	(sol.) 2x10 ⁻³	4x10 ⁻⁸		(insol.)	3x10 ⁻³	5x10 ⁻⁷	
	(insol.) 2x10 ⁻³	7x10 ⁻⁸	Manganese 52	(sol.)	10 ⁻³	2x10 ⁻⁷	
Holmium 166	(sol.) 9x10 ⁻⁴	2x10 ⁻⁷		(insol.)	9x10 ⁻⁴	10 ⁻⁷	
	(insol.) 9x10 ⁻⁴	2x10 ⁻⁷	Manganese 54	(sol.)	4x10 ⁻³	4x10 ⁻⁷	
Hydrogen 3	(sol.,	0.1	5x10 ⁻⁶		(insol.)	4x10 ⁻³	4x10 ⁻⁸
	insol.)	...	2x10 ⁻³	Manganese 56	(sol.)	4x10 ⁻³	8x10 ⁻⁷
	(imm.)	...	8x10 ⁻⁶		(insol.)	3x10 ⁻³	5x10 ⁻⁷
Indium 113m	(sol.) 0.04	7x10 ⁻⁶	Mercury 197m	(sol.)	6x10 ⁻³	7x10 ⁻⁷	
	(insol.) 0.04	7x10 ⁻⁶		(insol.)	5x10 ⁻³	8x10 ⁻⁷	
Indium 114m	(sol.) 5x10 ⁻⁴	10 ⁻⁷	Mercury 197	(sol.)	9x10 ⁻³	10 ⁻⁶	
	(insol.) 5x10 ⁻⁴	2x10 ⁻⁸		(insol.)	0.01	3x10 ⁻⁶	
Indium 115m	(sol.) 0.01	2x10 ⁻⁶	Mercury 203	(sol.)	5x10 ⁻⁴	7x10 ⁻⁸	
	(insol.) 0.01	2x10 ⁻⁶		(insol.)	3x10 ⁻³	10 ⁻⁷	
Indium 115	(sol.) 3x10 ⁻³	2x10 ⁻⁷	Molybdenum 99	(sol)	5x10 ⁻³	7x10 ⁻⁷	
	(insol.) 3x10 ⁻³	3x10 ⁻⁸		(insol.)	10 ⁻³	2x10 ⁻⁷	
Iodine 125	(sol.) 4x10 ⁻³	5x10 ⁻⁹	Neodymium 144	(sol.)	2x10 ⁻³	8x10 ⁻¹¹	
	(insol.) 6x10 ⁻³	2x10 ⁻⁷		(insol.)	2x10 ⁻³	3x10 ⁻¹⁰	
Iodine 126	(sol.) 5x10 ⁻⁵	8x10 ⁻⁹	Neodymium 147	(sol.)	2x10 ⁻³	4x10 ⁻⁷	
	(insol.) 3x10 ⁻⁷	3x10 ⁻⁷		(insol.)	2x10 ⁻³	2x10 ⁻⁷	
Iodine 129	(sol.) 10 ⁻⁵	2x10 ⁻⁹	Neodymium 149	(sol.)	8x10 ⁻³	2x10 ⁻⁶	
	(insol.) 6x10 ⁻³	7x10 ⁻⁸		(insol.)	8x10 ⁻³	10 ⁻⁶	
Iodine 131	(sol.) 6x10 ⁻⁵	9x10 ⁻⁹	Neptunium 237	(sol.)	9x10 ⁻⁵	4x10 ⁻¹²	
	(insol.) 2x10 ⁻³	3x10 ⁻⁷		(insol.)	9x10 ⁻⁴	10 ⁻¹⁰	
Iodine 132	(sol.) 2x10 ⁻³	2x10 ⁻⁷	Neptunium 239	(sol.)	4x10 ⁻³	8x10 ⁻⁷	
	(insol.) 5x10 ⁻³	9x10 ⁻⁷		(insol.)	4x10 ⁻³	7x10 ⁻⁷	
Iodine 133	(sol.) 2x10 ⁻⁴	3x10 ⁻⁸	Nickel 59	(sol.)	6x10 ⁻³	5x10 ⁻⁷	
	(insol.) 10 ⁻³	2x10 ⁻⁷		(insol.)	0.06	8x10 ⁻⁷	
Iodine 134	(sol.) 4x10 ⁻³	5x10 ⁻⁷	Nickel 63	(sol.)	8x10 ⁻⁴	6x10 ⁻⁸	
	(insol.) 0.02	3x10 ⁻⁶		(insol.)	0.02	3x10 ⁻⁷	
Iodine 135	(sol.) 7x10 ⁻³	10 ⁻⁷	Nickel 65	(sol.)	4x10 ⁻³	9x10 ⁻⁷	
	(insol.) 2x10 ⁻³	4x10 ⁻⁷		(insol.)	3x10 ⁻³	5x10 ⁻⁷	
Iridium 190	(sol.) 6x10 ⁻³	10 ⁻⁶	Niobium 93m	(sol.)	0.01	10 ⁻⁷	
	(insol.) 5x10 ⁻³	4x10 ⁻⁷		(insol.)	0.01	2x10 ⁻⁷	
Iridium 192	(sol.) 10 ⁻³	10 ⁻⁷	Niobium 95	(sol.)	3x10 ⁻³	5x10 ⁻⁷	
	(insol.) 10 ⁻³	3x10 ⁻⁸		(insol.)	3x10 ⁻³	10 ⁻⁷	
Iridium 194	(sol.) 10 ⁻³	2x10 ⁻⁷	Niobium 97	(sol.)	0.03	6x10 ⁻⁶	
	(insol.) 9x10 ⁻⁴	2x10 ⁻⁷		(insol.)	0.03	5x10 ⁻⁶	
			Osmium 185	(sol.)	2x10 ⁻³	5x10 ⁻⁷	
				(insol.)	2x10 ⁻³	5x10 ⁻⁸	

Radionuclide	Occupational 40-hr. Week		Radionuclide			
	Water uc/ml A	Air uc/ml B				
Column			Protactinium 233	(sol.)	4x10 ³	6x10 ⁷
Osmium 191m	(sol.) 0.07	2x10 ⁻⁵		(insol.)	3x10 ³	2x10 ⁷
	(insol.) 0.07	9x10 ⁻⁶	Radium 223	(sol.)	2x10 ⁵	2x10 ⁹
Osmium 191	(sol.) 5x10 ⁻³	10 ⁻⁶		(insol.)	10 ⁻⁴	2x10 ⁻¹⁰
	(insol.) 5x10 ⁻³	4x10 ⁻⁷	Radium 224	(sol.)	7x10 ⁵	5x10 ⁹
Osmium 193	(sol.) 2x10 ⁻³	4x10 ⁻⁷		(insol.)	2x10 ⁻⁴	7x10 ⁻¹⁰
	(insol.) 2x10 ⁻³	3x10 ⁻⁷	Radium 226	(sol.)	4x10 ⁻⁷	3x10 ⁻¹¹
Palladium 103	(sol.) 0.01	10 ⁻⁶		(insol.)	9x10 ⁻⁴	5x10 ⁻¹¹
	(insol.) 8x10 ⁻³	7x10 ⁻⁷	Radium 228	(sol.)	8x10 ⁻⁷	7x10 ⁻¹¹
Palladium 109	(sol.) 3x10 ⁻³	6x10 ⁻⁷		(insol.)	7x10 ⁻⁴	4x10 ⁻¹¹
	(insol.) 2x10 ⁻³	4x10 ⁻⁷	Radon 220		...	3x10 ⁻⁷
Phosphorus 32	(sol.) 5x10 ⁻⁴	7x10 ⁻⁸			...	3x10 ⁻⁸
	(insol.) 7x10 ⁻⁴	8x10 ⁻⁸	Rhenium 183	(sol.)	0.02	3x10 ⁻⁶
Platinum 191	(sol.) 4x10 ⁻³	8x10 ⁻⁷		(insol.)	8x10 ⁻³	2x10 ⁻⁷
	(insol.) 3x10 ⁻³	6x10 ⁻⁷	Rhenium 186	(sol.)	3x10 ⁻³	6x10 ⁻⁷
Platinum 193m	(sol.) 0.03	7x10 ⁻⁶		(insol.)	10 ³	2x10 ⁻⁷
	(insol.) 0.03	5x10 ⁻⁶	Rhenium 187	(sol.)	0.07	9x10 ⁻⁶
Platinum 193	(sol.) 0.03	10 ⁻⁶		(insol.)	0.04	5x10 ⁻⁷
	(insol.) 0.05	3x10 ⁻⁷	Rhenium 188	(sol.)	2x10 ⁻³	4x10 ⁻⁷
Platinum 197m	(sol.) 0.03	6x10 ⁻⁶		(insol.)	9x10 ⁻⁴	2x10 ⁻⁷
	(insol.) 0.03	5x10 ⁻⁶	Rhodium 103m	(sol.)	0.4	8x10 ⁻⁵
Platinum 197	(sol.) 4x10 ⁻³	8x10 ⁻⁷		(insol.)	0.3	6x10 ⁻⁵
	(insol.) 3x10 ⁻³	6x10 ⁻⁷	Rhodium 105	(sol.)	4x10 ⁻³	8x10 ⁻⁷
Plutonium 238	(sol.) 10 ⁻⁴	2x10 ⁻¹²		(insol.)	3x10 ⁻³	5x10 ⁻⁷
	(insol.) 8x10 ⁻⁴	3x10 ⁻¹¹	Rubidium 86	(sol.)	2x10 ⁻³	3x10 ⁻⁷
Plutonium 239	(sol.) 10 ⁻⁴	2x10 ⁻¹²		(insol.)	7x10 ⁻⁴	7x10 ⁻⁸
	(insol.) 8x10 ⁻⁴	4x10 ⁻¹¹	Rubidium 87	(sol.)	3x10 ⁻³	5x10 ⁻⁷
Plutonium 240	(sol.) 10 ⁻⁴	2x10 ⁻¹²		(insol.)	5x10 ⁻³	7x10 ⁻⁸
	(insol.) 8x10 ⁻⁴	4x10 ⁻¹¹	Ruthenium 97	(sol.)	0.01	2x10 ⁻⁶
Plutonium 241	(sol.) 7x10 ⁻³	9x10 ⁻¹¹		(insol.)	0.01	2x10 ⁻⁶
	(insol.) 0.04	4x10 ⁻⁸	Ruthenium 103	(sol.)	2x10 ⁻³	5x10 ⁻⁷
Plutonium 242	(sol.) 10 ⁻⁴	2x10 ⁻¹²		(insol.)	2x10 ⁻³	8x10 ⁻⁸
	(insol.) 9x10 ⁻⁴	4x10 ⁻¹¹	Ruthenium 105	(sol.)	3x10 ⁻³	7x10 ⁻⁷
Plutonium 243	(sol.) 1x10 ⁻²	2x10 ⁻⁶		(insol.)	3x10 ⁻³	5x10 ⁻⁷
	(insol.) 1x10 ⁻²	2x10 ⁻⁶	Ruthenium 106	(sol.)	4x10 ⁻⁴	8x10 ⁻⁸
Plutonium 244	(sol.) 1x10 ⁻⁴	2x10 ⁻¹²		(insol.)	3x10 ⁻⁴	6x10 ⁻⁹
	(insol.) 3x10 ⁻⁴	3x10 ⁻¹¹	Samarium 147	(sol.)	2x10 ⁻³	7x10 ⁻¹¹
Polonium 210	(sol.) 2x10 ⁻³	5x10 ⁻¹⁰		(insol.)	2x10 ⁻³	3x10 ⁻¹⁰
	(insol.) 8x10 ⁻⁴	2x10 ⁻¹⁰	Samarium 151	(sol.)	0.01	6x10 ⁻⁸
Potassium 42	(sol.) 9x10 ⁻³	2x10 ⁻⁶		(insol.)	0.01	10 ⁻⁷
	(insol.) 6x10 ⁻⁴	10 ⁻⁷	Samarium 153	(sol.)	2x10 ⁻³	5x10 ⁻⁷
Praseodymium 142	(sol.) 9x10 ⁻⁴	2x10 ⁻⁷		(insol.)	2x10 ⁻³	4x10 ⁻⁷
	(insol.) 9x10 ⁻⁴	2x10 ⁻⁷	Scandium 46	(sol.)	10 ³	2x10 ⁻⁷
Praseodymium 143	(sol.) 10 ⁻³	3x10 ⁻⁷		(insol.)	10 ³	2x10 ⁻⁸
	(insol.) 10 ⁻³	2x10 ⁻⁷	Scandium 47	(sol.)	3x10 ⁻³	6x10 ⁻⁷
Promethium 147	(sol.) 6x10 ⁻³	6x10 ⁻⁸		(insol.)	3x10 ⁻³	5x10 ⁻⁷
	(insol.) 6x10 ⁻³	10 ⁻⁷	Scandium 48	(sol.)	8x10 ⁻⁴	2x10 ⁻⁷
Promethium 149	(sol.) 10 ⁻³	3x10 ⁻⁷		(insol.)	8x10 ⁻⁴	10 ⁻⁷
	(insol.) 10 ⁻³	2x10 ⁻⁷	Selenium 75	(sol.)	9x10 ⁻³	10 ⁻⁶
Protactinium 230	(sol.) 7x10 ⁻³	2x10 ⁻⁹		(insol.)	8x10 ⁻³	10 ⁻⁷
	(insol.) 7x10 ⁻³	8x10 ⁻¹⁰	Silicon 31	(sol.)	0.03	6x10 ⁻⁶
Protactinium 231	(sol.) 3x10 ⁻⁵	10 ⁻¹²		(insol.)	6x10 ⁻³	10 ⁻⁶
	(insol.) 8x10 ⁻⁴	10 ⁻¹⁰	Silver 105	(sol.)	3x10 ⁻³	6x10 ⁻⁷
				(insol.)	3x10 ⁻³	8x10 ⁻⁸
			Silver 110m	(sol.)	9x10 ⁻⁴	2x10 ⁻⁷
				(insol.)	9x10 ⁻⁴	10 ⁻⁸

Radionuclide	Occupational 40-hr. Week		Radionuclide			
	Water uc/ml A	Air uc/ml B				
Column			Thallium 202	(sol.)	4×10^{-3}	8×10^{-7}
Silver 111	(sol.) 10^{-3}	3×10^{-7}	(insol.)	2×10^{-3}	2×10^{-7}	
	(insol.) 10^{-3}	2×10^{-7}	Thallium 204	(sol.)	3×10^{-3}	6×10^{-7}
Sodium 22	(sol.) 10^{-3}	2×10^{-7}	(insol.)	2×10^{-3}	3×10^{-8}	
	(insol.) 9×10^{-4}	9×10^{-9}	Thorium 227	(sol.)	5×10^{-4}	3×10^{-10}
Sodium 24	(sol.) 6×10^{-3}	10^{-6}	(insol.)	5×10^{-4}	2×10^{-10}	
	(insol.) 8×10^{-4}	10^{-7}	Thorium 228	(sol.)	2×10^{-4}	9×10^{-12}
Strontium 85m	(sol.) 0.2	4×10^{-5}	(insol.)	4×10^{-4}	6×10^{-12}	
	(insol.) 0.2	3×10^{-5}	Thorium 230	(sol.)	5×10^{-5}	2×10^{-12}
Strontium 85	(sol.) 3×10^{-3}	2×10^{-7}	(insol.)	9×10^{-4}	10^{-11}	
	(insol.) 5×10^{-3}	10^{-7}	Thorium 231	(sol.)	7×10^{-3}	10^{-6}
Strontium 89	(sol.) 3×10^{-4}	3×10^{-8}	(insol.)	7×10^{-3}	10^{-6}	
	(insol.) 8×10^{-4}	4×10^{-8}	Thorium 232	(sol.)	5×10^{-5}	3×10^{-11}
Strontium 90	(sol.) 1×10^{-5}	1×10^{-9}	(insol.)	10^{-3}	3×10^{-11}	
	(insol.) 10^{-3}	5×10^{-9}	Thorium 234	(sol.)	5×10^{-4}	6×10^{-8}
Strontium 91	(sol.) 2×10^{-3}	4×10^{-7}	(insol.)	5×10^{-4}	3×10^{-8}	
	(insol.) 10^{-3}	3×10^{-7}	Thorium Nat.	(sol.)	3×10^{-5}	3×10^{-11}
Strontium 92	(sol.) 2×10^{-3}	4×10^{-7}	(insol.)	3×10^{-4}	3×10^{-11}	
	(insol.) 2×10^{-3}	3×10^{-7}	Thulium 170	(sol.)	10^{-3}	4×10^{-8}
Sulfur 35	(sol.) 2×10^{-3}	3×10^{-7}	(insol.)	10^{-3}	3×10^{-8}	
	(insol.) 8×10^{-3}	3×10^{-7}	Thulium 171	(sol.)	0.01	10^{-7}
Tantalum 182	(sol.) 10^{-3}	4×10^{-8}	(insol.)	0.01	2×10^{-7}	
	(insol.) 10^{-3}	2×10^{-8}	Tin 113	(sol.)	2×10^{-3}	4×10^{-7}
Technetium 96m	(sol.) 0.4	8×10^{-5}	(insol.)	2×10^{-3}	5×10^{-8}	
	(insol.) 0.3	3×10^{-5}	Tin 125	(sol.)	5×10^{-4}	10^{-7}
Technetium 96	(sol.) 3×10^{-3}	6×10^{-7}	(insol.)	5×10^{-4}	8×10^{-8}	
	(insol.) 10^{-3}	2×10^{-7}	Tungsten 181	(sol.)	0.01	2×10^{-6}
Technetium 97m	(sol.) 0.01	2×10^{-6}	(insol.)	0.01	10^{-7}	
	(insol.) 5×10^{-3}	2×10^{-7}	Tungsten 185	(sol.)	4×10^{-3}	8×10^{-7}
Technetium 97	(sol.) 0.05	10^{-5}	(insol.)	3×10^{-3}	10^{-7}	
	(insol.) 0.02	3×10^{-7}	Tungsten 187	(sol.)	2×10^{-3}	4×10^{-7}
Technetium 99m	(sol.) 0.2	4×10^{-5}	(insol.)	2×10^{-3}	3×10^{-7}	
	(insol.) 0.08	10^{-5}	Uranium 230	(sol.)	7×10^{-5}	3×10^{-10}
Technetium 99	(sol.) 0.01	2×10^{-6}	(insol.)	10^{-4}	10^{-10}	
	(insol.) 5×10^{-3}	6×10^{-8}	Uranium 232	(sol.)	2×10^{-5}	10^{-10}
Tellurium 125m	(sol.) 5×10^{-3}	4×10^{-7}	(insol.)	8×10^{-4}	3×10^{-11}	
	(insol.) 3×10^{-3}	10^{-7}	Uranium 233	(sol.)	10^{-4}	5×10^{-10}
Tellurium 127m	(sol.) 2×10^{-3}	10^{-7}	(insol.)	9×10^{-10}	10^{-10}	
	(insol.) 2×10^{-3}	4×10^{-8}	Uranium 234	(sol.)	10^{-4}	6×10^{-10}
Tellurium 127	(sol.) 8×10^{-3}	2×10^{-6}	(insol.)	9×10^{-4}	10^{-10}	
	(insol.) 5×10^{-3}	9×10^{-7}	Uranium 235	(sol.)	10^{-3}	5×10^{-10}
Tellurium 129m	(sol.) 10^{-3}	8×10^{-8}	(insol.)	8×10^{-4}	10^{-10}	
	(insol.) 6×10^{-4}	3×10^{-8}	Uranium 236	(sol.)	10^{-4}	6×10^{-10}
Tellurium 129	(sol.) 0.02	5×10^{-6}	(insol.)	10^{-3}	10^{-10}	
	(insol.) 0.02	4×10^{-6}	Uranium 238	(sol.)	2×10^{-5}	7×10^{-11}
Tellurium 131m	(sol.) 2×10^{-3}	4×10^{-7}	(insol.)	10^{-3}	10^{-10}	
	(insol.) 10^{-3}	2×10^{-7}	Uranium 240 & Neptunium 240	(sol.)	1×10^{-3}	2×10^{-7}
Tellurium 132	(sol.) 9×10^{-4}	2×10^{-7}	(insol.)	1×10^{-3}	2×10^{-7}	
	(insol.) 6×10^{-4}	10^{-7}	Uranium-Nat.	(sol.)	2×10^{-5}	7×10^{-11}
Terbium 160	(sol.) 10^{-3}	10^{-7}	(insol.)	5×10^{-4}	6×10^{-11}	
	(insol.) 10^{-3}	3×10^{-8}	Vanadium 48	(sol.)	9×10^{-4}	2×10^{-7}
Thallium 200	(sol.) 0.01	3×10^{-6}	(insol.)	8×10^{-4}	6×10^{-8}	
	(insol.) 7×10^{-3}	10^{-6}	Xenon 131m	(imm.)	...	2×10^{-5}
Thallium 201	(sol.) 9×10^{-3}	2×10^{-6}	Xenon 133	(imm.)	...	10^{-5}
	(insol.) 5×10^{-3}	9×10^{-7}	Xenon 133m	(imm.)	...	1×10^{-5}
			Xenon 135	(imm.)	...	4×10^{-6}

Radionuclide		Occupational 40-hr. Week	
		Water uc/ml A	Air uc/ml B
Ytterbium 175	(sol.)	3x10 ⁻³	7x10 ⁻⁷
	(insol.)	3x10 ⁻³	6x10 ⁻⁷
Yttrium 90	(sol.)	6x10 ⁻⁴	10 ⁻⁷
	(insol.)	6x10 ⁻⁴	10 ⁻⁷
Yttrium 91m	(sol.)	0.1	2x10 ⁻⁵
	(insol.)	0.1	2x10 ⁻⁵
Yttrium 91	(sol.)	8x10 ⁻⁴	4x10 ⁻⁸
	(insol.)	8x10 ⁻⁴	3x10 ⁻⁸
Yttrium 92	(sol.)	2x10 ⁻³	4x10 ⁻⁷
	(insol.)	2x10 ⁻³	3x10 ⁻⁷
Yttrium 93	(sol.)	8x10 ⁻⁴	2x10 ⁻⁷
	(insol.)	8x10 ⁻⁴	10 ⁻⁷
Zinc 65	(sol.)	3x10 ⁻³	10 ⁻⁷
	(insol.)	5x10 ⁻³	6x10 ⁻⁸
Zinc 69m	(sol.)	2x10 ⁻³	4x10 ⁻⁷
	(insol.)	2x10 ⁻³	3x10 ⁻⁷
Zinc 69	(sol.)	0.05	7x10 ⁻⁶
	(insol.)	0.05	9x10 ⁻⁶
Zirconium 93	(sol.)	0.02	10 ⁻⁷
	(insol.)	0.02	3x10 ⁻⁷
Zirconium 95	(sol.)	2x10 ⁻³	10 ⁻⁷
	(insol.)	2x10 ⁻³	3x10 ⁻⁸
Zirconium 97	(sol.)	5x10 ⁻⁴	10 ⁻⁷
	(insol.)	5x10 ⁻⁴	9x10 ⁻⁸
Unidentified Radionuclides		3x10 ⁻⁷	1x10 ⁻¹²

Abbreviations— sol. = soluble
 insol. = insoluble
 imm. = immersion
 m = metastable

(b) In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this section shall be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values shall be derived as follows:

i. Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in this section for the specific radionuclide when not in a mixture.

ii. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" ("unity").

iii. For example, if radionuclides A, B, and C are present in concentrations, C_a, C_b, and C_c, and if the applicable MPC's are MPC_a and MPC_b and MPC_c respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \frac{C_c}{MPC_c} < 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of this section are:

i. For purposes of Column A — 3 x 10⁻⁷

ii. For purposes of Column B — 1 x 10⁻¹²

3. If any of the conditions specified in this paragraph are met, the corresponding values specified in this paragraph may be used in lieu of those specified in paragraph 2 of this subsection.

i. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in subsection (a) of this Section for the radionuclide in the mixture having the lowest concentration limit;

ii. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in subsection (a) of this Section are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in subsection (a) of this Section for any radionuclide which is not known to be absent from the mixture; or

iii.

c. Element (atomic number) and isotope	Table I		Table II	
	Col. 1 Air (uc/ml)	Col. 1 Water (uc/ml)	Col. 2 Air (uc/ml)	Col. 2 Water (uc/ml)
If it is known that Sr 90, I 129, Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231. Th 232, and Th-nat are not present . . . . .	....	9x10 ⁻⁵	....	3x10 ⁻⁶
If it is known that Sr 90, I 129, Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, and Th-nat are not present . . . . .	....	6x10 ⁻⁵	....	2x10 ⁻⁶
If it is known that Sr 90, Pb 210, Ra 226 and Ra 228 are not present . . . . .	....	2x10 ⁻⁵	....	6x10 ⁻⁷
If it is known that Ra 226 and Ra 228 are not present . . . . .	....	3x10 ⁻⁶	....	1x10 ⁻⁷
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241 and Bk 249 are not present . . .	3x10 ⁻⁹	....	1x10 ⁻¹⁰	....
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228 and Pu 241 are not present. . .	3x10 ⁻¹⁰	....	1x10 ⁻¹¹	....
If it is known that alpha-emitters and Ac 227 are not present. . .	3x10 ⁻¹¹	....	1x10 ⁻¹²	....
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242, and Cf 249 are not present.	3x10 ⁻¹²	....	11x10 ⁻¹³	....
If Pa 231, Pu 239, Pu 240, Pu 242 and Cf 249 are not present	2x10 ⁻¹²	....	7x10 ⁻¹⁴	....

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

i. For purposes of subsection (a) of this Section, Column B, 1 x 10⁻¹⁰ uc/ml gross alpha activity; or 2.5 x 10⁻¹¹ uc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

Amended by R.2005 d.156, effective May 16, 2005.
 See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
 Rewrote the section.
 Administrative correction.
 See: 37 N.J.R. 3343(a).

7:28-6.6 Dose equivalent to an embryo/fetus

(a) The State licensee or registrant shall ensure that the dose equivalent to the embryo/fetus during the entire pregnancy, due to the occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (five mSv). Recordkeeping shall meet the requirements set forth at N.J.A.C. 7:28-8.1.

(b) The State licensee or registrant shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in (a) above.

(c) The dose equivalent to the embryo/fetus is the sum of:

1. The deep-dose equivalent to the declared pregnant woman; and
2. The dose equivalent to the embryo/fetus resulting from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose equivalent to the embryo/fetus is found to have exceeded 0.5 rem (five mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the State licensee or registrant, the State licensee or registrant shall be deemed to be in compliance with (a) above if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

New Rule, R.2005 d.156, effective May 16, 2005.
 See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

SUBCHAPTER 7. RADIATION SURVEYS AND PERSONNEL MONITORING

7:28-7.1 Surveys inside controlled areas

(a) The State licensee or registrant shall ensure that controlled areas shall be surveyed by, or under the direction of, a qualified individual to determine if the installation is maintained and operations are conducted in compliance with this Chapter.

(b) The State licensee or registrant shall ensure that radiation levels shall be determined with the use of suitable instruments and methods.

(c) The State licensee or registrant shall ensure that surveys shall be made of the air for radioactive content when the average concentrations may exceed 1/4 the amount specified in N.J.A.C. 7:28-6.5(a), Column B, or prorated values when more than one isotope is present.

(d) The State licensee or registrant shall ensure that installations where unsealed radioactive materials are stored or used shall be periodically surveyed for contamination of surfaces. These surveys shall be conducted in a manner to insure that the levels of surface contamination are below those that could lead to exposures amounting to 10 percent of the limits specified in N.J.A.C. 7:28-6.1(a) and (d).

(e) The State licensee or registrant shall ensure that the record of a survey shall contain, but shall not be limited to the radiation levels, the time the radiation is produced, the workweek and the fraction of the workweek that any individual may be exposed to the radiation and when required, the radioactive air concentrations and surface contaminations.

(f) The State licensee or registrant shall ensure that subsequent surveys shall be conducted at such times and as frequently as may be necessary to assure that the controlled areas and operations remain in compliance with this Chapter.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
Rewrote the section.

7:28-7.2 Surveys outside controlled areas

Surveys shall be made outside controlled areas at sufficient intervals and locations as may be necessary to insure compliance with Sections 6.2 (Radiation levels outside controlled areas) and 6.3 (Concentrations in effluents from controlled areas) of this Chapter.

7:28-7.3 Statement in lieu of actual survey

A written statement signed by a qualified individual and including his calculations and analysis of the dose rates in the vicinity of a radiation source may be acceptable in place of the survey required in Section 7.1 (Surveys inside controlled areas) of this Chapter, except when radioactive-air contamination or surface contamination is involved.

7:28-7.4 Use of personnel-monitoring equipment

(a) Each owner shall supply appropriate personnel-monitoring equipment to and shall require that it be used by:

1. Each individual who enters a controlled area under such circumstances that he receives, or is likely to receive, a dose in excess of 25 millirems in any period of seven consecutive days;
2. Each individual under 18 years of age who enters a controlled area under such circumstances that he receives or is likely to receive a dose in excess of ten millirems in any period of seven consecutive days;
3. Each individual who enters a high radiation area; and
4. At least one visitor in a group of visitors entering a controlled area.

(b) All individuals required to wear personnel-monitoring equipment shall be instructed in its proper use and purpose. Records shall be kept in accordance with Section 8.1 (Personnel-monitoring records) of this Chapter.

(c) When an individual working on the premises of an owner, but not employed by him is wearing personnel-monitoring equipment provided by his employer, the owner of the radiation source shall not be required to provide additional personnel-monitoring equipment.

7:28-7.5 Requirements for bio-assays

Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Department may incorporate license provisions or issue an order requiring the owner to have appropriate bio-assays made and to furnish the Department with copies of such bio-assays.

SUBCHAPTER 8. RECORDS

7:28-8.1 Personnel-monitoring records

(a) Clear and legible records shall be maintained by the owner for calendar quarters on Form RH-26, or on a clear and legible form containing all the information required on RH-26. These records shall show the radiation exposures of all individuals who are required to wear personnel-monitoring equipment according to Section 7.4 (Use of personnel-monitoring equipment) of this Chapter and any required bio-assays according to Section 7.5 (Requirements for bio-assays) of this Chapter.

(b) Each employee, at his request, shall be supplied by the owner with an annual statement of his radiation exposure record and any bio-assays.

(c) At the request of an individual formerly employed by the owner, each owner shall furnish such individual a report of his exposure to radiation, including bio-assays, as shown in records maintained by the owner pursuant to subsection (a) of this Section. Such report shall be furnished within 30 days from the time the request is made or within 60 days from termination of employment, whichever is later. The report shall cover each calendar quarter of the individual's employment involving exposure to radiation.

(d) When an individual working on the premises of an owner, but not employed by him, is required by the owner to wear personnel-monitoring equipment, the owner of the radiation source shall furnish such individual's employer within 90 days a statement of the individual's radiation record and this shall be incorporated in the individual's exposure record.

(e) Each report or statement required by subsections (b) through (d) of this Section shall contain the following statement: "This report is furnished to you under the provisions of Subchapter 8 of the New Jersey Radiation Protection Code. You should preserve this report for future reference."

(f) The exposure records on each employee shall be preserved during the course of his employment and for at least ten years after termination of employment. Exposure records of other persons shall be preserved for at least ten years.

(g) These records or true copy of same shall be made available to the Department on request.

7:28-8.2 Records of surveys

(a) Records shall be maintained showing the results of such surveys as are required pursuant to Subchapter 7 (Radiation Surveys and Personnel Monitoring) of this Chapter.

(b) The records of each survey shall be retained for at least ten years.

(c) These records or true copy of same shall be made available to the Department on request.

(d) The owner of any installation covered in Subchapters 14 through 16 of this Chapter shall submit to the Department within 30 days of receipt a copy of each report of radiation surveys made in compliance with Subchapter 7 (Radiation Surveys and Personnel Monitoring) of this Chapter.

7:28-8.3 Records of radioactive materials

(a) An accurate accounting for all radioactive materials shall be maintained for a radiation installation. Such records shall show radioactive materials received, produced, and disposed, the amounts and form of the radioactive material received or produced and the amount on hand.

(b) Such records shall be retained for at least two years after the final disposition of any radioactive material.

(c) These records or true copy of same shall be made available to the Department on request.

7:28-8.4 Records of sealed source testing

Records of the results of sealed source testing shall be kept at least two years.

7:28-8.5 Records from discontinued installations

The discontinuance of a radiation installation does not relieve the owner from the responsibility of retaining the records required by this Subchapter. Such owner may, however, request the Department to accept the records. The acceptance of such records by the Department relieves the owner of subsequent responsibility only in respect to their preservation as required by this Chapter.

SUBCHAPTER 9. RADIOACTIVE CONTAMINATION CONTROL

7:28-9.1 General precautions

All work with radioactive materials shall be carried out under such conditions as to minimize the radioactive contamination of the area and of the person(s) working therein.

7:28-9.2 Personnel and material contamination

(a) When the nature of the work is such that an individual or his clothing may become contaminated, the individual and his clothing shall be suitably monitored.

(b) Any contamination which might lead to exposures greater than ten per cent of the limits specified in Section 6.1(a) or (d) (Exposure of individuals in controlled areas) of this Chapter shall be removed from the contaminated individual before that individual is permitted to leave the area.

(c) No clothing, equipment, or other material having contamination which might lead to exposures greater than those specified in subsection (b) of this Section shall be permitted to leave the area except as radioactive material.

7:28-9.3 Decontamination of premises

Radioactively contaminated premises shall be decontaminated so that individuals using these premises shall not receive exposures greater than those listed in Section 9.2(b) (Personnel and material contamination) of this Chapter.

7:28-9.4 Sealed source testing

(a) Unless otherwise specified in a Federal agency license, or a State license, sealed sources except tritium and krypton, containing more than 10 times the generally licensed quantities of N.J.A.C. 7:28-4.5(c) Column B shall be leak tested at intervals not longer than six months.

(b) Records of all sealed source testing shall be kept in accordance with Section 8.4 (Records of sealed source testing) of this Chapter.

Amended by R.2005 d.156, effective May 16, 2005.

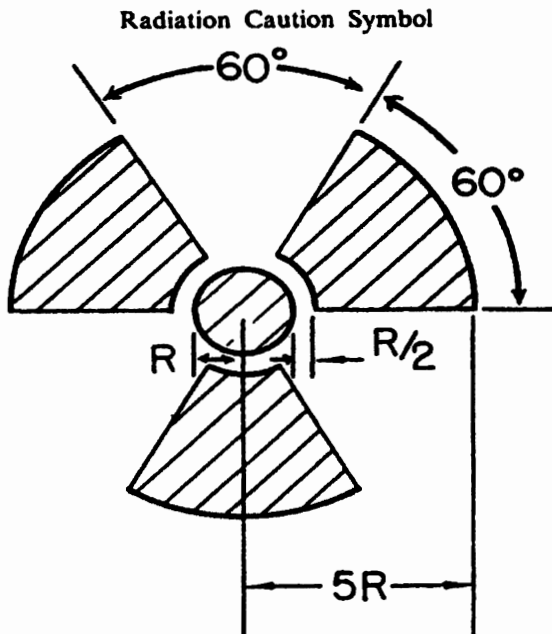
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote (a).

SUBCHAPTER 10. LABELING, POSTING, AND CONTROLS

7:28-10.1 General requirement

(a) All signs and labels required by this Subchapter shall use the conventional radiation caution symbol shaped and colored as follows:



1. Cross-hatched area is to be magenta or purple;
2. Background is to be yellow.

(b) In addition to the language prescribed in the various sections of this Subchapter, any supplementary information which might be appropriate in aiding individuals to minimize exposure to radiation or to radioactive materials may be provided on or near such required signs or labels.

7:28-10.2 Radiation areas

(a) Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

1. CAUTION—RADIATION AREA; or
2. DANGER—RADIATION AREA

7:28-10.3 High radiation areas

(a) Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

1. CAUTION—HIGH RADIATION AREA; or
2. DANGER—HIGH RADIATION AREA

(b) Each high radiation area shall be under direct, constant surveillance to protect against unauthorized or accidental entry unless:

1. It is equipped with a control device which shall cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in one hour upon entry into the area;

2. It is equipped with a control device which shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the owner or the supervisor of the activity are made aware of the entry; or

3. It is locked to protect against unauthorized or accidental entry and the owner or the supervisor of the activity maintains direct personal control over access to the key.

7:28-10.4 Airborne radioactivity areas

(a) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words;

1. CAUTION—AIRBORNE RADIOACTIVITY AREA; or
2. DANGER—AIRBORNE RADIOACTIVITY AREA

7:28-10.5 Areas containing radioactive materials

(a) Each area or room in which radioactive material, other than natural uranium or thorium is used or stored in an amount greater than ten times that listed in Section 10.9 (Labeling, posting and disposal quantities of radioactive material) of this Chapter shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

1. CAUTION—RADIOACTIVE MATERIAL(S); or
2. DANGER—RADIOACTIVE MATERIAL(S)

(b) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding 100 times the quantity listed in Section 10.9 (Labeling, posting and disposal quantities of radioactive material) of this Chapter shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

1. CAUTION—RADIOACTIVE MATERIAL(S); or
2. DANGER—RADIOACTIVE MATERIAL(S)

7:28-10.6 Labeling of equipment and containers

(a) Any equipment or container in which radioactive material, other than natural uranium or thorium, is transported, stored, or used, in an amount greater than that specifically listed in Section 10.9 (Labeling, posting and disposal quantities of radioactive material) of this Chapter shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

1. CAUTION—RADIOACTIVE MATERIAL; or
2. DANGER—RADIOACTIVE MATERIAL

(b) Each container in which natural uranium or thorium is transported, stored, or used in a quantity greater than 10 times the quantity listed in Section 10.9 (Labeling, posting

and disposal quantities of radioactive material) of this Chapter shall bear a durable, clearly visible label bearing the radiation caution symbol and the words:

1. CAUTION—RADIOACTIVE MATERIAL; or
2. DANGER—RADIOACTIVE MATERIAL

(c) Where containers are used for storage, the labels required in this Section shall state also the quantities and kinds of radioactive materials in the containers and the date of measurement of the quantities.

(d) All radiation-producing machines capable, when operated, of producing a radiation area shall be labeled in a manner which cautions individuals of this fact.

7:28-10.7 Removal of signs and labels

All radiation caution signs and labels which may have been posted at a time when they were required shall be removed when the condition which originally required the posting no longer exists.

7:28-10.8 Exceptions from posting and labeling requirements

(a) Radiation areas and high radiation areas which result from the operation of therapeutic x-ray machines operated at potentials of 60 kv and below or from the operation of diagnostic x-ray machines shall be exempt from the posting requirements of Sections 10.2, 10.3 and 10.6(d) of this Chapter provided that the operator of the equipment has taken precautions to insure that no individual other than the patient shall be in the radiation area.

(b) Rooms or other areas in hospitals are not required to be posted with radiation caution signs because of the presence of patients containing radioactive material provided that there are personnel in attendance who shall take the precautions necessary to prevent the exposure of any individual other than the patient to radiation or radioactive material in excess of the limits established in this Chapter.

(c) A room or area is not required to be posted with a radiation caution sign because of the presence of a sealed source provided the radiation level 12 inches from the surface of the source container or source housing does not exceed five millirems per hour.

(d) Radiation caution signs are not required to be posted at areas or rooms containing radioactive materials for periods of less than eight hours provided that:

1. The materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any other individual to radiation or radioactive materials in excess of the limits established in these regulations; and

2. Such area or room is subject to the user's control.

(e) Laboratory containers such as beakers, flasks and test tubes need not be labeled if they are being used transiently in laboratory procedures when the user is present.

(f) A container in which radioactive material is transported, stored, or used need not be labeled, if the concentration of the material in the container does not exceed that specified in Section 6.5(a) (Average concentrations) of this Chapter, Column A.

(g) Radioactive materials packaged and labeled in accordance with regulations of the appropriate Federal agency shall be exempt from the labeling and posting requirements of this Section during shipment, provided that the inside containers are labeled in accordance with the provisions of Section 10.6 (Labeling of equipment and containers) of this Chapter.

7:28-10.9 Quantities of radioactive materials that require labeling and posting

(a) The quantities of radioactive material subject to all labeling and posting regulations in atomic number order are as follows:

Quantities of Licensed or Registered Material Requiring Labeling (In Atomic Number Order)	
Radionuclide	Quantity (μ Ci)
Hydrogen-3	1,000
Beryllium-7	1,000
Beryllium-10	1
Carbon-11	1,000
Carbon-14	100
Fluorine-18	1,000
Sodium-22	10
Sodium-24	100
Magnesium-28	100
Aluminum-26	10
Silicon-31	1,000
Silicon-32	1
Phosphorus-32	10
Phosphorus-33	100
Sulfur-35	100
Chlorine-36	10
Chlorine-38	1,000
Chlorine-39	1,000
Argon-39	1,000
Argon-41	1,000
Potassium-40	100
Potassium-42	1,000
Potassium-43	1,000
Potassium-44	1,000
Potassium-45	1,000
Calcium-41	100
Calcium-45	100
Calcium-47	100
Scandium-43	1,000
Scandium-44m	100
Scandium-44	100
Scandium-46	10
Scandium-47	100
Scandium-48	100

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Scandium-49	1,000	Arsenic-74	100
Titanium-44	1	Arsenic-76	100
Titanium-45	1,000	Arsenic-77	100
Vanadium-47	1,000	Arsenic-78	1,000
Vanadium-48	100	Selenium-70	1,000
Vanadium-49	1,000	Selenium-73m	1,000
Chromium-48	1,000	Selenium-73	100
Chromium-49	1,000	Selenium-75	100
Chromium-51	1,000	Selenium-79	100
Manganese-51	1,000	Selenium-81m	1,000
Manganese-52m	1,000	Selenium-81	1,000
Manganese-52	100	Selenium-83	1,000
Manganese-53	1,000	Bromine-74m	1,000
Manganese-54	100	Bromine-74	1,000
Manganese-56	1,000	Bromine-75	1,000
Iron-52	100	Bromine-76	100
Iron-55	100	Bromine-77	1,000
Iron-59	10	Bromine-80m	1,000
Iron-60	1	Bromine-80	1,000
Cobalt-55	100	Bromine-82	100
Cobalt-56	10	Bromine-83	1,000
Cobalt-57	100	Bromine-84	1,000
Cobalt-58m	1,000	Krypton-74	1,000
Cobalt-58	100	Krypton-76	1,000
Cobalt-60m	1,000	Krypton-77	1,000
Cobalt-60	1	Krypton-79	1,000
Cobalt-61	1,000	Krypton-81	1,000
Cobalt-62m	1,000	Krypton-83m	1,000
Nickel-56	100	Krypton-85m	1,000
Nickel-57	100	Krypton-85	1,000
Nickel-59	100	Krypton-87	1,000
Nickel-63	100	Krypton-88	1,000
Nickel-65	1,000	Rubidium-79	1,000
Nickel-66	10	Rubidium-81m	1,000
Copper-60	1,000	Rubidium-81	1,000
Copper-61	1,000	Rubidium-82m	1,000
Copper-64	1,000	Rubidium-83	100
Copper-67	1,000	Rubidium-84	100
Zinc-62	100	Rubidium-86	100
Zinc-63	1,000	Rubidium-87	100
Zinc-65	10	Rubidium-88	1,000
Zinc-69m	100	Rubidium-89	1,000
Zinc-69	1,000	Strontium-80	100
Zinc-71m	1,000	Strontium-81	1,000
Zinc-72	100	Strontium-83	100
Gallium-65	1,000	Strontium-85m	1,000
Gallium-66	100	Strontium-85	100
Gallium-67	1,000	Strontium-87m	1,000
Gallium-68	1,000	Strontium-89	10
Gallium-70	1,000	Strontium-90	0.1
Gallium-72	100	Strontium-91	100
Gallium-73	1,000	Strontium-92	100
Germanium-66	1,000	Yttrium-86m	1,000
Germanium-67	1,000	Yttrium-86	100
Germanium-68	10	Yttrium-87	100
Germanium-69	1,000	Yttrium-88	10
Germanium-71	1,000	Yttrium-90m	1,000
Germanium-75	1,000	Yttrium-90	10
Germanium-77	1,000	Yttrium-91m	1,000
Germanium-78	1,000	Yttrium-91	10
Arsenic-69	1,000	Yttrium-92	100
Arsenic-70	1,000	Yttrium-93	100
Arsenic-71	100	Yttrium-94	1,000
Arsenic-72	100	Yttrium-95	1,000
Arsenic-73	100	Zirconium-86	100

Radionuclide	Quantity (μCi)	Radionuclide	Quantity (μCi)
Zirconium-88	10	Silver-112	100
Zirconium-89	100	Silver-115	1,000
Zirconium-93	1	Cadmium-104	1,000
Zirconium-95	10	Cadmium-107	1,000
Zirconium-97	100	Cadmium-109	1
Niobium-88	1,000	Cadmium-113m	0.1
Niobium-89m (66 min)	1,000	Cadmium-113	100
Niobium-89 (122 min)	1,000	Cadmium-115m	10
Niobium-90	100	Cadmium-115	100
Niobium-93m	10	Cadmium-117m	1,000
Niobium-94	1	Cadmium-117	1,000
Niobium-95m	100	Indium-109	1,000
Niobium-95	100	Indium-110 (69.1 min.)	1,000
Niobium-96	100	Indium-110 (4.9 h)	1,000
Niobium-97	1,000	Indium-111	100
Niobium-98	1,000	Indium-112	1,000
Molybdenum-90	100	Indium-113m	1,000
Molybdenum-93m	100	Indium-114m	10
Molybdenum-93	10	Indium-115m	1,000
Molybdenum-99	100	Indium-115	100
Molybdenum-101	1,000	Indium-116m	1,000
Technetium-93m	1,000	Indium-117m	1,000
Technetium-93	1,000	Indium-117	1,000
Technetium-94m	1,000	Indium-119m	1,000
Technetium-94	1,000	Tin-110	100
Technetium-96m	1,000	Tin-111	1,000
Technetium-96	100	Tin-113	100
Technetium-97m	100	Tin-117m	100
Technetium-97	1,000	Tin-119m	100
Technetium-98	10	Tin-121m	100
Technetium-99m	1,000	Tin-121	1,000
Technetium-99	100	Tin-123m	1,000
Technetium-101	1,000	Tin-123	10
Technetium-104	1,000	Tin-125	10
Ruthenium-94	1,000	Tin-126	10
Ruthenium-97	1,000	Tin-127	1,000
Ruthenium-103	100	Tin-128	1,000
Ruthenium-105	1,000	Antimony-115	1,000
Ruthenium-106	1	Antimony-116m	1,000
Rhodium-99m	1,000	Antimony-116	1,000
Rhodium-99	100	Antimony-117	1,000
Rhodium-100	100	Antimony-118m	1,000
Rhodium-101m	1,000	Antimony-119	1,000
Rhodium-101	10	Antimony-120 (16 min.)	1,000
Rhodium-102m	10	Antimony-120 (5.76 d)	100
Rhodium-102	10	Antimony-122	100
Rhodium-103m	1,000	Antimony-124m	1,000
Rhodium-105	100	Antimony-124	10
Rhodium-106m	1,000	Antimony-125	100
Rhodium-107	1,000	Antimony-126m	1,000
Palladium-100	100	Antimony-126	100
Palladium-101	1,000	Antimony-127	100
Palladium-103	100	Antimony-128 (10.4 min.)	1,000
Palladium-107	10	Antimony-128 (9.01 h)	100
Palladium-109	100	Antimony-129	100
Silver-102	1,000	Antimony-130	1,000
Silver-103	1,000	Antimony-131	1,000
Silver-104m	1,000	Tellurium-116	1,000
Silver-104	1,000	Tellurium-121m	10
Silver-105	100	Tellurium-121	100
Silver-106m	100	Tellurium-123m	10
Silver-106	1,000	Tellurium-123	100
Silver-108m	1	Tellurium-125m	10
Silver-110m	10	Tellurium-127m	10
Silver-111	100	Tellurium-127	1,000

Radionuclide	Quantity (uCi)	Radionuclide	Quantity (uCi)
Tellurium-129m	10	Lanthanum-138	100
Tellurium-129	1,000	Lanthanum-140	100
Tellurium-131m	10	Lanthanum-141	100
Tellurium-131	100	Lanthanum-142	100
Tellurium-132	10	Cerium-137m	100
Tellurium-133m	100	Cerium-137	1,000
Tellurium-133	1,000	Cerium-139	100
Tellurium-134	1,000	Cerium-141	100
Iodine-120m	1,000	Cerium-143	100
Iodine-120	100	Cerium-144	1
Iodine-121	1,000	Praseodymium-136	1,000
Iodine-123	100	Praseodymium-137	1,000
Iodine-124	10	Praseodymium-138m	1,000
Iodine-125	1	Praseodymium-139	1,000
Iodine-126	1	Praseodymium-142m	1,000
Iodine-128	1,000	Praseodymium-142	100
Iodine-129	1	Praseodymium-143	100
Iodine-130	10	Praseodymium-144	1,000
Iodine-131	1	Praseodymium-145	100
Iodine-132m	100	Praseodymium-147	1,000
Iodine-132	100	Neodymium-136	1,000
Iodine-133	10	Neodymium-138	100
Iodine-134	1,000	Neodymium-139m	1,000
Iodine-135	100	Neodymium-139	1,000
Xenon-120	1,000	Neodymium-141	1,000
Xenon-121	1,000	Neodymium-147	100
Xenon-122	1,000	Neodymium-149	1,000
Xenon-123	1,000	Neodymium-151	1,000
Xenon-125	1,000	Promethium-141	1,000
Xenon-127	1,000	Promethium-143	100
Xenon-129m	1,000	Promethium-144	10
Xenon-131m	1,000	Promethium-145	10
Xenon-133m	1,000	Promethium-146	1
Xenon-133	1,000	Promethium-147	10
Xenon-135m	1,000	Promethium-148m	10
Xenon-135	1,000	Promethium-148	10
Xenon-138	1,000	Promethium-149	100
Cesium-125	1,000	Promethium-150	1,000
Cesium-127	1,000	Promethium-151	100
Cesium-129	1,000	Samarium-141m	1,000
Cesium-130	1,000	Samarium-141	1,000
Cesium-131	1,000	Samarium-142	1,000
Cesium-132	100	Samarium-145	100
Cesium-134m	1,000	Samarium-146	1
Cesium-134	10	Samarium-147	100
Cesium-135m	1,000	Samarium-151	10
Cesium-135	100	Samarium-153	100
Cesium-136	10	Samarium-155	1,000
Cesium-137	10	Samarium-156	1,000
Cesium-138	1,000	Europium-145	100
Barium-126	1,000	Europium-146	100
Barium-128	100	Europium-147	100
Barium-131m	1,000	Europium-148	10
Barium-131	100	Europium-149	100
Barium-133m	100	Europium-150 (12.62 h)	100
Barium-133	100	Europium-150 (34.2 y)	1
Barium-135m	100	Europium-152m	100
Barium-139	1,000	Europium-152	1
Barium-140	100	Europium-154	1
Barium-141	1,000	Europium-155	10
Barium-142	1,000	Europium-156	100
Lanthanum-131	1,000	Europium-157	100
Lanthanum-132	100	Europium-158	1,000
Lanthanum-135	1,000	Gadolinium-145	1,000
Lanthanum-137	10	Gadolinium-146	10

Radionuclide	Quantity (μ Ci)	Radionuclide	Quantity (μ Ci)
Gadolinium-147	100	Lutetium-176	100
Gadolinium-148	0.001	Lutetium-177m	10
Gadolinium-149	100	Lutetium-177	100
Gadolinium-151	10	Lutetium-178m	1,000
Gadolinium-152	100	Lutetium-178	1,000
Gadolinium-153	10	Lutetium-179	1,000
Gadolinium-159	100	Hafnium-170	100
Terbium-147	1,000	Hafnium-172	1
Terbium-149	100	Hafnium-173	1,000
Terbium-150	1,000	Hafnium-175	100
Terbium-151	100	Hafnium-177m	1,000
Terbium-153	1,000	Hafnium-178m	0.1
Terbium-154	100	Hafnium-179m	10
Terbium-155	1,000	Hafnium-180m	1,000
Terbium-156m (5.0 h)	1,000	Hafnium-181	10
Terbium-156m (24.4 h)	1,000	Hafnium-182m	1,000
Terbium-156	100	Hafnium-182	0.1
Terbium-157	10	Hafnium-183	1,000
Terbium-158	1	Hafnium-184	100
Terbium-160	10	Tantalum-172	1,000
Terbium-161	100	Tantalum-173	1,000
Dysprosium-155	1,000	Tantalum-174	1,000
Dysprosium-157	1,000	Tantalum-175	1,000
Dysprosium-159	100	Tantalum-176	100
Dysprosium-165	1,000	Tantalum-177	1,000
Dysprosium-166	100	Tantalum-178	1,000
Holmium-155	1,000	Tantalum-179	100
Holmium-157	1,000	Tantalum-180m	1,000
Holmium-159	1,000	Tantalum-180	100
Holmium-161	1,000	Tantalum-182m	1,000
Holmium-162m	1,000	Tantalum-182	10
Holmium-162	1,000	Tantalum-183	100
Holmium-164m	1,000	Tantalum-184	100
Holmium-164	1,000	Tantalum-185	1,000
Holmium-166m	1	Tantalum-186	1,000
Holmium-166	100	Tungsten-176	1,000
Holmium-167	1,000	Tungsten-177	1,000
Erbium-161	1,000	Tungsten-178	1,000
Erbium-165	1,000	Tungsten-179	1,000
Erbium-169	100	Tungsten-181	1,000
Erbium-171	100	Tungsten-185	100
Erbium-172	100	Tungsten-187	100
Thulium-162	1,000	Tungsten-188	10
Thulium-166	100	Rhenium-177	1,000
Thulium-167	100	Rhenium-178	1,000
Thulium-170	10	Rhenium-181	1,000
Thulium-171	10	Rhenium-182 (12.7 h)	1,000
Thulium-172	100	Rhenium-182 (64.0 h)	100
Thulium-173	100	² Rhenium-183	100
Thulium-175	1,000	Rhenium-184m	10
Ytterbium-162	1,000	Rhenium-184	100
Ytterbium-166	100	Rhenium-186m	10
Ytterbium-167	1,000	Rhenium-186	100
Ytterbium-169	100	Rhenium-187	1,000
Ytterbium-175	100	Rhenium-188m	1,000
Ytterbium-177	1,000	Rhenium-188	100
Ytterbium-178	1,000	Rhenium-189	100
Lutetium-169	100	Osmium-180	1,000
Lutetium-170	100	Osmium-181	1,000
Lutetium-171	100	Osmium-182	100
Lutetium-172	100	Osmium-185	100
Lutetium-173	10	Osmium-189m	1,000
Lutetium-174m	10	Osmium-191m	1,000
Lutetium-174	10	Osmium-191	100
Lutetium-176m	1,000	Osmium-193	100

Radionuclide	Quantity (μCi)	Radionuclide	Quantity (μCi)
Osmium-194	1	Lead-209	1,000
Iridium-182	1,000	Lead-210	0.01
Iridium-184	1,000	Lead-211	100
Iridium-185	1,000	Lead-212	1
Iridium-186	100	Lead-214	100
Iridium-187	1,000	Bismuth-200	1,000
Iridium-188	100	Bismuth-201	1,000
Iridium-189	100	Bismuth-202	1,000
Iridium-190m	1,000	Bismuth-203	100
Iridium-190	100	Bismuth-205	100
Iridium-192 (73.8 d)	1	Bismuth-206	100
Iridium-192m (1.4 min.)	10	Bismuth-207	10
Iridium-194m	10	Bismuth-210m	0.1
Iridium-194	100	Bismuth-210	1
Iridium-195m	1,000	Bismuth-212	10
Iridium-195	1,000	Bismuth-213	10
Platinum-186	1,000	Bismuth-214	100
Platinum-188	100	Polonium-203	1,000
Platinum-189	1,000	Polonium-205	1,000
Platinum-191	100	Polonium-207	1,000
Platinum-193m	100	Polonium-210	0.1
Platinum-193	1,000	Astatine-207	100
Platinum-195m	100	Astatine-211	10
Platinum-197m	1,000	Radon-220	1
Platinum-197	100	Radon-222	1
Platinum-199	1,000	Francium-222	100
Platinum-200	100	Francium-223	100
Gold-193	1,000	Radium-223	0.1
Gold-194	100	Radium-224	0.1
Gold-195	10	Radium-225	0.1
Gold-198m	100	Radium-226	0.1
Gold-198	100	Radium-227	1,000
Gold-199	100	Radium-228	0.1
Gold-200m	100	Actinium-224	1
Gold-200	1,000	Actinium-225	0.01
Gold-201	1,000	Actinium-226	0.1
Mercury-193m	100	Actinium-227	0.001
Mercury-193	1,000	Actinium-228	1
Mercury-194	1	Thorium-226	10
Mercury-195m	100	Thorium-227	0.01
Mercury-195	1,000	Thorium-228	0.001
Mercury-197m	100	Thorium-229	0.001
Mercury-197	1,000	Thorium-230	0.001
Mercury-199m	1,000	Thorium-231	100
Mercury-203	100	¹ Thorium-232	100
Thallium-194m	1,000	Thorium-234	10
Thallium-194	1,000	Thorium-natural	100
Thallium-195	1,000	Protactinium-227	10
Thallium-197	1,000	Protactinium-228	1
Thallium-198m	1,000	Protactinium-230	0.1
Thallium-198	1,000	Protactinium-231	0.001
Thallium-199	1,000	Protactinium-232	1
Thallium-200	1,000	Protactinium-233	100
Thallium-201	1,000	Protactinium-234	100
Thallium-202	100	Uranium-230	0.01
Thallium-204	100	Uranium-231	100
Lead-195m	1,000	Uranium-232	0.001
Lead-198	1,000	Uranium-233	0.001
Lead-199	1,000	¹ Uranium-234	0.001
Lead-200	100	¹ Uranium-235	0.001
Lead-201	1,000	Uranium-236	0.001
Lead-202m	1,000	Uranium-237	100
Lead-202	10	¹ Uranium-238	100
Lead-203	1,000	Uranium-239	1,000
Lead-205	100	Uranium-240	100

Radionuclide	Quantity (μ Ci)
Uranium-natural	100
Neptunium-232	100
Neptunium-233	1,000
Neptunium-234	100
Neptunium-235	100
Neptunium-236 (1.15 x 10 ⁵ y)	0.001
Neptunium-236 (22.5 h)	1
Neptunium-237	0.001
Neptunium-238	10
Neptunium-239	100
Neptunium-240	1,000
Plutonium-234	10
Plutonium-235	1,000
Plutonium-236	0.001
Plutonium-237	100
Plutonium-238	0.001
Plutonium-239	0.001
Plutonium-240	0.001
Plutonium-241	0.01
Plutonium-242	0.001
Plutonium-243	1,000
Plutonium-244	0.001
Plutonium-245	100
Americium-237	1,000
Americium-238	100
Americium-239	1,000
Americium-240	100
Americium-241	0.001
Americium-242m	0.001
Americium-242	10
Americium-243	0.001
Americium-244m	100
Americium-244	10
Americium-245	1,000
Americium-246m	1,000
Americium-246	1,000
Curium-238	100
Curium-240	0.1
Curium-241	1
Curium-242	0.01
Curium-243	0.001
Curium-244	0.001
Curium-245	0.001
Curium-246	0.001
Curium-247	0.001
Curium-248	0.001
Curium-249	1,000
Berkelium-245	100
Berkelium-246	100
Berkelium-247	0.001
Berkelium-249	0.1
Berkelium-250	10
Californium-244	100
Californium-246	1
Californium-248	0.01
Californium-249	0.001
Californium-250	0.001
Californium-251	0.001
Californium-252	0.001
Californium-253	0.1
Californium-254	0.001
Einsteinium-250	100
Einsteinium-251	100
Einsteinium-253	0.1
Einsteinium-254m	1

Radionuclide	Quantity (μ Ci)
Einsteinium-254	0.01
Fermium-252	1
Fermium-253	1
Fermium-254	10
Fermium-255	1
Fermium-257	0.01
Mendelevium-257	10
Mendelevium-258	0.01

Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition 0.001

Any radionuclide other than alpha emitting radionuclides not listed above, or mixtures of beta emitters of unknown composition 0.01

The quantities listed above were derived by taking 1/10th of the most restrictive ALI listed in table 1, columns 1 and 2, of Appendix B to 10 CFR 20, rounding to the nearest factor of 10, and arbitrarily constraining the values listed between 0.001 and 1,000 Ci. Values of 100 Ci have been assigned for radionuclides having a radioactive half-life in excess of 10⁹ years (except rhenium, 1,000 Ci) to take into account their low specific activity.

These quantities do not apply to source materials as defined by the NRC for thorium and uranium.

The value for Re-183 is actually taken from Re-186. The value for Re-183 could not be calculated due to the fact that Re-183 is not listed in 10 CFR 20, Appendix B.

(b) For purposes of N.J.A.C. 7:28-10.5 and 10.6, where there is involved a combination of radionuclides in known amounts, the limit for the combination shall be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed "1" (that is, "unity").

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote the section.

SUBCHAPTER 11. DISPOSAL OF RADIOACTIVE MATERIALS

7:28-11.1 General requirements

The disposal of radioactive materials is permitted only to the extent and under the conditions specified in Sections 11.2 through 11.7 of this Chapter.

7:28-11.2 Disposal by release into sanitary sewer systems

(a) A State licensee may discharge State licensed or other radioactive material into a sanitary sewer system if each of the following conditions is satisfied:

1. The material is readily soluble (or is readily dispersible biological material) in water;

2. The quantity of State licensed or other radioactive material that the State licensee releases into the sewer in one month divided by the average monthly volume of water released into the sewer by the State licensee does not exceed the concentration listed in the Appendix, Table 2 of this subchapter, incorporated herein by reference;

3. If more than one radionuclide is released, the following conditions must also be satisfied:

i. The State licensee shall determine the fraction of the limit in the Appendix, Table 2 of this subchapter represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the State licensee into the sewer by the concentration of that radionuclide listed in the Appendix, Table 2 of this subchapter; and

ii. The sum of the fractions for each radionuclide required by (a)3i above does not exceed unity; and

4. The total quantity of State licensed and other radioactive material, excluding tritium and carbon-14, that the State licensee releases into the sanitary sewerage system in a year does not exceed one Curie (37 GBq).

(b) Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to the limitations contained in (a) above.

Repeal and New Rule, R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Section was "Disposal by release into sanitary sewerage systems".

7:28-11.3 Disposal by discharges into the air, ground waters or surface waters

(a) A State licensee may dispose of State licensed or any other radioactive material into the air outside a controlled area provided the concentration at the point where the State licensed or any other radioactive material leaves the controlled area is not in excess of the concentrations specified in the Appendix of this subchapter, Table 1, Column 1, incorporated herein by reference, or prorated values if more than one isotope is discharged. Where the State licensed or any other radioactive material is discharged through a stack, tube pipe, or similar conduit, the determination may be made with respect to the point where the State licensed or any other radioactive material leaves such a conduit. For purposes of this subsection, concentrations may be averaged over periods not greater than one year.

(b) No State licensee shall dispose of State licensed or any other radioactive material into surface waters or into ground waters without specific, prior permission in writing, in the form of a New Jersey Pollutant Discharge Elimination System permit, from the Department.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
Rewrote the section.

7:28-11.4 Disposal by burial in the soil

(a) No owner shall dispose of radioactive material by burial in the soil without prior approval in writing from the Department.

(b) Sites that have been used for burial of radioactive materials shall not be converted to other uses except with the written permission of the Department.

(c) The owner of any burial ground shall notify the Department in writing not less than 30 days in advance of any transfer of title to the property involved.

7:28-11.5 Disposal by transfer to a radioisotope disposal service

(a) An owner may dispose of radioactive materials by transfer to a radioisotope disposal service providing this service has been approved by the Department to receive such materials.

(b) An owner may dispose of radioactive materials by transfer to a person who is authorized to receive such material under a license issued by the Department, a Federal agency, or any agreement state.

7:28-11.6 Disposal by incineration

No owner shall incinerate radioactive materials for the purpose of disposal or preparation for disposal except as specifically approved by the Department in writing.

7:28-11.7 Disposal by a specially approved method

(a) Any person may apply to the Department for approval of proposed procedure to dispose of radioactive material in a manner not otherwise authorized in this Subchapter.

(b) Each application shall include a description of the radioactive material, including the quantities and kinds of radioactive material and the levels of radioactivity involved, and the proposed manner and conditions of disposal.

(c) The application, where appropriate, shall also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meteorological, and hydrological characteristics; usage of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures.

7:28-11.8 Unauthorized removal

Sources of radiation shall be secured against unauthorized removal from the place of storage.

APPENDIX

CONCENTRATIONS FOR EFFLUENT AND SANITARY SEWER RELEASES

Atomic Number	Radionuclide	Class	Table 1		Table 2
			Effluent Concentrations		Releases to Sewers
			Col. 1 Air ($\mu\text{Ci/ml}$)	Col. 2 Water ($\mu\text{Ci/ml}$)	Monthly Ave. Concentration ($\mu\text{Ci/ml}$)
1	Hydrogen-3	Water	1E-7	1E-3	1E-2
4	Beryllium-7	W, all compounds except those given for Y Y, oxides, halides, and nitrates	3E-8 3E-8	6E-4 —	6E-3 —
4	Beryllium-10	W, see ^7Be LLI wall Y, see ^7Be	2E-10 — 2E-11	— 2E-5 —	— 2E-4 —
6	Carbon-11	Monoxide Dioxide Compounds	2E-6 9E-7 6E-7	— — 6E-3	— — 6E-2
6	Carbon-14	Monoxide Dioxide Compounds	2E-6 3E-7 3E-9	— — 3E-5	— — 3E-4
9	Fluorine-18	D, fluorides of H, Li, Na, K, Rb, Cs, and Fr St wall 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 Y, lanthanum fluoride	1E-7 — 1E-7 1E-7	— 7E-4 — —	— 7E-3 — —
11	Sodium-22	D, all compounds	9E-10	6E-6	6E-5
11	Sodium-24	D, all compounds	7E-9	5E-5	5E-4
12	Magnesium-28	D, all compounds except those given for W W, oxides, hydroxides, carbides, halides, and nitrates	2E-9 2E-9	9E-6 —	9E-5 —
13	Aluminum-26	D, all compounds except those given for W W, oxides, hydroxides, carbides, halides, and nitrates	9E-11 1E-10	6E-6 —	6E-5 —
14	Silicon-31	D, all compounds except those given for W and Y W, oxides, hydroxides, carbides, and nitrates Y, aluminosilicate glass	4E-8 5E-8 4E-8	1E-4 — —	1E-3 — —

14	Silicon-32	D, see ^{31}Si	3E-10	—	—
		LLI wall			
		(3E+3)	—	4E-5	4E-4
		W, see ^{31}Si	2E-10	—	—
		Y, see ^{31}Si	7E-12	—	—
15	Phosphorus-32	D, all compounds except phosphates given for W	1E-9	9E-6	9E-5
		W, phosphates of Zn^{2+} , S^{2+} , Mg^{2+} , Fe^{2+} , Bi^{3+} , and lanthanides	5E-10	—	—
15	Phosphorus-33	D, see ^{32}P	1E-8	8E-5	8E-4
		W, see ^{32}P	4E-9	—	—
16	Sulfur-35	Vapor	2E-8	—	—
		D, sulfides and sulfates except those given for W	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	3E-9	—	—
17	Chlorine-36	D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	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	3E-10	—	—
17	Chlorine-38	D, see ^{36}Cl	6E-8	—	—
		St wall	—	3E-4	3E-3
		W, see ^{36}Cl	6E-8	—	—
17	Chlorine-39	D, see ^{36}Cl	7E-8	—	—
		St wall	—	5E-4	5E-3
		W, see ^{36}Cl	8E-8	—	—
18	Argon-37	Submersion ^v	6E-3	—	—
18	Argon-39	Submersion ^v	8E-7	—	—
18	Argon-41	Submersion ^v	1E-8	—	—
19	Potassium-40	D, all compounds	6E-10	4E-6	4E-5
19	Potassium-42	D, all compounds	7E-9	6E-5	6E-4
19	Potassium-43	D, all compounds	1E-8	9E-5	9E-4
19	Potassium-44	D, all compounds	9E-8	—	—
		St wall	—	5E-4	5E-3
19	Potassium-45	D, all compounds	2E-7	—	—
		St wall	—	7E-4	7E-3
20	Calcium-41	W, all compounds	—	—	—
		Bone surf	5E-9	6E-5	6E-4

20	Calcium-45	W, all compounds	1E-9	2E-5	2E-4
20	Calcium-47	W, all compounds	1E-9	1E-5	1E-4
21	Scandium-43	Y, all compounds	3E-8	1E-4	1E-3
21	Scandium-44m	Y, all compounds	1E-9	7E-6	7E-5
21	Scandium-44	Y, all compounds	2E-8	5E-5	5E-4
21	Scandium-46	Y, all compounds	3E-10	1E-5	1E-4
21	Scandium-47	Y, all compounds	4E-9	—	—
		LLI wall	—	4E-5	4E-4
21	Scandium-48	Y, all compounds	2E-9	1E-5	1E-4
21	Scandium-49	Y, all compounds	8E-8	3E-4	3E-3
22	Titanium-44	D, all compounds except those given for W and Y	2E-11	4E-6	4E-5
		W, oxides, hydroxides, carbides, halides, and nitrates	4E-11	—	—
		Y, SrTiO ₃	8E-12	—	—
22	Titanium-45	D, see ⁴⁴ Ti	3E-8	1E-4	1E-3
		W, see ⁴⁴ Ti	5E-8	—	—
		Y, see ⁴⁴ Ti	4E-8	—	—
23	Vanadium-47	D, all compounds except those given for W	1E-7	—	—
		St wall	—	4E-4	4E-3
		W, oxides, hydroxides, carbides, and halides	1E-7	—	—
23	Vanadium-48	D, see ⁴⁷ V	2E-9	9E-6	9E-5
		W, see ⁴⁷ V	9E-10	—	—
23	Vanadium-49	D, see ⁴⁷ V	—	—	—
		LLI wall/Bone surface	5E-8	1E-3	1E-2
		W, see ⁴⁷ V	2E-8	—	—
24	Chromium-48	D, all compounds except those given for W and Y	2E-8	8E-5	8E-4
		W, halides and nitrates	1E-8	—	—
		Y, oxides and hydroxides	1E-8	—	—
24	Chromium-49	D, see ⁴⁸ Cr	1E-7	4E-4	4E-3
		W, see ⁴⁸ Cr	1E-7	—	—
		Y, see ⁴⁸ Cr	1E-7	—	—
24	Chromium-51	D, see ⁴⁸ Cr	6E-8	5E-4	5E-3
		W, see ⁴⁸ Cr	3E-8	—	—
		Y, see ⁴⁸ Cr	3E-8	—	—
25	Manganese-51	D, all compounds except those given for W	7E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	8E-8	—	—
25	Manganese-52m	D, see ⁵¹ Mn	1E-7	—	—
		St wall	—	5E-4	5E-3
		W, see ⁵¹ Mn	1E-7	—	—
25	Manganese-52	D, see ⁵¹ Mn	2E-9	1E-5	1E-4
		W, see ⁵¹ Mn	1E-9	—	—
25	Manganese-53	D, see ⁵¹ Mn	—	7E-4	7E-3
		Bone surf	3E-8	—	—
		W, see ⁵¹ Mn	2E-8	—	—

25	Manganese-54	D, see ⁵⁴ Mn W, see ⁵⁴ Mn	1E-9 1E-9	3E-5 —	3E-4 —
25	Manganese-56	D, see ⁵⁶ Mn W, see ⁵⁶ Mn	2E-8 3E-8	7E-5 —	7E-4 —
26	Iron-52	D, all compounds except those given for W W, oxides, hydroxides, and halides	4E-9 3E-9	1E-5 —	1E-4 —
26	Iron-55	D, see ⁵⁵ Fe W, see ⁵⁵ Fe	3E-9 6E-9	1E-4 —	1E-3 —
26	Iron-59	D, see ⁵⁹ Fe W, see ⁵⁹ Fe	5E-10 7E-10	1E-5 —	1E-4 —
26	Iron-60	D, see ⁶⁰ Fe W, see ⁶⁰ Fe	9E-12 3E-11	4E-7 —	4E-6 —
27	Cobalt-55	W, all compounds except those given for Y Y, oxides, hydroxides, halides, and nitrates	4E-9 4E-9	2E-5 —	2E-4 —
27	Cobalt-56	W, see ⁵⁶ Co Y, see ⁵⁶ Co	4E-10 3E-10	6E-6 —	6E-5 —
27	Cobalt-57	W, see ⁵⁷ Co Y, see ⁵⁷ Co	4E-9 9E-10	6E-5 —	6E-4 —
27	Cobalt-58m	W, see ⁵⁸ Co Y, see ⁵⁸ Co	1E-7 9E-8	8E-4 —	8E-3 —
27	Cobalt-58	W, see ⁵⁸ Co Y, see ⁵⁸ Co	2E-9 1E-9	2E-5 —	2E-4 —
27	Cobalt-60m	W, see ⁶⁰ Co St wall Y, see ⁶⁰ Co	6E-6 — 4E-6	— 2E-2 —	— 2E-1 —
27	Cobalt-60	W, see ⁶⁰ Co Y, see ⁶⁰ Co	2E-10 5E-11	3E-6 —	3E-5 —
27	Cobalt-61	W, see ⁶¹ Co Y, see ⁶¹ Co	9E-8 8E-8	3E-4 —	3E-3 —
27	Cobalt-62m	W, see ⁶² Co St wall Y, see ⁶² Co	2E-7 — 2E-7	— 7E-4 —	— 7E-3 —
28	Nickel-56	D, all compounds except those given for W W, oxides, hydroxides, and carbides Vapor	3E-9 2E-9 2E-9	2E-5 — —	2E-4 — —
28	Nickel-57	D, see ⁵⁷ Ni W, see ⁵⁷ Ni Vapor	7E-9 4E-9 9E-9	2E-5 — —	2E-4 — —
28	Nickel-59	D, see ⁵⁹ Ni W, see ⁵⁹ Ni Vapor	5E-9 1E-8 3E-9	3E-4 — —	3E-3 — —
28	Nickel-63	D, see ⁶³ Ni W, see ⁶³ Ni Vapor	2E-9 4E-9 1E-9	1E-4 — —	1E-3 — —

28	Nickel-65	D, see ⁶⁵ Ni	3E-8	1E-4	1E-3
		W, see ⁶⁵ Ni	4E-8	—	—
		Vapor	2E-8	—	—
28	Nickel-66	D, see ⁶⁶ Ni	2E-9	—	—
		LLI wall	—	6E-6	6E-5
		W, see ⁶⁶ Ni	9E-10	—	—
		Vapor	4E-9	—	—
29	Copper-60	D, all compounds except those given for W and Y	1E-7	—	—
		St wall	—	4E-4	4E-3
		W, sulfides, halides, and nitrates	2E-7	—	—
		Y, oxides and hydroxides	1E-7	—	—
29	Copper-61	D, see ⁶¹ Cu	4E-8	2E-4	2E-3
		W, see ⁶¹ Cu	6E-8	—	—
		Y, see ⁶¹ Cu	5E-8	—	—
29	Copper-64	D, see ⁶⁴ Cu	4E-8	2E-4	2E-3
		W, see ⁶⁴ Cu	3E-8	—	—
		Y, see ⁶⁴ Cu	3E-8	—	—
29	Copper-67	D, see ⁶⁷ Cu	1E-8	6E-5	6E-4
		W, see ⁶⁷ Cu	7E-9	—	—
		Y, see ⁶⁷ Cu	6E-9	—	—
30	Zinc-62	Y, all compounds	4E-9	2E-5	2E-4
30	Zinc-63	Y, all compounds	9E-8	—	—
		St wall	—	3E-4	3E-3
30	Zinc-65	Y, all compounds	4E-10	5E-6	5E-5
30	Zinc-69m	Y, all compounds	1E-8	6E-5	6E-4
30	Zinc-69	Y, all compounds	2E-7	8E-4	8E-3
30	Zinc-71m	Y, all compounds	2E-8	8E-5	8E-4
30	Zinc-72	Y, all compounds	2E-9	1E-5	1E-4
31	Gallium-65	D, all compounds except those given for W	2E-7	—	—
		St wall	—	9E-4	9E-3
		W, oxides, hydroxides, carbides, halides, and nitrates	3E-7	—	—
31	Gallium-66	D, see ⁶⁶ Ga	5E-9	1E-5	1E-4
		W, see ⁶⁶ Ga	4E-9	—	—
31	Gallium-67	D, see ⁶⁷ Ga	2E-8	1E-4	1E-3
		W, see ⁶⁷ Ga	1E-8	—	—
31	Gallium-68	D, see ⁶⁸ Ga	6E-8	2E-4	2E-3
		W, see ⁶⁸ Ga	7E-8	—	—
31	Gallium-70	D, see ⁷⁰ Ga	2E-7	—	—
		St wall	—	1E-3	1E-2
		W, see ⁷⁰ Ga	3E-7	—	—
31	Gallium-72	D, see ⁷² Ga	5E-9	2E-5	2E-4
		W, see ⁷² Ga	4E-9	—	—
31	Gallium-73	D, see ⁷³ Ga	2E-8	7E-5	7E-4
		W, see ⁷³ Ga	2E-8	—	—

32	Germanium-66	D, all compounds except those given for W W, oxides, sulfides, and halides	4E-8 3E-8	3E-4 —	3E-3 —
32	Germanium-67	D, see ⁶⁶ Ge St wall W, see ⁶⁶ Ge	1E-7 — 1E-7	— 6E-4 —	— 6E-3 —
32	Germanium-68	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	5E-9 1E-10	6E-5 —	6E-4 —
32	Germanium-69	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	2E-8 1E-8	2E-4 —	2E-3 —
32	Germanium-71	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	6E-7 6E-8	7E-3 —	7E-2 —
32	Germanium-75	D, see ⁶⁶ Ge St wall W, see ⁶⁶ Ge	1E-7 — 1E-7	— 9E-4 —	— 9E-3 —
32	Germanium-77	D, see ⁶⁶ Ge W, see ⁶⁶ Ge	1E-8 8E-9	1E-4 —	1E-3 —
32	Germanium-78	D, see ⁶⁶ Ge St wall W, see ⁶⁶ Ge	3E-8 — 3E-8	— 3E-4 —	— 3E-3 —
33	Arsenic-69	W, all compounds St wall	2E-7 —	— 6E-4	— 6E-3
33	Arsenic-70	W, all compounds	7E-8	2E-4	2E-3
33	Arsenic-71	W, all compounds	6E-9	5E-5	5E-4
33	Arsenic-72	W, all compounds	2E-9	1E-5	1E-4
33	Arsenic-73	W, all compounds	2E-9	1E-4	1E-3
33	Arsenic-74	W, all compounds	1E-9	2E-5	2E-4
33	Arsenic-76	W, all compounds	2E-9	1E-5	1E-4
33	Arsenic-77	W, all compounds LLI wall	7E-9 —	— 6E-5	— 6E-4
33	Arsenic-78	W, all compounds	3E-8	1E-4	1E-3
34	Selenium-70	D, all compounds except those given for W W, oxides, hydroxides, carbides, and elemental Se	5E-8 6E-8	1E-4 —	1E-3 —
34	Selenium-73m	D, see ⁷⁰ Se W, see ⁷⁰ Se	2E-7 2E-7	4E-4 —	4E-3 —
34	Selenium-73	D, see ⁷⁰ Se W, see ⁷⁰ Se	2E-8 2E-8	4E-5 —	4E-4 —
34	Selenium-75	D, see ⁷⁰ Se W, see ⁷⁰ Se	1E-9 8E-10	7E-6 —	7E-5 —
34	Selenium-79	D, see ⁷⁰ Se W, see ⁷⁰ Se	1E-9 8E-10	8E-6 —	8E-5 —
34	Selenium-81m	D, see ⁷⁰ Se W, see ⁷⁰ Se	9E-8 1E-7	3E-4 —	3E-3 —
34	Selenium-81	D, see ⁷⁰ Se St wall W, see ⁷⁰ Se	3E-7 — 3E-7	— 1E-3 —	— 1E-2 —

37	Rubidium-81m	D, all compounds St wall	5E-7 —	— 4E-3	— 4E-2
37	Rubidium-81	D, all compounds	7E-8	5E-4	5E-3
37	Rubidium-82m	D, all compounds	2E-8	2E-4	2E-3
37	Rubidium-83	D, all compounds	1E-9	9E-6	9E-5
37	Rubidium-84	D, all compounds	1E-9	7E-6	7E-5
37	Rubidium-86	D, all compounds	1E-9	7E-6	7E-5
37	Rubidium-87	D, all compounds	2E-9	1E-5	1E-4
37	Rubidium-88	D, all compounds St wall	9E-8 —	— 4E-4	— 4E-3
37	Rubidium-89	D, all compounds St wall	2E-7 —	— 9E-4	— 9E-3
38	Strontium-80	D, all soluble compounds except SrTiO ₃ Y, all insoluble com- pounds and SrTiO ₃	2E-8 2E-8	6E-5 —	6E-4 —
38	Strontium-81	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	1E-7 1E-7	3E-4 —	3E-3 —
38	Strontium-82	D, see ⁸⁰ Sr LLI wal Y, see ⁸⁰ Sr	6E-10 — 1E-10	— 3E-6 —	— 3E-5 —
38	Strontium-83	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	1E-8 5E-9	3E-5 —	3E-4 —
38	Strontium-85m	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	9E-7 1E-6	3E-3 —	3E-2 —
38	Strontium-85	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	4E-9 2E-9	4E-5 —	4E-4 —
38	Strontium-87m	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	2E-7 2E-7	6E-4 —	6E-3 —
38	Strontium-89	D, see ⁸⁰ Sr LLI wall Y, see ⁸⁰ Sr	1E-9 — 2E-10	— 8E-6 —	— 8E-5 —
38	Strontium-90	D, see ⁸⁰ Sr Bone surf Y, see ⁸⁰ Sr	— 3E-11 6E-12	— 5E-7 —	— 5E-6 —
38	Strontium-91	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	8E-9 5E-9	2E-5 —	2E-4 —
38	Strontium-92	D, see ⁸⁰ Sr Y, see ⁸⁰ Sr	1E-8 9E-9	4E-5 —	4E-4 —
39	Yttrium-86m	W, all compounds except those given for Y Y, oxides and hydroxides	8E-8 8E-8	3E-4 —	3E-3 —
39	Yttrium-86	W, see ^{86m} Y Y, see ^{86m} Y	5E-9 5E-9	2E-5 —	2E-4 —
39	Yttrium-87	W, see ^{86m} Y Y, see ^{86m} Y	5E-9 5E-9	3E-5 —	3E-4 —
39	Yttrium-88	W, see ^{86m} Y Y, see ^{86m} Y	3E-10 3E-10	1E-5 —	1E-4 —

39	Yttrium-90m	W, see ^{86m}Y	2E-8	1E-4	1E-3
		Y, see ^{86m}Y	2E-8	—	—
39	Yttrium-90	W, see ^{86m}Y	9E-10	—	—
		LLI wall	—	7E-6	7E-5
		Y, see ^{86m}Y	9E-10	—	—
39	Yttrium-91m	W, see ^{86m}Y	3E-7	2E-3	2E-2
		Y, see ^{86m}Y	2E-7	—	—
39	Yttrium-91	W, see ^{86m}Y	2E-10	—	—
		LLI wall	—	8E-6	8E-5
		Y, see ^{86m}Y	2E-10	—	—
39	Yttrium-92	W, see ^{86m}Y	1E-8	4E-5	4E-4
		Y, see ^{86m}Y	1E-8	—	—
39	Yttrium-93	W, see ^{86m}Y	4E-9	2E-5	2E-4
		Y, see ^{86m}Y	3E-9	—	—
39	Yttrium-94	W, see ^{86m}Y	1E-7	—	—
		St wall	—	4E-4	4E-3
		Y, see ^{86m}Y	1E-7	—	—
39	Yttrium-95	W, see ^{86m}Y	2E-7	—	—
		St wall	—	7E-4	7E-3
		Y, see ^{86m}Y	2E-7	—	—
40	Zirconium-86	D, all compounds except those given for W and Y	6E-9	2E-5	2E-4
		W, oxides, hydroxides, halides, and nitrates	4E-9	—	—
		Y, carbide	3E-9	—	—
40	Zirconium-88	D, see ^{86}Zr	3E-10	5E-5	5E-4
		W, see ^{86}Zr	7E-10	—	—
		Y, see ^{86}Zr	4E-10	—	—
40	Zirconium-89	D, see ^{86}Zr	5E-9	2E-5	2E-4
		W, see ^{86}Zr	3E-9	—	—
		Y, see ^{86}Zr	3E-9	—	—
40	Zirconium-93	D, see ^{86}Zr	—	—	—
		Bone surf	2E-11	4E-5	4E-4
		W, see ^{86}Zr	—	—	—
		Bone surf	9E-11	—	—
		Y, see ^{86}Zr	—	—	—
40	Zirconium-95	Bone surf	9E-11	—	—
		D, see ^{86}Zr	—	2E-5	2E-4
		Bone surf	4E-10	—	—
		W, see ^{86}Zr	5E-10	—	—
		Y, see ^{86}Zr	4E-10	—	—
40	Zirconium-97	D, see ^{86}Zr	3E-9	9E-6	9E-5
		W, see ^{86}Zr	2E-9	—	—
		Y, see ^{86}Zr	2E-9	—	—
41	Niobium-88	W, all compounds except those given for Y	3E-7	—	—
		St wall	—	1E-3	1E-2
		Y, oxides and hydroxides	3E-7	—	—
41	Niobium-89m (66 min)	W, see ^{88}Nb	6E-8	1E-4	1E-3
		Y, see ^{88}Nb	5E-8	—	—

41	Niobium-89 (122 min)	W, see ⁸⁹ Nb Y, see ⁸⁹ Nb	3E-8 2E-8	7E-5 —	7E-4 —
41	Niobium-90	W, see ⁹⁰ Nb Y, see ⁹⁰ Nb	4E-9 3E-9	1E-5 —	1E-4 —
41	Niobium-93m	W, see ^{93m} Nb LLI wall Y, see ^{93m} Nb	3E-9 — 2E-10	— 2E-4 —	— 2E-3 —
41	Niobium-94	W, see ⁹⁴ Nb Y, see ⁹⁴ Nb	3E-10 2E-11	1E-5 —	1E-4 —
41	Niobium-95m	W, see ^{95m} Nb LLI wall Y, see ^{95m} Nb	4E-9 — 3E-9	— 3E-5 —	— 3E-4 —
41	Niobium-95	W, see ⁹⁵ Nb Y, see ⁹⁵ Nb	2E-9 2E-9	3E-5 —	3E-4 —
41	Niobium-96	W, see ⁹⁶ Nb Y, see ⁹⁶ Nb	4E-9 3E-9	2E-5 —	2E-4 —
41	Niobium-97	W, see ⁹⁷ Nb Y, see ⁹⁷ Nb	1E-7 1E-7	3E-4 —	3E-3 —
41	Niobium-98	W, see ⁹⁸ Nb Y, see ⁹⁸ Nb	8E-8 7E-8	2E-4 —	2E-3 —
42	Molybdenum-90	D, all compounds except those given for Y Y, oxides, hydroxides, and MoS ₂	1E-8 6E-9	3E-5 —	3E-4 —
42	Molybdenum-93m	D, see ^{93m} Mo Y, see ^{93m} Mo	2E-8 2E-8	6E-5 —	6E-4 —
42	Molybdenum-93	D, see ⁹³ Mo Y, see ⁹³ Mo	8E-9 2E-10	5E-5 —	5E-4 —
42	Molybdenum-99	D, see ⁹⁹ Mo LLI wall Y, see ⁹⁹ Mo	4E-9 — 2E-9	— 2E-5 —	— 2E-4 —
42	Molybdenum-101	D, see ¹⁰¹ Mo St wall Y, see ¹⁰¹ Mo	2E-7 — 2E-7	— 7E-4 —	— 7E-3 —
43	Technetium-93m	D, all compounds except those given for W W, oxides, hydroxides, halides, and nitrates	2E-7 4E-7	1E-3 —	1E-2 —
43	Technetium-93	D, see ^{93m} Tc W, see ^{93m} Tc	1E-7 1E-7	4E-4 —	4E-3 —
43	Technetium-94m	D, see ^{94m} Tc W, see ^{94m} Tc	6E-8 8E-8	3E-4 —	3E-3 —
43	Technetium-94	D, see ⁹⁴ Tc W, see ⁹⁴ Tc	3E-8 3E-8	1E-4 —	1E-3 —
43	Technetium-95m	D, see ^{95m} Tc W, see ^{95m} Tc	8E-9 3E-9	5E-5 —	5E-4 —
43	Technetium-95	D, see ⁹⁵ Tc W, see ⁹⁵ Tc	3E-8 3E-8	1E-4 —	1E-3 —
43	Technetium-96m	D, see ^{96m} Tc W, see ^{96m} Tc	4E-7 3E-7	2E-3 —	2E-2 —

43	Techneium-96	D, see ^{93m}Tc W, see ^{93m}Tc	5E-9 3E-9	3E-5 —	3E-4 —
43	Techneium-97m	D, see ^{93m}Tc St wall W, see ^{93m}Tc	— 1E-8 2E-9	6E-5 — —	6E-4 — —
43	Techneium-97	D, see ^{93m}Tc W, see ^{93m}Tc	7E-8 8E-9	5E-4 —	5E-3 —
43	Techneium-98	D, see ^{93m}Tc W, see ^{93m}Tc	2E-9 4E-10	1E-5 —	1E-4 —
43	Techneium-99m	D, see ^{93m}Tc W, see ^{93m}Tc	2E-7 3E-7	1E-3 —	1E-2 —
43	Techneium-99	D, see ^{93m}Tc St wall W, see ^{93m}Tc	— 8E-9 9E-10	6E-5 — —	6E-4 — —
43	Techneium-101	D, see ^{93m}Tc St wall W, see ^{93m}Tc	5E-7 — 5E-7	— 2E-3 —	— 2E-2 —
43	Techneium-104	D, see ^{93m}Tc St wall W, see ^{93m}Tc	1E-7 — 1E-7	— 4E-4 —	— 4E-3 —
44	Ruthenium-94	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	6E-8 9E-8 8E-8	2E-4 — —	2E-3 — —
44	Ruthenium-97	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	3E-8 2E-8 2E-8	1E-4 — —	1E-3 — —
44	Ruthenium-103	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	2E-9 1E-9 9E-10	3E-5 — —	3E-4 — —
44	Ruthenium-105	D, see ^{94}Ru W, see ^{94}Ru Y, see ^{94}Ru	2E-8 2E-8 2E-8	7E-5 — —	7E-4 — —
44	Ruthenium-106	D, see ^{94}Ru LLI wall W, see ^{94}Ru Y, see ^{94}Ru	1E-10 — 8E-11 2E-11	— 3E-6 — —	— 3E-5 — —
45	Rhodium-99m	D, all compounds except those given for W and Y W, halides Y, oxides and hydroxides	8E-8 1E-7 9E-8	2E-4 — —	2E-3 — —
45	Rhodium-99	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	4E-9 3E-9 3E-9	3E-5 — —	3E-4 — —
45	Rhodium-100	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	7E-9 6E-9 5E-9	2E-5 — —	2E-4 — —
45	Rhodium-101m	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	2E-8 1E-8 1E-8	8E-5 — —	8E-4 — —
45	Rhodium-101	D, see ^{99m}Rh W, see ^{99m}Rh Y, see ^{99m}Rh	7E-10 1E-9 2E-10	3E-5 — —	3E-4 — —

45	Rhodium-102m	D, see ^{99m} Rh	7E-10	—	—
		LLI wall	—	2E-5	2E-4
		W, see ^{99m} Rh	5E-10	—	—
		Y, see ^{99m} Rh	2E-10	—	—
45	Rhodium-102	D, see ^{99m} Rh	1E-10	8E-6	8E-5
		W, see ^{99m} Rh	2E-10	—	—
		Y, see ^{99m} Rh	8E-11	—	—
45	Rhodium-103m	D, see ^{99m} Rh	2E-6	6E-3	6E-2
		W, see ^{99m} Rh	2E-6	—	—
		Y, see ^{99m} Rh	2E-6	—	—
45	Rhodium-105	D, see ^{99m} Rh	2E-8	—	—
		LLI wall	—	5E-5	5E-4
		W, see ^{99m} Rh	9E-9	—	—
		Y, see ^{99m} Rh	8E-9	—	—
45	Rhodium-106m	D, see ^{99m} Rh	4E-8	1E-4	1E-3
		W, see ^{99m} Rh	5E-8	—	—
		Y, see ^{99m} Rh	5E-8	—	—
45	Rhodium-107	D, see ^{99m} Rh	3E-7	—	—
		St wall	—	1E-3	1E-2
		W, see ^{99m} Rh	4E-7	—	—
		Y, see ^{99m} Rh	3E-7	—	—
46	Palladium-100	D, all compounds except those given for W and Y	2E-9	2E-5	2E-4
		W, nitrates	2E-9	—	—
		Y, oxides and hydroxides	2E-9	—	—
46	Palladium-101	D, see ¹⁰⁰ Pd	5E-8	2E-4	2E-3
		W, see ¹⁰⁰ Pd	5E-8	—	—
		Y, see ¹⁰⁰ Pd	4E-8	—	—
46	Palladium-103	D, see ¹⁰⁰ Pd	9E-9	—	—
		LLI wall	—	1E-4	1E-3
		W, see ¹⁰⁰ Pd	6E-9	—	—
		Y, see ¹⁰⁰ Pd	5E-9	—	—
46	Palladium-107	D, see ¹⁰⁰ Pd	—	—	—
		LLI wall	3E-8	5E-4	5E-3
		W, see ¹⁰⁰ Pd	1E-8	—	—
		Y, see ¹⁰⁰ Pd	6E-10	—	—
46	Palladium-109	D, see ¹⁰⁰ Pd	9E-9	3E-5	3E-4
		W, see ¹⁰⁰ Pd	8E-9	—	—
		Y, see ¹⁰⁰ Pd	6E-9	—	—
47	Silver-102	D, all compounds except those given for W and Y	2E-7	—	—
		St wall	—	9E-4	9E-3
		W, nitrates and sulfides	3E-7	—	—
		Y, oxides and hydroxides	3E-7	—	—
47	Silver-103	D, see ¹⁰² Ag	1E-7	5E-4	5E-3
		W, see ¹⁰² Ag	2E-7	—	—
		Y, see ¹⁰² Ag	2E-7	—	—
47	Silver-104m	D, see ¹⁰² Ag	1E-7	4E-4	4E-3
		W, see ¹⁰² Ag	2E-7	—	—
		Y, see ¹⁰² Ag	2E-7	—	—
47	Silver-104	D, see ¹⁰² Ag	1E-7	3E-4	3E-3
		W, see ¹⁰² Ag	2E-7	—	—
		Y, see ¹⁰² Ag	2E-7	—	—

47	Silver-105	D, see ^{102}Ag	1E-9	4E-5	4E-4
		W, see ^{102}Ag	2E-9	—	—
		Y, see ^{102}Ag	2E-9	—	—
47	Silver-106m	D, see ^{102}Ag	1E-9	1E-5	—
		W, see ^{102}Ag	1E-9	—	—
		Y, see ^{102}Ag	1E-9	—	—
47	Silver-106	D, see ^{102}Ag	3E-7	—	—
		St wall	—	9E-4	9E-3
		W, see ^{102}Ag	3E-7	—	—
		Y, see ^{102}Ag	3E-7	—	—
47	Silver-108m	D, see ^{102}Ag	3E-10	9E-6	9E-5
		W, see ^{102}Ag	4E-10	—	—
		Y, see ^{102}Ag	3E-11	—	—
47	Silver-110m	D, see ^{102}Ag	2E-10	6E-6	6E-5
		W, see ^{102}Ag	3E-10	—	—
		Y, see ^{102}Ag	1E-10	—	—
47	Silver-111	D, see ^{102}Ag	—	—	—
		LLI wall	2E-9	2E-5	2E-4
		W, see ^{102}Ag	1E-9	—	—
		Y, see ^{102}Ag	1E-9	—	—
47	Silver-112	D, see ^{102}Ag	1E-8	4E-5	4E-4
		W, see ^{102}Ag	1E-8	—	—
		Y, see ^{102}Ag	1E-8	—	—
47	Silver-115	D, see ^{102}Ag	1E-7	—	—
		St wall	—	4E-4	4E-3
		W, see ^{102}Ag	1E-7	—	—
		Y, see ^{102}Ag	1E-7	—	—
48	Cadmium-104	D, all compounds except those given for W and Y	9E-8	3E-4	3E-3
		W, sulfides, halides, and nitrates	2E-7	—	—
		Y, oxides and hydroxides	2E-7	—	—
48	Cadmium-107	D, see ^{104}Cd	8E-8	3E-4	3E-3
		W, see ^{104}Cd	8E-8	—	—
		Y, see ^{104}Cd	7E-8	—	—
48	Cadmium-109	D, see ^{104}Cd	—	—	—
		Kidneys	7E-11	6E-6	6E-5
		W, see ^{104}Cd	—	—	—
		Kidneys	2E-10	—	—
48	Cadmium-113m	Y, see ^{104}Cd	2E-10	—	—
		D, see ^{104}Cd	—	—	—
		Kidneys	5E-12	5E-7	5E-6
48	Cadmium-113	W, see ^{104}Cd	—	—	—
		Kidneys	2E-11	—	—
		Y, see ^{104}Cd	2E-11	—	—
		D, see ^{104}Cd	—	—	—
48	Cadmium-113	Kidneys	5E-12	4E-7	4E-6
		W, see ^{104}Cd	—	—	—
		Kidneys	2E-11	—	—
		Y, see ^{104}Cd	2E-11	—	—

48	Cadmium-115m	D, see ^{104}Cd	—	4E-6	4E-5
		Kidneys	1E-10	—	—
		W, see ^{104}Cd	2E-10	—	—
		Y, see ^{104}Cd	2E-10	—	—
48	Cadmium-115	D, see ^{104}Cd	2E-9	—	—
		LLI wall	—	1E-5	1E-4
		W, see ^{104}Cd	2E-9	—	—
		Y, see ^{104}Cd	2E-9	—	—
48	Cadmium-117m	D, see ^{104}Cd	2E-8	6E-5	6E-4
		W, see ^{104}Cd	2E-8	—	—
		Y, see ^{104}Cd	2E-8	—	—
48	Cadmium-117	D, see ^{104}Cd	2E-8	6E-5	6E-4
		W, see ^{104}Cd	2E-8	—	—
		Y, see ^{104}Cd	2E-8	—	—
49	Indium-109	D, all compounds except those given for W	6E-8	3E-4	3E-3
		W, oxides, hydroxides, halides, and nitrates	9E-8	—	—
49	Indium-110 (69.1 min)	D, see ^{109}In	6E-8	2E-4	2E-3
		W, see ^{109}In	8E-8	—	—
49	Indium-110 (4.9 h)	D, see ^{109}In	2E-8	7E-5	7E-4
		W, see ^{109}In	3E-8	—	—
49	Indium-111	D, see ^{109}In	9E-9	6E-5	6E-4
		W, see ^{109}In	9E-9	—	—
49	Indium-112	D, see ^{109}In	9E-7	2E-3	2E-2
		W, see ^{109}In	1E-6	—	—
49	Indium-113m	D, see ^{109}In	2E-7	7E-4	7E-3
		W, see ^{109}In	3E-7	—	—
49	Indium-114m	D, see ^{109}In	9E-11	—	—
		LLI wall	—	5E-6	5E-5
		W, see ^{109}In	1E-10	—	—
49	Indium-115m	D, see ^{109}In	6E-8	2E-4	2E-3
		W, see ^{109}In	7E-8	—	—
49	Indium-115	D, see ^{109}In	2E-12	5E-7	5E-6
		W, see ^{109}In	8E-12	—	—
49	Indium-116m	D, see ^{109}In	1E-7	3E-4	3E-3
		W, see ^{109}In	2E-7	—	—
49	Indium-117m	D, see ^{109}In	5E-8	2E-4	2E-3
		W, see ^{109}In	6E-8	—	—
49	Indium-117	D, see ^{109}In	2E-7	8E-4	8E-3
		W, see ^{109}In	3E-7	—	—
49	Indium-119m	D, see ^{109}In	2E-7	—	—
		St wall	—	7E-4	7E-3
		W, see ^{109}In	2E-7	—	—
50	Tin-110	D, all compounds except those given for W	2E-8	5E-5	5E-4
		W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	2E-8	—	—
50	Tin-111	D, see ^{110}Sn	3E-7	1E-3	1E-2
		W, see ^{110}Sn	4E-7	—	—

50	Tin-113	D, see ^{110}Sn	2E-9	—	—
		LLI wall	—	3E-5	3E-4
		W, see ^{110}Sn	8E-10	—	—
50	Tin-117m	D, see ^{110}Sn	—	—	—
		LLI wall	3E-9	3E-5	3E-4
		W, see ^{110}Sn	2E-9	—	—
50	Tin-119m	D, see ^{110}Sn	3E-9	—	—
		LLI wall	—	6E-5	6E-4
		W, see ^{110}Sn	1E-9	—	—
50	Tin-121m	D, see ^{110}Sn	1E-9	—	—
		LLI wall	—	5E-5	5E-4
		W, see ^{110}Sn	8E-10	—	—
50	Tin-121	D, see ^{110}Sn	2E-8	—	—
		LLI wall	—	8E-5	8E-4
		W, see ^{110}Sn	2E-8	—	—
50	Tin-123m	D, see ^{110}Sn	2E-7	7E-4	7E-3
		W, see ^{110}Sn	2E-7	—	—
50	Tin-123	D, see ^{110}Sn	9E-10	—	—
		LLI wall	—	9E-6	9E-5
		W, see ^{110}Sn	2E-10	—	—
50	Tin-125	D, see ^{110}Sn	1E-9	—	—
		LLI wall	—	6E-6	6E-5
		W, see ^{110}Sn	5E-10	—	—
50	Tin-126	D, see ^{110}Sn	8E-11	4E-6	4E-5
		W, see ^{110}Sn	9E-11	—	—
50	Tin-127	D, see ^{110}Sn	3E-8	9E-5	9E-4
		W, see ^{110}Sn	3E-8	—	—
50	Tin-128	D, see ^{110}Sn	4E-8	1E-4	1E-3
		W, see ^{110}Sn	5E-8	—	—
51	Antimony-115	D, all compounds except those given for W	3E-7	1E-3	1E-2
		W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	4E-7	—	—
51	Antimony-116m	D, see ^{115}Sb	1E-7	3E-4	3E-3
		W, see ^{115}Sb	2E-7	—	—
51	Antimony-116	D, see ^{115}Sb	4E-7	—	—
		St wall	—	1E-3	1E-2
		W, see ^{115}Sb	5E-7	—	—
51	Antimony-117	D, see ^{115}Sb	3E-7	9E-4	9E-3
		W, see ^{115}Sb	4E-7	—	—
51	Antimony-118m	D, see ^{115}Sb	3E-8	7E-5	7E-4
		W, see ^{115}Sb	3E-8	—	—
51	Antimony-119	D, see ^{115}Sb	6E-8	2E-4	2E-3
		W, see ^{115}Sb	4E-8	—	—
51	Antimony-120 (16 min)	D, see ^{115}Sb	6E-7	—	—
		St wall	—	2E-3	2E-2
		W, see ^{115}Sb	7E-7	—	—
51	Antimony-120 (5.76 d)	D, see ^{115}Sb	3E-9	1E-5	1E-4
		W, see ^{115}Sb	2E-9	—	—

51	Antimony-122	D, see ¹¹⁵ Sb	3E-9	—	—
		LLI wall	—	1E-5	1E-4
		W, see ¹¹⁵ Sb	2E-9	—	—
51	Antimony-124m	D, see ¹¹⁵ Sb	1E-63	E-3	3E-2
		W, see ¹¹⁵ Sb	8E-7	—	—
51	Antimony-124	D, see ¹¹⁵ Sb	1E-9	7E-6	7E-5
		W, see ¹¹⁵ Sb	3E-10	—	—
51	Antimony-125	D, see ¹¹⁵ Sb	3E-9	3E-5	3E-4
		W, see ¹¹⁵ Sb	7E-10	—	—
51	Antimony-126m	D, see ¹¹⁵ Sb	3E-7	—	—
		St wall	—	9E-4	9E-3
		W, see ¹¹⁵ Sb	3E-7	—	—
51	Antimony-126	D, see ¹¹⁵ Sb	2E-9	7E-6	7E-5
		W, see ¹¹⁵ Sb	7E-10	—	—
51	Antimony-127	D, see ¹¹⁵ Sb	3E-9	—	—
		LLI wall	—	1E-5	1E-4
		W, see ¹¹⁵ Sb	1E-9	—	—
51	Antimony-128 (10.4 min)	D, see ¹¹⁵ Sb	5E-7	—	—
		St wall	—	1E-3	1E-2
		W, see ¹¹⁵ Sb	6E-7	—	—
51	Antimony-128 (9.01 h)	D, see ¹¹⁵ Sb	6E-9	2E-5	2E-4
		W, see ¹¹⁵ Sb	5E-9	—	—
51	Antimony-129	D, see ¹¹⁵ Sb	1E-8	4E-5	4E-4
		W, see ¹¹⁵ Sb	1E-8	—	—
51	Antimony-130	D, see ¹¹⁵ Sb	9E-8	3E-4	3E-3
		W, see ¹¹⁵ Sb	1E-7	—	—
51	Antimony-131	D, see ¹¹⁵ Sb	—	—	—
		Thyroid	6E-8	2E-4	2E-3
		W, see ¹¹⁵ Sb	—	—	—
		Thyroid	6E-8	—	—
52	Tellurium-116	D, all compounds except those given for W	3E-8	1E-4	1E-3
		W, oxides, hydroxides, and nitrates	4E-8	—	—
52	Tellurium-121m	D, see ¹¹⁶ Te	—	—	—
		Bone surf	5E-10	1E-5	1E-4
		W, see ¹¹⁶ Te	6E-10	—	—
52	Tellurium-121	D, see ¹¹⁶ Te	6E-9	4E-5	4E-4
		W, see ¹¹⁶ Te	4E-9	—	—
52	Tellurium-123m	D, see ¹¹⁶ Te	—	—	—
		Bone surf	8E-10	1E-5	1E-4
		W, see ¹¹⁶ Te	8E-10	—	—
52	Tellurium-123	D, see ¹¹⁶ Te	—	—	—
		Bone surf	7E-10	2E-5	2E-4
		W, see ¹¹⁶ Te	—	—	—
		Bone surf	2E-9	—	—
52	Tellurium-125m	D, see ¹¹⁶ Te	—	—	—
		Bone surf	1E-9	2E-5	2E-4
		W, see ¹¹⁶ Te	1E-9	—	—
52	Tellurium-127m	D, see ¹¹⁶ Te	—	9E-6	9E-5
		Bone surf	6E-10	—	—
		W, see ¹¹⁶ Te	4E-10	—	—

52	Tellurium-127	D, see ¹¹⁶ Te	3E-8	1E-4	1E-3
		W, see ¹¹⁶ Te	2E-8	—	—
52	Tellurium-129m	D, see ¹¹⁶ Te	9E-10	7E-6	7E-5
		W, see ¹¹⁶ Te	3E-10	—	—
52	Tellurium-129	D, see ¹¹⁶ Te	9E-8	4E-4	4E-3
		W, see ¹¹⁶ Te	1E-7	—	—
52	Tellurium-131m	D, see ¹¹⁶ Te	—	—	—
		Thyroid	2E-9	8E-6	8E-5
		W, see ¹¹⁶ Te	—	—	—
		Thyroid	1E-9	—	—
52	Tellurium-131	D, see ¹¹⁶ Te	—	—	—
		Thyroid	2E-8	8E-5	8E-4
		W, see ¹¹⁶ Te	—	—	—
		Thyroid	2E-8	—	—
52	Tellurium-132	D, see ¹¹⁶ Te	—	—	—
		Thyroid	1E-9	9E-6	9E-5
		W, see ¹¹⁶ Te	—	—	—
		Thyroid	9E-10	—	—
52	Tellurium-133m	D, see ¹¹⁶ Te	—	—	—
		Thyroid	2E-8	9E-5	9E-4
		W, see ¹¹⁶ Te	—	—	—
		Thyroid	2E-8	—	—
52	Tellurium-133	D, see ¹¹⁶ Te	—	—	—
		Thyroid	8E-8	4E-4	4E-3
		W, see ¹¹⁶ Te	—	—	—
		Thyroid	8E-8	—	—
52	Tellurium-134	D, see ¹¹⁶ Te	—	—	—
		Thyroid	7E-8	3E-4	3E-3
		W, see ¹¹⁶ Te	—	—	—
		Thyroid	7E-8	—	—
53	Iodine-120m	D, all compounds	3E-8	—	—
		Thyroid	—	2E-4	2E-3
53	Iodine-120	D, all compounds	—	—	—
		Thyroid	2E-8	1E-4	1E-3
53	Iodine-121	D, all compounds	—	—	—
		Thyroid	7E-8	4E-4	4E-3
53	Iodine-123	D, all compounds	—	—	—
		Thyroid	2E-8	1E-4	1E-3
53	Iodine-124	D, all compounds	—	—	—
		Thyroid	4E-10	2E-6	2E-5
53	Iodine-125	D, all compounds	—	—	—
		Thyroid	3E-10	2E-6	2E-5
53	Iodine-126	D, all compounds	—	—	—
		Thyroid	2E-10	1E-6	1E-5
53	Iodine-128	D, all compounds	2E-7	—	—
		St wall	—	8E-4	8E-3
53	Iodine-129	D, all compounds	—	—	—
		Thyroid	4E-11	2E-7	2E-6
53	Iodine-130	D, all compounds	—	—	—
		Thyroid	3E-9	2E-5	2E-4

53	Iodine-131	D, all compounds Thyroid	— 2E-10	— 1E-6	— 1E-5
53	Iodine-132m	D, all compounds Thyroid	— 3E-8	— 1E-4	— 1E-3
53	Iodine-132	D, all compounds Thyroid	— 2E-8	— 1E-4	— 1E-3
53	Iodine-133	D, all compounds Thyroid	— 1E-9	— 7E-6	— 7E-5
53	Iodine-134	D, all compounds Thyroid	6E-8 —	— 4E-4	— 4E-3
53	Iodine-135	D, all compounds Thyroid	— 6E-9	— 3E-5	— 3E-4
54	Xenon-120	Submersion ^v	4E-8	—	—
54	Xenon-121	Submersion ^v	1E-8	—	—
54	Xenon-122	Submersion ^v	3E-7	—	—
54	Xenon-123	Submersion ^v	3E-8	—	—
54	Xenon-125	Submersion ^v	7E-8	—	—
54	Xenon-127	Submersion ^v	6E-8	—	—
54	Xenon-129m	Submersion ^v	9E-7	—	—
54	Xenon-131m	Submersion ^v	2E-6	—	—
54	Xenon-133m	Submersion ^v	6E-7	—	—
54	Xenon-133	Submersion ^v	5E-7	—	—
54	Xenon-135m	Submersion ^v	4E-8	—	—
54	Xenon-135	Submersion ^v	7E-8	—	—
54	Xenon-138	Submersion ^v	2E-8	—	—
55	Cesium-125	D, all compounds St wall	2E-7 —	— 1E-3	— 1E-2
55	Cesium-127	D, all compounds	1E-7	9E-4	9E-3
55	Cesium-129	D, all compounds	5E-8	3E-4	3E-3
55	Cesium-130	D, all compounds St wall	3E-7 —	— 1E-3	— 1E-2
55	Cesium-131	D, all compounds	4E-8	3E-4	3E-3
55	Cesium-132	D, all compounds	6E-9	4E-5	4E-4
55	Cesium-134m	D, all compounds St wall	2E-7 —	— 2E-3	— 2E-2
55	Cesium-134	D, all compounds	2E-10	9E-7	9E-6
55	Cesium-135m	D, all compounds	3E-7	1E-3	1E-2
55	Cesium-135	D, all compounds	2E-9	1E-5	1E-4
55	Cesium-136	D, all compounds	9E-10	6E-6	6E-5
55	Cesium-137	D, all compounds	2E-10	1E-6	1E-5
55	Cesium-138	D, all compounds St wall	8E-8 —	— 4E-4	— 4E-3
56	Barium-126	D, all compounds	2E-8	8E-5	8E-4

56	Barium-128	D, all compounds	2E-9	7E-6	7E-5
56	Barium-131m	D, all compounds St wall	2E-6 —	— 7E-3	— 7E-2
56	Barium-131	D, all compounds	1E-8	4E-5	4E-4
56	Barium-133m	D, all compounds LLI wall	1E-8 —	— 4E-5	— 4E-4
56	Barium-133	D, all compounds	9E-10	2E-5	2E-4
56	Barium-135m	D, all compounds	2E-8	4E-5	4E-4
56	Barium-139	D, all compounds	4E-8	2E-4	2E-3
56	Barium-140	D, all compounds LLI wall	2E-9 —	— 8E-6	— 8E-5
56	Barium-141	D, all compounds	1E-7	3E-4	3E-3
56	Barium-142	D, all compounds	2E-7	7E-4	7E-3
57	Lanthanum-131	D, all compounds except those given for W W, oxides and hydroxides	2E-7 2E-7	6E-4 —	6E-3 —
57	Lanthanum-132	D, see ¹³¹ La W, see ¹³¹ La	1E-8 2E-8	4E-5 —	4E-4 —
57	Lanthanum-135	D, see ¹³¹ La W, see ¹³¹ La	1E-7 1E-7	5E-4 —	5E-3 —
57	Lanthanum-137	D, see ¹³¹ La Liver W, see ¹³¹ La Liver	— 1E-10 — 4E-10	2E-4 — — —	2E-3 — — —
57	Lanthanum-138	D, see ¹³¹ La W, see ¹³¹ La	5E-12 2E-11	1E-5 —	1E-4 —
57	Lanthanum-140	D, see ¹³¹ La W, see ¹³¹ La	2E-9 2E-9	9E-6 —	9E-5 —
57	Lanthanum-141	D, see ¹³¹ La W, see ¹³¹ La	1E-8 2E-8	5E-5 —	5E-4 —
57	Lanthanum-142	D, see ¹³¹ La W, see ¹³¹ La	3E-8 5E-8	1E-4 —	1E-3 —
57	Lanthanum-143	D, see ¹³¹ La St wall W, see ¹³¹ La	1E-7 — 1E-7	— 5E-4 —	— 5E-3 —
58	Cerium-134	W, all compounds except those given for Y LLI wall Y, oxides, hydroxides, and fluorides	1E-9 — 9E-10	— 8E-6 —	— 8E-5 —
58	Cerium-135	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	5E-9 5E-9	2E-5 —	2E-4 —
58	Cerium-137m	W, see ¹³⁴ Ce LLI wall Y, see ¹³⁴ Ce	6E-9 — 5E-9	— 3E-5 —	— 3E-4 —
58	Cerium-137	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	2E-7 2E-7	7E-4 —	7E-3 —
58	Cerium-139	W, see ¹³⁴ Ce Y, see ¹³⁴ Ce	1E-9 9E-10	7E-5 —	7E-4 —

58	Cerium-141	W, see ¹³⁴ Ce	1E-9	—	—
		LLI wall	—	3E-5	3E-4
		Y, see ¹³⁴ Ce	8E-10	—	—
58	Cerium-143	W, see ¹³⁴ Ce	3E-9	—	—
		LLI wall	—	2E-5	2E-4
		Y, see ¹³⁴ Ce	2E-9	—	—
58	Cerium-144	W, see ¹³⁴ Ce	4E-11	—	—
		LLI wall	—	3E-6	3E-5
		Y, see ¹³⁴ Ce	2E-11	—	—
59	Praseodymium-136	W, all compounds except those given for Y	3E-7	—	—
		St wall	—	1E-3	1E-2
		Y, oxides, hydroxides, carbides, and fluorides	3E-7	—	—
59	Praseodymium-137	W, see ¹³⁶ Pr	2E-7	5E-4	5E-3
		Y, see ¹³⁶ Pr	2E-7	—	—
59	Praseodymium-138m	W, see ¹³⁶ Pr	8E-8	1E-4	1E-3
		Y, see ¹³⁶ Pr	6E-8	—	—
59	Praseodymium-139	W, see ¹³⁶ Pr	2E-7	6E-4	6E-3
		Y, see ¹³⁶ Pr	2E-7	—	—
59	Praseodymium-142m	W, see ¹³⁶ Pr	2E-7	1E-3	1E-2
		Y, see ¹³⁶ Pr	2E-7	—	—
59	Praseodymium-142	W, see ¹³⁶ Pr	3E-9	1E-5	1E-4
		Y, see ¹³⁶ Pr	3E-9	—	—
59	Praseodymium-143	W, see ¹³⁶ Pr	1E-9	—	—
		LLI wall	—	2E-5	2E-4
		Y, see ¹³⁶ Pr	9E-10	—	—
59	Praseodymium-144	W, see ¹³⁶ Pr	2E-7	—	—
		St wall	—	6E-4	6E-3
		Y, see ¹³⁶ Pr	2E-7	—	—
59	Praseodymium-145	W, see ¹³⁶ Pr	1E-8	4E-5	4E-4
		Y, see ¹³⁶ Pr	1E-8	—	—
59	Praseodymium-147	W, see ¹³⁶ Pr	3E-7	—	—
		St wall	—	1E-3	1E-2
		Y, see ¹³⁶ Pr	3E-7	—	—
60	Neodymium-136	W, all compounds except those given for Y	8E-8	2E-4	2E-3
		Y, oxides, hydroxides, carbides, and fluorides	8E-8	—	—
60	Neodymium-138	W, see ¹³⁶ Nd	9E-9	3E-5	3E-4
		Y, see ¹³⁶ Nd	7E-9	—	—
60	Neodymium-139m	W, see ¹³⁶ Nd	2E-8	7E-5	7E-4
		Y, see ¹³⁶ Nd	2E-8	—	—
60	Neodymium-139	W, see ¹³⁶ Nd	5E-7	1E-3	1E-2
		Y, see ¹³⁶ Nd	4E-7	—	—
60	Neodymium-141	W, see ¹³⁶ Nd	1E-6	2E-3	2E-2
		Y, see ¹³⁶ Nd	9E-7	—	—
60	Neodymium-147	W, see ¹³⁶ Nd	1E-9	—	—
		LLI wall	—	2E-5	2E-4
		Y, see ¹³⁶ Nd	1E-9	—	—

60	Neodymium-149	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	4E-8 3E-8	1E-4 —	1E-3 —
60	Neodymium-151	W, see ¹³⁶ Nd Y, see ¹³⁶ Nd	3E-7 3E-7	9E-4 —	9E-3 —
61	Promethium-141	W, all compounds except those given for Y St wall Y, oxides, hydroxides, carbides, and fluorides	3E-7 — 2E-7	— 8E-4 —	— 8E-3 —
61	Promethium-143	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	8E-10 1E-9	7E-5 —	7E-4 —
61	Promethium-144	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	2E-10 2E-10	2E-5 —	2E-4 —
61	Promethium-145	W, see ¹⁴¹ Pm Bone surf Y, see ¹⁴¹ Pm	— 3E-10 3E-10	1E-4 — —	1E-3 — —
61	Promethium-146	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	7E-11 6E-11	2E-5 —	2E-4 —
61	Promethium-147	W, see ¹⁴¹ Pm LLI wall Y, see ¹⁴¹ Pm	— 3E-10 2E-10	— 7E-5 —	— 7E-4 —
61	Promethium-148m	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pmm	4E-10 5E-10	1E-5 —	1E-4 —
61	Promethium-148	W, see ¹⁴¹ Pm LLI wall Y, see ¹⁴¹ Pm	8E-10 — 7E-10	— 7E-6 —	— 7E-5 —
61	Promethium-149	W, see ¹⁴¹ Pm LLI wall Y, see ¹⁴¹ Pm	3E-9 — 2E-9	— 2E-5 —	— 2E-4 —
61	Promethium-150	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	3E-8 2E-8	7E-5 —	7E-4 —
61	Promethium-151	W, see ¹⁴¹ Pm Y, see ¹⁴¹ Pm	5E-9 4E-9	2E-5 —	2E-4 —
62	Samarium-141m	W, all compounds	1E-7	4E-4	4E-3
62	Samarium-141	W, all compounds St wall	2E-7 —	— 8E-4	— 8E-3
62	Samarium-142	W, all compounds	4E-8	1E-4	1E-3
62	Samarium-145	W, all compounds	7E-10	8E-5	8E-4
62	Samarium-146	W, all compounds Bone surf	— 9E-14	— 3E-7	— 3E-6
62	Samarium-147	W, all compounds Bone surf	— 1E-13	— 4E-7	— 4E-6
62	Samarium-151	W, all compounds LLI wall	— 2E-10	— 2E-4	— 2E-3
62	Samarium-153	W, all compounds LLI wall	4E-9 —	— 3E-5	— 3E-4
62	Samarium-155	W, all compounds St wall	3E-7 —	— 1E-3	— 1E-2
62	Samarium-156	W, all compounds	1E-8	7E-5	7E-4

63	Europium-145	W, all compounds	3E-9	2E-5	2E-4
63	Europium-146	W, all compounds	2E-9	1E-5	1E-4
63	Europium-147	W, all compounds	2E-9	4E-5	4E-4
63	Europium-148	W, all compounds	5E-10	1E-5	1E-4
63	Europium-149	W, all compounds	4E-9	2E-4	2E-3
63	Europium-150 (12.62h)	W, all compounds	1E-8	4E-5	4E-4
63	Europium-150 (34.2y)	W, all compounds	3E-11	1E-5	1E-4
63	Europium-152m	W, all compounds	9E-9	4E-5	4E-4
63	Europium-152	W, all compounds	3E-11	1E-5	1E-4
63	Europium-154	W, all compounds	3E-11	7E-6	7E-5
63	Europium-155	W, all compounds	—	5E-5	5E-4
		Bone surf	2E-10	—	—
63	Europium-156	W, all compounds	6E-10	8E-6	8E-5
63	Europium-157	W, all compounds	7E-9	3E-5	3E-4
63	Europium-158	W, all compounds	8E-8	3E-4	3E-3
64	Gadolinium-145	D, all compounds except those given for W St wall	2E-7 —	— 6E-4	— 6E-3
		W, oxides, hydroxides, and fluorides	2E-7	—	—
64	Gadolinium-146	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	2E-10 4E-10	2E-5 —	2E-4 —
64	Gadolinium-147	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	6E-9 5E-9	3E-5 —	3E-4 —
64	Gadolinium-149	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	3E-9 3E-9	4E-5 —	4E-4 —
64	Gadolinium-151	D, see ¹⁴⁵ Gd Bone surf W, see ¹⁴⁵ Gd	— 9E-10 2E-9	9E-5 — —	9E-4 — —
64	Gadolinium-152	D, see ¹⁴⁵ Gd Bone surf W, see ¹⁴⁵ Gd Bone surf	— 3E-14 — 1E-13	— 4E-7 — —	— 4E-6 — —
64	Gadolinium-153	D, see ¹⁴⁵ Gd Bone surf W, see ¹⁴⁵ Gd	— 3E-10 8E-10	6E-5 — —	6E-4 — —
64	Gadolinium-159	D, see ¹⁴⁵ Gd W, see ¹⁴⁵ Gd	1E-8 8E-9	4E-5 —	4E-4 —
65	Terbium-147	W, all compounds	5E-8	1E-4	1E-3
65	Terbium-149	W, all compounds	1E-9	7E-5	7E-4
65	Terbium-150	W, all compounds	3E-8	7E-5	7E-4
65	Terbium-151	W, all compounds	1E-8	5E-5	5E-4
65	Terbium-153	W, all compounds	1E-8	7E-5	7E-4
65	Terbium-154	W, all compounds	6E-9	2E-5	2E-4

65	Terbium-155	W, all compounds	1E-8	8E-5	8E-4
65	Terbium-156m (5.0 h)	W, all compounds	4E-8	2E-4	2E-3
65	Terbium-156m (24.4 h)	W, all compounds	1E-8	1E-4	1E-3
65	Terbium-156	W, all compounds	2E-9	1E-5	1E-4
65	Terbium-157	W, all compounds LLI wall	— 8E-10	— 7E-4	— 7E-3
65	Terbium-158	W, all compounds	3E-11	2E-5	2E-4
65	Terbium-160	W, all compounds	3E-10	1E-5	1E-4
65	Terbium-161	W, all compounds LLI wall	2E-9 —	— 3E-5	— 3E-4
66	Dysprosium-155	W, all compounds	4E-8	1E-4	1E-3
66	Dysprosium-157	W, all compounds	9E-8	3E-4	3E-3
66	Dysprosium-159	W, all compounds	3E-9	2E-4	2E-3
66	Dysprosium-165	W, all compounds	6E-8	2E-4	2E-3
66	Dysprosium-166	W, all compounds LLI wall	1E-9 —	— 1E-5	— 1E-4
67	Holmium-155	W, all compounds	2E-7	6E-4	6E-3
67	Holmium-157	W, all compounds	2E-6	4E-3	4E-2
67	Holmium-159	W, all compounds	1E-6	3E-3	3E-2
67	Holmium-161	W, all compounds	6E-7	1E-3	1E-2
67	Holmium-162m	W, all compounds	4E-7	7E-4	7E-3
67	Holmium-162	W, all compounds St wall	3E-6 —	— 1E-2	— 1E-1
67	Holmium-164m	W, all compounds	4E-7	1E-3	1E-2
67	Holmium-164	W, all compounds St wall	9E-7 —	— 3E-3	— 3E-2
67	Holmium-166m	W, all compounds	9E-12	9E-6	9E-5
67	Holmium-166	W, all compounds LLI wall	2E-9 —	— 1E-5	— 1E-4
67	Holmium-167	W, all compounds	8E-8	2E-4	2E-3
68	Erbium-161	W, all compounds	9E-8	2E-4	2E-3
68	Erbium-165	W, all compounds	3E-7	9E-4	9E-3
68	Erbium-169	W, all compounds LLI wall	4E-9 —	— 5E-5	— 5E-4
68	Erbium-171	W, all compounds	1E-8	5E-5	5E-4
68	Erbium-172	W, all compounds LLI wall	2E-9 —	— 2E-5	— 2E-4
69	Thulium-162	W, all compounds St wall	4E-7 —	— 1E-3	— 1E-2
69	Thulium-166	W, all compounds	2E-8	6E-5	6E-4
69	Thulium-167	W, all compounds LLI wall	3E-9 —	— 3E-5	— 3E-4

69	Thulium-170	W, all compounds LLI wall	3E-10 —	— 1E-5	— 1E-4
69	Thulium-171	W, all compounds LLI wall	— 8E-10	— 2E-4	— 2E-3
69	Thulium-172	W, all compounds LLI wall	2E-9 —	— 1E-5	— 1E-4
69	Thulium-173	W, all compounds	2E-8	6E-5	6E-4
69	Thulium-175	W, all compounds St wall	4E-7 —	— 1E-3	— 1E-2
70	Ytterbium-162	W, all compounds except those given for Y Y, oxides, hydroxides, and fluorides	4E-7 4E-7	1E-3 —	1E-2 —
70	Ytterbium-166	W, see ¹⁶² Yb Y, see ¹⁶² Yb	3E-9 3E-9	2E-5 —	2E-4 —
70	Ytterbium-167	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E-6 1E-6	4E-3 —	4E-2 —
70	Ytterbium-169	W, see ¹⁶² Yb Y, see ¹⁶² Yb	1E-9 1E-9	2E-5 —	2E-4 —
70	Ytterbium-175	W, see ¹⁶² Yb LLI wall Y, see ¹⁶² Yb	5E-9 — 5E-9	— 4E-5 —	— 4E-4 —
70	Ytterbium-177	W, see ¹⁶² Yb Y, see ¹⁶² Yb	7E-8 6E-8	2E-4 —	2E-3 —
70	Ytterbium-178	W, see ¹⁶² Yb Y, see ¹⁶² Yb	6E-8 5E-8	2E-4 —	2E-3 —
71	Lutetium-169	W, all compounds except those given for Y Y, oxides, hydroxides, and fluorides	6E-9 6E-9	3E-5 —	3E-4 —
71	Lutetium-170	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	3E-9 3E-9	2E-5 —	2E-4 —
71	Lutetium-171	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	3E-9 3E-9	3E-5 —	3E-4 —
71	Lutetium-172	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	2E-9 2E-9	1E-5 —	1E-4 —
71	Lutetium-173	W, see ¹⁶⁹ Lu Bone surf Y, see ¹⁶⁹ Lu	— 6E-10 4E-10	7E-5 — —	7E-4 — —
71	Lutetium-174m	W, see ¹⁶⁹ Lu LLI wall Y, see ¹⁶⁹ Lu	— 5E-10 3E-10	— 4E-5 —	— 4E-4 —
71	Lutetium-174	W, see ¹⁶⁹ Lu Bone surf Y, see ¹⁶⁹ Lu	— 3E-10 2E-10	7E-5 — —	7E-4 — —
71	Lutetium-176m	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	3E-8 3E-8	1E-4 —	1E-3 —
71	Lutetium-176	W, see ¹⁶⁹ Lu Bone surf Y, see ¹⁶⁹ Lu	— 2E-11 1E-11	1E-5 — —	1E-4 — —

71	Lutetium-177m	W, see ¹⁶⁹ Lu Bone surf Y, see ¹⁶⁹ Lu	— 2E-10 1E-10	1E-5 — —	1E-4 — —
71	Lutetium-177	W, see ¹⁶⁹ Lu LLI wall Y, see ¹⁶⁹ Lu	3E-9 — 3E-9	— 4E-5 —	— 4E-4 —
71	Lutetium-178m	W, see ¹⁶⁹ Lu St wall Y, see ¹⁶⁹ Lu	3E-7 — 2E-7	— 8E-4 —	— 8E-3 —
71	Lutetium-178	W, see ¹⁶⁹ Lu St wall Y, see ¹⁶⁹ Lu	2E-7 — 2E-7	— 6E-4 —	— 6E-3 —
71	Lutetium-179	W, see ¹⁶⁹ Lu Y, see ¹⁶⁹ Lu	3E-8 3E-8	9E-5 —	9E-4 —
72	Hafnium-170	D, all compounds except those given for W W, oxides, hydroxides, carbides, and nitrates	8E-9 6E-9	4E-5 —	4E-4 —
72	Hafnium-172	D, see ¹⁷⁰ Hf Bone surf W, see ¹⁷⁰ Hf Bone surf	— 3E-11 — 8E-11	2E-5 — — —	2E-4 — — —
72	Hafnium-173	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	2E-8 2E-8	7E-5 —	7E-4 —
72	Hafnium-175	D, see ¹⁷⁰ Hf Bone surf W, see ¹⁷⁰ Hf	— 1E-9 2E-9	4E-5 — —	4E-4 — —
72	Hafnium-177m	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	8E-8 1E-7	3E-4 —	3E-3 —
72	Hafnium-178m	D, see ¹⁷⁰ Hf Bone surf W, see ¹⁷⁰ Hf Bone surf	— 3E-12 — 1E-11	3E-6 — — —	3E-5 — — —
72	Hafnium-179m	D, see ¹⁷⁰ Hf Bone surf W, see ¹⁷⁰ Hf	— 8E-10 8E-10	1E-5 — —	1E-4 — —
72	Hafnium-180m	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	3E-8 4E-8	1E-4 —	1E-3 —
72	Hafnium-181	D, see ¹⁷⁰ Hf Bone surf W, see ¹⁷⁰ Hf	— 6E-10 6E-10	2E-5 — —	2E-4 — —
72	Hafnium-182m	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	1E-7 2E-7	5E-4 —	5E-3 —
72	Hafnium-182	D, see ¹⁷⁰ Hf Bone surf W, see ¹⁷⁰ Hf Bone surf	— 2E-12 — 1E-11	— 5E-6 — —	— 5E-5 — —
72	Hafnium-183	D, see ¹⁷⁰ Hf W, see ¹⁷⁰ Hf	6E-8 8E-8	3E-4 —	3E-3 —

72	Hafnium-184	D, see ^{170}Hf W, see ^{170}Hf	1E-8 9E-9	3E-5 —	3E-4 —
73	Tantalum-172	W, all compounds except those given for Y Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	2E-7 1E-7	5E-4 —	5E-3 —
73	Tantalum-173	W, see ^{172}Ta Y, see ^{172}Ta	3E-8 2E-8	9E-5 —	9E-4 —
73	Tantalum-174	W, see ^{172}Ta Y, see ^{172}Ta	1E-7 1E-7	4E-4 —	4E-3 —
73	Tantalum-175	W, see ^{172}Ta Y, see ^{172}Ta	2E-8 2E-8	8E-5 —	8E-4 —
73	Tantalum-176	W, see ^{172}Ta Y, see ^{172}Ta	2E-8 2E-8	5E-5 —	5E-4 —
73	Tantalum-177	W, see ^{172}Ta Y, see ^{172}Ta	3E-8 2E-8	2E-4 —	2E-3 —
73	Tantalum-178	W, see ^{172}Ta Y, see ^{172}Ta	1E-7 1E-7	2E-4 —	2E-3 —
73	Tantalum-179	W, see ^{172}Ta Y, see ^{172}Ta	8E-9 1E-9	3E-4 —	3E-3 —
73	Tantalum-180m	W, see ^{172}Ta Y, see ^{172}Ta	9E-8 8E-8	3E-4 —	3E-3 —
73	Tantalum-180	W, see ^{172}Ta Y, see ^{172}Ta	6E-10 3E-11	2E-5 —	2E-4 —
73	Tantalum-182m	W, see ^{172}Ta St wall Y, see ^{172}Ta	8E-7 — 6E-7	— 3E-3 —	— 3E-2 —
73	Tantalum-182	W, see ^{172}Ta Y, see ^{172}Ta	5E-10 2E-10	1E-5 —	1E-4 —
73	Tantalum-183	W, see ^{172}Ta LLI wall Y, see ^{172}Ta	2E-9 — 1E-9	— 2E-5 —	— 2E-4 —
73	Tantalum-184	W, see ^{172}Ta Y, see ^{172}Ta	8E-9 7E-9	3E-5 —	3E-4 —
73	Tantalum-185	W, see ^{172}Ta Y, see ^{172}Ta	1E-7 9E-8	4E-4 —	4E-3 —
73	Tantalum-186	W, see ^{172}Ta St wall Y, see ^{172}Ta	3E-7 — 3E-7	— 1E-3 —	— 1E-2 —
74	Tungsten-176	D, all compounds	7E-8	1E-4	1E-3
74	Tungsten-177	D, all compounds	1E-7	3E-4	3E-3
74	Tungsten-178	D, all compounds	3E-8	7E-5	7E-4
74	Tungsten-179	D, all compounds	2E-6	7E-3	7E-2
74	Tungsten-181	D, all compounds	5E-8	2E-4	2E-3
74	Tungsten-185	D, all compounds LLI wall	9E-9 —	— 4E-5	— 4E-4
74	Tungsten-187	D, all compounds	1E-8	3E-5	3E-4

74	Tungsten-188	D, all compounds LLI wall	2E-9 —	— 7E-6	— 7E-5
75	Rhenium-177	D, all compounds except those given for W St wall W, oxides, hydroxides, and nitrates	4E-7 — 5E-7	— 2E-3 —	— 2E-2 —
75	Rhenium-178	D, see ¹⁷⁷ Re St wall W, see ¹⁷⁷ Re	4E-7 — 4E-7	— 1E-3 —	— 1E-2 —
75	Rhenium-181	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	1E-8 1E-8	7E-5 —	7E-4 —
75	Rhenium-182 (12.7 h)	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E-8 2E-8	9E-5 —	9E-4 —
75	Rhenium-182 (64.0 h)	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	3E-9 3E-9	2E-5 —	2E-4 —
75	Rhenium-184m	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	4E-9 6E-10	3E-5 —	3E-4 —
75	Rhenium-184	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	5E-9 2E-9	3E-5 —	3E-4 —
75	Rhenium-186m	D, see ¹⁷⁷ Re St wall W, see ¹⁷⁷ Re	— 3E-9 2E-10	— 2E-5 —	— 2E-4 —
75	Rhenium-186	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	4E-9 2E-9	3E-5 —	3E-4 —
75	Rhenium-187	D, see ¹⁷⁷ Re St wall W, see ¹⁷⁷ Re	— 1E-6 1E-7	8E-3 — —	8E-2 — —
75	Rhenium-188m	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	2E-7 2E-7	1E-3 —	1E-2 —
75	Rhenium-188	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	4E-9 4E-9	2E-5 —	2E-4 —
75	Rhenium-189	D, see ¹⁷⁷ Re W, see ¹⁷⁷ Re	7E-9 6E-9	4E-5 —	4E-4 —
76	Osmium-180	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	5E-7 7E-7 6E-7	1E-3 — —	1E-2 — —
76	Osmium-181	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	6E-8 6E-8 6E-8	2E-4 — —	2E-3 — —
76	Osmium-182	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	8E-9 6E-9 6E-9	3E-5 — —	3E-4 — —
76	Osmium-185	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	7E-10 1E-9 1E-9	3E-5 — —	— — —
76	Osmium-189m	D, see ¹⁸⁰ Os W, see ¹⁸⁰ Os Y, see ¹⁸⁰ Os	3E-7 3E-7 2E-7	1E-3 — —	1E-2 — —

76	Osmium-191m	D, see ^{180}Os	4E-8	2E-4	2E-3
		W, see ^{180}Os	3E-8	—	—
		Y, see ^{180}Os	2E-8	—	—
76	Osmium-191	D, see ^{180}Os	3E-9	—	—
		LLI wall	—	3E-5	3E-4
		W, see ^{180}Os	2E-9	—	—
		Y, see ^{180}Os	2E-9	—	—
76	Osmium-193	D, see ^{180}Os	6E-9	—	—
		LLI wall	—	2E-5	2E-4
		W, see ^{180}Os	4E-9	—	—
		Y, see ^{180}Os	4E-9	—	—
76	Osmium-194	D, see ^{180}Os	6E-11	—	—
		LLi wall	—	8E-6	8E-5
		W, see ^{180}Os	8E-11	—	—
		Y, see ^{180}Os	1E-11	—	—
77	Iridium-182	D, all compounds except those given for W and Y	2E-7	—	—
		St wall	—	6E-4	6E-3
		W, halides, nitrates, and metallic iridium	2E-7	—	—
		Y, oxides and hydroxides	2E-7	—	—
77	Iridium-184	D, see ^{182}Ir	3E-8	1E-4	1E-3
		W, see ^{182}Ir	5E-8	—	—
		Y, see ^{182}Ir	4E-8	—	—
77	Iridium-185	D, see ^{182}Ir	2E-8	7E-5	7E-4
		W, see ^{182}Ir	2E-8	—	—
		Y, see ^{182}Ir	1E-8	—	—
77	Iridium-186	D, see ^{182}Ir	1E-8	3E-5	3E-4
		W, see ^{182}Ir	9E-9	—	—
		Y, see ^{182}Ir	8E-9	—	—
77	Iridium-187	D, see ^{182}Ir	5E-8	1E-4	1E-3
		W, see ^{182}Ir	4E-8	—	—
		Y, see ^{182}Ir	4E-8	—	—
77	Iridium-188	D, see ^{182}Ir	6E-9	3E-5	3E-4
		W, see ^{182}Ir	5E-9	—	—
		Y, see ^{182}Ir	5E-9	—	—
77	Iridium-189	D, see ^{182}Ir	7E-9	—	—
		LLI wall	—	7E-5	7E-4
		W, see ^{182}Ir	5E-9	—	—
		Y, see ^{182}Ir	5E-9	—	—
77	Iridium-190m	D, see ^{182}Ir	3E-7	2E-3	2E-2
		W, see ^{182}Ir	3E-7	—	—
		Y, see ^{182}Ir	3E-7	—	—
77	Iridium-190	D, see ^{182}Ir	1E-9	1E-5	1E-4
		W, see ^{182}Ir	1E-9	—	—
		Y, see ^{182}Ir	1E-9	—	—
77	Iridium-192m	D, see ^{182}Ir	1E-10	4E-5	4E-4
		W, see ^{182}Ir	3E-10	—	—
		Y, see ^{182}Ir	2E-11	—	—
77	Iridium-192	D, see ^{182}Ir	4E-10	1E-5	1E-4
		W, see ^{182}Ir	6E-10	—	—
		Y, see ^{182}Ir	3E-10	—	—

77	Iridium-194m	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	1E-10 2E-10 1E-10	9E-6 — —	9E-5 — —
77	Iridium-194	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	4E-9 3E-9 3E-9	1E-5 — —	1E-4 — —
77	Iridium-195m	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	3E-8 4E-8 3E-8	1E-4 — —	1E-3 — —
77	Iridium-195	D, see ¹⁸² Ir W, see ¹⁸² Ir Y, see ¹⁸² Ir	6E-8 7E-8 6E-8	2E-4 — —	2E-3 — —
78	Platinum-186	D, all compounds	5E-8	2E-4	2E-3
78	Platinum-188	D, all compounds	2E-9	2E-5	2E-4
78	Platinum-189	D, all compounds	4E-8	1E-4	1E-3
78	Platinum-191	D, all compounds	1E-8	5E-5	5E-4
78	Platinum-193m	D, all compounds LLI wall	8E-9 —	— 4E-5	— 4E-4
78	Platinum-193	D, all compounds LLI wall	3E-8 —	— 6E-4	— 6E-3
78	Platinum-195m	D, all compounds LLI wall	6E-9 —	— 3E-5	— 3E-4
78	Platinum-197m	D, all compounds	6E-8	2E-4	2E-3
78	Platinum-197	D, all compounds	1E-8	4E-5	4E-4
78	Platinum-199	D, all compounds	2E-7	7E-4	7E-3
78	Platinum-200	D, all compounds	5E-9	2E-5	2E-4
79	Gold-193	D, all compounds except those given for W and Y W, halides and nitrates Y, oxides and hydroxides	4E-8 3E-8 3E-8	1E-4 — —	1E-3 — —
79	Gold-194	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	1E-8 8E-9 7E-9	4E-5 — —	4E-4 — —
79	Gold-195	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	2E-8 2E-9 6E-10	7E-5 — —	7E-4 — —
79	Gold-198m	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	4E-9 2E-9 2E-9	1E-5 — —	1E-4 — —
79	Gold-198	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	5E-9 3E-9 2E-9	2E-5 — —	2E-4 — —
79	Gold-199	D, see ¹⁹³ Au LLI wall W, see ¹⁹³ Au Y, see ¹⁹³ Au	1E-8 — 6E-9 5E-9	— 4E-5 — —	— 4E-4 — —
79	Gold-200m	D, see ¹⁹³ Au W, see ¹⁹³ Au Y, see ¹⁹³ Au	5E-9 4E-9 3E-9	2E-5 — —	2E-4 — —

79	Gold-200	D, see ¹⁹³ Au	9E-8	4E-4	4E-3
		W, see ¹⁹³ Au	1E-7	—	—
		Y, see ¹⁹³ Au	1E-7	—	—
79	Gold-201	D, see ¹⁹³ Au	3E-7	—	—
		St wall	—	1E-3	1E-2
		W, see ¹⁹³ Au	3E-7	—	—
		Y, see ¹⁹³ Au	3E-7	—	—
80	Mercury-193m	Vapor	1E-8	—	—
		Organic D	2E-8	6E-5	6E-4
		D, sulfates	1E-8	4E-5	4E-4
		W, oxides, hydroxides, halides, nitrates, and sulfides	1E-8	—	—
80	Mercury-193	Vapor	4E-8	—	—
		Organic D	9E-8	3E-4	3E-3
		D, see ^{193m} Hg	6E-8	2E-4	2E-3
		W, see ^{193m} Hg	6E-8	—	—
80	Mercury-194	Vapor	4E-11	—	—
		Organic D	4E-11	2E-7	2E-6
		D, see ^{193m} Hg	6E-11	1E-5	1E-4
		W, see ^{193m} Hg	2E-10	—	—
80	Mercury-195m	Vapor	6E-9	—	—
		Organic D	8E-9	4E-5	4E-4
		D, see ^{193m} Hg	7E-9	3E-5	3E-4
		W, see ^{193m} Hg	5E-9	—	—
80	Mercury-195	Vapor	4E-8	—	—
		Organic D	6E-8	2E-4	2E-3
		D, see ^{193m} Hg	5E-8	2E-4	2E-3
		W, see ^{193m} Hg	5E-8	—	—
80	Mercury-197m	Vapor	7E-9	—	—
		Organic D	1E-8	5E-5	5E-4
		D, see ^{193m} Hg	1E-8	4E-5	4E-4
		W, see ^{193m} Hg	7E-9	—	—
80	Mercury-197	Vapor	1E-8	—	—
		Organic D	2E-8	9E-5	9E-4
		D, see ^{193m} Hg	2E-8	8E-5	8E-4
		W, see ^{193m} Hg	1E-8	—	—
80	Mercury-199m	Vapor	1E-7	—	—
		Organic D	2E-7	—	—
		St wall	—	1E-3	1E-2
		D, see ^{193m} Hg	2E-7	8E-4	8E-3
		W, see ^{193m} Hg	2E-7	—	—
80	Mercury-203	Vapor	1E-9	—	—
		Organic D	1E-9	7E-6	7E-5
		D, see ^{193m} Hg	2E-9	3E-5	3E-4
		W, see ^{193m} Hg	2E-9	—	—
81	Thallium-194m	D, all compounds	2E-7	—	—
		St wall	—	1E-3	1E-2
81	Thallium-194	D, all compounds	8E-7	—	—
		St wall	—	4E-3	4E-2
81	Thallium-195	D, all compounds	2E-7	9E-4	9E-3
81	Thallium-197	D, all compounds	2E-7	1E-3	1E-2
81	Thallium-198m	D, all compounds	8E-8	4E-4	4E-3

81	Thallium-198	D, all compounds	5E-8	3E-4	3E-3
81	Thallium-199	D, all compounds	1E-7	9E-4	9E-3
81	Thallium-200	D, all compounds	2E-8	1E-4	1E-3
81	Thallium-201	D, all compounds	3E-8	2E-4	2E-3
81	Thallium-202	D, all compounds	7E-9	5E-5	5E-4
81	Thallium-204	D, all compounds	3E-9	2E-5	2E-4
82	Lead-195m	D, all compounds	3E-7	8E-4	8E-3
82	Lead-198	D, all compounds	9E-8	4E-4	4E-3
82	Lead-199	D, all compounds	1E-7	3E-4	3E-3
82	Lead-200	D, all compounds	9E-9	4E-5	4E-4
82	Lead-201	D, all compounds	3E-8	1E-4	1E-3
82	Lead-202m	D, all compounds	4E-8	1E-4	1E-3
82	Lead-202	D, all compounds	7E-11	2E-6	2E-5
82	Lead-203	D, all compounds	1E-8	7E-5	7E-4
82	Lead-205	D, all compounds	2E-9	5E-5	5E-4
82	Lead-209	D, all compounds	8E-8	3E-4	3E-3
82	Lead-210	D, all compounds	—	—	—
		Bone surf	6E-13	1E-8	1E-7
82	Lead-211	D, all compounds	9E-10	2E-4	2E-3
82	Lead-212	D, all compounds	5E-11	—	—
		Bone surf	—	2E-6	2E-5
82	Lead-214	D, all compounds	1E-9	1E-4	1E-3
83	Bismuth-200	D, nitrates	1E-7	4E-4	4E-3
		W, all other compounds	1E-7	—	—
83	Bismuth-201	D, see ²⁰⁰ Bi	4E-8	2E-4	2E-3
		W, see ²⁰⁰ Bi	5E-8	—	—
83	Bismuth-202	D, see ²⁰⁰ Bi	6E-8	2E-4	2E-3
		W, see ²⁰⁰ Bi	1E-7	—	—
83	Bismuth-203	D, see ²⁰⁰ Bi	9E-9	3E-5	3E-4
		W, see ²⁰⁰ Bi	9E-9	—	—
83	Bismuth-205	D, see ²⁰⁰ Bi	3E-9	2E-5	2E-4
		W, see ²⁰⁰ Bi	2E-9	—	—
83	Bismuth-206	D, see ²⁰⁰ Bi	2E-9	9E-6	9E-5
		W, see ²⁰⁰ Bi	1E-9	—	—
83	Bismuth-207	D, see ²⁰⁰ Bi	2E-9	1E-5	1E-4
		W, see ²⁰⁰ Bi	5E-10	—	—
83	Bismuth-210m	D, see ²⁰⁰ Bi	—	—	—
		Kidneys	9E-12	8E-7	8E-6
		W, see ²⁰⁰ Bi	9E-13	—	—
83	Bismuth-210	D, see ²⁰⁰ Bi	—	1E-5	1E-4
		Kidneys	5E-10	—	—
		W, see ²⁰⁰ Bi	4E-11	—	—
83	Bismuth-212	D, see ²⁰⁰ Bi	3E-10	7E-5	7E-4
		W, see ²⁰⁰ Bi	4E-10	—	—

83	Bismuth-213	D, see ²⁰⁰ Bi	4E-10	1E-4	1E-3
		W, see ²⁰⁰ Bi	5E-10	—	—
83	Bismuth-214	D, see ²⁰⁰ Bi	1E-9	—	—
		St wall	—	3E-4	3E-3
		W, see ²⁰⁰ Bi	1E-9	—	—
84	Polonium-203	D, all compounds except those given for W	9E-8	3E-4	3E-3
		W, oxides, hydroxides, Wand nitrates	—	—	—
			1E-7	—	—
84	Polonium-205	D, see ²⁰³ Po	5E-8	3E-4	3E-3
		W, see ²⁰³ Po	1E-7	—	—
84	Polonium-207	D, see ²⁰³ Po	3E-8	1E-4	1E-3
		W, see ²⁰³ Po	4E-8	—	—
84	Polonium-210	D, see ²⁰³ Po	9E-13	4E-8	4E-7
		W, see ²⁰³ Po	9E-13	—	—
85	Astatine-207	D, halides	4E-9	8E-5	8E-4
		W	3E-9	—	—
85	Astatine-211	D, halides	1E-10	2E-6	2E-5
		W	8E-11	—	—
86	Radon-220	With daughters removed	2E-8	—	—
		With daughters present	3E-11	—	—
86	Radon-222	With daughters removed	1E-8	—	—
		With daughters present	1E-10	—	—
87	Francium-222	D, all compounds	6E-10	3E-5	3E-4
87	Francium-223	D, all compounds	1E-9	8E-6	8E-5
88	Radium-223	W, all compounds	9E-13	—	—
		Bone surf	—	1E-7	1E-6
88	Radium-224	W, all compounds	2E-12	—	—
		Bone surf	—	2E-7	2E-6
88	Radium-225	W, all compounds	9E-13	—	—
		Bone surf	—	2E-7	2E-6
88	Radium-226	W, all compounds	9E-13	—	—
		Bone surf	—	6E-8	6E-7
88	Radium-227	W, all compounds	—	—	—
		Bone surf	3E-8	3E-4	3E-3
88	Radium-228	W, all compounds	2E-12	—	—
		Bone surf	—	6E-8	6E-7
89	Actinium-224	D, all compounds except those given for W and Y	—	—	—
		LLI wall	5E-11	3E-5	3E-4
		W, halides and nitrates	7E-11	—	—
		Y, oxides and hydroxides	6E-11	—	—
89	Actinium-225	D, see ²²⁴ Ac	—	—	—
		LLI wall	7E-13	7E-7	7E-6
		W, see ²²⁴ Ac	9E-13	—	—
		Y, see ²²⁴ Ac	9E-13	—	—

89	Actinium-226	D, see ²²⁴ Ac	—	—	—
		LLI wall	5E-12	2E-6	2E-5
		W, see ²²⁴ Ac	7E-12	—	—
		Y, see ²²⁴ Ac	6E-12	—	—
89	Actinium-227	D, see ²²⁴ Ac	—	—	—
		Bone surf	1E-15	5E-9	5E-8
		W, see ²²⁴ Ac	—	—	—
		Bone surf	4E-15	—	—
89	Actinium-228	Y, see ²²⁴ Ac	6E-15	—	—
		D, see ²²⁴ Ac	—	3E-5	3E-4
		Bone surf	2E-11	—	—
		W, see ²²⁴ Ac	—	—	—
90	Thorium-226	Bone surf	8E-11	—	—
		Y, see ²²⁴ Ac	6E-11	—	—
		W, all compounds except those given for Y	2E-10	—	—
		St wall	—	7E-5	7E-4
90	Thorium-227	Y, oxides and hydroxides	2E-10	—	—
		W, see ²²⁶ Th	5E-13	2E-6	2E-5
		Y, see ²²⁶ Th	5E-13	—	—
90	Thorium-228	W, see ²²⁶ Th	—	—	—
		Bone surf	3E-14	2E-7	2E-6
		Y, see ²²⁶ Th	2E-14	—	—
90	Thorium-229	W, see ²²⁶ Th	—	—	—
		Bone surf	3E-15	2E-8	2E-7
		Y, see ²²⁶ Th	—	—	—
		Bone surf	4E-15	—	—
90	Thorium-230	W, see ²²⁶ Th	—	—	—
		Bone surf	2E-14	1E-7	1E-6
		Y, see ²²⁶ Th	—	—	—
		Bone surf	3E-14	—	—
90	Thorium-231	W, see ²²⁶ Th	9E-9	5E-5	5E-4
		Y, see ²²⁶ Th	9E-9	—	—
90	Thorium-232	W, see ²²⁶ Th	—	—	—
		Bone surf	4E-15	3E-8	3E-7
		Y, see ²²⁶ Th	—	—	—
		Bone surf	6E-15	—	—
90	Thorium-234	W, see ²²⁶ Th	3E-10	—	—
		LLI wall	—	5E-6	5E-5
		Y, see ²²⁶ Th	2E-10	—	—
91	Protactinium-227	W, all compounds except those given for Y	2E-10	5E-5	5E-4
		Y, oxides and hydroxides	1E-10	—	—
91	Protactinium-228	W, see ²²⁷ Pa	—	2E-5	2E-4
		Bone surf	3E-11	—	—
		see ²²⁷ Pa	2E-11	—	—
91	Protactinium-230	W, see ²²⁷ Pa	7E-12	—	—
		Bone surf	—	1E-5	1E-4
		Y, see ²²⁷ Pa	5E-12	—	—
91	Protactinium-231	W, see ²²⁷ Pa	—	—	—
		Bone surf	6E-15	6E-9	6E-8
		Y, see ²²⁷ Pa	—	—	—
		Bone surf	8E-15	—	—

91	Protactinium-232	W, see ²²⁷ Pa	—	2E-5	2E-4
		Bone surf	8E-11	—	—
		Y, see ²²⁷ Pa	—	—	—
		Bone surf	1E-10	—	—
91	Protactinium-233	W, see ²²⁷ Pa	1E-9	—	—
		LLI wall	—	2E-5	2E-4
		Y, see ²²⁷ Pa	8E-10	—	—
91	Protactinium-234	W, see ²²⁷ Pa	1E-8	3E-5	3E-4
		Y, see ²²⁷ Pa	9E-9	—	—
92	Uranium-230	D, UF ₆ , UO ₂ F ₂ , UO ₂ , (NO ₃) ₂	—	—	—
		Bone surf	8E-13	8E-8	8E-7
		W, UO ₃ , UF ₆ , UCl ₄	5E-13	—	—
		Y, UO ₂ , U ₃ O ₈	4E-13	—	—
92	Uranium-231	D, see ²³⁰ U	1E-8	—	—
		LLI wall	—	6E-5	6E-4
		W, see ²³⁰ U	8E-9	—	—
		Y, see ²³⁰ U	6E-9	—	—
92	Uranium-232	D, see ²³⁰ U	—	—	—
		Bone surf	6E-13	6E-8	6E-7
		W, see ²³⁰ U	5E-13	—	—
		Y, see ²³⁰ U	1E-14	—	—
92	Uranium-233	D, see ²³⁰ U	—	—	—
		Bone surf	3E-12	3E-7	3E-6
		W, see ²³⁰ U	1E-12	—	—
		Y, see ²³⁰ U	5E-14	—	—
92	Uranium-234	D, see ²³⁰ U	—	—	—
		Bone surf	3E-12	3E-7	3E-6
		W, see ²³⁰ U	1E-12	—	—
		Y, see ²³⁰ U	5E-14	—	—
92	Uranium-235	D, see ²³⁰ U	—	—	—
		Bone surf	3E-12	3E-7	3E-6
		W, see ²³⁰ U	1E-12	—	—
		Y, see ²³⁰ U	6E-14	—	—
92	Uranium-236	D, see ²³⁰ U	—	—	—
		Bone surf	3E-12	3E-7	3E-6
		W, see ²³⁰ U	1E-12	—	—
		Y, see ²³⁰ U	6E-14	—	—
92	Uranium-237	D, see ²³⁰ U	4E-9	—	—
		LLI wall	—	3E-5	3E-4
		W, see ²³⁰ U	2E-9	—	—
		Y, see ²³⁰ U	2E-9	—	—
92	Uranium-238	D, see ²³⁰ U	—	—	—
		Bone surf	3E-12	3E-7	3E-6
		W, see ²³⁰ U	1E-12	—	—
		Y, see ²³⁰ U	6E-14	—	—
92	Uranium-239	D, see ²³⁰ U	3E-7	9E-4	9E-3
		W, see ²³⁰ U	2E-7	—	—
		Y, see ²³⁰ U	2E-7	—	—

92	Uranium-240	D, see ²³⁰ U	5E-9	2E-5	2E-4
		W, see ²³⁰ U	4E-9	—	—
		Y, see ²³⁰ U	3E-9	—	—
92	Uranium-natural	D, see ²³⁰ U	—	—	—
		Bone surf	3E-12	3E-7	3E-6
		W, see ²³⁰ U	9E-13	—	—
		Y, see ²³⁰ U	9E-14	—	—
93	Neptunium-232	W, all compounds	—	2E-3	2E-2
		Bone surf	6E-9	—	—
93	Neptunium-233	W, all compounds	4E-6	1E-2	1E-1
93	Neptunium-234	W, all compounds	4E-9	3E-5	3E-4
93	Neptunium-235	W, all compounds	—	—	—
		Bone surf	2E-9	3E-4	3E-3
93	Neptunium-236 (1.15E+5 y)	W, all compounds	—	—	—
		Bone surf	8E-14	9E-8	9E-7
93	Neptunium-236 (22.5 h)	W, all compounds	—	—	—
		Bone surf	1E-10	5E-5	5E-4
93	Neptunium-237	W, all compounds	—	—	—
		Bone surf	1E-14	2E-8	2E-7
93	Neptunium-238	W, all compounds	—	2E-5	2E-4
		Bone surf	2E-10	—	—
93	Neptunium-239	W, all compounds	3E-9	—	—
		LLI wall	—	2E-5	2E-4
93	Neptunium-240	W, all compounds	1E-7	3E-4	3E-3
94	Plutonium-234	W, all compounds except PuO ₂	3E-10	1E-4	1E-3
		Y, PuO ₂	3E-10	—	—
		W, see ²³⁴ Pu	4E-6	1E-2	1E1
94	Plutonium-235	Y, see ²³⁴ Pu	3E-6	—	—
		W, see ²³⁴ Pu	—	—	—
94	Plutonium-236	Bone surf	5E-14	6E-8	6E-7
		Y, see ²³⁴ Pu	6E-14	—	—
		W, see ²³⁴ Pu	—	—	—
94	Plutonium-237	W, see ²³⁴ Pu	5E-9	2E-4	2E-3
		Y, see ²³⁴ Pu	4E-9	—	—
94	Plutonium-238	W, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	2E-8	2E-7
		Y, see ²³⁴ Pu	2E-14	—	—
94	Plutonium-239	W, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	2E-8	2E-7
		Y, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	—	—
94	Plutonium-240	W, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	2E-8	2E-7
		Y, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	—	—
94	Plutonium-241	W, see ²³⁴ Pu	—	—	—
		Bone surf	8E-13	1E-6	1E-5
		Y, see ²³⁴ Pu	—	—	—
		Bone surf	1E-12	—	—

94	Plutonium-242	W, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	2E-8	2E-7
		Y, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	—	—
94	Plutonium-243	W, see ²³⁴ Pu	5E-8	2E-4	2E-3
		Y, see ²³⁴ Pu	5E-8	—	—
94	Plutonium-244	W, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	2E-8	2E-7
		Y, see ²³⁴ Pu	—	—	—
		Bone surf	2E-14	—	—
94	Plutonium-245	W, see ²³⁴ Pu	6E-9	3E-5	3E-4
		Y, see ²³⁴ Pu	6E-9	—	—
94	Plutonium-246	W, see ²³⁴ Pu	4E-10	—	—
		LLI wall	—	6E-6	6E-5
		Y, see ²³⁴ Pu	4E-10	—	—
95	Americium-237	W, all compounds	4E-7	1E-3	1E-2
95	Americium-238	W, all compounds	—	5E-4	5E-3
		Bone surf	9E-9	—	—
95	Americium-239	W, all compounds	2E-8	7E-5	7E-4
95	Americium-240	W, all compounds	4E-9	3E-5	3E-4
95	Americium-241	W, all compounds	—	—	—
		Bone surf	2E-14	2E-8	2E-7
95	Americium-242m	W, all compounds	—	—	—
		Bone surf	2E-14	2E-8	2E-7
95	Americium-242	W, all compounds	—	5E-5	5E-4
		Bone surf	1E-10	—	—
95	Americium-243	W, all compounds	—	—	—
		Bone surf	2E-14	2E-8	2E-7
95	Americium-244m	W, all compounds	—	—	—
		St wall	1E-8	1E-3	1E-2
95	Americium-244	W, all compounds	—	4E-5	4E-4
		Bone surf	4E-10	—	—
95	Americium-245	W, all compounds	1E-7	4E-4	4E-3
95	Americium-246m	W, all compounds	3E-7	—	—
		St wall	—	8E-4	8E-3
95	Americium-246	W, all compounds	1E-7	4E-4	4E-3
96	Curium-238	W, all compounds	2E-9	2E-4	2E-3
96	Curium-240	W, all compounds	—	—	—
		Bone surf	9E-13	1E-6	1E-5
96	Curium-241	W, all compounds	—	2E-5	2E-4
		Bone surf	5E-11	—	—
96	Curium-242	W, all compounds	—	—	—
		Bone surf	4E-13	7E-7	7E-6
96	Curium-243	W, all compounds	—	—	—
		Bone surf	2E-14	3E-8	3E-7
96	Curium-244	W, all compounds	—	—	—
		Bone surf	3E-14	3E-8	3E-7
96	Curium-245	W, all compounds	—	—	—
		Bone surf	2E-14	2E-8	2E-7

96	Curium-246	W, all compounds Bone surf	— 2E-14	— 2E-8	— 2E-7
96	Curium-247	W, all compounds Bone surf	— 2E-14	— 2E-8	— 2E-7
96	Curium-248	W, all compounds Bone surf	— 4E-15	— 5E-9	— 5E-8
96	Curium-249	W, all compounds Bone surf	— 4E-8	— 7E-4	— 7E-3
96	Curium-250	W, all compounds Bone surf	— 8E-16	— 9E-10	— 9E-9
97	Berkelium-245	W, all compounds	2E-9	3E-5	3E-4
97	Berkelium-246	W, all compounds	4E-9	4E-5	4E-4
97	Berkelium-247	W, all compounds Bone surf	— 1E-14	— 2E-8	— 2E-7
97	Berkelium-249	W, all compounds Bone surf	— 5E-12	— 6E-6	— 6E-5
97	Berkelium-250	W, all compounds Bone surf	— 1E-9	— 1E-4	— 1E-3
98	Californium-244	W, all compounds except those given for Y St wall Y, oxides and hydroxides	8E-10 — 8E-10	— 4E-4 —	— 4E-3 —
98	Californium-246	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	1E-11 1E-11	5E-6 —	5E-5 —
98	Californium-248	W, see ²⁴⁴ Cf Bone surf Y, see ²⁴⁴ Cf	— 2E-13 1E-13	— 2E-7 —	— 2E-6 —
98	Californium-249	W, see ²⁴⁴ Cf Bone surf Y, see ²⁴⁴ Cf Bone surf	— 1E-14 — 2E-14	— 2E-8 — —	— 2E-7 — —
98	Californium-250	W, see ²⁴⁴ Cf Bone surf Y, see ²⁴⁴ Cf	— 3E-14 4E-14	— 3E-8 —	— 3E-7 —
98	Californium-251	W, see ²⁴⁴ Cf Bone surf Y, see ²⁴⁴ Cf Bone surf	— 1E-14 — 2E-14	— 2E-8 — —	— 2E-7 — —
98	Californium-252	W, see ²⁴⁴ Cf Bone surf Y, see ²⁴⁴ Cf	— 5E-14 5E-14	— 7E-8 —	— 7E-7 —
98	Californium-253	W, see ²⁴⁴ Cf Bone surf Y, see ²⁴⁴ Cf	3E-12 — 2E-12	— 5E-6 —	— 5E-5 —
98	Californium-254	W, see ²⁴⁴ Cf Y, see ²⁴⁴ Cf	3E-14 2E-14	3E-8 —	3E-7 —
99	Einsteinium-250	W, all compounds Bone surf	— 2E-9	6E-4 —	6E-3 —
99	Einsteinium-251	W, all compounds Bone surf	— 2E-9	1E-4 —	1E-3 —

99	Einsteinium-253	W, all compounds	2E-12	2E-6	2E-5
99	Einsteinium-254m	W, all compounds	1E-11	—	—
		LLI wall	—	4E-6	4E-5
99	Einsteinium-254	W, all compounds	—	—	—
		Bone surf	2E-13	2E-7	2E-6
100	Fermium-252	W, all compounds	2E-11	6E-6	6E-5
100	Fermium-253	W, all compounds	1E-11	1E-5	1E-4
100	Fermium-254	W, all compounds	1E-10	4E-5	4E-4
100	Fermium-255	W, all compounds	3E-11	7E-6	7E-5
100	Fermium-257	W, all compounds	—	—	—
		Bone surf	3E-13	5E-7	5E-6
101	Mendelevium-257	W, all compounds	—	1E-4	1E-3
		Bone surf	1E-10	—	—
101	Mendelevium-258	W, all compounds	—	—	—
		Bone surf	5E-13	6E-7	6E-6
—	Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours	Submersion ^a	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		1E-12	1E-8	1E-7
—	Any single radionuclide not listed above that decays by alpha emission or spontaneous fission, or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known. . . .		1E-15	2E-9	2E-8

Footnotes:

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

Note:

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

If it is known that Ac-227-D,W,Y, Th-229-W,Y, Th-232-W,Y, Pa-231-W,Y, Cm-248-W, and Cm-250-W are not present

1E-14 — —

If, in addition, it is known that Sm-146-W, Gd-148-D,W, Gd-152-D, Th-228-W,Y, Th-230-W,Y, U-232-Y, U-233-Y, U-234-Y, U-235-Y, U-236 Y, U-238-Y, U-Nat-Y, Np-236-W, Np-237-W, Pu-236-W,Y, Pu-238-W,Y, Pu-239-W,Y, Pu-240 W,Y, Pu-242-W,Y, Pu-244-W,Y, Am-241-W, Am-242m-W, Am-243-W, Cm-243-W, Cm-244-W, Cm-245-W, Cm-246-W, Cm-247-W, Bk-247-W, Cf-249-W,Y, Cf-250-W,Y, Cf-251-W,Y, Cf-252-W,Y, and Cf-254-W,Y 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

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

Example: If radionuclides "A," "B," and "C" are present in concentrations C_A , C_B , and C_C , and if the applicable effluent concentrations (EC) are EC_A , EC_B , and EC_C , respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_A}{EC_A} + \frac{C_B}{EC_B} + \frac{C_C}{EC_C} \leq 1$$

New Rule, R.2005 d.156, effective May 16, 2005.
 See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).
 Administrative correction.
 See: 37 N.J.R. 3343(a).

SUBCHAPTER 12. REMEDIATION STANDARDS FOR RADIOACTIVE MATERIALS

7:28-12.1 Purpose and scope

The purpose of this subchapter is to establish minimum standards for the remediation of real property contaminated by radioactive materials. This subchapter also provides direction on remediating a site contaminated with radioactive materials with regard to sampling, surveying,

and laboratory requirements, remedial action selection, and remedial action requirements.

7:28-12.2 Applicability

(a) The standards in this subchapter are applicable to:

1. Remediation of radioactive contamination of real property by any technologically enhanced naturally occurring radioactive materials;
2. Remediation of radioactive contamination of real property by accelerator-produced radionuclides; and

3. Any other remediation of radioactive contamination including, without limitation, any remediation pursuant to: the Spill Compensation and Control Act, N.J.S.A. 58:10-23.11 et seq.; the Water Pollution Control Act, N.J.S.A. 58:10A-1 et seq.; the Industrial Site Recovery Act, N.J.S.A. 13:1K-6 et seq.; the Solid Waste Management Act, N.J.S.A. 13:1E-1 et seq.; the Comprehensive Regulated Medical Waste Management Act, N.J.S.A. 13:1E-48.1 et seq.; the Major Hazardous Waste Facilities Siting Act, N.J.S.A. 13:1E-49 et seq.; the Sanitary Landfill Facility Closure and Contingency Fund Act, N.J.S.A. 13:1E-100 et seq.; the Regional Low Level Radioactive Waste Disposal Facility Siting Act, N.J.S.A. 13:1E-177 et seq.; any law or regulation by which the State may compel a person to perform remediation activities; or N.J.A.C. 7:26C.

(b) The standards in this subchapter are not applicable to:

1. Materials containing naturally occurring radionuclides whose concentrations have not been technologically enhanced; or
2. Coal ash that has been or is being used in:
 - i. The manufacture of construction materials including, but not limited to, cinder blocks, concrete products and roofing materials;
 - ii. Road construction materials including, but not limited to, asphalt filler or road base material; or
 - iii. Landfill cover.

(c) The Department shall apply the radiation soil standards in this chapter at applicable sites as "Applicable or Relevant and Appropriate Requirements" as defined in the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§ 9601 et seq.

7:28-12.3 Definitions

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

"Appropriate period of time" means the length of time required for the radionuclide to decay seven half-lives.

"Committed dose equivalent" means the total dose equivalent averaged throughout any body tissue in the 50 years after intake of a radionuclide into the body.

"Committed effective dose equivalent" means the sum of the products of the committed dose equivalents to individual tissues resulting from an intake of a radionuclide multiplied by the appropriate weighting factor (W_T) indicated below:

Organ or Tissue	W_T
Gonads	0.25
Breast	0.15
Red bone marrow	0.12
Lung	0.12
Thyroid	0.03
Bone Surfaces	0.03
Remainder	0.30*
Whole Body (external)	1.00

*0.30 results from 0.06 for each of five "remainder" organs (excluding the skin and the lens of the eye) that receive the highest doses.

"Deep-dose equivalent" means, applied to external whole-body exposure, the dose equivalent at a tissue depth of one centimeter.

"Derived concentration guideline level" means the radionuclide-specific activity concentration corresponding to the release criterion.

"Design features" means those features of a remediation that do not rely on additional expenditures after installation to achieve their intended purpose.

"Dose equivalent" means the product of the absorbed dose (D), the quality factor (Q), and other modifying factors (N). For purposes of this definition, $N = 1$.

"Engineering controls" means any mechanism to contain or stabilize contamination or ensure the effectiveness of a remedial action. Engineering controls under this subchapter may include, without limitation, caps, covers, dikes, trenches, leachate collection systems, radon remediation systems, signs, fences and physical access controls.

"Final status survey" is a survey or analysis, performed after remediation, which provides data that demonstrates that all radiological parameters satisfy the remediation standards.

“Institutional controls” means a mechanism used to limit human activities at or near a contaminated site, or to ensure the effectiveness of the remedial action over time, when contaminants remain at a site in levels or concentrations above the applicable remediation standard that would allow unrestricted use of that property. Institutional controls under this subchapter may include, without limitation, structure, land and natural resource use restrictions, well restriction areas, classification exception areas, deed notices, and declarations of environmental restrictions.

“Intake dose” means the annual radiation dose to a person from all potential intake pathways (exclusive of radon inhalation), including the ingestion of water, direct ingestion of soil, intake of foods, and the inhalation of resuspended particulate matter (in committed effective dose equivalent).

“Limited restricted-use remedial action” means any remedial action that requires the continued use of institutional controls but does not require the use of an engineering control.

“Natural background radionuclide concentration” means the average value of a particular radionuclide concentration in soils measured in areas in the vicinity of the site, in an area that has not been influenced by localized human activities, including the site’s prior or current operations.

“Quality factor” means the factor by which absorbed doses are multiplied to obtain a quantity that expresses the effectiveness of the absorbed dose on a common scale for all types of ionizing radiation.

“Radioactive contamination or radioactive contaminant” means the collective amount of radiation emitted from one or more radionuclides in the soil at concentrations above natural background levels.

“Radioactive materials” means any material, solid, liquid, or gas, that emits radiation spontaneously.

“Radionuclide” means a type of atom that spontaneously undergoes radioactive decay.

“Regional natural background variation” means the best Department estimate, based on available data, of a region’s naturally experienced variation in radiation dose from mean levels that are commonly and consistently experienced by persons in the State.

“Remedial action” means those actions taken at a site, or offsite if a radioactive contaminant has migrated or is migrating there from a radioactively contaminated site as may be required by the Department, including, without limitation, removal, treatment, containment, transportation, securing, or other engineering or treatment measures, whether to an unrestricted use or otherwise, designed to ensure that any discharged radioactive contaminant at the site, or that has migrated or is migrating from the site, is remediated in compliance with the applicable remediation standards in this subchapter.

“Remediation” or “remediate” means all necessary actions to investigate and cleanup or respond to any known, suspected, or threatened discharge of radioactive contaminants, including, as necessary, the preliminary assessment, site investigation, remedial investigation, and remedial action.

“Remediation standards” means the combination of numeric standards that establish a level or concentration, and narrative standards, to which radioactive contaminants must be treated, removed or otherwise cleaned for soil, ground water or surface water, as provided by the Department pursuant to N.J.S.A. 58:10B-12, in order to meet the health risk or environmental standards.

“Residual radionuclides” means the concentration of radionuclides remaining after the remediation is successfully completed, excluding background.

“Restricted use remedial action” means any remedial action that requires the continued use of engineering and institutional controls in order to meet the established health risk or environmental standards.

“Technologically enhanced naturally occurring radioactive materials” means any naturally occurring radioactive materials whose radionuclide concentrations or potential for human exposure have been increased by any human activities.

“Total effective dose equivalent” means the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

“Uncontaminated surface soil” means soil whose average natural background radionuclide total concentrations are less than the limits for residual radionuclides, and cannot exceed the background established for the site by more than two standard deviations.

“Unrestricted use remedial action” means any remedial action that does not require the continued use of engineering or institutional controls in order to meet the established standards.

“Vertical extent” means the average depth, measured in feet, of the post-remediation radioactive contamination over an affected area.

7:28-12.4 General requirements

(a) Any person conducting remediation pursuant to this subchapter shall comply with the requirements of N.J.A.C. 7:26E, Technical Requirements for Site Remediation, excluding those sections related to sampling, surveying, and background investigations. Sampling, surveying and laboratory requirements shall be in accordance with N.J.A.C. 7:28-12.5.

(b) Compliance with this subchapter shall not relieve any person from complying with more stringent cleanup standards or

provisions imposed by any other applicable statute, rule or regulation.

7:28-12.5 Sampling, surveying and laboratory requirements

(a) Facilities licensed under 10 C.F.R. Part 50 that have Nuclear Regulatory Commission-approved quality assurance plans are exempt from the requirements of this section. Otherwise, in addition to the requirements in N.J.A.C. 7:26E Appendix A IV.1, persons responsible for conducting remediations shall include the following in the radionuclide analysis reports:

1. Report final results as a value plus or minus the associated error for each sample;
2. Report data as calculated, and not report "less than" values for any sample;
3. Report minimum detectable activities;
4. Calculate results for single sample and composites to the sample collection period mid point;
5. Provide a quantitation report; and
6. Provide copies of the instrument run logs.

(b) If available, persons responsible for conducting remediations shall provide:

1. The Gamma Spectroscopy Report which includes sample specific header information, peak search, peak identification, background subtraction, activity, and minimum detectable activity;
2. The Gross Beta calculation worksheets and computer generated result forms;
3. Radiochemical Iodine calculation worksheets and computer generated result forms;
4. Liquid Scintillation calculation worksheets and computer-generated result forms; and
5. Gross Alpha and Gross Beta, radium-226, uranium, and strontium-89 and 90 calculation worksheets and computer-generated result forms.

(c) For radionuclides, analytical methods contained in the following publications, incorporated herein by reference, or equivalents as approved by the Department, shall be used for determining radionuclide concentrations and/or radiation levels:

1. U.S. Environmental Protection Agency; "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA 600/4-80-32, as amended and supplemented. This document may be obtained from the USEPA National Air and Radiation Environmental Laboratory, 540 S. Morris Ave., Montgomery, AL 36115-2601;

2. U.S. Department Of Energy; "Environmental Measurements Laboratory—Procedures Manual," HASL-300, 27th Ed., Vol. 1, as amended and supplemented. This document may be obtained from the US Department of Energy, Environmental Measurements Laboratory, 201 Varick St., 5th Floor, New York, NY 10014-4811; and/or

3. U.S. Environmental Protection Agency Eastern Environmental Radiation Facility; "Radiochemistry Procedures Manual," EPA 520/5-84-006, as amended and supplemented. This document may be obtained from the address in (c)1 above.

(d) Any laboratory providing radiological analysis for soil shall be certified pursuant to N.J.A.C. 7:18 for radionuclide analysis in water and, in addition, shall have participated in and passed a soil intercomparison analysis administered by either the International Atomic Energy Agency or the U.S. Department of Energy's Environmental Measurements Laboratory within the year preceding the radiological analysis for the methods of interest.

(e) Sampling and surveying for radioactive contamination shall be done in accordance with the protocol specified in that version of the Department of Environmental Protection's Field Sampling Procedure Manual's section on Radiological Assessment, incorporated herein by reference, in effect at the time of sampling and surveying which may be obtained by calling the Bureau of Environmental Radiation at (609) 984-5400 or from the Radiation Protection Program's web site at <http://www.state.nj.us/dep/rpp/index.htm>.

7:28-12.6 Remedial action selection

Remedial action selection for all sites contaminated with radioactive material shall be in accordance with N.J.A.C. 7:26E-5.

7:28-12.7 Remedial action requirements

The remedial action requirements for all sites contaminated with radioactive material shall be in accordance with N.J.A.C. 7:26E-6, with the exception of N.J.A.C. 7:26E-6.4, Post-remedial action requirements. Post-remedial sampling shall be conducted in accordance with the guidance provided in that version of the Department of Environmental Protection's Field Sampling Procedure Manual's section on Radiological Assessment, in effect at the time of the post-remedial sampling.

7:28-12.8 Radiation dose standards applicable to remediation of radioactive contamination of all real property

(a) Sites shall be remediated so that the incremental radiation dose to any person from any residual radioactive contamination at the site above that due to natural background radionuclide concentration, under either an unrestricted use remedial action, limited restricted use remedial action, or a restricted use remedial action, shall be as specified below:

1. For the sum of annual external gamma radiation dose (in effective dose equivalent) and intake dose (in committed effective dose equivalent), including the groundwater pathway: 15 millirem (0.15 milliSievert) total annual effective dose equivalent (15 mrem/yr TEDE).

2. For radon-222: three picocuries per liter (pCi/L) of radon gas (111 Bq/m³).

3. Radioactively contaminated ground water shall be remediated to comply with the New Jersey Groundwater Quality Standards rules, N.J.A.C. 7:9C.

Administrative correction.
See: 37 N.J.R. 4245(a).

7:28-12.9 Minimum remediation standards for radionuclide contamination of soil

(a) For radioactive contamination in soils, the requirements of N.J.A.C. 7:28-12.8 shall be considered to be met for a specific radionuclide if:

1. Where only one radionuclide adds to the radioactive contamination of the site, the incremental concentration of the radionuclide above the natural background radionuclide concentration does not exceed the value in Table 1A, 1B (for unrestricted use), 2A, 2B (for limited restricted use), 3A, or 3B (for restricted use) below;

Table 1A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Unrestricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	54	35	26	20	17	14	12	11	10
U234 ⁽²⁾	62	37	26	21	17	14	12	11	10
Ra226 ⁽³⁾	3	2	2	2	2	2	2	2	2
U235 ⁽²⁾	29	22	17	14	12	10	9	8	7
Ac227	3	2	2	2	2	2	2	2	2
Th232	2	2	2	2	2	2	1	1	1

Table 1B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Unrestricted Use Standards for Radioactive Contamination (Bq/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	2.02	1.29	0.94	0.75	0.62	0.53	0.46	0.41	0.36
U234 ⁽²⁾	2.29	1.36	0.98	0.76	0.62	0.53	0.46	0.41	0.36
Ra226 ⁽³⁾	0.10	0.08	0.08	0.08	0.07	0.07	0.07	0.06	0.06
U235 ⁽²⁾	1.07	0.08	0.63	0.52	0.44	0.38	0.34	0.30	0.27
Ac227	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.07
Th232	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05

Table 2A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Limited Restricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	64	41	30	24	20	17	15	13	12
U234 ⁽²⁾	69	42	30	24	19	16	14	13	11
Ra226 ⁽³⁾	5	4	3	3	2	2	2	2	2
U235 ⁽²⁾	37	27	22	18	15	13	11	10	9
Ac227	5	5	5	5	5	5	5	4	4
Th232	3	3	3	3	3	3	3	3	3

Table 2B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Limited Restricted Use Standards for Radioactive Contamination (Bq/g)⁽¹⁾

Radionuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	2.37	1.52	1.12	0.88	0.73	0.62	0.54	0.48	0.43
U234 ⁽²⁾	2.56	1.56	1.12	0.88	0.72	0.61	0.53	0.47	0.42
Ra226 ⁽³⁾	0.19	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235 ⁽²⁾	1.38	1.01	0.80	0.65	0.55	0.48	0.42	0.38	0.34
Ac227	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Th232	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.10	0.10

Table 3A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Restricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9

U238 ⁽²⁾	USS 1	82	46	32	24	20	17	15	13	12
	USS 2	83	46	32	25	20	17	15	13	12
	USS 3	83	46	33	25	20	17	15	13	12
	USS 4	83	47	33	25	20	18	15	13	12
	USS 5	85	47	33	25	21	16	14	13	12
U234 ⁽²⁾	USS 1	81	45	31	24	19	16	14	13	11
	USS 2	81	45	31	24	20	17	14	13	11
	USS 3	81	46	32	24	20	17	14	13	11
	USS 4	81	46	32	24	20	17	15	13	11
	USS 5	83	46	32	25	20	17	15	13	12
Ra226 ⁽³⁾	USS 1	7	4	3	3	2	2	2	2	2
	USS 2	7	4	3	3	2	2	2	2	2
	USS 3	7	4	3	3	2	2	2	2	2
	USS 4	7	4	3	3	2	2	2	2	2
	USS 5	7	4	3	3	2	2	2	2	2
U235 ⁽²⁾	USS 1	62	35	25	19	16	13	11	10	9
	USS 2	67	37	25	20	16	13	12	10	9
	USS 3	67	37	26	20	16	14	12	11	10
	USS 4	67	37	26	20	16	14	12	11	10
	USS 5	68	37	26	20	17	14	13	11	10
Ac227	USS 1	17	9	6	5	5	5	5	4	4
	USS 2	18	10	7	7	6	5	5	5	5
	USS 3	18	10	10	8	6	6	6	6	6
	USS 4	18	15	10	8	8	8	8	8	8
	USS 5	26	15	10	10	10	10	10	10	10
Th232	USS 1	15	9	7	5	4	2	3	3	3
	USS 2	21	10	7	5	4	3	3	3	3
	USS 3	21	10	7	5	4	4	4	4	4
	USS 4	21	10	7	5	5	5	5	5	5
	USS 5	21	10	7	6	6	6	6	6	6

Table 3B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Restricted Use Standards for Radioactive Contamination (pCi/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	USS 1	3.03	1.70	1.18	0.90	0.74	0.63	0.54	0.48	0.43
	USS 2	3.08	1.71	1.18	0.92	0.75	0.63	0.55	0.48	0.43
	USS 3	3.09	1.71	1.21	0.92	0.75	0.63	0.55	0.49	0.44
	USS 4	3.09	1.74	1.21	0.92	0.75	0.64	0.56	0.49	0.44
	USS 5	3.14	1.74	1.21	0.93	0.77	0.65	0.56	0.50	0.44
U234 ⁽²⁾	USS 1	2.98	1.66	1.15	0.88	0.72	0.61	0.53	0.47	0.42
	USS 2	2.98	1.66	1.15	0.89	0.73	0.61	0.53	0.47	0.42
	USS 3	2.98	1.66	1.17	0.90	0.73	0.62	0.54	0.47	0.42
	USS 4	2.98	1.70	1.18	0.90	0.74	0.62	0.54	0.47	0.42
	USS 5	3.05	1.70	1.18	0.91	0.74	0.63	0.54	0.48	0.43
Ra226 ⁽³⁾	USS 1	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 2	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 3	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 4	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 5	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235 ⁽²⁾	USS 1	2.30	1.30	0.91	0.70	0.59	0.49	0.42	0.38	0.34
	USS 2	2.47	1.36	0.94	0.73	0.59	0.49	0.43	0.39	0.35
	USS 3	2.48	1.36	0.95	0.73	0.59	0.50	0.44	0.40	0.36
	USS 4	2.49	1.38	0.95	0.73	0.60	0.52	0.45	0.41	0.37
	USS 5	2.51	1.38	0.95	0.74	0.62	0.53	0.47	0.42	0.37
Ac227	USS 1	0.62	0.34	0.24	0.18	0.18	0.18	0.17	0.17	0.17
	USS 2	0.66	0.36	0.24	0.24	0.23	0.20	0.19	0.19	0.19
	USS 3	0.66	0.36	0.36	0.29	0.23	0.23	0.23	0.23	0.23
	USS 4	0.66	0.54	0.37	0.29	0.28	0.28	0.28	0.28	0.28
	USS 5	0.97	0.54	0.37	0.36	0.36	0.36	0.36	0.36	0.36
Th232	USS 1	0.56	0.35	0.25	0.19	0.15	0.13	0.11	0.10	0.10
	USS 2	0.77	0.39	0.26	0.19	0.15	0.13	0.12	0.12	0.12
	USS 3	0.77	0.39	0.26	0.19	0.15	0.14	0.14	0.14	0.14
	USS 4	0.77	0.39	0.26	0.19	0.17	0.17	0.17	0.17	0.17
	USS 5	0.77	0.39	0.26	0.22	0.22	0.22	0.22	0.22	0.22

- (1) The allowed Incremental Concentrations are added to the natural background radionuclide concentration to obtain the absolute value of the allowed radionuclide concentration following site remediation.
- (2) These allowable concentrations may however, further be limited by the chemical toxicity of uranium. Applicants should inquire with NJDEP's Site Remediation Program for the additional applicable chemical cleanup standards for uranium.
- (3) When more than one nuclide is present, use the Radium-226 Table in Appendix A, incorporated herein by reference, for applying the sum of the fractions rule. Then use whatever number is more restrictive for radium-226, the value in Tables 1A through 3B or the value derived by using the sum of the fractions rule.

2. Where more than one radionuclide contaminant is present at the site, their concentrations meet the sum of the fractions as described below:

$$\sum \frac{CA_i}{C_i} < 1$$

where:

CA_i = the incremental concentration of radionuclide i at the site, and

C_i = the incremental allowed concentration of radionuclide i from Table 1A, 1B, 2A, 2B, 3A, or 3B above, if it were the only remaining radionuclide at the site; and

3. Natural background radionuclide concentration shall be established by the methods presented in the Multi

Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, EPA 402 R-97-018, and any subsequent revisions thereto, or as discussed in Chapter 12 of the Department's Field Sampling Procedures Manual.

(b) As an alternate, the requirements of N.J.A.C. 7:28-12.8 shall be considered to be met for a specific radionuclide if:

1. Where only one radionuclide adds to the radioactive contamination of the site, the incremental concentration of the radionuclide above the natural background radionuclide concentration and the amount of uncontaminated surface soil meet the pre-mixing values in Table 4A, 4B (for unrestricted use), 5A, or 5B (for limited restricted use) below;

Table 4A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Required Depth of USS; Pre-Mixing Values—Unrestricted Use (pCi/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	USS 1	70*	39	27	21	17	14	12	11	10
	USS 2	76	40	28	21	17	14	13	11	10
	USS 3	76	41	28	22	17	15	13	11	10
	USS 4	77	42	28	22	18	15	13	11	10
	USS 5	78	42	28	22	18	15	13	12	10
U234 ⁽²⁾	USS 1	74	40	27	21	17	14	12	11	10
	USS 2	74	40	27	21	17	14	13	11	10
	USS 3	74	40	28	21	17	15	13	11	10
	USS 4	76	42	28	22	18	15	13	11	10
	USS 5	78	42	28	22	18	15	13	11	10
Ra226 ⁽³⁾	USS 1	5*	3*	3	3	2	2	2	2	2
	USS 2	7	4	3	3	2	2	2	2	2
	USS 3	7	4	3	3	2	2	2	2	2
	USS 4	7	4	3	3	2	2	2	2	2
	USS 5	7	4	3	3	2	2	2	2	2
U235 ⁽²⁾	USS 1	43*	26*	19*	15	13	11	9	8	7
	USS 2	51*	29*	21	15*	13	11	9	8	8
	USS 3	58*	31*	21	16	13	11	10	9	8
	USS 4	62*	31*	21	16	13	11	10	9	8
	USS 5	62*	32*	21	16	14	12	10	9	8
Ac227	USS 1	5*	3*	3	2	2	2	2	2	2
	USS 2	6*	4	3	3	3	3	3	3	3
	USS 3	8	5	4*	3*	4	3	3*	3*	3*
	USS 4	11*	6*	5*	4*	3*	3*	3*	3*	3*
	USS 5	13*	8*	5*	5*	4*	4*	4*	3*	3*
Th232	USS 1	4*	3*	2*	2	2	2	1	1	1
	USS 2	6*	4*	3	3	2	2	2	2	2
	USS 3	8*	5	4	2*	2	2	2	2	2
	USS 4	10*	6	3*	2*	2	2	2	2	2
	USS 5	11	5*	3*	3	3	2*	2*	2*	2*

Table 4B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Required Depth of USS; Pre-Mixing Values—Unrestricted Use (Bq/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
U238 ⁽²⁾	USS 1	2.60*	1.46	1.00	0.77	0.64	0.53	0.46	0.41	0.36
	USS 2	2.80	1.49	1.03	0.79	0.64	0.54	0.46	0.41	0.37
	USS 3	2.81	1.51	1.05	0.80	0.64	0.54	0.47	0.42	0.37
	USS 4	2.86	1.54	1.05	0.80	0.65	0.55	0.48	0.42	0.38
	USS 5	2.88	1.54	1.05	0.81	0.66	0.56	0.49	0.43	0.38
U234 ⁽²⁾	USS 1	2.75	1.46	1.00	0.76	0.62	0.53	0.46	0.41	0.36
	USS 2	2.75	1.47	1.01	0.78	0.64	0.53	0.46	0.41	0.37
	USS 3	2.75	1.48	1.04	0.80	0.64	0.54	0.47	0.41	0.37
	USS 4	2.80	1.54	1.05	0.80	0.65	0.55	0.47	0.41	0.37
	USS 5	2.88	1.54	1.05	0.81	0.65	0.55	0.47	0.42	0.37

Ra226 ⁽³⁾	USS 1	0.18*	0.11*	0.11	0.10	0.09	0.08	0.07	0.06	0.06
	USS 2	0.28	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.07
	USS 3	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 4	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 5	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235 ⁽²⁾	USS 1	1.59*	0.96*	0.70*	0.57	0.47	0.39	0.34	0.30	0.27
	USS 2	1.89*	1.07*	0.78	0.55*	0.47	0.39	0.34	0.31	0.28
	USS 3	2.15*	1.15*	0.78	0.59	0.47	0.40	0.35	0.32	0.29
	USS 4	2.30*	1.15*	0.79	0.59	0.48	0.41	0.37	0.33	0.30
	USS 5	2.30*	1.17	0.79	0.59	0.50	0.43	0.38	0.34	0.31
Ac227	USS 1	0.18*	0.10*	0.10	0.08	0.08	0.08	0.08	0.07	0.07
	USS 2	0.21*	0.14	0.11	0.11	0.11*	0.10	0.09	0.09	0.09
	USS 3	0.28	0.18	0.14*	0.11*	0.13	0.13	0.09*	0.09*	0.09*
	USS 4	0.41*	0.22*	0.18*	0.14*	0.11*	0.11*	0.09*	0.09*	0.09*
	USS 5	0.48*	0.30*	0.18*	0.18*	0.14*	0.14*	0.14*	0.11*	0.11*
Th232	USS 1	0.15*	0.11*	0.09*	0.09	0.07	0.06	0.06	0.05	0.05
	USS 2	0.22*	0.15*	0.13	0.10	0.08	0.07	0.06	0.06	0.06
	USS 3	0.30*	0.20	0.14	0.08*	0.08	0.07	0.07	0.07	0.07
	USS 4	0.37*	0.21	0.11*	0.08*	0.09	0.09	0.09	0.09	0.09
	USS 5	0.42	0.20*	0.11*	0.11	0.11	0.09*	0.09*	0.09*	0.09*

Table 5A Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Required Depth of USS; Pre-Mixing Values—Limited Restricted Use (pCi/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclides (VE)									
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9	
U238 ⁽²⁾	USS 1	82	45*	32	24	20	17	15	13	12
	USS 2	83	46	32	25	20	17	15	13	12
	USS 3	83	46	33	25	20	17	15	13	12
	USS 4	83	47	33	25	20	17	15	13	12
	USS 5	85	47	33	25	21	18	15	13	12
U234 ⁽²⁾	USS 1	81	45	31	24	19	16	14	13	11
	USS 2	81	45	31	24	20	17	14	13	11
	USS 3	81	45	32	24	20	17	14	13	11
	USS 4	81	46	32	24	20	17	15	13	11
	USS 5	83	46	32	25	20	17	15	13	11*
Ra226 ⁽³⁾	USS 1	7	4	3	3	2	2	2	2	2
	USS 2	7	4	3	3	2	2	2	2	2
	USS 3	7	4	3	3	2	2	2	2	2
	USS 4	7	4	3	3	2	2	2	2	2
	USS 5	7	4	3	3	2	2	2	2	2
U235 ⁽²⁾	USS 1	62	32*	24*	19	16	13	11	10	9
	USS 2	67	37	25	20	16	13	12	10	9
	USS 3	67	37	26	20	16	14	12	11	10
	USS 4	67	37	26	20	16	14	12	11	10
	USS 5	68	37	26	20	17	14	13	11	10
Ac227	USS 1	9*	7*	6	5	5	5	5	4	4
	USS 2	14*	10	7	7	6	5	5	5	5
	USS 3	18	10	10	8	6	6	6	6	6
	USS 4	18	15	10	8	8	7*	7*	7*	7*
	USS 5	26	15	10	10	9*	8*	8*	7*	7*
Th232	USS 1	7*	5*	5*	4*	4	3	3	3	3
	USS 2	10*	7*	6*	5	4	3	3	3	3
	USS 3	14*	8*	7	5	4	4	4	4	4
	USS 4	17*	10	7	5	5	5	5	5	5
	USS 5	20*	10	7	6	6	6	6	5*	5*

Table 5B Allowed Incremental Derived Concentration Guideline Level of Individual Radionuclides in Soils; Required Depth of USS; Pre-Mixing Values—Limited Restricted Use (Bq/g)⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)	Feet of Vertical Extent of Residual Radionuclides (VE)									
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9	
U238 ⁽²⁾	USS 1	3.03	1.67	1.18	0.90	0.74	0.63	0.54	0.48	0.43
	USS 2	3.08	1.71	1.18	0.92	0.75	0.63	0.55	0.48	0.43
	USS 3	3.09	1.71	1.21	0.92	0.75	0.63	0.55	0.49	0.44
	USS 4	3.09	1.74	1.21	0.92	0.75	0.64	0.56	0.49	0.44
	USS 5	3.14	1.74	1.21	0.93	0.77	0.65	0.56	0.50	0.44
U234 ⁽²⁾	USS 1	2.98	1.66	1.15	0.88	0.72	0.61	0.53	0.47	0.42
	USS 2	2.98	1.66	1.15	0.89	0.73	0.61	0.53	0.47	0.42
	USS 3	2.98	1.66	1.17	0.90	0.73	0.62	0.54	0.47	0.42
	USS 4	2.98	1.70	1.18	0.90	0.74	0.62	0.54	0.47	0.42
	USS 5	3.05	1.70	1.18	0.91	0.74	0.63	0.54	0.48	0.43
Ra226 ⁽³⁾	USS 1	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08

	USS 2	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 3	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 4	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
	USS 5	0.28	0.13	0.11	0.10	0.09	0.09	0.08	0.08	0.08
U235 ⁽²⁾	USS 1	2.30	1.18*	0.89*	0.70	0.59	0.49	0.42	0.38	0.34
	USS 2	2.47	1.36	0.94	0.73	0.59	0.49	0.43	0.39	0.35
	USS 3	2.48	1.36	0.95	0.73	0.59	0.50	0.44	0.40	0.36
	USS 4	2.49	1.38	0.95	0.73	0.60	0.52	0.45	0.41	0.37
	USS 5	2.51	1.38	0.95	0.74	0.62	0.53	0.47	0.42	0.37
Ac227	USS 1	0.33	0.26*	0.24	0.18	0.18	0.18	0.17	0.17	0.17
	USS 2	0.52*	0.36	0.24	0.24	0.23	0.20	0.19	0.19	0.19
	USS 3	0.66	0.36	0.36	0.29	0.23	0.23	0.23	0.23	0.23
	USS 4	0.66	0.54	0.37	0.29	0.28	0.26*	0.26*	0.26*	0.26*
	USS 5	0.97	0.54	0.37	0.36	0.33*	0.28*	0.28*	0.26*	0.26*
Th232	USS 1	0.26*	0.18*	0.18*	0.15*	0.15	0.13	0.11	0.10	0.10
	USS 2	0.37*	0.26*	0.22*	0.19	0.15	0.13	0.12	0.12	0.12
	USS 3	0.52*	0.30*	0.26	0.19	0.15	0.14	0.14	0.14	0.14
	USS 4	0.63*	0.39	0.26	0.19	0.17	0.17	0.17	0.17	0.17
	USS 5	0.74*	0.39	0.26	0.22	0.22	0.22	0.22	0.17	0.17

⁽¹⁾ The allowed Incremental Concentrations are added to the natural background radionuclide concentration to obtain the absolute value of the allowed radionuclide concentration before mixing.

⁽²⁾ These allowable concentrations may however, further be limited by the chemical toxicity of uranium. Applicants should inquire with NJDEP's Site Remediation Program for the additional applicable chemical cleanup standards for uranium.

⁽³⁾ When more than one nuclide is present, use the Radium-226 Table in Appendix B, incorporated herein by reference, for applying the sum of the fractions rule. Then use whatever number is more restrictive for radium-226, the value in Tables 4A through 5B or the value derived using the sum of the fractions rule.

* Values were back-calculated to ensure 15 mrem/yr TEDE after mixing.

2. After it is established that the concentrations in Table 4A, 4B, 5A, or 5B above are met, the layer of residual radionuclides shall be mixed thoroughly with the layer of uncontaminated surface soil to achieve a uniform concentration, as outlined in Chapter 12 of the Department's Field Sampling Procedures Manual, throughout the soil column;

3. Where more than one radionuclide contaminant is present at the site, their concentrations meet the sum of the fractions as described below:

$$\text{Sum of } \frac{CA_i}{C_i} \leq 1$$

where:

CA_i = the incremental concentration of radionuclide i at the site, and

C_i = the incremental allowed concentration of radionuclide i from Table 4A, 4B, 5A, or 5B above, if it were the only remaining radionuclide at the site; and

4. The requirements in (a)3 above shall be met.

7:28-12.10 Petition for alternative remediation standards for radioactive contamination

(a) In lieu of using the minimum remediation standards for radioactive contamination of soil found at N.J.A.C. 7:28-12.9, a person may petition the Department for an alternative soil standard for radioactive contamination. Such an alternate soil cleanup standard:

1. Shall not result in incremental doses, for sum of annual external radiation dose and intake dose, exceeding 15 mrem/yr (0.15 mSv/yr) total effective dose equivalent;

2. Shall not result in incremental concentrations exceeding three pCi/L (111 Bq/m³) of radon in indoor air in the lowest level of the building; and

3. Shall not result in radionuclide in groundwater levels exceeding those in the New Jersey Groundwater Quality Standards in N.J.A.C. 7:9C.

(b) The Department shall not consider a petition for an alternative soil standard for radionuclides that is supported by increasing, in any manner, the allowed incremental background dose value of 15 mrem/yr (0.15 mSv/yr) or the allowed incremental radon in air concentration of three pCi/L (111 Bq/m³), or varying the parameters listed in Tables 6 or 7 below.

Table 6

Parameter	Limited or	
	Unrestricted	Restricted
Indoor onsite breathing rate(m ³ /hr)	0.63	1.4
Outdoor onsite breathing rate(m ³ /hr)	1.40	1.4
Soil ingestion rate (g/yr)	70	12.5
Homegrown crop ingestion rate(g/yr)	17,136	0
Drinking water consumption rate(l/yr)	700	700
Shielding factor through basement or slab	0.20	0.20
Shielding factor through wall	0.80	0.80
Shielding factor outside	1.00	1.00

Table 7 Soil to Vegetation Transfer Factors

Element	pCi/g plant (wet) to pCi/g soil (dry)
Th	1E-3
Ra	4E-2
Pb	1E-2
Po	1E-3
U	2.5E-3
Ac	2.5E-3

Pa	1E-2
Bi	1E-1

outdoor occupancy times will result in substantially different soil standards than those in N.J.A.C. 7:28-12.9.

(c) The Department shall consider petitions only in cases where site-specific or waste specific factors, and/or site design features are used in performing the dose assessment, which are different than those used by the Department in establishing the soil concentrations in N.J.A.C. 7:28-12.9. Factors which the Department shall consider in a petition for an alternate soil standard include, but are not limited to:

1. The chemical or physical state of the radioactive material;
2. Site-specific soil characteristics, depth to groundwater and other geological and hydrogeological characteristics which may substantially change the potential dose from radionuclides, as compared to the values listed in Tables 8 and 9 below.

Table 8 Generic Site Input Parameters for Groundwater Pathway Analysis

Dimensions of contaminated zone, LxW (m)	100 x 100
Percolation rate (vertical Darcy velocity, m/yr)	0.5
Volumetric water content in contaminated zone (m ³ /m ³)	0.35
Volumetric water content in unsaturated zone (m ³ /m ³)	0.2
Bulk density of contaminated zone (g/m ³)	1.6
Bulk density of saturated zone (g/m ³)	1.6
Unsaturated zone thickness (distance from bottom of source to aquifer, m)	0.5
Porosity of aquifer	0.45
Longitudinal dispersivity in aquifer (m)	9
Transverse dispersivity in aquifer (m)	4
Pore velocity in aquifer (m/yr)	4
Well screen thickness (mixing depth, m)	10

Table 9 Sorption Coefficients used for Groundwater Pathway Analysis

<u>Isotopes</u>	<u>Kd (mg/L)</u>
uranium	35
thorium	3,200
radium	500
lead	270
proactinium	550
actinium	450

3. Use of caps, covers, sealants, geotextile membranes, limits on the vertical extent of radioactive contamination remaining on site and/or other engineering or institutional controls that reduce potential exposures to radioactive materials; and

4. Changes in indoor and outdoor occupancy times, which are justified by land uses other than residential or commercial.

(d) A petition for an alternate soil standard shall include an analysis demonstrating how and why the difference in factors such as those in Tables 8 and 9 above and/or indoor and

(e) Regardless of the factors used by the petitioner, the Department shall not approve alternative standard petitions that include institutional and engineering controls where failure of those controls, not including the failure of a radon remediation system, would result in more than 100 mrem (one mSv) total annual effective dose equivalent.

(f) In the event the Department determines that sufficient evidence exists to support consideration of an alternative soil standard, the petitioner shall submit a written analysis which demonstrates compliance with the dose limits in N.J.A.C. 7:28-12.9 including:

1. The remedial action informational requirements of N.J.A.C. 7:26E-6; and

2. A dose assessment analysis, including:

i. An estimate of the radiation doses received by a post-remediation on-site resident for an unrestricted use remedial action, or by a resident or an employee (of a proposed commercial use facility) for a limited restricted use remedial action;

ii. A presentation of all equations or other mathematical techniques used, either directly or embodied in a computer model, to predict the movement of radionuclides and/or their resulting radiation dose;

iii. Groundwater radionuclide concentration calculations which shall be extended for a period of 1,000 years;

iv. A presentation of all numerical input parameters to equations or computer models, the range of values for those parameters, including reference sources, the value selected for use and the basis for that selection;

v. A presentation of other relevant factors and assumptions used in the analyses, such as site-specific geology, land use, etc.;

vi. An analysis of which input parameters, when varied, would most significantly affect radiation dose results, commonly referred to as a sensitivity analysis; and

vii. An analysis of both continued use of existing structures and future use scenarios. Future use scenarios shall include, if applicable, the construction of buildings for either unrestricted use remedial actions or limited restricted use remedial actions, including excavations for basements and/or footings.

(g) Engineering controls or institutional controls may be incorporated as part of a petition for an alternative remediation standard provided that these controls will be durable and implemented for an appropriate period of time to achieve their intended purpose.

(h) Computer models acceptable to the Department may be used by the petitioner for an alternative soil standard to confirm that the requirements of N.J.A.C. 7:28-12.9 have been and will continue to be met.

Administrative correction.
See: 37 N.J.R. 4245(a).

7:28-12.11 Requirements pertaining to engineering or institutional controls

(a) All remediation proposals shall designate the intended use(s) of the property. Such intended use(s) shall be restricted as necessary to prevent future exposure, and shall otherwise be consistent with current and projected State and local zoning designations or land uses. For sites not remediated to the unrestricted use standards in N.J.A.C. 7:28-12.9, the Department shall define the nature and duration of all appropriate engineering or institutional controls necessary to meet the standards in N.J.A.C. 7:28-12.9 or 12.10(a), based upon the particular conditions of the site.

(b) In order for any remediation under this subchapter requiring engineering controls or institutional controls to meet the standards in N.J.A.C. 7:28-12.9 or 12.10(a), the person responsible for conducting the remediation shall, in addition to meeting the provisions of N.J.S.A. 58:10B-13:

1. Implement all necessary actions, as determined by the Department, to assure that such engineering or institutional controls are being implemented and maintained for an appropriate period of time; and
2. Provide for the costs of implementing and maintaining the requisite active engineered or institutional controls for an appropriate period of time.

7:28-12.12 Requirements pertaining to a change in land use

(a) Any subsequent proposed use of a property that is different from the intended use (other than unrestricted use remedial actions) described in the original remediation proposal shall require a prior review and prior approval by the Department. To initiate this review, 90 calendar days prior to a proposed change in land use, the person proposing such use shall prepare and submit to the Department, at the Bureau of

Environmental Radiation, PO Box 415, Trenton, NJ 08625-0415, and to each affected municipality, a brief written description of the new proposed use as compared to the intended use upon which the original remediation was based including all planned soil excavations, and any additional remedial actions to be implemented.

(b) If the Department determines that the proposed new use may cause the dose limitations of N.J.A.C. 7:28-12.8 to be exceeded, the person requesting the use change shall be required to prepare and submit to the Department's Bureau of Environmental Radiation, PO Box 415, Trenton, NJ 08625-0415, a dose assessment analysis, containing the information required under N.J.A.C. 7:28-12.10(f)2, (g), and (h), to ascertain whether the dose limitation requirements of N.J.A.C. 7:28-12.8 will be met for the proposed new use.

(c) In preparing the dose assessment analysis, the person may incorporate into the new use plan new remedial measures such as different radionuclide in soil concentrations, or radioactive contamination vertical extents, and/or new engineering or institutional controls, provided that for engineering or institutional controls, the person responsible for conducting the remediation provides for the cost of implementing and maintaining them as specified in N.J.A.C. 7:28-12.11(c)3.

7:28-12.13 Requirements pertaining to the final status survey

The final status survey is performed to demonstrate that a site meets the remediation standards. It shall be done in accordance with that version of the Department of Environmental Protection's Field Sampling Manual's section on Radiological Assessment, which is incorporated herein by reference, in effect at the time of the survey which may be obtained by calling the Bureau of Environmental Radiation at (609) 984-5400 or from the Radiation Protection Program's web site at <http://www.state.nj.us/dep/rpp/index.htm>. Chapter 12 of the Department's Field Sampling Procedures Manual follows the methodology provided in MARSSIM with some modifications.

APPENDIX A

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Nuclide	Feet of Vertical Extent of Residual Radionuclides (VE)								
	VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Ra226									
Unrestricted Use Standards	3	2	2	2	2	2	2	2	2
Ra226									
Limited Restricted									

Use Standards	5	5	5	5	5	5	5	4	4
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Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
Ra226		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Restricted Use Standards	USS 1	22	15	10	8	6	5	5	4	4
	USS 2	28	15	10	8	6	5	5	5	5
	USS 3	28	15	10	8	6	6	6	6	6
	USS 4	28	15	10	8	7	7	7	7	7
	USS 5	28	15	10	9	9	9	9	9	9

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Nuclide		Feet of Vertical Extent of Residual Radionuclides (VE)								
Ra226		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Unrestricted Use Standards		0.13	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08
Limited Restricted Use Standards		0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.15	0.15

Allowed Incremental Derived Concentration Guideline Levels (Bq/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
Ra226		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Restricted Use Standards	USS 1	0.81	0.55	0.37	0.30	0.22	0.18	0.18	0.15	0.15
	USS 2	1.04	0.56	0.37	0.30	0.22	0.18	0.18	0.18	0.18
	USS 3	1.04	0.56	0.37	0.30	0.22	0.22	0.22	0.22	0.22
	USS 4	1.04	0.56	0.37	0.30	0.23	0.23	0.26	0.26	0.26
	USS 5	1.04	0.56	0.37	0.33	0.33	0.33	0.33	0.33	0.33

(1) These Ra226 concentration numbers may be used only when more than one radionuclide is present for the sum of the fractions rule at N.J.A.C. 7:28-12.9(b).

APPENDIX B

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
Ra226		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Unrestricted Use	USS 1	5*	3*	3	3	3	3	2	2	2
Pre-mixing Values	USS 2	7*	4*	4*	3*	3	3	2	2	2
	USS 3	7	5*	4*	4	3	3	3	3	3
	USS 4	11	7*	5*	4	3	3	3	3	3
	USS 5	13*	8	6	4	4	4	4	4	4
Limited Restricted Use	USS 1	11*	8*	7*	7*	6*	6*	5*	5*	5*
	USS 2	16*	11*	9*	8*	7*	6*	6*	5*	5*
	USS 3	21*	13*	10*	9*	7*	6*	6*	6*	6*
	USS 4	26*	16*	12*	9*	8*	7*	7*	6*	6*
	USS 5	31*	18*	11*	10*	9*	8*	7*	7*	7*

*Back calculated to ensure 15 mrem/yr TEDE after mixing

Allowed Incremental Derived Concentration Guideline Levels (pCi/g) for the Gamma and Intake Pathways⁽¹⁾

Feet of Uncontaminated Surface Soil (USS)		Feet of Vertical Extent of Residual Radionuclides (VE)								
Ra226		VE1	VE2	VE3	VE4	VE5	VE6	VE7	VE8	VE9
Unrestricted	USS 1	0.18*	0.12*	0.12*	0.12*	0.12	0.10	0.09	0.08	0.08

Use	USS 2	0.25*	0.15*	0.15*	0.15*	0.12*	0.11	0.09	0.09	0.09
Pre-mixing	USS 3	0.25*	0.18*	0.17*	0.17	0.14	0.11	0.11	0.11	0.11
Values	USS 4	0.40*	0.25*	0.18*	0.17	0.13	0.13	0.13	0.13	0.13
	USS 5	0.48*	0.32	0.22	0.16	0.16	0.16	0.16	0.16	0.16
Ra226										
Limited	USS 1	0.40*	0.30*	0.26*	0.26*	0.22*	0.22*	0.18*	0.18*	0.18*
Restricted	USS 2	0.59*	0.40*	0.33*	0.30*	0.26*	0.22*	0.22*	0.18*	0.18*
Use	USS 3	0.77*	0.48*	0.37*	0.33*	0.26*	0.22*	0.22*	0.22*	0.22*
Pre-mixing	USS 4	0.96*	0.59*	0.44*	0.33*	0.30*	0.26*	0.26*	0.22*	0.22*
Values	USS 5	1.15*	0.67*	0.41*	0.37*	0.33*	0.30*	0.26*	0.26*	0.26*

* Back-calculated to ensure 15 mrem/yr TEDE after mixing

(1) These Ra226 concentration numbers may be used only when more than one radionuclide is present for the sum of the fractions rule at N.J.A.C. 7:28-12.9(b).

SUBCHAPTER 13. REPORTS OF THEFTS AND RADIATION INCIDENTS

7:28-13.1 Reports of theft or loss

A State licensee, radioactive materials registrant or registrant shall immediately notify the Department by telephone, telefax or telegraph of any theft or loss of any source of radiation including machine sources and any naturally occurring or accelerator produced radioactive material, including TENORM, in such quantities and under such circumstances that a substantial radiation hazard and/or contamination hazard may result.

Amended by R.2005 d.156, effective May 16, 2005.
See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote the section.

7:28-13.2 Reportable radiation incidents

(a) A State licensee, radioactive materials registrant or registrant shall immediately notify the Department by telephone, telefax or telegraph of any radiation incident which may have caused or threatens to cause the following:

1. Exposure of the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual to 150 rems or more of radiation; or exposure of the feet, ankles, hands or forearms of any individual to 375 rems or more of radiation;
2. The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in N.J.A.C. 7:28-11 Appendix, Table 1, or prorated values if more than one isotope is released;
3. A loss of one working week or more of the operation of any facilities affected; or
4. Damage to property in excess of \$100,000.

(b) The names of any individuals who have been exposed to radiation levels set forth in subsection (a) of this Section shall not be included in the report.

(c) A State licensee, radioactive materials registrant or registrant shall notify the Department within 24 hours by telephone, telefax or telegraph of any radiation incident which may have caused or threatens to cause the following:

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

2. The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limit specified for such materials in N.J.A.C. 7:28-11 Appendix, Table 1, or prorated values if more than one isotope is released;

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

4. Damage to property in excess of \$1,000.

(d) The names of any individuals who have been exposed to radiation levels set forth in subsection (c) of this Section shall not be included in the report.

(e) A State licensee, radioactive materials registrant or registrant shall notify the Department in writing within 30 days of the following:

1. Each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit of N.J.A.C. 7:28-6, or of a State licensee's license;
2. Any incident for which notification is required by subsections (a) and (c) of this Section; or
3. Levels of radiation or concentrations of radioactivity, not involving exposure of any individual in excess of any applicable limit of N.J.A.C. 7:28-6 outside a controlled area in excess of 10 times the limits of N.J.A.C. 7:28-6.2 and 11 or of a State licensee's license.

(f) The reports set forth in subsection (e) of this Section shall describe the extent of exposure of individuals to radiation or to radioactive materials, the levels of radiation and concentrations of radioactive materials involved, the cause of the exposure, levels, or concentrations and corrective steps taken or planned to assure against a recurrence.

(g) In each case where (e)1 above requires a report to the Department of exposure of an individual, the owner shall:

1. Delete from the report all references to the names and addresses of individuals so exposed. The identity of such individuals shall be privileged and shall be submitted as a separate document of such report; and

2. Concurrently give written notification to the individual of the nature and extent of the exposure. Such notice shall contain the following statement: "This report is furnished to you under the provisions of Subchapter 13 (Reports of Thefts and Radiation Incidents) of the New Jersey Administrative Code. You should preserve this report for future reference."

Amended by R.2005 d.156, effective May 16, 2005.

See: 36 N.J.R. 2336(a), 37 N.J.R. 1826(a).

Rewrote (a), (c), and (e).

Amended by R.2005 d.239, effective July 18, 2005.

See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

In (g), substituted "above" for "of this section" in the introductory paragraph, and substituted "give" for "given" in 2.

SUBCHAPTER 14. THERAPEUTIC INSTALLATIONS

7:28-14.1 Scope

(a) This subchapter covers therapeutic installations used in the healing arts. These therapeutic installations include x-ray, accelerator and teletherapy installations. No registrant shall operate or permit the operation of therapeutic equipment used in the healing arts unless the equipment and installation meet the applicable requirements of this subchapter.

7:28-14.2 Definitions

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

"Applicator" means a structure which determines the extent of the treatment field at a given distance from the virtual source and which may or may not incorporate the beam limiting device.

"Beam interceptor" means a device located on the central axis of the primary beam whose purpose is to substantially attenuate the beam so that the room shielding requirements may be reduced.

"Beam limiting device" means a device which provides a means to restrict the dimensions of the radiation field and which is an integral part of the equipment.

"Beam monitoring system" means a system designed to detect and measure the radiation present in the useful beam.

"Beam scattering filter" means a filter used to scatter a beam of electrons.

"Central axis of the beam" means a line passing through the virtual source and the center of the plane figure formed by the edge of the final beam limiting device.

"Contact therapy system" means an x-ray system used for therapy not capable of operating above 60 kVp and with a source distance less than or equal to five centimeters.

"Department" means the New Jersey Department of Environmental Protection.

"Dose monitoring system" means a system of devices for the detection, measurement, and display of dose information for the useful beam.

"Dose monitor unit" means a unit response from the dose monitoring system from which the absorbed dose can be calculated.

"Field flattening filter" means a filter used to provide dose uniformity over the area of a useful beam of x-rays at a specified depth.

"Field size" means the projection on a plane perpendicular to the beam axis, of the distal end of the collimator as seen from the front center of the source.

"Full beam detector" means a radiation detector of such size that the total cross section of the maximum-size useful beam is intercepted.

"Gantry" means that part of the system supporting and allowing possible movements of the radiation head.

"Interlock" means a device arranged or connected such that the occurrence of an event or condition is required before a second event or condition can occur or continue to occur.

"Interruption of irradiation" means the stopping of irradiation with the possibility of continuing irradiation without resetting of operating conditions at the control panel.

"Isocenter" means a fixed point in space located at the center of the smallest sphere through which the central axis of the beam pass.

"Leakage radiation" means radiation emanating from the diagnostic or therapeutic source assembly except for the useful beam.

"Moving beam therapy" means radiation therapy with relative movement of the useful beam and the patient during irradiation.

"Normal treatment distance" means:

1. The x-ray field in the plane of the image receptor shall not exceed each dimension of the image receptor by more than two percent of the source-to-image distance, when the axis of the x-ray beam is perpendicular to the plane of the image receptor. In addition, the center of the x-ray field shall be aligned with the center of the image receptor to within two percent of the SID, or there shall be a device provided to both size and align the x-ray field such that the x-ray field at the plane of the image receptor does not extend beyond any edge of the image receptor.

2. The x-ray unit used for cephalometric radiographs shall meet all the requirements of this subchapter with the exception of N.J.A.C. 7:28-16.3(a)3 and 7:28-16.6.

7:28-16.6 Panoramic radiographic installations

(a) No person shall use any panoramic radiographic unit or cause it to be used unless the following requirements are met:

1. The x-ray field in the plane of the image receptor shall not exceed each dimension of the image receptor by more than two percent of the SID, when the axis of the x-ray beam is perpendicular to the plane of the image receptor. In addition, the center of the x-ray field shall be aligned with the center of the image receptor to within two percent of the SID or there shall be a device provided to both size and align the x-ray field such that the x-ray field at the plane of the image receptor does not extend beyond any edge of the image receptor.

2. These units shall meet all the requirements of this subchapter with the exception of N.J.A.C. 7:28-16.3(a)3 and 7:28-16.5.

7:28-16.7 Structural shielding

(a) No person shall operate or permit the operation of x-ray equipment used in the practice of dentistry unless the following requirements are met:

1. Permanent structural shielding and protective barriers shall be used to ensure that no person other than the patient being x-rayed receives a radiation dose in excess of two milliroentgens in any one hour.

2. When dental x-ray units are installed in adjacent areas of the same room, such units shall not be used simultaneously unless protective barriers are provided and used in the area between the units when necessary to comply with the radiation exposure limits in N.J.A.C. 7:28-6.

7:28-16.8 Radiation safety surveys

(a) No person shall operate or permit the operation of x-ray equipment used for dental radiography unless the installation meets the following requirements:

1. The registrant of a dental ionizing radiation-producing machine shall ensure that a qualified individual

performs or supervises the performance of a radiation safety survey of the environs and submits a copy of the radiation safety survey report to the Department within 60 days of the date the machine is acquired. The registrant shall maintain the original survey report for as long as the machine is registered plus one year and shall make the original survey report available for review by the Department during any inspection;

2. The registrant of a dental ionizing radiation-producing machine shall ensure that a qualified individual performs or supervises the performance of a radiation safety survey of the environs when changes have been made to shielding, equipment, or equipment location which affect the radiation levels of the environs. A copy of the survey report shall be submitted to the Department within 60 days of the date of such change. The registrant shall maintain the original survey report for as long as the machine is registered plus one year and shall make the original survey report available for review by the Department during any inspection; and

3. The minimum requirements for the information to be included in the radiation safety survey report are as follows:

i. The name of the registrant of the installation as it appears on form VRH-001, address, telephone number, and room location of the unit;

ii. The New Jersey Registration Number, if available;

iii. The manufacturer, model number, generator serial number, control panel serial number, tube manufacturer, tube serial number, and tube housing number;

iv. The name and address of the qualified individual performing the survey;

v. The date of survey;

vi. The survey instrument manufacturer, model number, and date calibrated;

vii. A diagram or floor plan of the area indicating the x-ray tube location, exposure switch location, normal operator position, lead shielding if present, wall, floor, and ceiling construction, labeling of all areas adjacent to the exposure room including those above and below, and labeling of all areas as to occupancy and use;

viii. Records of the measurement of radiation exposure with a suitable phantom in the average patient position. Measurements shall be taken at the operator's position and at all nearby locations which are normally occupied. For each measurement, the kVp, mA, exposure time, instrument reading, and correction made to the instrument reading (such as energy response, calibration, etc.) shall be recorded; and

ix. Exposure rates at each measured location shall be converted into Coulombs/kilogram/week or mR/week. Records shall include all assumptions of workload, use and occupancy factors used in the calculations.

Repeal and New Rule, R.1993 d.510, effective October 18, 1993.
See: 25 N.J.R. 7(a), 25 N.J.R. 1039(a), 25 N.J.R. 4770(a).

7:28-16.9 Operating criteria

(a) No person shall operate a dental ionizing radiation-producing machine in such a manner as to expose human beings unless such person is a licensed practitioner or holds a valid license issued by the Department pursuant to N.J.A.C. 7:28-19 and the Radiologic Technologist Act, N.J.S.A. 26:2D-24 through 36.

(b) A person shall operate a dental ionizing radiation-producing machine in a manner consistent with the scope of practice defined on that person's license issued by the Department pursuant to N.J.A.C. 7:28-19.

7:28-16.10 Operating procedures

(a) All persons who operate or permit the operation of dental radiographic equipment shall comply with following operating procedures:

1. No individual other than the patient being x-rayed shall be in the path of the useful beam;
2. During each exposure the operator shall stand at least 1.83 meters (six feet) from the patient or behind a protective barrier;
3. The film shall not be held by the dentist, the operator, or the assistant during any radiographic exposure;
4. The diagnostic type protective tube housing and the cone shall not be hand held during exposures;
5. Fluoroscopy shall not be used in dental examinations; and
6. The registrant shall provide personnel monitoring equipment to and require that it be worn by each individual who enters a controlled area and receives or is likely to receive a dose in excess of 25 millirems in any period of seven consecutive days.
 - i. Each personnel monitoring device shall be assigned to and worn by only one person.
 - ii. Records of radiation exposure derived from the personnel monitoring device shall be kept in accordance with the requirements of N.J.A.C. 7:28-8.

iii. The registrant shall keep the personnel monitoring records at the facility. These records shall be kept in accordance with the requirements of N.J.A.C. 7:28-8. These records or true copy of same shall be produced for review by the Department during an inspection, and shall be submitted to the Department upon request.

iv. The personnel monitoring records shall be available to the employees.

SUBCHAPTER 17. INDUSTRIAL AND NONMEDICAL RADIOGRAPHY

7:28-17.1 Scope

(a) This subchapter establishes radiation-safety requirements for persons utilizing sealed sources, radiographic-exposure devices or ionizing radiation-producing machines for industrial and nonmedical radiography.

(b) The requirements of this subchapter are in addition to the requirements of N.J.A.C. 7:28-1 through 7:28-13.

(c) This Subchapter does not apply to radiography in any of the healing arts.

(d) The provisions of N.J.A.C. 7:28-17.4(e), 17.6(c) and 17.6(d)1 do not apply to the use of portable x-ray bomb detection equipment.

Amended by R.1985 d.502, effective October 7, 1985.
See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

Language change.
Amended by R.2004 d.44, effective January 20, 2004.
See: 35 N.J.R. 2008(a), 36 N.J.R. 445(a).

Added (d).

7:28-17.2 Definitions

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

"Cabinet x-ray system" means an ionizing radiation-producing machine with the x-ray tube installed in an enclosure which, independent of existing architectural structures except the floor on which it may be placed, is intended to contain at least that portion of a material being irradiated, provide radiation attenuation, and exclude personnel from its interior during generation of x-radiation, including but not limited to all x-ray systems designed primarily for the inspection of carry-on baggage at air, railroad, and bus terminals, and similar facilities, and all x-ray systems designed primarily for the inspection of letters, periodicals, and packages in mailrooms. An x-ray tube used within a shielded part of a building or x-ray equipment which may temporarily or occasionally incorporate portable shielding, is not considered a cabinet x-ray system.

"External surface" means the outside surface of the cabinet x-ray system, including the high-voltage generator, doors, access panels, latches, control knobs, and other permanently mounted hardware and including the plane across any aperture or port.

"Industrial radiography" means the examination of the macroscopic structure of materials by nondestructive methods using sources of radiation.

"Portable x-ray bomb detection equipment" means a portable x-ray system used exclusively for examining packages or devices suspected to contain explosive or incendiary materials or weapons of mass destruction.

"Shielded room radiography" means industrial radiography which is conducted in an enclosed room, the interior of which is not occupied during radiographic operations.

"Temporary job site" means any location where industrial radiography is performed other than the location(s) listed in a license or registration issued by the Department pursuant to N.J.A.C. 7:28-3 or 7:28-4.

New Rule, R.1985 d.502, effective October 7, 1985.

See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

"Registration and licensing requirements" recodified to 17.3.

Amended by R.2004 d.44, effective January 20, 2004.

See: 35 N.J.R. 2008(a), 36 N.J.R. 445(a).

Added "Portable x-ray bomb detection equipment".

7:28-17.3 Registration and licensing requirements

(a) All owners of ionizing radiation-producing machines shall comply with N.J.A.C. 7:28-3.

(b) All owners of sealed sources or radiographic-exposure devices shall comply with N.J.A.C. 7:28-3 and 7:28-4.

Amended by R.1985 d.502, effective October 7, 1985.

See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

Recodified from 17.2; "Equipment control" recodified to 17.4.

7:28-17.4 Equipment control

(a) The permissible levels of radiation from radiographic-exposure devices and storage containers shall be as follows:

1. Radiographic-exposure devices measuring less than four inches from the sealed source storage position to any external surface of the device shall not produce a radiation level in excess of 50 milliroentgens per hour at least six inches from any point on the external surface of the device.

2. Radiographic-exposure devices measuring a minimum of four inches from the sealed source storage position to any external surface of the device and all storage containers for sealed sources or for radiographic-exposure devices shall not produce radiation levels in excess of 200 milliroentgens per hour at any point on the external surface and 10 milliroentgens per hour at one meter from any point on the external surface.

3. The radiation levels specified in 1 and 2 above are with the sealed source in the shielded or "off" position.

(b) Each radiation-producing machine shall be provided with a lock designed to prevent unauthorized use of the equipment.

(c) Each radiographic-exposure device and each storage container shall be provided with a lock or outer locked container designed to prevent unauthorized or accidental removal of a sealed source or its change from a shielded to an unshielded position. All ionizing radiation-producing machines, radiographic-exposure devices and storage containers shall be kept locked at all times except when under the direct surveillance of a radiographer or of a radiographer's assistant or as provided in N.J.A.C. 7:28-17.6(a).

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

(e) The owner shall maintain calibrated and operable radiation-survey instruments to make radiation surveys as required by N.J.A.C. 7:28-17.6(d) and by N.J.A.C. 7:28-7. The requirements for the radiation-survey instruments are as follows:

1. Each radiation-survey instrument shall be calibrated at intervals not to exceed three months and the instrument shall be recalibrated after each servicing involving other than battery replacement. An operational check source test shall be performed on each radiation-survey instrument prior to its use.

2. Records shall be maintained of each date of calibration and the operational check source test results.

3. The instrumentation shall have a range such that two milliroentgens per hour through one roentgen per hour can be measured to a precision of plus or minus 20 per cent.

(f) The replacement of any sealed source fastened to or contained in a radiographic-exposure device and leak testing, repair, tagging, opening or any other modification of any sealed source shall be performed only by persons specifically authorized by the Department, a Federal agency or any Agreement state.

(g) Sealed sources are to be leak tested under the following conditions and requirements:

1. Each sealed source shall be tested for leakage at intervals not to exceed six months. In the absence of a certificate from a transferor that a test has been made within the six months prior to the transfer, the sealed source shall not be put into use until tested.

2. The leak test shall be capable of detecting the presence of 0.005 microcuries of removable contamination on the sealed source. A test made at the nearest accessi-

ble point to the sealed source storage position may be an acceptable leak test.

3. Leak tests shall be carried out only by individuals and by procedures both of which require prior approval by the Department. Approval will be based upon a description of the following:

- i. Instrumentation to be used;
- ii. Method of performing test including points on equipment to be tested; and
- iii. Pertinent experience of person who will perform the test.

4. Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Department.

(h) Requirements regarding any leaking sealed source shall be as follows:

1. Any test conducted pursuant to (g) above which reveals the presence of 0.005 microcuries or more of removable radioactive material shall be considered evidence that a sealed source is leaking.

2. The owner shall immediately withdraw any leaking sealed source above from use and shall cause it to be decontaminated and repaired in accordance with (f) or to be disposed of in accordance with N.J.A.C. 7:28-11.

3. Within five working days after obtaining results of the test performed pursuant to (g) above, a report shall be filed with the Department, describing the equipment involved, the test results, and the corrective action taken.

(i) A sealed source which is not fastened to or contained in a radiographic-exposure device shall have permanently attached to it a durable tag at least one inch square, bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger—Radioactive Material—Do Not Handle—Notify Civil Authorities if Found."

(j) Each owner shall conduct an ongoing inventory and keep a written record of each sealed source that is received, possessed, and used. This record shall include the date of receipt of each sealed source, the identity and quantity of the radioactive material contained within each sealed source, the date and to whom each sealed source is assigned and of the location at which each sealed source is to be used, the date that each sealed source is returned for storage at the owner's facility, the date that the source is returned for replacement, and the date of calibration.

(k) Each owner shall maintain current logs, which shall be kept available for inspection by the Department at the address specified in the license, showing for each radiation source the following information.

1. A description, or make and model number of the ionizing radiation-producing machine, or of the radiographic-exposure device or storage container in which the sealed source is located;

2. The identity of the radiographer to whom assigned; and

3. The plant or site where used and dates of use.

(l) Each owner conducting industrial radiography at a temporary job site shall make the following records available at the site for inspection by the Department:

1. A copy of the owner's current license to possess or use radioactive materials issued by the Department pursuant to N.J.A.C. 7:28-4.

2. A copy of the owner's current registration of a radioactive material or ionizing radiation-producing machine issued by the Department pursuant to N.J.A.C. 7:28-3;

3. A copy of the owner's current license to possess or use radioactive materials issued by the United States Nuclear Regulatory Commission;

4. A copy of the owner's operating and emergency procedures prepared pursuant to N.J.A.C. 7:28-17.5(d);

5. A copy of N.J.A.C. 7:28;

6. Survey records required pursuant to N.J.A.C. 7:28-17.6(d) for the period of the operation at the site;

7. Daily pocket dosimeter records for the period of operation at the site required to be made pursuant to N.J.A.C. 7:28-17.5(e)2;

8. A copy of the latest instrument calibration and the original log of daily instrument operational check source test results for the specific devices in use at the site required to be made pursuant to (e)1 and 2 above; and

9. A copy of the record of leak test results made pursuant to (g)4 above.

Amended by R.1985 d.502, effective October 7, 1985.

See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

Recodified from 17.3 with substantive changes.

Amended by R.2004 d.44, effective January 20, 2004.

See: 35 N.J.R. 2008(a), 36 N.J.R. 445(a).

Amended the N.J.A.C. references throughout.

7:28-17.5 Personal radiation safety requirements for radiographers

(a) The owner shall not permit any person to act as a radiographer until such person:

1. Has been instructed by a qualified individual in the subjects outlined in (b) below and has demonstrated an understanding of those subjects by passing a written examination given by a qualified individual;

2. Has received copies of and instruction in the applicable sections of this Chapter and the owner's operating and emergency procedures required pursuant to (d) below, and demonstrated an understanding of this Chapter and the procedures specified therein; and

3. Has demonstrated competence to use the ionizing radiation-producing machines, radiographic-exposure devices, sealed sources, related handling tools and survey instruments which will be employed in his assignment.

(b) The outline of the course for radiographer's training is as follows:

1. Fundamentals of radiation safety:

- i. Characteristics of gamma and x-radiation;
- ii. Units of radiation dose and quantity of radioactivity;
- iii. Hazards of excessive exposure to radiation;
- iv. Levels of radiation from ionizing radiation-producing machines and radioactive materials;
- v. Methods of controlling radiation dose:

- (1) Working time;
- (2) Working distances;
- (3) Shielding.

2. Radiation detection instrumentation to be used:

i. Use of ionizing radiation survey instruments:

- (1) Operation;
- (2) Calibration;
- (3) Limitations.

ii. Survey techniques;

iii. Use of personnel-monitoring equipment:

- (1) Film badges;
- (2) Pocket dosimeters;
- (3) Pocket chambers;

3. Radiographic equipment to be used:

- i. Ionizing radiation-producing machines;
- ii. Radiographic-exposure devices;
- iii. Storage containers;
- iv. Remote handling equipment.

4. The requirements of pertinent Federal and State regulations;

5. The owner's written operating and emergency procedures.

(c) The owner shall not permit any person to act as a radiographer's assistant until such person:

1. Has received copies of and instruction in the owner's operating and emergency procedures, required pursuant to (d) below, and has demonstrated an understanding of the procedures; and

2. Has demonstrated competence to use under the personal supervision of the radiographer the ionizing radiation-producing machines, radiographic-exposure devices, sealed sources, related handling tools and radiation-survey instruments which will be employed in his assignment; and

3. Has been instructed by a qualified individual in the subjects outlined in (b) above, and has demonstrated an understanding of those subjects by written examination given by a qualified individual.

(d) The owner shall prepare written operating and emergency procedures which shall include instructions in at least the following:

1. The handling and the use of ionizing radiation-producing machines, sealed sources and radiographic-exposure devices to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in N.J.A.C. 7:28-6;

2. Methods and occasions for conducting radiation surveys;

3. Methods for controlling access to radiographic areas;

4. Methods and occasions for locking and securing ionizing radiation-producing machines, radiographic-exposure devices, storage containers and sealed sources;

5. Personnel monitoring and the use of personnel-monitoring equipment;

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

7. Minimizing exposure of persons in the event of an accident;

8. The procedure for notifying proper persons in the event of an accident; and

9. Maintenance of records.

(e) The owner shall not permit any person to act as a radiographer or as a radiographer's assistant unless the owner has supplied to each such person and requires that each such person shall wear a film badge and either a pocket dosimeter or pocket chamber. The requirement for use of film badges, pocket dosimeters, and pocket chambers are as follows:

1. Pocket dosimeters and pocket chambers shall be capable of measuring doses from zero to at least 200 milliroentgens.
2. Pocket dosimeters and pocket chambers shall be read and doses recorded daily.
3. A film badge will be assigned to and worn by only one person.
4. A film badge shall be immediately processed if a pocket chamber or pocket dosimeter is discharged beyond its range.
5. The film badge reports received from the film badge processor and records of pocket dosimeter and pocket chamber readings shall be maintained for inspection by the Department.

Amended by R.1985 d.502, effective October 7, 1985.
See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).
Recodified from 17.4 with substantive changes.

7:28-17.6 Precautionary procedures in radiographic operations

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

1. Where the high radiation area is equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in one hour upon entry into the area, or shall energize a conspicuous visible and audible alarm signal in such a manner that the individual entering and the owner or the supervisor of the activity are made aware of the entry; or
2. Where the high radiation area is locked to protect against unauthorized or accidental entry.

(b) Notwithstanding any provisions in N.J.A.C. 7:28-10.8, areas in which radiography is being performed shall be conspicuously posted as required by N.J.A.C. 7:28-10.2 and 7:28-10.3.

(c) No radiographic operation shall be conducted unless calibrated and operable ionizing radiation-survey instrumentation as described in N.J.A.C. 7:28-17.4(e) is available and used at each site where radiographic exposures are made.

(d) In addition to the requirements of N.J.A.C. 7:28-7, no radiographic operation shall be conducted unless the owner ensures that radiation surveys are made and recorded as follows:

1. Physical radiation surveys shall be made as necessary during radiographic exposures to determine compliance with N.J.A.C. 7:28-6.

2. A physical radiation survey shall be made after each radiographic exposure employing a sealed source to determine that the sealed source has been returned to its shielded condition.

3. After radiographic operations employing a sealed source or sources have been completed, a physical radiation survey shall be made to determine that each sealed source is in its shielded condition prior to securing the radiographic-exposure device and storage container as specified in N.J.A.C. 7:28-17.4(a) and (c).

4. Clear and legible records shall be kept of the surveys that are required by (d)1 and 3 above and maintained for inspection by the Department.

Amended by R.1985 d.502, effective October 7, 1985.
See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).
Recodified from 17.5 with substantive changes.
Amended by R.2004 d.44, effective January 20, 2004.
See: 35 N.J.R. 2008(a), 36 N.J.R. 445(a).
Inserted new (d).

7:28-17.7 Cabinet x-rays systems

(a) No person shall operate or permit the operation of a cabinet x-ray system unless such system meets the requirement of N.J.A.C. 7:28-17.1, 7:28-17.2, 7:28-17.3, and 7:28-17.7.

(b) No person shall operate or permit any other person to operate a cabinet x-ray system until the operator has received a copy of the operator's manual, has been trained in the operating procedures for the system, and has demonstrated competence in operating the system. The owner shall maintain a copy of the operator's manual in the proximity of the system.

(c) Each owner shall supply appropriate personnel monitoring equipment to and shall require that it be used by every individual who operates, makes "set-ups", or performs maintenance on a cabinet radiography unit.

(d) Radiation emitted from the cabinet x-ray system shall not exceed an exposure of 0.5 milliroentgen in one hour at any point five centimeters outside the external surface.

(e) No cabinet x-ray system shall be placed into operation until a radiation survey is made by a qualified individual demonstrating that the exposure level in (d) above is not exceeded. Where an operating system is subsequently modified, repaired or moved to a new location, an additional survey shall be performed and operation shall not resume until a survey demonstrates compliance with this limit. The owner shall perform such additional surveys as required by the Department or as determined by a qualified individual. The owner shall maintain a record of all surveys performed and shall make such records available to the Department for inspection.

(f) Safety interlocks shall be provided on cabinet x-ray systems as follows:

1. Each door of a cabinet x-ray system shall have a minimum of two safety interlocks installed in such a manner that the opening of any door would disconnect the energy supply circuit to the high-voltage generator.

2. Each access panel on a cabinet x-ray system shall have at least one safety interlock.

3. Following interruption of x-ray generation by the functioning of any safety interlock, a manually reset control button shall be activated before x-ray generation can resume.

4. Failure of any single component of the cabinet x-ray system shall not cause failure of more than one required safety interlock.

5. Safety interlocks shall be tested for operation at intervals not to exceed six months. A record of these tests shall be maintained for inspection by the Department.

(g) A cabinet x-ray system shall have a permanent floor. Any support surface to which a cabinet x-ray system is permanently affixed may be deemed the floor of the system.

(h) Warning labels shall be provided on cabinet x-ray systems and shall meet the following requirements:

1. There shall be permanently affixed or inscribed on the cabinet x-ray system at the location of any controls which can be used to initiate x-ray generation a clearly legible and visible label bearing the statement or words having a similar meaning: "CAUTION: X-RAYS PRODUCED WHEN ENERGIZED"; and

2. There shall be permanently affixed or inscribed on the cabinet x-ray system adjacent to each port a clearly legible and visible label bearing the statement or words having a similar meaning: "CAUTION: DO NOT INSERT ANY PART OF THE BODY WHEN SYSTEM IS ENERGIZED: X-RAY HAZARD".

(i) All cabinet x-ray systems shall be provided with the following controls and indicators:

1. A key-actuated control to insure that x-ray generation is not possible with the key removed;

2. A control button or control switch to initiate and terminate the generation of x-rays other than by the functioning of a safety interlock or the main power control;

3. A warning light at the control button or control switch that indicates when and only when x-rays are being generated. This light shall be clearly labeled with the words: "X-RAY ON";

4. A warning light which indicates when and only when x-rays are being generated. This warning light shall be visible from each door, access panel, and port and shall be clearly labeled with words: "X-RAY ON".

5. A meter which indicates the kilovoltage and current during the generation of x-rays at each x-ray control button or control switch unless the x-ray tube current is preset.

(j) Cabinet x-ray systems designed primarily for the inspection of carry-on baggage at airline, railroad, and bus terminals, and similar facilities, shall be provided with means to insure that an operator is present at the control area in a position which permits surveillance of the ports and doors during the generation of x-radiation as follows:

1. During an exposure or preset succession of exposures of one-half second or greater duration, the system shall contain a mechanism to enable the operator to terminate the exposure or preset succession of exposures at any time.

2. During an exposure or preset succession of exposures of less than one-half second duration, there shall be a mechanism provided to allow completion of the exposure in progress but shall enable the operator to prevent additional exposures.

New Rule, R.1985 d.502, effective October 7, 1985.

See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

Amended by R.2005 d.239, effective July 18, 2005.

See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

7:28-17.8 Shielded room radiography

(a) No person shall operate or permit the operation of any ionizing radiation-producing machine, radiographic-exposure device, or sealed source used in shielded room radiography unless the equipment, installation, and personnel meet the requirements of N.J.A.C. 7:28-17.1 through 7:28-17.6 and 7:28-17.8.

(b) No person shall operate or permit any person to operate an ionizing radiation-producing machine, radiographic-exposure device, or sealed source used in shielded room radiography until such operator has completed the following requirements:

1. The operator has met the requirements of N.J.A.C. 7:28-17.5;

2. The operator has received a copy of and instruction in N.J.A.C. 7:28-1 through 7:28-13 and 7:28-17 and a copy of the owner's operating and emergency procedures as required by N.J.A.C. 7:28-17.5(d) and has demonstrated an understanding of the procedures and regulations by written examination given by a qualified individual; and

3. The operator has demonstrated competence to operate appropriate safety systems.

(c) Each owner shall supply appropriate personnel monitoring equipment and shall require that it be used by every individual who operates, makes "set-ups," or performs maintenance on an ionizing radiation-producing machine, radiographic-exposure device, or sealed source used in shielded room radiography.

(d) The enclosed room in which shielded room radiography is conducted shall be shielded so that no location on the exterior exceeds the radiation levels and limits established in N.J.A.C. 7:28-6. No industrial radiography shall be conducted in a shielded room until a radiation survey is first made to insure compliance with these radiation levels and limits. A record of this survey shall be maintained and a copy shall be available for inspection by the Department.

(e) No person shall enter an enclosed room in which shielded room radiography is performed until after a physical radiation survey is conducted to determine whether the ionizing radiation producing machine is off or the radiographic-exposure device or the sealed source is in the shielded or "off" position. A record shall be maintained of the date and exposure rate measured for each physical radiation survey and shall be made available for inspection by the Department.

(f) The radiation surveys required in (d) and (e) above shall be made with a radiation survey instrument measuring radiation at the energies and at the exposure rates to be encountered. This instrument shall have an operational check source test conducted prior to each use and shall be calibrated at intervals not to exceed one year and shall be recalibrated after each servicing other than a battery replacement. Records shall be maintained of each date of calibration and the daily operational check and shall be made available for inspection by the Department.

(g) Adequate methods shall be provided to restrict the access of personnel and the public to any and all shielded room radiography areas to prevent the exposure of any person to radiation in excess of the level limits of N.J.A.C. 7:28-5, 7:28-6 and 7:28-17. No person is permitted to remain within the enclosed room where shielded room radiography is being performed.

(h) All ionizing radiation-producing machines, radiographic-exposure devices, and sealed sources used in shielded room radiography and all objects exposed thereto shall be confined within an installation or structure designed or intended for radiography and in which radiography is regularly performed in accordance with the following requirements:

1. A reliable interlock or other mechanism shall be installed at each means of access to the shielded room which will turn off the source(s) of radiation if a person tries to enter or open the door to the shielded room.
2. A door-fastening mechanism shall be installed so that the door to the shielded room can be opened from the inside at all times in case of emergency.
3. A visible and audible signal alarm system shall be installed within the shielded room which will be actuated at a reasonable length of time before the power to the radiation source can be activated which enables persons in the vicinity of the shielded room to take appropriate protective actions.

4. One or more scram or emergency buttons shall be installed at a highly visible and easily accessible location or locations within the shielded room that will terminate the power to the source of radiation. This scram or emergency button shall be installed so that it shall require manual resetting before the power to the source of radiation can be reactivated.

5. Each source of radiation used in shielded room radiography shall be provided with a lock at the control panel to prevent unauthorized use of the source.

6. If more than one source of radiation is used in the same shielded room, all such sources of radiation shall meet the requirements of 1-5 above.

New Rule, R.1985 d.502, effective October 7, 1985.
See: 17 N.J.R. 1626(a), 17 N.J.R. 2389(a).

SUBCHAPTER 18. MAJOR NUCLEAR FACILITIES

7:28-18.1 Scope

(a) The special requirements of this Subchapter shall apply to major nuclear facilities including nuclear reactors, nuclear fuel fabrication plants, nuclear fuel reprocessing plants, and nuclear waste handling or disposal facilities.

(b) These requirements are in addition to the requirements of other applicable Sections of this Chapter.

(c) The intent of this Section is to insure that individuals outside of these facilities receive no radiation exposures from environmental or direct radiation that are in excess of the limits of Sections 6.1 (Exposure of individuals in controlled areas) and 6.2 (Radiation levels outside controlled areas) of this Chapter.

7:28-18.2 Facility description and required monitoring program

(a) Any person desiring to construct a major nuclear facility within this State shall submit a general description of the proposed facility with a discussion of probable and maximum potential radioactive discharges. This description shall be submitted to the Department for evaluation, as early as possible, but not less than six months prior to the start of construction, and shall include the following:

1. A general description of the proposed facility;
2. The nature of and the proposed rates of discharge of radioactive contaminants to the environment and/or the nature of and amounts of radioactive materials subject to temporary or permanent storage;
3. The proposed methods of limiting the discharge of radioactive contaminants to the atmosphere;

4. The proposed methods of limiting the discharge of radioactive contaminants to ground or surface waters;
5. The proposed methods of disposal of radioactive or radioactively contaminated materials; and
6. Preliminary description of the proposed radiological monitoring program.

(b) As used in this section, the term "construction" includes pouring the foundation for, or the installation of, any portion of the permanent facility on the site, but does not include the following:

1. Site exploration, site excavation, preparation of the site for construction of the facility, including the driving of piles, and construction of roadways, railroad spurs, and transmission lines;

2. Procurement or manufacture of components of the facility; or

3. Construction of non-nuclear facilities (such as construction equipment storage sheds) for use in connection with the construction of the facility.

(c) Any person desiring to operate a major nuclear facility within this State shall develop an adequate program of radiological monitoring consistent with the hazard from actual or potential discharges. The proposed program shall be submitted to the Department for evaluation as to its adequacy as early as possible but at least six months prior to the start of operation. The proposed radiological monitoring program shall include revised statements of the information required in (a) and (b) above, and it shall also include:

“Controlling interest” means the interest held by the person or persons who owns more than 50 percent of the voting stock or other equity interest in an owner; it also means the interest held by a person or persons who owns 50 percent or less of the voting stock or other equity interest in an owner and who possesses, directly or indirectly, the power to direct or cause the direction of the management and policies in an owner.

“Dispose” or “disposal” means the discarding or destroying of a nonionizing radiation producing source.

“Gigahertz” (GHz) means 1,000,000,000 hertz or cycles per second.

“Kilohertz” (kHz) means 1,000 hertz or cycles per second.

“Megahertz” (MHz) means 1,000,000 hertz or cycles per second.

“Microwave heater, sealer and industrial oven” means any source which uses microwave radiation between the frequencies of 300 MHz and 100 GHz to heat, melt, dry, cure, sanitize, disinfect or alter the chemical composition of materials such as, but not limited to, plastics, rubber, glue, wood, dyes or food.

“Microwave radiation” means, for the purposes of this subchapter, nonionizing radiation between the frequencies of 300 MHz and 100 GHz. (By convention, microwave radiation describes all the frequencies between 300 MHz and 300 GHz. Microwave radiation is a subset of the radiofrequency radiation spectrum.)

“Nonionizing radiation” means radiation which does not have the capability of ionizing the medium through which it is passing.

“Nonionizing radiation producing source” or “source” means, for the purposes of this subchapter, any equipment, machine or device capable of emitting nonionizing radiation between the frequencies of 300 kHz and 100 GHz.

“Owner” means a person who has title to a radiation source or who possesses a radiation source as a lessee, bailee or pursuant to the terms of a registration issued by the Department, by a Federal agency, or by any other state.

“Person” includes an individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, municipality, any state or other legal entity; and any legal successor, representative agent, or agency of the foregoing.

“Radiation Assessment Document” means a form or series of forms issued by the Department requiring information such as, but not limited to, radiation frequency, duty cycle of each source, the source operator’s position in relation to each source and any additional information which will be

used to predict radiation levels in the areas surrounding nonionizing radiation producing sources.

“Radiofrequency radiation” means, for the purposes of this subchapter, nonionizing radiation between the frequencies of 300 kHz and 100 GHz. (By convention, radiofrequency radiation described all the frequencies below 300 GHz, with microwave radiation as a subset of the radiofrequency radiation spectrum.)

“Radiofrequency heater and sealer” means any source, including induction and dielectric heaters, which uses radiofrequency radiation between the frequencies of 300 kHz and 299 MHz to heat, melt, dry, cure, sanitize, disinfect or alter the chemical composition of materials such as, but not limited to, plastics, rubber, glue, wood, dyes or food.

“Registration” means the submission by the owner and receipt by the Department of the completed registration form and Radiation Assessment Document, and the payment of fees.

“Transferee” means a person who obtains either:

1. Ownership of a nonionizing radiation producing source; or
2. A controlling interest in the owner of such a source.

“Transferor” means a person who sells or otherwise transfers either:

1. A nonionizing radiation producing source; or
2. A controlling interest in the owner of such a source.

7:28-48.3 Registration of a nonionizing radiation producing source

(a) (Reserved)

(b) No owner shall operate a nonionizing radiation producing source listed in (b)1 or 2 below unless the owner completes the registration form and it is received by the Department by March 4, 1995. Thereafter, no owner shall operate the sources listed in (b)1 or 2 below unless the owner completes the registration form and it is received by the Department 30 calendar days after the owner takes possession of any of the sources listed below:

1. Radiofrequency heaters and sealers; or
2. Microwave heaters, sealers and industrial ovens.

(c) An owner shall register on forms made available by the Department. The registration form shall include the following information:

1. The owner’s name, address and telephone number;
2. The type of source(s);

3. The number of source(s);
4. The location of source(s);
5. The frequency or frequency range of radiation emitted from each source; and
6. Any additional information which is reasonably necessary to identify the source or the owner of the source.

(d) An owner shall produce immediately, upon request by the Department, a copy of the completed registration form.

(e) If an owner of a nonionizing radiation producing source fails to register that source with the Department, and the Department has reason to believe that the source is a radiofrequency or microwave heater, sealer, or industrial oven, the Department may require the owner to provide information on the source and may conduct an inspection of the source, facility and any documents or records pertaining thereto.

7:28-48.4 Amendments to the registration of a nonionizing radiation producing source

An owner shall notify the Department in writing within 30 calendar days of any change in the information on the registration form.

7:28-48.5 Radiation Assessment Document

(a) An owner shall submit to the Department a Radiation Assessment Document, on forms made available by the Department, no later than 60 calendar days after the owner's receipt of the bill for the initial registration fee.

(b) (Reserved)

(c) For sources listed in N.J.A.C. 7:28-48.3(b), the Radiation Assessment Document shall include the following information:

1. The owner's name, address and telephone number;
2. The type of source(s);
3. The number of source(s);
4. The location of each source;
5. The frequency or frequency range of radiation emitted from each source;
6. The duty cycle of each source;
7. The source operator's position in relation to each source; and
8. Any additional information which is reasonably necessary to assess compliance of the sources with the provisions of N.J.A.C. 7:28-42.

7:28-48.6 Amendments to Radiation Assessment Documents

An owner shall notify the Department in writing within 30 calendar days of any change in the information contained in the Radiation Assessment Document.

7:28-48.7 Initial registration fee and annual renewal fee for nonionizing radiation producing sources

(a) An owner shall remit to the Department the initial registration fee or annual renewal fee no later than 30 calendar days after the owner's receipt of the bill issued by the Department.

(b) An owner shall pay the fees for initial registration and annual renewal as follows:

Source Category	Initial Registration Fee	Annual Renewal Fee
1. Radiofrequency heaters and sealers, per location		
One source	\$ 180.00	\$160.00
Two sources	305.00	285.00
Three sources	415.00	395.00
Four sources	565.00	545.00
Five sources	675.00	650.00
Six sources	795.00	770.00
Seven sources	910.00	890.00
Eight sources	1,010.00	990.00
For each additional source at the same location, add:	90.00	90.00
2. Microwave heaters, sealers and industrial ovens, per location		
One source	\$ 125.00	\$125.00
Two sources	220.00	225.00
Three sources	325.00	330.00
Four sources	415.00	425.00
Five sources	505.00	520.00
Six sources	600.00	615.00
Seven sources	705.00	725.00
Eight sources	805.00	830.00
For each additional source at the same location, add:	80.00	85.00

(c) An owner remitting an initial registration fee or annual renewal fee shall mail a check or money order, made payable to "Treasurer, State of New Jersey," to the Department of Treasury at the following address:

State of New Jersey
 Department of Treasury
 Division of Revenue
 PO Box 417
 Trenton, NJ 08646-0417

(d) An owner who fails to remit the initial registration fee or annual renewal fee within 30 calendar days after the owner's receipt of the bill shall be assessed a late charge, which is 20 percent of the amount of the billed fee.

(e) The registration of an owner who fails to submit an annual renewal fee within 60 calendar days after the owner's receipt of the bill shall be considered expired.

1. Any owner whose registration has expired pursuant to this subsection shall, upon a written request transmitted to the Department within 30 calendar days of the expiration of the registration, be afforded the opportunity for a hearing thereon in the manner provided for contested cases pursuant to the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq., and the Uniform Administrative Procedure Rules, N.J.A.C. 1:1.

2. Requests for hearings shall be sent to the Office of Legal Affairs, ATTENTION: Adjudicatory Hearing Requests, Department of Environmental Protection, PO Box 402, Trenton, NJ 08625-0402.

(f) An owner who allows the registration of a source to expire by failing to remit the annual renewal fee within 60 calendar days after the owner's receipt of the bill shall be required to file a new registration form along with the appropriate initial registration fee listed in (b) above.

(g) Fees submitted to the Department are not refundable.

Administrative Correction.

See: 27 N.J.R. 498(b).

Amended by R.2005 d.239, effective July 18, 2005.

See: 37 N.J.R. 8(a), 37 N.J.R. 2675(b).

Amended the addresses throughout.

7:28-48.8 Sale of a nonionizing radiation producing source or transfer of a controlling interest; termination of registration upon sale of nonionizing radiation producing source or upon transfer of controlling interest

(a) A person who sells or otherwise transfers either a nonionizing radiation producing source, or a controlling interest in the owner of such a source, shall notify the Department in writing at least 30 calendar days before the sale or transfer occurs. The transferor shall include the following information in the notice:

1. The name and address of the transferee; and
2. The date of the proposed sale or transfer.

(b) Unless the procedures set forth in either (c) or (d) below are followed, the registration of a nonionizing radiation producing source shall terminate upon the sale of the source or upon the transfer of a controlling interest in the person who owns the source.

(c) The registration of a nonionizing radiation producing source shall not terminate upon the sale of the source or upon the transfer of a controlling interest under (b) above, and shall be transferred to the transferee, if the transferee certifies to the Department in writing that it will assume all of the transferor's liabilities in connection with:

1. Any deficiencies in the operation of source that would result in a violation of any of the provisions of N.J.A.C. 7:28-42; and

2. All penalties arising in connection with the source from occurrences or circumstances existing before the date of the sale or transfer.

(d) The registration of a nonionizing radiation producing source shall not terminate upon the sale of the source or upon the transfer of a controlling interest under (b) above, if the transferor takes the actions required of the transferor under the following procedure:

1. The transferor shall notify the Department in writing of the proposed sale or transfer, prior to the sale or transfer in accordance with (a) above;

2. The Department may, in its discretion, perform an onsite audit of the nonionizing radiation producing source. If the Department performs such an audit, it shall be completed within 90 calendar days after receipt of notice under (d)1 above;

3. Within 45 calendar days after the deadline for completion of the audit in (d)2 above, based on the audit and/or a review of Department records, the Department shall either:

- i. Issue to the transferor a notice stating that there are no deficiencies in the operations of the nonionizing radiation producing source and that no violations exist; or

- ii. Issue to the transferor a report of all deficiencies and one or more notices of prosecutions or administrative orders; and

4. The transferor corrects all deficiencies and pays all the penalties noted in (d)3 above.

(e) If the registration of a nonionizing radiation producing source continues pursuant to the procedures set forth in either (c) or (d) above, the transferee shall operate its nonionizing radiation producing source in compliance with this subchapter and all applicable provisions of this chapter.

(f) If the registration of a nonionizing radiation producing source terminates pursuant to (b) above, the transferee shall submit an initial registration form and the appropriate initial registration fee within 30 calendar days after it takes possession of the nonionizing radiation producing source or assumes a controlling interest in the owner of such a source, unless it is the intent of the transferee to dispose of the source. If the transferee operates the nonionizing radiation producing source before it submits the completed initial registration form, the transferee shall be in violation of N.J.A.C. 7:28-48.3.

7:28-48.9 Disposal of a nonionizing radiation producing source

(a) Whenever an owner disposes of a nonionizing radiation producing source, as listed in N.J.A.C. 7:28-48.3(a) and (b), the owner shall give written notification to the Department within 30 calendar days after such disposal. The

owner shall provide to the Department a complete description of the final disposition of the source.

(b) The registration of a nonionizing radiation producing source shall terminate upon the disposal of the source.

7:28-48.10 Exemption from registration and payment of initial registration fee and annual renewal fee

(a) An owner of a nonionizing radiation producing source is exempt from registration and payment of initial registration and annual renewal fees if:

1. The source is not operational, and does not emit nonionizing radiation;

2. (Reserved)

3. (Reserved)

4. The source is used for display purposes only, and does not emit nonionizing radiation;

5. The source is possessed, used or stored by the United States Government; or

6. The source is a microwave oven used to cook food for customers' consumption in locations such as, but not limited to, restaurants, canteens, and other eating establishments, or a microwave oven purchased by a consumer for use in the home.