CHAPTER 4731

DEPARTMENT OF HEALTH

RADIATION SAFETY

GENERAL PROVISIONS

TRANSPORTATION OF LICENSED MATERIAL

DOMESTIC LICENSING OF SPECIAL NUCLEAR MATERIAL

DOMESTIC LICENSING OF SOURCE MATERIAL

STANDARDS FOR PROTECTION AGAINST RADIATION

DOMESTIC LICENSING OF RADIOACTIVE MATERIALS

NUCLEAR MEDICINE TECHNOLOGY

IRRADIATORS

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PHYSICAL PROTECTION OF CATEGORY 1 AND CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL

GENERAL PROVISIONS

4731.0100 DEFINITIONS.

Subpart 1. **Scope.** For purposes of this chapter, the terms in this part have the meanings given them.

Subp. 2. **A_1.** "A_1" means the maximum activity of special form radioactive material permitted in a Type A package. These values are either listed in part 4731.0422 or may be derived according to the procedure in part 4731.0423.

Subp. 3. **A_2.** "A_2" means the maximum activity of radioactive material, other than special form radioactive material, low specific activity material, and surface contaminated object material permitted in a Type A package. These values are either listed in part 4731.0422 or may be derived according to the procedure in part 4731.0423.

Subp. 4. **Absorbed dose.** "Absorbed dose" means the energy imparted by ionizing radiation per unit mass of irradiated material. The units of absorbed dose are the rad and the gray.

Subp. 4a. **Accelerator-produced radioactive material.** "Accelerator-produced radioactive material" means any material made radioactive by a particle accelerator.

Subp. 4b. **Access control.** "Access control" means a system for allowing only approved individuals to have unescorted access to the security zone and for ensuring that all other individuals are subject to escorted access.

Subp. 5. **Active maintenance.** "Active maintenance" means any significant remedial activity needed during the period of institutional control to maintain a reasonable assurance that the performance objectives in Code of Federal Regulations, title 10, sections 61.41 and 61.42, are met. Active maintenance includes ongoing activities, such as the pumping and treatment of water from

a disposal unit, or one time measures, such as replacement of a disposal unit cover. Active maintenance does not include custodial activities such as repair of fencing, repair or replacement of monitoring equipment, revegetation, minor additions to soil cover, minor repair of disposal unit covers, and general disposal site upkeep, such as mowing grass.

Subp. 6. **Activity.** "Activity" is the rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie and becquerel.

Subp. 7. **Acute.** "Acute" is a single radiation dose or chemical exposure event or multiple radiation doses or chemical exposure events occurring within a short time, 24 hours or less.

Subp. 8. **Address of use.** "Address of use" means the building or buildings that are identified on a license and where radioactive material may be received, prepared, used, or stored.

Subp. 9. **Adult.** "Adult" means an individual 18 or more years of age.

Subp. 9a. **Aggregated.** "Aggregated" means accessible by the breach of a single physical barrier that would allow access to radioactive material in any form, including any devices that contain the radioactive material, when the total activity equals or exceeds a category 2 quantity of radioactive material.

Subp. 10. **Agreement state.** "Agreement state" means a state with which the NRC or the federal Atomic Energy Commission has entered into an effective agreement under subsection 274b of the Atomic Energy Act of 1954, United States Code, title 42, section 2021, paragraph (b), as amended.

Subp. 11. **Air-purifying respirator.** "Air-purifying respirator" means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Subp. 12. **Airborne radioactive material.** "Airborne radioactive material" means radioactive material dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases.

Subp. 13. **Airborne radioactivity area.** "Airborne radioactivity area" means a room, enclosure, or area in which airborne radioactive materials, composed wholly or partly of licensed material, exist in concentrations:

A. in excess of the derived air concentrations (DACs) specified in part 4731.2750; or

B. to such a degree that an individual present in the area without respiratory protective equipment could exceed, during the hours an individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

Subp. 14. **Alert.** "Alert" means a situation in which events may occur, are in progress, or have occurred that could lead to a release of radioactive material, but the release is not expected to require a response by off-site response organizations to protect persons off site.

Subp. 15. **Annual limit on intake or ALI.** "Annual limit on intake" or "ALI" means the derived limit for the amount of radioactive material taken into the body of an adult worker by

inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year by the reference man that would result in a committed effective dose equivalent of five rems (0.05 Sv) or a committed dose equivalent of 50 rems (0.5 Sv) to any individual organ or tissue. ALI values for intake by ingestion and by inhalation of selected radionuclides are given in part 4731.2750.

Subp. 16. **Annual refresher safety training or safety review.** "Annual refresher safety training" or "safety review" means a review conducted or provided by the licensee for its employees on radiation safety aspects of industrial radiography or well logging using radioactive materials.

Subp. 16a. **Approved individual.** "Approved individual" means an individual whom the licensee has determined to be trustworthy and reliable for unescorted access in accordance with parts 4731.8010 to 4731.8040 and who has completed the training required by part 4731.8055, subpart 3.

Subp. 17. **Area of use.** "Area of use" means a portion of an address of use that has been set aside for the purpose of receiving, preparing, using, or storing radioactive material.

Subp. 18. **As low as reasonably achievable or ALARA.** "As low as reasonably achievable" or "ALARA" means making every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the licensed or registered activity is undertaken, taking into account the state of technology, the economics of improvement in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

Subp. 19. **Assigned protection factor or APF.** "Assigned protection factor" or "APF" means the expected workplace level of respiratory protection that would be provided by a properly functioning respirator or a class of respirators to properly fitted and trained users. Operationally, the inhaled concentration can be estimated by dividing the ambient airborne concentration by the APF.

Subp. 19a. **Associate radiation safety officer.** "Associate radiation safety officer" means an individual who:

A. meets the requirements in parts 4731.4411 and 4731.4415; and

B. is currently identified as an associate radiation safety officer for the types of use of radioactive material for which the individual has been assigned duties and tasks by the radiation safety officer on:

(1) a specific medical use license issued by the commissioner, the NRC, or an agreement state; or

(2) a medical use permit issued by an NRC master material licensee.

Subp. 20. **Associated equipment.** "Associated equipment" means equipment, which is used in conjunction with a radiographic exposure device to make radiographic exposures, that drives,

guides, or comes in contact with the sealed source when it is used as an exposure head, for example a guide tube, control tube, control cable, removable source stop, "J" tube, or collimator.

Subp. 21. **Atmosphere-supplying respirator.** "Atmosphere-supplying respirator" means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere and includes supplied-air respirators and self-contained breathing apparatus units.

Subp. 22. **Authorized medical physicist.** "Authorized medical physicist" means an individual who:

A. meets the requirements in parts 4731.4412 and 4731.4415; or

B. is identified as an authorized medical physicist or teletherapy physicist on:

(1) a specific medical use license issued by the NRC or an agreement state;

(2) a medical use permit issued by an NRC master material licensee;

(3) a permit issued by an NRC or agreement state broad scope medical use licensee; or

(4) a permit issued by an NRC master material license broad scope medical use permittee.

Subp. 23. **Authorized nuclear pharmacist.** "Authorized nuclear pharmacist" means a pharmacist who:

A. meets the requirements in parts 4731.4413 and 4731.4415;

B. is identified as an authorized nuclear pharmacist on:

(1) a specific license issued by the NRC or an agreement state that authorizes medical use or the practice of nuclear pharmacy;

(2) a permit issued by an NRC master material licensee that authorizes medical use or the practice of nuclear pharmacy;

(3) a permit issued by an NRC or agreement state broad scope medical use licensee that authorizes medical use or the practice of nuclear pharmacy; or

(4) a permit issued by an NRC master material licensee broad scope medical use permitted that authorizes medical use or the practice of nuclear pharmacy;

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

D. is designated as an authorized nuclear pharmacist according to part 4731.3395, subpart 2, item C.

Subp. 24. **Authorized user.** "Authorized user" means a licensed practitioner of the healing arts who:

A. meets the requirements in part 4731.4415 and in parts 4731.4433, 4731.4436, 4731.4443 to 4731.4445, 4731.4458, 4731.4461, or 4731.4479; or

B. is identified as an authorized user on:

(1) an NRC or agreement state license that authorizes the medical use of radioactive material;

(2) a permit issued by an NRC master material licensee that is authorized to permit the medical use of radioactive material;

(3) a permit issued by an NRC or agreement state specific licensee of broad scope that is authorized to permit the medical use of radioactive material; or

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

Subp. 24a. **Background investigation.** "Background investigation" means the investigation conducted by a licensee or applicant to support the determination of trustworthiness and reliability.

Subp. 25. **Background radiation.** "Background radiation" means radiation from cosmic sources; naturally occurring radioactive material, including radon, except as a decay product of source or special nuclear 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 are not under the control of the licensee. Background radiation does not include radiation from source, radioactive, or special nuclear materials regulated by the commissioner.

Subp. 26. **Becquerel or Bq.** One "becquerel" or "Bq" is equal to one disintegration per second. One curie is equal to 3.7×10^{10} becquerels. The conventional system equivalent is the curie.

Subp. 27. **Bioassay or radiobioassay.** "Bioassay" or "radiobioassay" means the determination of kinds, quantities, or concentrations, and, in some cases, the locations of radioactive material in the human body, whether by direct measurement (in vivo counting) or by analysis and evaluation of materials excreted or removed from the human body.

Subp. 28. **Boring.** "Boring" has the meaning given in Minnesota Statutes, section 103I.005, subdivision 2.

Subp. 29. **Brachytherapy.** "Brachytherapy" means a method of radiation therapy in which sources are used to deliver a radiation dose at a distance of up to a few centimeters by surface, intracavitary, intraluminal, or interstitial application.

Subp. 30. **Brachytherapy source.** "Brachytherapy source" means a radioactive sealed source or a manufacturer-assembled source train or a combination of these sources that is designed to deliver a therapeutic dose within a distance of a few centimeters.

Subp. 31. **Broad scope license.** "Broad scope license" is one kind of a specific license that permits the licensee to use radionuclides, in any chemical or physical form, as long as the amount does not exceed the quantity indicated in the broad scope license.

Subp. 32. **Byproduct material.** "Byproduct material" means:

A. any radioactive material, except special nuclear material, yielded in, or made radioactive by, exposure to the radiation incident to the process of producing or using special nuclear material;

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

C. any discrete source of radium-226 that is produced, extracted, or converted after extraction for commercial, medical, or research activity, or any material that:

(1) has been made radioactive by use of a particle accelerator; and

(2) is produced, extracted, or converted after extraction for commercial, medical, or research activity; and

D. any discrete source of naturally occurring radioactive material, other than source material, that:

(1) the United States Nuclear Regulatory Commission, in consultation with the Administrator of Environmental Protection Agency, the Secretary of Energy, the Secretary of Homeland Security, and the head of any other appropriate federal agency determines would pose a threat similar to the threat posed by a discrete source of radium-226 to the public health and safety or the common defense and security; and

(2) is extracted or converted after extraction for use in a commercial, medical, or research activity.

Subp. 33. **Carrier.** "Carrier" means a person engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or by civil aircraft.

Subp. 33a. **Category 1 quantity of radioactive material.** "Category 1 quantity of radioactive material" means a quantity of radioactive material meeting or exceeding the category 1 threshold under part 4731.8140, subpart 1. This is determined by calculating the ratio of the total activity of each radionuclide to the category 1 threshold for that radionuclide and adding the ratios together. If the sum is equal to or exceeds one, the quantity would be considered a category 1 quantity. Category 1 quantities of radioactive material do not include the radioactive material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet.

Subp. 33b. **Category 2 quantity of radioactive material.** "Category 2 quantity of radioactive material" means a quantity of radioactive material meeting or exceeding the category 2 threshold but less than the category 1 threshold under part 4731.8140, subpart 1. This is determined by calculating the ratio of the total activity of each radionuclide to the category 2 threshold for that radionuclide and adding the ratios together. If the sum is equal to or exceeds one, the quantity would be considered a category 2 quantity. Category 2 quantities of radioactive material do not include the radioactive material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet.

Subp. 33c. **Certificate holder.** "Certificate holder" means a person who has been issued a certificate of compliance or other package approval by the NRC.

Subp. 33d. **Certificate of compliance.** "Certificate of compliance" means the certificate issued by the NRC under Code of Federal Regulations, title 10, part 71, subpart D, which approves the design of a package for transportation of radioactive material.

Subp. 34. **Certifying entity or independent certifying organization.** "Certifying entity" or "independent certifying organization" means an independent certifying organization meeting the requirements in part 4731.4360 or an agreement state meeting the requirements in part 4731.4360, subparts 2 and 3, for certifying industrial radiographers.

Subp. 35. **Chelating agent.** "Chelating agent" means amine polycarboxylic acids, for example EDTA and DTPA; hydroxy-carboxylic acids; and polycarboxylic acids, for example citric acid, carbolic acid, and glucinic acid.

Subp. 36. **Class, inhalation class, or lung class.** "Class," "inhalation class," or "lung class" means a classification scheme for inhaled material according to its rate of clearance from the pulmonary region of the lung. Materials are classified as D, W, or Y, which applies to a range of clearance half-times of:

A. less than ten days for class D (days);

B. from ten to 100 days for class W (weeks); and

C. greater than 100 days for class Y (years).

Subp. 37. **Client's address.** "Client's address" means the area of use or a temporary job site for the purpose of providing mobile medical service according to part 4731.4428.

Subp. 38. **Collective dose.** "Collective dose" is 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.

Subp. 39. **Collimator.** "Collimator" means a radiation shield that is placed on the end of the guide tube or directly onto a radiographic exposure device to restrict the size of the radiation beam when the sealed source is cranked into position to make a radiographic exposure.

Subp. 40. **Commencement of construction.** "Commencement of construction" means taking any action defined as construction or any other activity at the site of a facility subject to the regulations in this chapter that has a reasonable nexus to radiological health and safety.

Subp. 41. **Commissioner.** "Commissioner" means the commissioner of the Minnesota Department of Health.

Subp. 42. **Committed dose equivalent or $H_{T,50}$.** "Committed dose equivalent" or "$H_{T,50}$" 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.

Subp. 43. **Committed effective dose equivalent or $H_{E,50}$.** "Committed effective dose equivalent" or "$H_{E,50}$" is the sum of the products of the weighting factors (W_T) applicable to each

of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \Sigma W_T H_{T,50}$).

Subp. 43a. **Consignment.** "Consignment" means each shipment of a package or groups of packages or load of radioactive material offered by a shipper for transport.

Subp. 43b. **Consortium.** "Consortium" means an association of medical use licensees and a PET radionuclide production facility in the same geographical area that jointly own or share in the operation and maintenance cost of the PET radionuclide production facility that produces PET radionuclides for use in producing radioactive drugs within the consortium for noncommercial distributions among its associated members for medical use. The PET radionuclide production facility within the consortium must be located at an educational institution or a federal facility or a medical facility.

Subp. 44. **Constraint or dose constraint.** "Constraint" or "dose constraint" means a value above which specified licensee or registrant actions are required.

Subp. 44a. **Construction.** "Construction" means the installation of foundations or in-place assembly, erection, fabrication, or testing for any structure, system, or component of a facility or activity subject to the regulations in this chapter that are related to radiological safety or security. Construction does not include:

A. changes for temporary use of the land for public recreational purposes;

B. site exploration, including necessary borings to determine foundation conditions or other preconstruction monitoring to establish background information related to the suitability of the site, the environmental impacts of construction or operation, or the protection of environmental values;

C. preparation of the site for construction of the facility, including clearing of the site, grading, installation of drainage, erosion and other environmental mitigation measures, and construction of temporary roads and borrow areas;

D. erection of fences and other access control measures that are not related to the safe use of, or security of, radiological materials subject to this part;

E. excavation;

F. erection of support buildings, such as construction equipment storage sheds, warehouse and shop facilities, utilities, concrete mixing plants, docking and unloading facilities, and office buildings for use in connection with the construction of the facility;

G. building of service facilities, such as paved roads, parking lots, railroad spurs, exterior utility and lighting systems, potable water systems, sanitary sewerage treatment facilities, and transmission lines;

H. procurement or fabrication of components or portions of the proposed facility occurring at other than the final, in-place location at the facility; or

I. taking any other action that has no reasonable nexus to radiological health and safety.

Subp. 44b. **Containment system.** "Containment system" means the assembly of components of the packaging intended to retain the radioactive material during transport.

Subp. 45. **Contiguous sites.** "Contiguous sites" means licensee-controlled locations that are deemed by the commissioner to be in close enough proximity to each other so that the special nuclear material must be considered in the aggregate for the purpose of physical protection.

Subp. 46. **Control cable or drive cable.** "Control cable" or "drive cable" means the cable that is connected to the source assembly and used to drive the source to and from the exposure location.

Subp. 47. **Control drive mechanism.** "Control drive mechanism" means a device that enables the source assembly to be moved to and from the exposure device.

Subp. 48. **Control tube.** "Control tube" means a protective sheath for guiding the control cable. The control tube connects the control drive mechanism to the radiographic exposure device.

Subp. 49. **Controlled area.** "Controlled area" means an area outside of a restricted area but inside the site boundary, access to which can be limited by the licensee or registrant for any reason.

Subp. 49a. **Conveyance.** "Conveyance" means:

A. for transport by public highway or rail, any transport vehicle or large freight container;

B. for transport by water, any vessel or any hold, compartment, or defined deck area of a vessel, including any transport vehicle on board the vessel; and

C. for transport by air, any aircraft.

Subp. 50. **Critical group.** "Critical group" means the group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.

Subp. 50a. **Criticality safety index or CSI.** "Criticality safety index" or "CSI" means the dimensionless number, rounded up to the next tenth, assigned to and placed on the label of a fissile material package, to designate the degree of control of accumulation of packages, overpacks, or freight containers containing fissile material during transportation. Determination of the criticality safety index is described in parts 4731.0410 and 4731.0411 and Code of Federal Regulations, title 10, section 71.59. The criticality safety index for an overpack, freight container, consignment, or conveyance containing fissile material packages is the arithmetic sum of the criticality safety indices of all the fissile material packages contained within the overpack, freight container, consignment, or conveyance.

Subp. 51. **Curie or Ci.** One "curie" or "Ci" is the quantity of radioactive material that decays at the rate of 3.7×10^{10} disintegrations per second (dps). The SI equivalent is the becquerel.

Subp. 51a. **Cyclotron.** "Cyclotron" means a particle accelerator in which the charged particles travel in an outward spiral or circular path. A cyclotron accelerates charged particles at energies usually in excess of ten MeV and is commonly used for production of short half-life radionuclides for medical use.

Subp. 52. **Declared pregnant woman.** "Declared pregnant woman" means a woman who has voluntarily informed the licensee 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.

Subp. 53. **Decommission.** "Decommission" means to safely remove a facility or site from service and reduce residual radioactivity to a level that permits:

A. release of the property for unrestricted use and termination of the license or registration; or

B. release of the property under restricted conditions and termination of the license or registration.

Subp. 54. **Dedicated check source.** "Dedicated check source" means a radioactive source that is used to ensure the constant operation of a radiation detection or measurement device over several months or years.

Subp. 55. **Deep dose equivalent or H_d.** "Deep dose equivalent" or "H_d," which applies to external whole-body exposure, is the dose equivalent at a tissue depth of one centimeter (1,000 mg/cm^2).

Subp. 56. **Demand respirator.** "Demand respirator" means an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.

Subp. 57. **Depleted uranium.** "Depleted uranium" means the source material uranium in which the isotope uranium-235 is less than 0.711 weight percent of the total uranium present. Depleted uranium does not include special nuclear material.

Subp. 58. **Derived air concentration or DAC.** "Derived air concentration" or "DAC" means the concentration of a given radionuclide in air which, if breathed by the reference man for a working year of 2,000 hours under conditions of light work (inhalation rate 1.2 cubic meters of air per hour), results in an intake of one ALI. DAC values are given in part 4731.2750, subpart 7, Table 1, column 3.

Subp. 59. **Derived air concentration-hour or DAC-hour.** "Derived air concentration-hour" or "DAC-hour" is the product of the concentration of radioactive material in air, expressed as a fraction or multiple of the derived air concentration for each radionuclide, and the time of exposure to that radionuclide, in hours. A licensee or registrant may take 2,000 DAC-hours to represent one ALI, equivalent to a committed effective dose equivalent of five rems (0.05 Sv).

Subp. 59a. **Deuterium.** "Deuterium" means, for purposes of parts 4731.0403, subpart 4, and 4731.0410, deuterium and any deuterium compounds, including heavy water, in which the ratio of deuterium atoms to hydrogen atoms exceeds 1:5000.

Subp. 60. **Disposable respirator.** "Disposable respirator" means a respirator for which maintenance is not intended and that is designed to be discarded after excessive breathing resistance,

sorbent exhaustion, physical damage, or end-of-service-life renders it unsuitable for use. Examples of this type of respirator are a disposable half-mask respirator or a disposable escape-only self-contained breathing apparatus.

Subp. 60a. **Discrete source.** "Discrete source" means a radionuclide that has been processed so that its concentration within a material has been purposely increased for use for commercial, medical, or research activities.

Subp. 61. **Distinguishable from background.** "Distinguishable from background" means that the detectable concentration of a radionuclide is statistically different from the background concentration of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

Subp. 62. **Distribution.** "Distribution" means the act of distributing or the condition of being distributed.

Subp. 63. **Distributor.** "Distributor" means one who distributes, markets, or sells merchandise that includes a radiation source or radiation-producing equipment, especially a wholesaler.

Subp. 63a. **Diversion.** "Diversion" means the unauthorized movement of radioactive material subject to this chapter to a location different from the material's authorized destination inside or outside of the site at which the material is used or stored.

Subp. 64. **Dose or radiation dose.** "Dose" or "radiation dose" means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent.

Subp. 64a. **Dose commitment.** "Dose commitment" means the total radiation dose to a part of the body that will result from retention in the body of radioactive material. For purposes of estimating the dose commitment, it is assumed from the time of intake the period of exposure to retained material will not exceed 50 years.

Subp. 65. **Dose equivalent or H_T.** "Dose equivalent" or "H_T" means the product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem and sievert.

Subp. 66. **Dose limits or limits.** "Dose limits" or "limits" means the permissible upper bounds of radiation doses.

Subp. 67. **DOT.** "DOT" means the United States Department of Transportation.

Subp. 68. **Doubly encapsulated sealed source.** "Doubly encapsulated sealed source" means a sealed source in which the radioactive material is sealed within a capsule and that capsule is sealed within another capsule.

Subp. 69. **Effective dose equivalent or H_E.** "Effective dose equivalent" or "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. ($H_E = \Sigma\alpha\mu\rho\times W_T H_T$).

Subp. 70. **Effective kilogram.** "Effective kilogram" means:

A. for the source material uranium in which the uranium isotope uranium-235 is greater than 0.005 (0.5 weight percent) of the total uranium present, 10,000 kilograms; and

B. for any other source material, 20,000 kilograms.

Subp. 71. **Electron-beam generator.** "Electron-beam generator" means a type of electron accelerator in which the electron beam is brought out into the atmosphere for irradiation purposes.

Subp. 72. **Embryo/fetus.** "Embryo/fetus" means the developing human organism from conception until the time of birth.

Subp. 73. **Energy compensation source or ECS.** "Energy compensation source" or "ECS" means a small sealed source, with an activity not exceeding 100 microcuries (3.7 MBq), used within a logging tool, or other tool components, to provide a reference standard to maintain the tool's calibration when in use.

Subp. 74. **Enriched uranium.** "Enriched uranium" means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

Subp. 75. **Entrance or access point.** "Entrance" or "access point" means any location through which an individual could gain access to radiation areas or to radioactive materials. Entrance or access point includes entry or exit portals of sufficient size to permit human entry, irrespective of their intended use.

Subp. 75a. **Escorted access.** "Escorted access" means accompaniment while in a security zone by an approved individual who maintains continuous direct visual surveillance at all times over an individual who is not approved for unescorted access.

Subp. 76. **Exclusive use.** "Exclusive use" means the sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out according to the direction of the consignor or consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions, in writing, for maintenance of exclusive use shipment controls and include them with the shipping paper information provided to the carrier by the consignor.

Subp. 77. **Exposure.** "Exposure" means being exposed to ionizing radiation or to radioactive material.

Subp. 78. **Exposure head or source stop.** "Exposure head" or "source stop" means a device that locates the gamma radiography sealed source in the selected working position.

Subp. 79. **Exposure rate.** "Exposure rate" means the exposure per unit of time, such as roentgen per minute, milliroentgen per hour, sievert per minute, or millisievert per hour.

Subp. 80. **External dose.** "External dose" means that portion of the dose equivalent received from radiation sources outside the body.

Subp. 81. **Extremity.** "Extremity" means hand, elbow, arm below the elbow, foot, knee, or leg below the knee.

Subp. 82. **Field station.** "Field station" means a facility where licensed or registered material may be stored or used and from which equipment is dispatched to a temporary job site.

Subp. 83. **Filtering facepiece or dust mask.** "Filtering facepiece" or "dust mask" means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium, not equipped with elastomeric sealing surfaces and adjustable straps.

Subp. 83a. **Fingerprint orders.** "Fingerprint orders" means the orders issued by the NRC or the legally binding requirements issued by agreement states that require fingerprints and criminal history records checks for individuals with unescorted access to category 1 and category 2 quantities of radioactive material or safeguards information-modified handling.

Subp. 84. **Fissile material.** "Fissile material" means the radionuclides plutonium-239, plutonium-241, uranium-233, uranium-235, or any combination of these radionuclides. Fissile material means the fissile nuclides themselves, not material containing fissile nuclides. Unirradiated natural uranium and depleted uranium and natural uranium or depleted uranium, that has been irradiated in thermal reactors only, are not included in this definition. Certain exclusions from fissile material controls are provided in parts 4731.0400 to 4731.0424.

Subp. 85. **Fit factor.** "Fit factor" means a quantitative estimate of the fit of a particular respirator to a specific individual and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Subp. 86. **Fit test.** "Fit test" means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual.

Subp. 87. **Freshwater aquifer.** "Freshwater aquifer" means a geologic formation that is capable of yielding fresh water to a well or spring.

Subp. 88. **General license.** "General license" means a license that is provided by rule, grants authority to a person for certain activities involving radioactive material, and is effective without the filing of an application with the commissioner or the issuance of a licensing document to a particular person. The commissioner may require registration by the particular general licensee.

Subp. 89. **Geologic repository.** "Geologic repository" means a system that is intended to be used for, or may be used for, the disposal of radioactive wastes in excavated geologic media. Geologic repository includes:

A. the geologic repository operations area; and

B. the portion of the geologic setting that provides isolation of the radioactive waste.

Subp. 90. **Government agency.** "Government agency" means an executive department, commission, independent establishment, or corporation wholly or partly owned by the United States or the state of Minnesota and which is an instrumentality of the United States or the state of

Minnesota or a board, bureau, division, service, office, officer, authority, administration, or other establishment in the executive branch of federal government.

Subp. 90a. **Graphite.** "Graphite" means graphite with a boron equivalent content less than five parts per million and density greater than 1.5 grams per cubic centimeter.

Subp. 91. **Gray or Gy.** "Gray" or "Gy" is the SI unit of absorbed dose. One gray is equal to an absorbed dose of one joule/kilogram. One gray is also equal to 100 rads.

Subp. 92. **Guide tube or projection sheath.** "Guide tube" or "projection sheath" means a flexible or rigid tube, such as a "J" tube, for guiding the source assembly and the attached control cable from the exposure device to the exposure head. Guide tube or projection sheath includes the connections necessary for attachment to the exposure device and to the exposure head.

Subp. 93. **Hands-on experience.** "Hands-on experience" means experience in all of those areas considered to be directly involved in the industrial radiography process.

Subp. 94. **Hazardous waste.** "Hazardous waste" means those wastes designated as hazardous by the Environmental Protection Agency regulations in Code of Federal Regulations, title 40, part 261.

Subp. 95. **Helmet.** "Helmet" means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

Subp. 96. **High dose-rate remote afterloader.** "High dose-rate remote afterloader" means a device that remotely delivers a dose rate in excess of 1,200 rads (12 Gy) per hour at the point or surface where the dose is prescribed.

Subp. 96a. **High integrity container or HIC.** "High integrity container" or "HIC" means a container commonly designed to meet the structural stability requirements of Code of Federal Regulations, title 10, section 61.56, and to meet the United States Department of Transportation requirements for a Type A package.

Subp. 97. **High radiation area.** "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 a dose equivalent in excess of 0.1 rem (1 mSv) in one hour at 30 centimeters from the radiation source or 30 centimeters from any surface that the radiation penetrates.

Subp. 98. **Hood.** "Hood" means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

Subp. 99. **Inadvertent intruder.** "Inadvertent intruder" means a person who might occupy a disposal site after closure and engage in normal activities, such as agriculture, dwelling construction, or other pursuits in which the person might be unknowingly exposed to radiation from the waste.

Subp. 100. **Incident.** "Incident" means an occurrence or event that interrupts normal procedure or precipitates a crisis.

Subp. 100a. **Indian Tribe.** "Indian Tribe" means an Indian or Alaska Native Tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian Tribe pursuant to the Federally Recognized Indian Tribe List Act of 1994, United States Code, title 25, section 479a.

Subp. 101. **Individual.** "Individual" means a human being.

Subp. 102. **Individual monitoring.** "Individual monitoring" means:

A. the assessment of dose equivalent by the use of devices designed to be worn by an individual;

B. the assessment of committed effective dose equivalent by bioassay or by determination of the time-weighted air concentrations to which an individual has been exposed, such as derived air concentration-hours (DAC-hours); or

C. the assessment of dose equivalent by the use of survey data.

Subp. 103. **Individual monitoring devices.** "Individual monitoring devices" means devices designed to be worn by a single individual for the assessment of dose equivalent such as film badges, thermoluminescence dosimeters, pocket ionization chambers, or personal air sampling devices.

Subp. 104. **Industrial radiographer or radiographer.** "Industrial radiographer" or "radiographer" means an individual who performs or who, in attendance at the site where radiation exposure devices, sealed source, or sources are being used, personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for ensuring compliance with the requirements of this chapter and the conditions of the license or registration.

Subp. 105. **Industrial radiographer certification or radiographer certification.** "Industrial radiographer certification" or "radiographer certification" means written approval received from a certifying entity stating that an individual has satisfactorily met certain established radiation safety, testing, and experience criteria.

Subp. 106. **Industrial radiographer's assistant or radiographer's assistant.** "Industrial radiographer's assistant" or "radiographer's assistant" means an individual who, under the direct supervision of a radiographer, uses radiographic exposure devices, sealed sources, or related handling tools or radiation survey instruments in industrial radiography.

Subp. 107. **Industrial radiography or radiography.** "Industrial radiography" or "radiography" means an examination of the structure of materials by nondestructive methods, utilizing ionizing radiation to make radiographic images.

Subp. 108. **Injection tool.** "Injection tool" means a device used for controlled subsurface injection of radioactive tracer material.

Subp. 109. **Internal dose.** "Internal dose" means that portion of the dose equivalent received from radioactive material taken into the body.

Subp. 110. **Intruder barrier.** "Intruder barrier" means a sufficient depth of cover over radioactive waste that inhibits contact with the waste and helps to ensure that radiation exposure to an inadvertent intruder meets the performance objectives in this chapter or an engineered structure that provides equivalent protection to an inadvertent intruder.

Subp. 111. **Irradiation.** "Irradiation" means the exposure of matter to ionizing radiation.

Subp. 112. **Irradiator.** "Irradiator" means a facility that uses radioactive sealed sources for the irradiation of objects or materials and in which radiation dose rates exceeding 500 rads (5 Gy) per hour exist at one meter from the sealed radioactive sources in air or water, as applicable for the irradiator type. Irradiator does not include facilities in which both the sealed source and the area subject to irradiation are contained within a device and are not accessible to personnel.

Subp. 113. **Irradiator operator.** "Irradiator operator" means an individual who has successfully completed the training and testing described in part 4731.6160 and is authorized by the terms of the license to operate the irradiator without a supervisor present.

Subp. 114. **Irretrievable well logging source.** "Irretrievable well logging source" means any sealed source containing licensed material that is pulled off or not connected to the wireline that suspends the source in the well and for which all reasonable effort at recovery has been expended.

Subp. 115. **Land disposal facility.** "Land disposal facility" means the land, buildings and structures, and equipment that are intended to be used for the disposal of radioactive wastes. A geologic repository is not a land disposal facility.

Subp. 116. **Lay-barge radiography.** "Lay-barge radiography" means industrial radiography performed on any water vessel used for laying pipe.

Subp. 117. **Lens dose equivalent or eye dose equivalent.** "Lens dose equivalent" or "eye dose equivalent" applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Subp. 118. **License.** "License" means a license issued under this chapter.

Subp. 118a. **License issuing authority.** "License issuing authority" means the commissioner, the NRC, or the appropriate agency of an agreement state that issued the license.

Subp. 119. **Licensee.** "Licensee" means a person issued a license under this chapter.

Subp. 120. **Licensed material.** "Licensed material" means source material, special nuclear material, or radioactive material received, possessed, used, transferred, or disposed of under a general or specific license issued by the commissioner.

Subp. 121. **Licensed practitioner of the healing arts.** "Licensed practitioner of the healing arts" means a health professional for diagnostic or healing treatment of human and animal maladies who is licensed under Minnesota Statutes, chapter 147, 153, or 156, Minnesota Statutes, section 148.01 or 150A.05, subdivision 1, clause (4), or Minnesota Statutes 1961, sections 148.11 to 148.16, for the lawful practice of medicine, podiatry, veterinary medicine, chiropractic, dentistry, or osteopathic medicine, respectively.

Subp. 121a. **Licensing state.** "Licensing state" means any state that has been finally designated as a licensing state by the Conference of Radiation Control Program Directors, Inc., which reviews state regulations to establish equivalency with the suggested state regulations and ascertains whether a state has an effective program for control of natural occurring or accelerator produced radioactive material (NARM). The conference will designate as licensing states those states with regulations for control of radiation relating to, and an effective program for, the regulatory control of NARM.

Subp. 121b. **Local law enforcement agency or LLEA.** "Local law enforcement agency" or "LLEA" means a public or private organization that has been approved by a federal, state, or local government to carry firearms and make arrests, and is authorized and has the capability to provide an armed response in the jurisdiction where the licensed category 1 or category 2 quantity of radioactive material is used, stored, or transported.

Subp. 122. **Logging assistant.** "Logging assistant" means an individual who, under the personal supervision of a logging supervisor, handles sealed sources or tracers that are not in logging tools or shipping containers or who performs surveys required under part 4731.7230.

Subp. 123. **Logging supervisor.** "Logging supervisor" means an individual who uses licensed material or provides personal supervision in the use of licensed material at a temporary job site and who is responsible to the licensee for ensuring compliance with this chapter and the conditions of the license.

Subp. 124. **Logging tool.** "Logging tool" means a device used subsurface to perform well logging.

Subp. 125. **Loose-fitting facepiece.** "Loose-fitting facepiece" means a respiratory inlet covering that is designed to form a partial seal with the face.

Subp. 126. **Lost or missing licensed material.** "Lost or missing licensed material" means licensed material, the location of which is unknown. Lost or missing licensed material includes material that has been shipped but has not reached its destination and for which the location cannot be readily traced in the transportation system.

Subp. 127. **Lot tolerance percent defective.** "Lot tolerance percent defective" means, expressed in percent defective, the poorest quality in an individual inspection lot that should be accepted.

Subp. 128. **Low dose-rate remote afterloader.** "Low dose-rate remote afterloader" means a brachytherapy device that remotely delivers a dose rate of less than or equal to 200 rads (2 Gy) per hour at the point or surface where the dose is prescribed.

Subp. 129. **Low specific activity material or LSA.** "Low specific activity material" or "LSA" means radioactive material with limited specific activity that is nonfissile or is excepted under part 4731.0403, subpart 3, and that satisfies the descriptions and limits in subpart 130, 131, or 132. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. LSA material must be in group I, group II, or group III.

Subp. 130. **Low specific activity material group I.** "Low specific activity material group I" means:

A. uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radioactive radionuclides that are intended to be processed for the use of these radionuclides;

B. natural uranium, depleted uranium, natural thorium, or their compounds or mixtures, provided they are unirradiated and in solid or liquid form;

C. radioactive material, other than fissile material, for which the A_2 value is unlimited; or

D. other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the value for exempt material activity concentration determined according to part 4731.0423.

Subp. 131. **Low specific activity material group II.** "Low specific activity material group II" means:

A. water with tritium concentration up to 20.0 Ci/liter (0.8 TBq/liter); or

B. other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 10^{-4} A_2/g for solids and gases or 10^{-5} A_2/g for liquids.

Subp. 132. **Low specific activity material group III.** "Low specific activity material group III" means solids, such as consolidated wastes and activated materials, excluding powders, that satisfy the requirements in Code of Federal Regulations, title 10, section 71.77, in which:

A. the radioactive material is distributed throughout a solid or a collection of solid objects or is essentially uniformly distributed in a solid compact binding agent such as concrete, bitumen, or ceramic;

B. the radioactive material is relatively insoluble or it is intrinsically contained in a relatively insoluble material, so that even under loss of packaging, the loss of radioactive material per package by leaching, when placed in water for seven days, would not exceed 0.1 A_2; and

C. the estimated average specific activity of the solid, excluding any shielding material, does not exceed 2 x $10^{-3}$$A_2$/g.

Subp. 133. **Low toxicity alpha emitters.** "Low toxicity alpha emitters" means:

A. natural uranium, depleted uranium, natural thorium;

B. uranium-235, uranium-238, thorium-232, thorium-228, or thorium-230 when contained in ores or physical or chemical concentrates or tailings; or

C. alpha emitters with a half-life of less than ten days.

Subp. 134. **Management.** "Management" means the chief executive officer or other individual having the authority to manage, direct, or administer a licensee's activities or the delegate of a chief

executive officer or other individual having the authority to manage, direct, or administer a licensee's activities.

Subp. 135. **Manual brachytherapy.** "Manual brachytherapy" means a type of brachytherapy in which the brachytherapy sources are manually placed topically on or inserted either into the body cavities that are in close proximity to a treatment site or directly into the tissue volume.

Subp. 136. **Maximum normal operating pressure.** "Maximum normal operating pressure" means the maximum gauge pressure that would develop in a containment system in a period of one year under the heat condition specified in Code of Federal Regulations, title 10, section 71.71, paragraph (c), clause (1), in the absence of venting, external cooling by an ancillary system, or operational controls during transport.

Subp. 137. **Medical event.** "Medical event" means an event that requires a report under part 4731.4525.

Subp. 138. **Medical institution.** "Medical institution" means an organization in which more than one medical discipline is practiced.

Subp. 139. **Medical use.** "Medical use" means the intentional internal or external administration of radioactive material or the radiation from radioactive material to patients or human research subjects under the supervision of an authorized user.

Subp. 140. **Medium dose-rate remote afterloader.** "Medium dose-rate remote afterloader" means a brachytherapy device that remotely delivers a dose rate of greater than 200 rads (2 Gy), but less than or equal to 1,200 rads (12 Gy) per hour at the point or surface where the dose is prescribed.

Subp. 141. **Member of the public.** "Member of the public" means an individual other than an individual receiving an occupational dose.

Subp. 142. **Microcurie or μCi.** "Microcurie" or "μCi" means the amount of radioactive material that disintegrates at the rate of 37,000 atoms per second.

Subp. 143. **Millicurie or mCi.** "Millicurie" or "mCi" means the amount of radioactive material that disintegrates at the rate of 37,000,000 atoms per second.

Subp. 144. **Minor.** "Minor" means an individual less than 18 years of age.

Subp. 144a. **Mobile device.** "Mobile device" means a piece of equipment containing licensed radioactive material that is either mounted on wheels or casters, or otherwise equipped for moving without a need for disassembly or dismounting; or designed to be hand carried. A mobile device does not include stationary equipment installed in a fixed location.

Subp. 145. **Mobile medical service.** "Mobile medical service" means the transportation of radioactive materials and its medical use by the same licensee or registrant at a client's address.

Subp. 146. **Monitoring.** "Monitoring" means:

A. the measurement of radiation levels, concentrations, surface area concentrations, or quantities of radioactive material; and

B. the use of the results of the measurements to evaluate potential exposures and doses.

Subp. 146a. **Movement control center.** "Movement control center" means an operations center that is remote from transport activity and that maintains position information on the movement of radioactive material, receives reports of attempted attacks or thefts, provides a means for reporting these and other problems to appropriate agencies, and can request and coordinate appropriate aid.

Subp. 147. **National Voluntary Laboratory Accreditation Program or NVLAP.** "National Voluntary Laboratory Accreditation Program" or "NVLAP" is the laboratory accreditation program of the National Institute of Standards and Technology.

Subp. 147a. **Nationally tracked source.** "Nationally tracked source" means a sealed source containing a quantity equal to or greater than Category 1 or Category 2 levels of any radioactive material listed in part 4731.2820. In this context, a sealed source is defined as radioactive material that is sealed in a capsule or closely bonded, in a solid form, and which is not exempt from regulatory control. It does not mean material encapsulated solely for disposal, or nuclear material contained in any fuel assembly, subassembly, fuel rod, or fuel pellet. Category 1 nationally tracked sources are those containing radioactive material at a quantity equal to or greater than the Category 1 threshold. Category 2 nationally tracked sources are those containing radioactive material at a quantity equal to or greater than the Category 2 threshold but less than the Category 1 threshold.

Subp. 148. **Natural thorium.** "Natural thorium" means thorium with the naturally occurring distribution of thorium isotopes, essentially 100 weight percent thorium-232.

Subp. 149. **Natural uranium.** "Natural uranium" means uranium, which may be chemically separated, with the naturally occurring distribution of uranium isotopes, approximately 0.711 weight percent uranium-235, and the remainder by weight essentially uranium-238.

Subp. 150. **Naturally occurring or accelerator-produced radioactive material or NARM.** "Naturally occurring or accelerator-produced radioactive material" or "NARM" does not include by-product, source, or special nuclear material.

Subp. 151. **Negative pressure respirator (tight fitting).** "Negative pressure respirator (tight fitting)" means a respirator in which the air pressure inside the facepiece is negative during inhalation with respect to the ambient air pressure outside the respirator.

Subp. 152. **Neutron generator.** "Neutron generator" means a type of accelerator in which the ion beam is used mainly for the production of neutrons. Neutron generation is also possible for high energy photon-producing equipment.

Subp. 152a. **No-later-than arrival time.** "No-later-than arrival time" means the date and time that the shipping licensee and receiving licensee have established as the time at which an investigation will be initiated if the shipment has not arrived at the receiving facility. The no-later-than arrival time may not be more than six hours after the estimated arrival time for shipments of category 2 quantities of radioactive material.

Subp. 153. **Nonstochastic effect or deterministic effect.** "Nonstochastic effect" or "deterministic effect" means a health effect, the severity of which varies with the dose and for which a threshold is believed to exist. Radiation-induced cataract formation is an example of a nonstochastic effect.

Subp. 154. **Normal form radioactive material.** "Normal form radioactive material" means radioactive material that has not been demonstrated to qualify as special form radioactive material.

Subp. 154a. **NRC.** "NRC" means the United States Nuclear Regulatory Commission.

Subp. 155. **Occupational dose.** "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 or to radioactive material from registered, licensed, or unlicensed sources of radiation, whether in the possession of a licensee, registrant, or other person. Occupational dose does not include doses received:

A. from background radiation;

B. from any medical administration the individual has received;

C. from exposure to individuals administered radioactive materials and released according to part 4731.4427;

D. from voluntary participation in medical research programs; or

E. as a member of the public.

Subp. 156. **Offshore platform radiography.** "Offshore platform radiography" means industrial radiography conducted from a platform over a body of water.

Subp. 157. **Offshore waters.** "Offshore waters" means that area of land and water on or above the United States outer continental shelf and beyond the jurisdiction of an agreement state according to the Submerged Lands Act, United States Code, title 43, sections 1301 to 1314.

Subp. 157a. **Ophthalmic physicist.** "Ophthalmic physicist" means an individual who:

A. meets the requirements in parts 4731.4456, item A, subitem (2), and 4731.4415; and

B. is identified as an ophthalmic physicist on a:

(1) specific medical use license issued by the commissioner, the NRC, or an agreement state;

(2) permit issued by the commissioner, the NRC, or an agreement state broad scope medical use licensee;

(3) medical use permit issued by an NRC master material licensee; or

(4) permit issued by an NRC master material licensee broad scope medical use permittee.

Subp. 158. **Output.** "Output" means the exposure rate, dose rate, or a quantity related in a known manner to these rates from a brachytherapy source, teletherapy remote afterloader, or gamma stereotactic radiosurgery unit for a specified set of exposure conditions.

Subp. 159. **Package.** "Package" means the packaging together with its radioactive contents as presented for transport.

A. "Fissile material package" or "Type AF package, Type BF package, Type B(U)F package, or Type B(M)F package" means a fissile material packaging together with its fissile material contents.

B. "Type A package" means a Type A packaging together with its radioactive contents. A Type A package is defined and must comply with DOT regulations in Code of Federal Regulations, title 49, part 173.

C. "Type B package" means a Type B packaging together with its radioactive contents. On approval, a Type B package design is designated by the NRC as B(U) unless the package has a maximum normal operating pressure of more than 100 lb/in^2 (700 kPascal) gauge or a pressure relief device that would allow the release of radioactive material to the environment under the tests specified in Code of Federal Regulations, title 10, section 71.73, for hypothetical accident conditions, in which case it will receive a designation B(M). B(U) refers to the need for unilateral approval of international shipments. B(M) refers to the need for multilateral approval of international shipments. There is no distinction made in how packages with these designations may be used in domestic transportation. To determine their distinction for international transportation, see DOT regulations in Code of Federal Regulations, title 49, part 173. A Type B package approved before September 6, 1983, was designated only as Type B. Limitations on its use are specified in Code of Federal Regulations, title 10, section 71.19.

Subp. 160. **Packaging.** "Packaging" means the assembly of components necessary to ensure compliance with the packaging requirements in this chapter. Packaging may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may be designated as part of the packaging.

Subp. 161. **Panoramic dry-source-storage irradiator.** "Panoramic dry-source-storage irradiator" means an irradiator in which the irradiations occur in air in areas potentially accessible to personnel and in which the sources are stored in shields made of solid material. Panoramic dry-source-storage irradiator includes beam-type dry-source-storage irradiators in which only a narrow beam of radiation is produced for performing irradiations.

Subp. 162. **Panoramic irradiator.** "Panoramic irradiator" means an irradiator in which the irradiations occur in air in areas potentially accessible to personnel. Panoramic irradiator includes beam-type irradiators.

Subp. 163. **Panoramic wet-source-storage irradiator.** "Panoramic wet-source-storage irradiator" means an irradiator in which the irradiations occur in air in areas potentially accessible to personnel and in which the sources are stored under water in a storage pool.

Subp. 163a. **Particle accelerator.** "Particle accelerator" means any machine capable of accelerating electrons, protons, deuterons, or other charged particles in a vacuum and of discharging the resultant particulate or other radiation into a medium at energies usually in excess of one megaelectron volt (MeV). For purposes of this definition, "accelerator" is an equivalent term.

Subp. 164. **Patient intervention.** "Patient intervention" means actions by the patient or human research subject, whether intentional or unintentional, such as dislodging or removing treatment devices or prematurely terminating the administration.

Subp. 165. **Permanent radiographic installation.** "Permanent radiographic installation" means a shielded, enclosed room, cell, vault, or structure that is not moved, is not located at a temporary job site, and is designed or intended for radiography where radiography is regularly performed.

Subp. 166. **Person.** "Person" means an individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, state or political subdivision of a state, or a legal successor, representative, agent, or agency of the foregoing. Person does not include federal government agencies.

Subp. 167. **Personal supervision.** "Personal supervision" means guidance and instruction by an industrial radiographer or logging supervisor who:

A. is physically present at a temporary job site;

B. is in personal contact with an industrial radiographer's assistant or logging assistant; and

C. can give immediate assistance.

Subp. 168. **Pharmacist.** "Pharmacist" means an individual licensed by a state or territory of the United States, the District of Columbia, or the Commonwealth of Puerto Rico to practice pharmacy.

Subp. 169. **Planned special exposure.** "Planned special exposure" means an infrequent exposure to radiation, separate from and in addition to the annual dose limits.

Subp. 170. **Pool irradiator.** "Pool irradiator" means an irradiator at which the sources are stored or used in a pool of water, including panoramic wet-source-storage irradiators and underwater irradiators.

Subp. 171. **Positive pressure respirator.** "Positive pressure respirator" means a respirator in which the pressure inside the respiratory inlet covering exceeds the ambient air pressure outside the respirator.

Subp. 171a. **Positron emission tomography (PET) radionuclide production facility.** "Positron emission tomography (PET) radionuclide production facility" is defined as a facility operating a cyclotron or accelerator for the purpose of producing PET radionuclides.

Subp. 172. **Powered air-purifying respirator.** "Powered air-purifying respirator" means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Subp. 173. **Practical examination.** "Practical examination" means a demonstration through practical application of the safety rules and principles in industrial radiography, including use of all appropriate equipment and procedures.

Subp. 174. **Preceptor.** "Preceptor" means an individual who provides, directs, or verifies the training and experience required for an individual to become an authorized user, authorized medical physicist, authorized nuclear pharmacist, a radiation safety officer, or an associate radiation safety officer.

Subp. 175. **Prescribed dosage.** "Prescribed dosage" means the specified activity or range of activity of unsealed radioactive material as documented:

A. in a written directive; or

B. according to the directions of the authorized user for procedures performed according to parts 4731.4432 and 4731.4434.

Subp. 176. **Prescribed dose.** "Prescribed dose" means:

A. for gamma stereotactic radiosurgery, the total dose as documented in a written directive;

B. for teletherapy, the total dose and dose per fraction as documented in a written directive;

C. for manual brachytherapy, either the total source strength and exposure time or the total dose, as documented in a written directive; and

D. for remote brachytherapy afterloaders, the total dose and dose per fraction as documented in a written directive.

Subp. 177. **Pressure demand respirator.** "Pressure demand respirator" means a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

Subp. 178. **Principal activities.** "Principal activities" means activities authorized by the license that are essential to achieving the purpose for which the license was issued or amended. Principal activities does not include storage during which no licensed material is accessed for use or disposal or activities incidental to decontamination or decommissioning.

Subp. 179. **Product conveyor system.** "Product conveyor system" means a system for moving the product to be irradiated to, from, and within the area where irradiation takes place. Product conveyor system does not include a hand fed system.

Subp. 180. **Public dose.** "Public dose" means the dose received by a member of the public from exposure to radiation or radioactive material released by a licensee or registrant or to any other source of radiation under the control of a licensee or registrant. Public dose does not include occupational dose or doses received from background radiation, from any medical administration

the individual has received, from exposure to individuals administered radioactive material and released according to part 4731.4427, or from voluntary participation in medical research programs.

Subp. 181. **Pulsed dose-rate remote afterloader.** "Pulsed dose-rate remote afterloader" means a special type of remote afterloading brachytherapy device that uses a single source capable of delivering dose rates in the high dose-rate range, but:

A. is approximately one-tenth of the activity of typical high dose-rate remote afterloader sources; and

B. is used to simulate the radiobiology of a low dose-rate treatment by inserting the source for a given fraction of each hour.

Subp. 182. **Qualitative fit test.** "Qualitative fit test" means a pass or fail fit test to assess the adequacy of respirator fit that relies on the individual's response to the test agent.

Subp. 183. **Quality factor.**

A. "Quality factor" means the modifying factor that is used to derive dose equivalent from absorbed dose, as follows:

Type of radiation	Quality factor (Q)	Absorbed dose equal to a unit dose equivalent[a]
X-, gamma, or beta radiation	1	1
Alpha particles, multiple-charged particles, fission fragments, and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1

[a]Absorbed dose in rad equal to one rem or the absorbed dose in gray equal to one sievert.

B. If it is more convenient to measure the neutron fluence rate than to determine the neutron dose equivalent rate in rems per hour or sieverts per hour, one rem (0.01 Sv) of neutron radiation of unknown energies may, for purposes of this subpart, be assumed to result from a total fluence of 25 million neutrons per square centimeter incident upon the body. If sufficient information exists to estimate the approximate energy distribution of the neutrons, a licensee may use the fluence rate per unit dose equivalent or the appropriate Q value as follows to convert a measured tissue dose in rads to dose equivalent in rems.

Neutron energy (MeV)	Quality factor[a] (Q)	Fluence per unit dose equivalent[b] (neutrons cm^{-2} rem^{-1})
2.5×10^{-8}	2	980×10^{6}

1×10^{-7}	2	980×10^{6}
1×10^{-6}	2	810×10^{6}
1×10^{-5}	2	810×10^{6}
1×10^{-4}	2	840×10^{6}
1×10^{-3}	2	980×10^{6}
1×10^{-2}	2.5	1010×10^{6}
1×10^{-1}	7.5	170×10^{6}
5×10^{-1}	11	39×10^{6}
1	11	27×10^{6}
2.5	9	29×10^{6}
5	8	23×10^{6}
7	7	24×10^{6}
10	6.5	24×10^{6}
14	7.5	17×10^{6}
20	8	16×10^{6}
40	7	14×10^{6}
60	5.5	16×10^{6}
1×10^{2}	4	20×10^{6}
2×10^{2}	3.5	19×10^{6}
3×10^{2}	3.5	16×10^{6}
4×10^{2}	3.5	14×10^{6}

[a]Value of quality factor (Q) at the point where the dose equivalent is maximum in a 30-cm diameter cylinder tissue-equivalent phantom.

[b]Monoenergetic neutrons incident normally on a 30-cm diameter cylinder tissue-equivalent phantom.

Subp. 184. **Quantitative fit test.** "Quantitative fit test" means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Subp. 185. **Quarter.** "Quarter" means a period of time equal to one-fourth of the year observed by the licensee or registrant, approximately 13 consecutive weeks, provided that the first quarter

in a year coincides with the starting date of the year and that no day is omitted or duplicated in consecutive quarters.

Subp. 186. **Rad.** "Rad" is the special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram or 0.01 joule/kilogram (0.01 Gy).

Subp. 187. **Radiation.** "Radiation" means the emission and propagation of waves or alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation does not include nonionizing radiation such as radio or microwaves or visible, infrared, or ultraviolet light.

Subp. 188. **Radiation area.** "Radiation area" means an area accessible to individuals in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005 rem (0.05 mSv) in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Subp. 189. **Radiation detector or detector.** "Radiation detector" or "detector" means a device that in the presence of radiation provides a signal or other indication suitable for use in measuring one or more quantities of incident radiation.

Subp. 190. **Radiation hazard.** "Radiation hazard" means a condition under which individuals might receive radiation in excess of the dose limits.

Subp. 191. **Radiation protection.** "Radiation protection" means the use of shielding, protective clothing, protective equipment, and other means to eliminate or reduce exposure to ionizing radiation.

Subp. 192. **Radiation room.** "Radiation room" means a shielded room in which irradiations take place.

Subp. 193. **Radiation safety officer or RSO.** "Radiation safety officer" or "RSO" is an individual who:

A. has the training, knowledge, authority, and responsibility to apply appropriate radiation protection regulations according to part 4731.4130 on behalf of the licensee; or

B. meets the requirements in part 4731.4411, subpart 1, item A, or parts 4731.4411, subpart 1, item C, and 4731.4415 or is identified as a radiation safety officer on:

(1) a specific medical use license issued by the commissioner, the NRC, or an agreement state; or

(2) a medical use permit issued by an NRC master material licensee.

Subp. 194. **Radioactive marker.** "Radioactive marker" means licensed material used for depth determination or direction orientation. Radioactive marker includes radioactive collar markers and radioactive iron nails.

Subp. 195. **Radioactive material.** "Radioactive material" means a solid, liquid, or gaseous substance that emits radiation spontaneously.

Subp. 196. **Radioactive waste or waste.** "Radioactive waste" or "waste" means those low-level radioactive wastes containing source, special nuclear, or byproduct material that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level radioactive waste means radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in subpart 32, items B, C, and D.

Subp. 197. **Radiographic exposure device.** "Radiographic exposure device" means an instrument containing a sealed source, fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to an unshielded position for purposes of making a radiographic exposure.

Subp. 198. **Radiographic operations.** "Radiographic operations" means all activities associated with the presence of radiation sources in a radiographic exposure device, including x-ray radiographic devices, during use of the device or transport, except when being transported by a common or contract transport. Radiographic operations include surveys to confirm the adequacy of boundaries, setting up equipment, and any activity inside restricted area boundaries.

Subp. 199. **Reference man.** "Reference man" means a hypothetical aggregation of human physical and physiological characteristics arrived at by international consensus. The characteristics may be used by researchers and public health workers to standardize results of experiments and to relate biological insult to a common base.

Subp. 200. **Registrant.** "Registrant" means a person or facility registered with the commissioner or legally obligated to register with the commissioner according to this chapter.

Subp. 201. **Rem.** "Rem" is the special unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert).

Subp. 202. **Research and development.** "Research and development" means:

A. theoretical analysis, exploration, or experimentation; or

B. the extension of investigative findings and theories of a scientific or technical nature into practical application for experimental and demonstration purposes, including the 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 the radiation therefrom, to human beings, unless the research using human subjects is conducted according to part 4731.4401.

Subp. 203. **Residual radioactivity.** "Residual radioactivity" means radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from activities under a licensee's or registrant's control. Residual radioactivity includes radioactivity from all licensed and unlicensed sources used by the licensee or registrant, but excludes background radiation. Residual radioactivity includes radioactive materials remaining at a site as a result of routine or accidental releases of radioactive material at the site and previous burials at the site, even if those burials were made according to this chapter.

Subp. 204. **Respiratory protective device.** "Respiratory protective device" means an apparatus, such as a respirator, used to reduce an individual's intake of airborne radioactive materials.

Subp. 205. **Restricted area.** "Restricted area" means an area, access to which is limited by a licensee or registrant to protect individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but includes separate rooms in a residential building that are set apart as a restricted area.

Subp. 205a. **Reviewing official.** "Reviewing official" means the individual who must make the trustworthiness and reliability determination of an individual to determine whether the individual may have, or continue to have, unescorted access to the category 1 or category 2 quantities of radioactive materials that are possessed by the licensee.

Subp. 206. **Roentgen or R.** "Roentgen" or "R" is a special unit of exposure equal to 2.58 x 10^{-4} coulomb per kilogram of air. One milliroentgen (mR) equals 0.001 roentgen.

Subp. 207. **S-tube.** "S-tube" means a tube through which the radioactive source travels when inside a radiographic exposure device.

Subp. 207a. **Sabotage.** "Sabotage" means deliberate damage, with malevolent intent, to a category 1 or category 2 quantity of radioactive material, a device that contains a category 1 or category 2 quantity of radioactive material, or the components of the security system.

Subp. 207b. **Safe haven.** "Safe haven" means a readily recognizable and readily accessible site at which security is present or from which, in the event of an emergency, the transport crew can notify and wait for the local law enforcement authorities.

Subp. 208. **Sanitary sewerage.** "Sanitary sewerage" means a system of public sewers for carrying off waste water and refuse, but excluding sewage treatment facilities, septic tanks, and leach fields owned or operated by a licensee.

Subp. 209. **Sealed source.** "Sealed source" means radioactive material that is encased in a capsule designed to prevent leakage or escape of the radioactive material.

Subp. 210. **Sealed source and device registry.** "Sealed source and device registry" means the national registry that contains all the registration certificates, generated by both the NRC and agreement states, that summarize the radiation safety information for sealed sources and devices and describe the licensing and use conditions approved for the product.

Subp. 210a. **Security zone.** "Security zone" means any temporary or permanent area determined and established by the licensee for the physical protection of category 1 or category 2 quantities of radioactive material.

Subp. 211. **Self-contained breathing apparatus.** "Self-contained breathing apparatus" means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Subp. 212. **Shallow dose equivalent or H_S.** "Shallow dose equivalent" or "H_S" means the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area of one

square centimeter. Shallow dose equivalent applies to the external exposure of the skin or an extremity.

Subp. 213. **Shielded position.** "Shielded position" means the location within the radiographic exposure device or source changer where the sealed source is secured and restricted from movement.

Subp. 214. **SI.** "SI" means the international system of units.

Subp. 215. **Sievert or Sv.** "Sievert" or "Sv" is the SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor identified in subpart 183 (1 Sv = 100 rems).

Subp. 216. **Site area emergency.** "Site area emergency" means a situation in which events may occur, are in progress, or have occurred that could lead to a significant release of radioactive material and that could require a response by off-site response organizations to protect persons off-site.

Subp. 217. **Site boundary.** "Site boundary" means the line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee.

Subp. 218. **Source.** "Source" means a discrete amount of radioactive material.

Subp. 219. **Source assembly.** "Source assembly" means an assembly that consists of the sealed source and a connector that attaches the source to the control cable. The source assembly may also include a stop ball used to secure the source in the shielded position.

Subp. 220. **Source changer.** "Source changer" means a device designed and used for replacement of sealed sources in radiographic exposure devices, including those also used for transporting and storage of sealed sources.

Subp. 221. **Source holder.** "Source holder" means a housing or assembly into which a sealed source is placed to facilitate the handling and use of the source in well logging.

Subp. 222. **Source material.** "Source material" means:

A. uranium, thorium, or any combination thereof, in any physical or chemical form; or

B. ores that contain by weight 1/20 of one percent (0.05 percent) or more of:

(1) uranium;

(2) thorium; or

(3) any combination thereof.

Source material does not include special nuclear material.

Subp. 223. **Source of radiation.** "Source of radiation" means radioactive material, a device, or equipment that emits, or is capable of producing, radiation.

Subp. 224. **Special form radioactive material.** "Special form radioactive material" means radioactive material that satisfies the following conditions:

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

B. the piece or capsule has at least one dimension not less than 0.2 inches (5 mm); and

C. it satisfies the requirements of Code of Federal Regulations, title 10, section 71.75. A special form encapsulation designed according to Code of Federal Regulations, title 10, section 71.4, in effect on June 30, 1983, and constructed before July 1, 1985, a special form encapsulation designed according to Code of Federal Regulations, title 10, section 71.4, in effect on March 31, 1996, and constructed before April 1, 1998, and special form material that was successfully tested before September 10, 2015, according to the requirements of Code of Federal Regulations, title 10, section 71.75 (d), in effect before September 10, 2015, may continue to be used. Any other special form encapsulation must meet the specifications of this subpart.

Subp. 225. **Special nuclear material.** "Special nuclear material" means:

A. plutonium, uranium-233, uranium enriched in the isotope 233 or in the isotope 235, and any other material the NRC, under the Atomic Energy Act of 1954, as amended, United States Code, title 42, section 2071, determines to be special nuclear material; or

B. any material artificially enriched by a material listed in item A.

Special nuclear material does not include source material.

Subp. 226. **Specific activity.** "Specific activity" means the radioactivity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the radioactivity per unit mass of the material.

Subp. 227. **Stereotactic radiosurgery.** "Stereotactic radiosurgery" means the use of external radiation in conjunction with a stereotactic guidance device to very precisely deliver a dose to a tissue volume. Use of a gamma knife is stereotactic radiosurgery.

Subp. 228. **Stochastic effect.** "Stochastic effect" means a health effect that occurs randomly and for which the probability of the effect occurring, rather than its severity, is assumed to be a linear function of dose without threshold, such as hereditary effects and cancer incidence.

Subp. 229. **Storage area.** "Storage area" means a location, facility, or vehicle that is used to store or secure a radiographic exposure device, a storage container, or a sealed source when it is not in use and that is locked or has a physical barrier to prevent accidental exposure to, tampering with, or unauthorized removal of the device, container, or source.

Subp. 230. **Storage container.** "Storage container" means a container in which sealed sources are secured and stored.

Subp. 231. **Structured educational program.** "Structured educational program" means an educational program designed to impart particular knowledge and practical education through interrelated studies and supervised training.

Subp. 232. **Subsurface tracer study.** "Subsurface tracer study" means the release of unsealed licensed material or a substance labeled with licensed material in a single well or boring to trace the movement or position of the material or substance in the well, boring, or adjacent formation.

Subp. 233. **Supplied-air respirator or airline respirator.** "Supplied-air respirator" or "airline respirator" means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

Subp. 234. **Surface casing for protecting freshwater aquifers.** "Surface casing for protecting freshwater aquifers" means a pipe or tube used as a lining in a well or boring to isolate freshwater aquifers from the well or boring.

Subp. 235. **Surface contaminated object or SCO.** "Surface contaminated object" or "SCO" means a solid object that is not itself classed as radioactive material, but that has radioactive material distributed on any of its surfaces. SCO must be in one of two groups, with surface activity not exceeding the following limits:

A. SCO-I is a solid object on which:

(1) the nonfixed contamination on the accessible surface averaged over 300 cm^2, or the area of the surface if less than 300 cm^2, does not exceed:

(a) 10^{-4} $\mu Ci/cm^2$ (4 Bq/cm^2) for beta and gamma and low toxicity alpha emitters; or

(b) 10^{-5} $\mu Ci/cm^2$ (0.4 Bq/cm^2) for all other alpha emitters;

(2) the fixed contamination on the accessible surface averaged over 300 cm^2, or the area of the surface if less than 300 cm^2, does not exceed:

(a) 1.0 $\mu Ci/cm^2$ (4 x 10^4 Bq/cm^2) for beta and gamma and low toxicity alpha emitters; or

(b) 0.1 $\mu Ci/cm^2$ (4 x 10^3 Bq/cm^2) for all other alpha emitters; and

(3) the nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2, or the area of the surface if less than 300 cm^2, does not exceed:

(a) 1.0 $\mu Ci/cm^2$ (4 x 10^4 Bq/cm^2) for beta and gamma and low toxicity alpha emitters; or

(b) 0.1 $\mu Ci/cm^2$ (4 x 10^3 Bq/cm^2) for all other alpha emitters; and

B. SCO-II is a solid object on which the limits for SCO-I are exceeded and on which:

(1) the nonfixed contamination on the accessible surface averaged over 300 cm^2, or the area of the surface if less than 300 cm^2, does not exceed:

(a) 10^{-2} μCi/cm^2 (400 Bq/cm^2) for beta and gamma and low toxicity alpha emitters; or

(b) 10^{-3} μCi/cm^2 (40 Bq/cm^2) for all other alpha emitters;

(2) the fixed contamination on the accessible surface averaged over 300 cm^2, or the area of the surface if less than 300 cm^2, does not exceed:

(a) 20 μCi/cm^2 (8 x 10^5 Bq/cm^2) for beta and gamma and low toxicity alpha emitters; or

(b) 2 μCi/cm^2 (8 x 10^4 Bq/cm^2) for all other alpha emitters; and

(3) the nonfixed contamination plus the fixed contamination on the inaccessible surface averaged over 300 cm^2, or the area of the surface if less than 300 cm^2, does not exceed:

(a) 20 μCi/cm^2 (8 x 10^5 Bq/cm^2) for beta and gamma and low toxicity alpha emitters; or

(b) 2 μCi/cm^2 (8 x 10^4 Bq/cm^2) for all other alpha emitters.

Subp. 236. **Survey or radiation safety survey.** "Survey" or "radiation safety survey" means an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation. When appropriate, such an evaluation includes a physical survey of the location of radioactive material or other radiation sources and measurements or calculations of levels of radiation or concentrations or quantities of radioactive material present.

Subp. 237. **Target.** "Target" means the part of a radiation-producing system that by design intercepts a beam of accelerated particles with subsequent emission of other radiation.

Subp. 237a. **Telemetric position monitoring system.** "Telemetric position monitoring system" means a data transfer system that captures information by instrumentation and measuring devices about the location and status of a transport vehicle or package between the departure and destination locations.

Subp. 238. **Teletherapy.** "Teletherapy" means a method of radiation therapy in which collimated gamma rays are delivered at a distance from the patient or human research subject.

Subp. 239. **Temporary job site.** "Temporary job site" means a location where licensed operations are conducted and where licensed or registered material may be stored, other than those locations of use authorized on the license or registration.

Subp. 240. **Therapeutic dosage.** "Therapeutic dosage" means a dosage of unsealed radioactive material that is intended to deliver a radiation dose to a patient or human research subject for palliative or curative treatment.

Subp. 241. **Therapeutic dose.** "Therapeutic dose" means a radiation dose delivered from a source containing radioactive material to a patient or human research subject for palliative or curative treatment.

Subp. 242. **Tight-fitting facepiece.** "Tight-fitting facepiece" means a respiratory inlet covering that forms a complete seal with the face.

Subp. 243. **Total effective dose equivalent or TEDE.** "Total effective dose equivalent" or "TEDE" means the sum of the effective dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.

Subp. 244. **Traceable to a standard.** "Traceable to a standard" means a comparison directly to a standard maintained by the National Institute of Standards and Technology, provided that all comparisons are documented.

Subp. 245. **Transient shipment.** "Transient shipment" means a shipment of nuclear material originating and terminating in foreign countries on a vessel or aircraft that stops at a United States port.

Subp. 246. **Transport index.** "Transport index" means the dimensionless number, rounded up to the next tenth, placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is the number determined by multiplying the maximum radiation level in millisievert (mSv) per hour at 3.3 feet (one meter) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 3.3 feet (one meter)).

Subp. 247. **Treatment site.** "Treatment site" means the anatomical description of the tissue intended to receive a radiation dose, as described in a written directive.

Subp. 247a. **Tribal official.** "Tribal official" means the highest ranking individual that represents Tribal leadership, such as the chief, president, or Tribal council leadership.

Subp. 248. **Tritium neutron generator target source.** "Tritium neutron generator target source" means a tritium source used within a neutron generator tube to produce neutrons for use in well logging applications.

Subp. 248a. **Trustworthiness and reliability.** "Trustworthiness and reliability" means characteristics of an individual considered dependable in judgment, character, and performance, such that unescorted access to category 1 or category 2 quantities of radioactive material by that individual does not constitute an unreasonable risk to public health and safety or security. A determination of trustworthiness and reliability for this purpose is based upon the results from a background investigation.

Subp. 249. **Type A quantity.** "Type A quantity" means a quantity of radioactive material, the aggregate radioactivity of which does not exceed A_1 for special form radioactive material or A_2 for normal form radioactive material where A_1 and A_2 are given in part 4731.0422 or determined by procedures described in part 4731.0423.

Subp. 250. **Type B quantity.** "Type B quantity" means a quantity of radioactive material greater than a Type A quantity.

Subp. 251. **Type of use.** "Type of use" means use of radioactive material under part 4731.4404, 4731.4432, 4731.4434, 4731.4440, 4731.4450, 4731.4460, or 4731.4463.

Subp. 252. **Underwater irradiator.** "Underwater irradiator" means an irradiator in which the sources always remain shielded under water and humans do not have access to the sealed sources or the space subject to irradiation without entering the pool.

Subp. 253. **Underwater radiography.** "Underwater radiography" means industrial radiography performed when the radiographic exposure device or related equipment are beneath the surface of the water.

Subp. 253a. **Unescorted access.** "Unescorted access" means solitary access to an aggregated category 1 or category 2 quantity of radioactive material or the devices that contain the material.

Subp. 253b. **Unirradiated uranium.** "Unirradiated uranium" means uranium containing not more than 2×10^3 Bq of plutonium per gram of uranium-235, not more than 9×10^6 Bq of fission products per gram of uranium-235, and not more than 5×10^{-3} gram of uranium-236 per gram of uranium-235.

Subp. 254. **Unit dosage.** "Unit dosage" means a dosage prepared for medical use in a single patient or human research subject without any further manipulations of the dosage after it is initially prepared.

Subp. 255. **Unrefined and unprocessed ore.** "Unrefined and unprocessed ore" means ore in its natural form prior to any processing, such as grinding, roasting, or beneficiating, or refining. Processing does not include sieving or encapsulation of ore or preparation of samples for laboratory analysis.

Subp. 256. **Unrestricted area.** "Unrestricted area" means an area, the access to which is neither limited nor controlled by the licensee or registrant.

Subp. 257. **Uranium sinker bar.** "Uranium sinker bar" means a weight containing depleted uranium used to pull a logging tool toward the bottom of a well.

Subp. 258. **User seal check or fit check.** "User seal check" or "fit check" means an action by the respirator user to determine if the respirator is properly seated to the face, including a negative pressure check, positive pressure check, irritant smoke check, or isoamyl acetate check.

Subp. 259. **Very high radiation area.** "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 (5 Gy) in one hour at one meter from a radiation source or one meter from any surface that the radiation penetrates. At very high doses received at high dose rates, units of absorbed dose (rads and grays) are appropriate, rather than units of dose equivalent (rems and sieverts).

Subp. 260. **Week.** "Week" means seven consecutive days.

Subp. 261. **Weighting factor or W_T.** "Weighting factor" or "W_T" for an organ or tissue (T) is 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 surface	0.03
Remainder	0.30[1]
Whole Body	1.00[2]

[1]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.

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

Subp. 262. **Well.** "Well" has the meaning given in Minnesota Statutes, section 103I.005, subdivision 21.

Subp. 263. **Well logging or logging.** "Well logging" or "logging" means all operations involving the lowering and raising of measuring devices or tools that contain licensed material or are used to detect licensed materials in wells or borings to obtain information about the well, boring, or adjacent formations, which may be used in oil, gas, mineral, groundwater, or geological exploration.

Subp. 264. **Whole body.** "Whole body" means, for purposes of external exposure, head, trunk including male gonads, arms above the elbow, or legs above the knee.

Subp. 265. **Worker.** "Worker" means an individual who engages in activities that are licensed or registered by the commissioner and that are controlled by a licensee. Worker does not include a licensee or registrant.

Subp. 266. **Working level.** "Working level" is any combination of short-lived radon daughters in one liter of air that results in the ultimate emission of 1.3×10^5 MeV of potential alpha particle energy. Radon daughters include:

A. for radon-220: polonium-216, lead-212, bismuth-212, and polonium-212; and

B. for radon-222: polonium-218, lead-214, bismuth-214, and polonium-214.

Subp. 267. **Working level month.** "Working level month" means an exposure to one working level for 170 hours (2,000 working hours per year/12 months per year=approximately 170 hours per month).

Subp. 268. **Written directive.** "Written directive" means an authorized user's written order for the administration of radioactive material or radiation from radioactive material to a specific patient or human research subject, as specified under part 4731.4408.

Subp. 269. **Year.** "Year" means the 12-month period of time used to determine compliance with this chapter, beginning in January unless the licensee changes the starting date of the 12-month period used to determine compliance by the licensee, provided that the change is made at the beginning of the year and that no day is omitted or duplicated in consecutive years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 40 SR 145; L 2016 c 119 s 7; 44 SR 239; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.0200 GENERAL APPLICATIONS.

Subpart 1. **Applicability.**

A. This chapter consists of rules for the regulation of radiation from radioactive materials, including source and special nuclear material not sufficient to form a critical mass and other nonpower plant radiation hazards. Except as otherwise specifically provided, this chapter applies to all persons who own, receive, possess, use, transfer, acquire, or dispose of any radioactive material.

B. Nothing in this chapter applies to a person to the extent that the person is subject to rules of the NRC or to sources in the possession of federal agencies.

C. Nothing in this chapter relieves a licensee from complying with applicable Food and Drug Administration requirements or any other federal and state requirements governing radioactive drugs or devices or any other toxic or hazardous properties of materials that may be disposed of under this chapter.

Subp. 2. **Exemptions or variances.** The commissioner may, according to parts 4717.7000 to 4717.7050, grant an exemption or variance from the requirements of this chapter, if it is determined to be authorized by law, would not endanger life or property, and is otherwise in the public interest.

Subp. 3. **Responsibilities.**

A. Responsibilities of licensees include compliance with applicable parts of this chapter that are consistent with each licensee's area of use.

B. It is the responsibility of each applicant or licensee to notify the commissioner of any change in information related to the regulated activity that has an impact on public health and safety

according to this subpart. Notification must be provided to the commissioner within two working days of identifying the information. This item does not apply to information that a person is otherwise required to provide to the commissioner by other reporting requirements of this chapter.

C. Information provided to the commissioner by an applicant for a license must be complete and accurate in all material submitted.

Subp. 4. **Submissions.** Except as otherwise specified in this chapter, all communications and reports under this chapter must be addressed to or delivered in person to: Radioactive Materials Unit, Minnesota Department of Health, 625 Robert Street N, P.O. Box 64975, St. Paul, MN 55164-0975.

Subp. 5. **Telephone notifications.** Telephone notifications required by this chapter must be made to the Radioactive Materials Unit at 651-201-4400. If an immediate or 24-hour notification is required after business hours or if no one can be reached at the contact telephone number, notify the Minnesota duty officer at 651-649-5451 or 1-800-422-0798.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0210 RECORDS.

Subpart 1. **Applicability.** Each person who receives source or radioactive material pursuant to a license issued under this chapter must keep records showing the receipt, transfer, and disposal of the source or radioactive material. Subparts 2 to 5 are in addition to other applicable rules in this chapter pertaining to records. If there is a conflict between this chapter, a license condition, or other written commissioner approval or authorization pertaining to the retention period for the same type of record, the longest retention period specified takes precedence.

Subp. 2. **Format and safeguarding.**

A. A record required under this chapter must be legible throughout the specified retention period. The record may be:

(1) the original;

(2) a reproduced copy;

(3) a microform, if authorized personnel authenticate the copy or microform and the microform is capable of producing a clear copy throughout the required retention period; or

(4) stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period.

B. Records, such as letters, drawings, and specifications, must include all pertinent information, such as stamps, initials, and signatures.

C. A licensee must maintain adequate safeguards against tampering with and loss of records.

Subp. 3. **Reporting units.** A licensee must use the units curie, rad, or rem or the international systems of units (SI) as appropriate, including multiples and subdivisions, and must clearly indicate the units of all quantities on records required under this chapter.

Subp. 4. **Shipment manifests.** Notwithstanding the requirements of subpart 3, when recording information on shipment manifests, required under part 4731.2450, subpart 2, information must be recorded in SI units or in SI and units as specified in subpart 3.

Subp. 5. **Distinguishing quantities.** A licensee must make a clear distinction among the quantities entered on records required under this chapter, for example, among the quantities of total effective dose equivalent, shallow dose equivalent, lens dose equivalent, deep dose equivalent, and committed effective dose equivalent.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0230 REQUEST FOR WRITTEN STATEMENTS.

The commissioner may at any time after the filing of an original application, and before the expiration of a license, require further statements to enable the commissioner to determine whether the application should be granted or denied or whether a license should be revoked.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0240 DATA PRIVACY.

Collection, security, and dissemination of information gathered for a license or registration is governed by Minnesota Statutes, chapter 13.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0250 INSPECTIONS AND TESTING.

Subpart 1. **Inspections.**

A. A licensee or registrant must afford to the commissioner or commissioner's designee, at all reasonable times, opportunity to inspect radioactive material and the premises and facilities wherein the radioactive material is used or stored for compliance with this chapter.

B. A licensee or registrant must make available to the commissioner or commissioner's designee for inspection, upon reasonable notice, records kept by the licensee or registrant according to this chapter.

Subp. 2. **Tests.** A licensee or registrant must perform, or permit the commissioner or commissioner's designee to perform, such tests as the commissioner deems appropriate or necessary for the administration of this chapter, including tests of:

A. radioactive material;

B. facilities wherein the radioactive material is utilized or stored;

C. radiation detection and monitoring instruments; and

D. other equipment and devices used in connection with the utilization or storage of radioactive material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *October 3, 2013*

4731.0260 VIOLATIONS, ENFORCEMENT, AND PENALTIES.

Violations found by a routine inspection, complaint based inspection, incident or accident inspection, or other inspection deemed necessary by the commissioner must be brought into compliance within 30 days from the date of the inspection report or as otherwise instructed in writing. All violations are subject to penalty under Minnesota Statutes, sections 144.989 to 144.993.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0270 MODIFICATION AND REVOCATION OF LICENSES.

Subpart 1. **Modification.** The terms and conditions of a license are subject to amendment, revision, or modification for compliance with this chapter or orders issued according to this chapter.

Subp. 2. **Revocation and suspension.** A license may be revoked, suspended, or modified, in whole or in part:

A. for any materially false statement in an application or any false statement of fact required under this chapter;

B. because of conditions revealed by an application, a statement of fact, a report, a record, an inspection, or other means that would warrant the commissioner to refuse to grant a license on an original application; or

C. for violation of or failure to observe any of the terms and provisions of this chapter or an order of the commissioner.

Subp. 3. **Notice of noncompliance.** Except in cases of willfulness or when the public health, interest, or safety requires otherwise, the commissioner shall not modify, suspend, or revoke a license unless, prior to the institution of proceedings, facts or conduct that warrant such action are

called to the attention of the licensee in writing and the licensee is accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

Subp. 4. **Possession upon modification.** Upon revocation, suspension, or modification of a license, the commissioner may immediately take possession of all radioactive material held by the licensee.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0280 DELIBERATE MISCONDUCT.

Subpart 1. **Applicability.** This part applies to:

A. a licensee, registrant, industrial radiography certificate holder, or quality assurance program approval holder;

B. an applicant for a license or registration, applicant for industrial radiography certificate, or applicant for quality assurance program approval;

C. a contractor, including a supplier or consultant, or subcontractor to any person identified in this subpart; or

D. an employee of any person identified in this subpart.

Subp. 2. **Prohibition.** A person identified in subpart 1 who knowingly provides to any entity listed in subpart 1, any components, equipment, materials, or other goods or services that relate to a licensee's, industrial radiography certificate holder's, quality assurance program approval holder's, registrant's, or applicant's activities in this chapter may not:

A. engage in deliberate misconduct that causes or would have caused, if not detected, any entity listed in subpart 1 to be in violation of a rule; an order; a regulation; or a term, condition, or limitation of a license, certificate, approval, or registration issued by the commissioner; or

B. deliberately submit to the commissioner, a licensee, a registrant, an industrial radiography certificate holder, a quality assurance program approval holder, an applicant for a license, certificate, or quality assurance program approval, or a licensee's, registrant's, or applicant's contractor or subcontractor, any information that the person submitting the information knows to be incomplete or inaccurate in some respect material to the commissioner.

Subp. 3. **Enforcement.** A person who violates this part may be subject to enforcement action under part 4731.0260.

Subp. 4. **Definition.** For purposes of this part, deliberate misconduct by a person means an intentional act or omission that the person knows:

A. would cause a licensee, registrant, or applicant to be in violation of a rule, an order, or a term, condition, or limitation of a license issued by the commissioner; or

B. constitutes a violation of a requirement, procedure, instruction, contract, purchase order, or policy of a licensee, registrant, applicant, contractor, or subcontractor.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*
Published Electronically: *March 12, 2009*

4731.0290 EMPLOYEE PROTECTION.

Employee protection and employment discrimination issues are governed by Minnesota Statutes, sections 181.931 to 181.935.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0300 FEDERAL JURISDICTION EXCLUSION.

In areas under exclusive federal jurisdiction, nothing in this chapter applies to the extent that the persons are subject to regulation by the NRC or other federal agencies.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0315 CRITICAL MASS.

Subpart 1. **Calculation.**

A. For purposes of this chapter, special nuclear material in quantities not sufficient to form a critical mass means:

(1) uranium enriched with the isotope U-235 in quantities not exceeding 350 grams of contained U-235;

(2) uranium-233 in quantities not exceeding 200 grams;

(3) plutonium in quantities not exceeding 200 grams; or

(4) any combination of special nuclear material under subitems (1) to (3) according to the formula in item B.

B. For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity under item A for the same kind of special nuclear material. The sum of the ratios for all kinds of special nuclear materials in combination must not exceed unity. For example, the following quantities in combination would not exceed the limitation and are within the formula, as follows:

(175 grams U-235/350) + (50 grams U-233/200) + (50 grams Pu/200) = 1

Subp. 2. **Exemption.** To determine whether the exemption granted in Code of Federal Regulations, title 10, part 150.10, applies to the receipt, possession, or use of special nuclear material at any particular plant or other authorized location of use, a person must include in the quantity computed according to subpart 1 the total quantity of special nuclear material that the person is authorized to receive, possess, or use at the plant or other location of use at any one time.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0355 RECIPROCITY.

Subpart 1. **Application; recognition.**

A. Subject to this chapter, a person who holds a specific license from the NRC or an agreement state, and issued by the agency having jurisdiction where the licensee maintains an office for directing the licensed activity and at which radiation safety records are normally maintained, may apply for reciprocity. Once reciprocity is approved, the out-of-state licensee is granted a general license to conduct the activities authorized in the NRC or agreement state license within this state for a period not in excess of 180 days in a calendar year.

B. Applications for reciprocal recognition of licenses issued by the NRC or other agreement states may be made by completing a report of proposed activity reciprocity form prescribed by the commissioner. The form may be obtained by contacting the Radioactive Materials Unit, Minnesota Department of Health, 625 Robert Street N, P.O. Box 64975, St. Paul, MN 55164-0975.

C. The application must be signed and dated by the radiation safety officer or the responsible management representative.

D. The applicant must submit a copy of the current licensing document. The licensing document must not limit the activity authorized by the document to specified installations or locations.

E. The applicant must pay the reciprocity fee under Minnesota Statutes, section 144.1205.

Subp. 2. **Review and inspection.**

A. The commissioner shall review applications for reciprocity for compliance with this chapter. The commissioner may withdraw, limit, or qualify acceptance of a specific license or equivalent licensing document issued by the NRC or an agreement state or a product distributed under the licensing document upon determining that the action is necessary to prevent undue hazard to public health and safety or property.

B. Inspections by the commissioner may be performed on any licensee who has been granted a reciprocal license.

Subp. 3. **Notification.**

A. An out-of-state licensee approved for reciprocity must notify the commissioner in writing at least three days before engaging in activities in the state. The notification must include:

(1) the name of the company for whom service will be performed;

(2) the name and telephone number of the individual representing the company under subitem (1);

(3) the location where services will be performed;

(4) the start date;

(5) the duration of the service;

(6) the type of service to be performed;

(7) the name of individuals performing the service; and

(8) identification of the sources of radiation to be used.

B. The out-of-state licensee must:

(1) notify the commissioner in advance of any changes in the work location, schedule, radioactive material, or work activities;

(2) comply with this chapter and with all the terms and conditions of the licensing document, except any terms and conditions that may be inconsistent with this chapter; and

(3) supply any other information requested by the commissioner.

C. The out-of-state licensee must not transfer or dispose of radioactive material possessed or used under the general license under this part except by transfer to a person who is specifically licensed by the NRC or an agreement state to receive the material.

D. If, for a specific case, the three-day notification period would impose an undue hardship on the out-of-state licensee, the licensee may, upon written application to the commissioner, obtain permission to proceed sooner.

Subp. 4. **Jurisdictional status.**

A. A licensee must determine the jurisdictional status of a temporary job site before radioactive materials may be used at a job site at any federal facility within the state. If the jurisdictional status is unknown, the licensee must contact the federal agency that controls the site to determine if the job site is under exclusive federal jurisdiction.

B. A licensee must obtain authorization from the NRC or an agreement state before radioactive material may be used at a temporary job site in another state. Authorization may be obtained by applying for reciprocity or a specific license from the state or the NRC in areas of exclusive federal jurisdiction.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 40 SR 145; 44 SR 239*
Published Electronically: *September 13, 2019*

TRANSPORTATION OF LICENSED MATERIAL

4731.0400 SCOPE; ENFORCEMENT NOTICE.

Subpart 1. **Scope.** Parts 4731.0400 to 4731.0424 establish requirements for the packaging, preparation for shipment, and transportation of licensed material.

Subp. 2. **Application of other law.** The packaging and transport of licensed material are subject to this chapter and the regulations of other agencies, such as the NRC, DOT, and United States Postal Service, having jurisdiction over means of transport. The requirements of parts 4731.0400 to 4731.0424 are in addition to, and not in substitution for, other requirements.

Subp. 3. **Applicability.** Parts 4731.0400 to 4731.0424 apply to any licensee authorized by a specific or general license issued by the commissioner to receive, possess, use, or transfer licensed material, if the licensee delivers that material to a carrier for transport, transports the material outside the site of usage as specified in an NRC or agreement state license, or transports that material on public highways. Parts 4731.0400 to 4731.0424 do not authorize possession of licensed material.

Subp. 4. **Definitions.** The following definitions apply to parts 4731.0400 to 4731.0424.

A. Contamination means the presence of a radioactive substance on a surface in quantities in excess of 1×10^{-5} $\mu Ci/cm^2$ (0.4 Bq/cm^2) for beta and gamma emitters and low-toxicity alpha emitters, or (1×10^{-6} $\mu Ci/cm^2$) 0.04 $Bq/cm^2$for all other alpha emitters.

B. Fixed contamination means contamination that cannot be removed from a surface during normal conditions of transport.

C. Nonfixed contamination means contamination that can be removed from a surface during normal conditions of transport.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0401 REQUIREMENT FOR LICENSE.

No licensee shall deliver licensed material to a carrier for transport or transport licensed material, except as authorized in a general license or a specific license issued by the commissioner or as exempted under parts 4731.0400 to 4731.0424.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0402 TRANSPORTATION OF LICENSED MATERIAL.

Subpart 1. **DOT regulations.**

A. A licensee who transports licensed material outside of the site of usage, as specified in a license issued by the NRC or an agreement state, or where transport is on public highways or a licensee who delivers licensed material to a carrier for transport must comply with the applicable DOT regulations in Code of Federal Regulations, title 49, parts 107, 171 to 180, and 390 to 397, appropriate to the mode of transport.

B. A licensee must particularly note DOT regulations in the following areas:

(1) packaging, Code of Federal Regulations, title 49, part 173, subparts A, B, and I;

(2) marking and labeling, Code of Federal Regulations, title 49, part 172, subparts D and E, sections 172.400 to 172.407 and 172.436 to 172.441;

(3) placarding, Code of Federal Regulations, title 49, part 172, subpart F, especially sections 172.500 to 172.519 and 172.556, and appendices B and C;

(4) accident reporting, Code of Federal Regulations, title 49, sections 171.15 and 171.16;

(5) shipping papers and emergency information, Code of Federal Regulations, title 49, part 172, subparts C and G;

(6) hazardous material employee training, Code of Federal Regulations, title 49, part 172, subpart H;

(7) security plans, Code of Federal Regulations, title 49, part 172, subpart I; and

(8) hazardous material shipper and carrier registration, Code of Federal Regulations, title 49, part 107, subpart G.

C. A licensee must also note DOT regulations pertaining to the following modes of transportation:

(1) rail, Code of Federal Regulations, title 49, part 174, subparts A to D and K;

(2) air, Code of Federal Regulations, title 49, part 175;

(3) vessel, Code of Federal Regulations, title 49, part 176, subparts A to F and M; and

(4) public highways, Code of Federal Regulations, title 49, parts 177 and 390 to 397.

Subp. 2. **Compliance; waiver.** If DOT regulations are not applicable to a shipment of licensed material, a licensee must conform to the standards and requirements of the DOT specified in subpart 1 to the same extent as if the shipment or transportation were subject to DOT regulations. A request for modification, waiver, or exemption from those requirements, and any notification referred to in those requirements, must be filed with or made to the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*
Published Electronically: *March 12, 2009*

4731.0403 SPECIFIC EXEMPTIONS.

Subpart 1. **Physicians.** A physician licensed by a state to dispense drugs in the practice of medicine is exempt from part 4731.0402 with respect to transport by the physician of licensed material for use in the practice of medicine. A physician operating under this exemption must be licensed under parts 4731.4400 to 4731.4527 or equivalent regulations of the NRC or an agreement state.

Subp. 1a. **Grounds.** On application of any interested person or on the commissioner's own initiative, the commissioner may grant any exemption from parts 4731.0400 to 4731.0424 that the commissioner determines is authorized by law and will not endanger life or property nor the common defense and security.

Subp. 2. **Low-level materials.** A licensee is exempt from the requirements of parts 4731.0400 to 4731.0424 with respect to shipment or carriage of a package of the following low-level material:

A. natural material and ores containing naturally occurring radionuclides that are either in their natural state, or have only been processed for purposes other than for the extraction of the radionuclides, and that are not intended to be processed for use of these radionuclides, provided the activity concentration of the material does not exceed ten times the applicable radionuclide activity concentration values specified in part 4731.0422, subpart 3;

B. materials for which the activity concentration is not greater than the activity concentration values specified in part 4731.0422, subpart 3, or for which the consignment activity is not greater than the limit for an exempt consignment under part 4731.0422, subpart 3; and

C. nonradioactive solid objects with radioactive substances present on any surfaces in quantities that do not exceed the levels cited in the definition of contamination in part 4731.0400, subpart 4, item A.

Subp. 3. **Exemption from classification as fissile material.** Fissile material meeting at least one of the requirements in items A to F is exempt from classification as fissile material and from the fissile material package standards of Code of Federal Regulations, title 10, sections 71.55 and 71.59, but is subject to all other requirements of this chapter, except as noted:

A. an individual package containing two grams or less of fissile material;

B. individual or bulk packaging containing 15 grams or less of fissile material, provided the package has at least 200 grams of solid nonfissile material for every gram of fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass for solid nonfissile material;

C. low concentrations of solid fissile material commingled with solid nonfissile material, provided that:

(1) there is at least 2,000 grams of solid nonfissile material for every gram of fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but may not be included in determining the required mass of solid nonfissile material; and

(2) there is no more than 180 grams of fissile material distributed within 360 kilograms of contiguous nonfissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but may not be included in determining the required mass of solid nonfissile material;

D. uranium enriched in uranium-235 to a maximum of one percent by weight, and with total plutonium and uranium-233 content of up to one percent of the mass of uranium-235, provided that the mass of any beryllium, graphite, and hydrogenous material enriched in deuterium constitutes less than five percent of the uranium mass, and that the fissile material is distributed homogenously and does not form a lattice arrangement within the package;

E. liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of two percent by mass, with a total plutonium and uranium-233 content not exceeding 0.002 percent of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio (N/U) of two. The material must be contained in at least a DOT Type A package; or

F. packages containing, individually, a total plutonium mass of not more than 1,000 grams, of which not more than 20 percent by mass may consist of plutonium-239, plutonium-241, or any combination of these radionuclides.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0405 [Repealed, 32 SR 831]

Published Electronically: *March 12, 2009*

4731.0406 GENERAL LICENSE; NRC-APPROVED PACKAGE.

Subpart 1. **License to transport or deliver.** A general license is issued to any licensee of the commissioner to transport, or to deliver to a carrier for transport, licensed material in a package for which a license, certificate of compliance, or other approval has been issued by the NRC.

Subp. 2. **Approved quality assurance program.** The general license issued under subpart 1 applies only to a licensee who has a quality assurance program approved by the commissioner as complying with part 4731.0420.

Subp. 3. **Compliance with conditions.** Each licensee issued a general license under subpart 1 must:

A. maintain a copy of the certificate of compliance or other approval of the package and have the drawings and other documents referenced in the approval relating to the use and maintenance of the packaging and to the actions to be taken before shipment;

B. comply with the terms and conditions of the license, certificate, or other approval, as applicable, and the applicable requirements of this chapter and Code of Federal Regulations, title 10, part 71, subpart H; and

C. submit in writing to the NRC, before the licensee's first use of the package, the licensee's name and license number and the package identification number specified in the package approval. For the submittal to the NRC, the licensee must use an approved method listed in the Code of Federal Regulations, title 10, section 71.1(a), addressed to: ATTN: Document Control Desk, Director, Division of Fuel Management, Office of Nuclear Material Safety and Safeguards.

Subp. 4. **Package approval.** The general license issued under subpart 1 applies only when the package approval authorizes use of the package under the general license under subpart 1.

Subp. 5. **Type B or fissile material package.** For a Type B or fissile material package, the design of which was approved by the NRC before April 1, 1996, the general license under subpart 1 is subject to the additional restrictions of Code of Federal Regulations, title 10, section 71.19.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.0407 [Repealed, 44 SR 239]

Published Electronically: *September 13, 2019*

4731.0408 MR 2008 [Expired]

Published Electronically: *March 12, 2009*

4731.0409 GENERAL LICENSE; FOREIGN-APPROVED PACKAGE.

Subpart 1. **License for foreign-approved package.** A general license is issued to any licensee of the commissioner to transport, or to deliver to a carrier for transport, licensed material in a package the design of which has been approved in a foreign national competent authority certificate that has been revalidated by the DOT as meeting the applicable requirements of Code of Federal Regulations, title 49, section 171.23.

Subp. 2. **Approved quality assurance program.** Except as otherwise provided in parts 4731.0400 to 4731.0424, the general license issued under subpart 1 applies only to a licensee who has a quality assurance program approved by the commissioner as complying with part 4731.0420.

Subp. 3. **Use outside United States.** The general license issued under subpart 1 applies only to shipments made to or from locations outside the United States.

Subp. 4. **Certificate conditions.** Each licensee issued a general license under subpart 1 must:

A. maintain a copy of the applicable certificate, the revalidation, and the drawings and other documents referenced in the certificate relating to the use and maintenance of the packaging and to the actions to be taken before shipment; and

B. comply with the terms and conditions of the certificate and revalidation and with the applicable requirements of this chapter and Code of Federal Regulations, title 10, part 71, subpart H.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0410 GENERAL LICENSE; FISSILE MATERIAL.

Subpart 1. **License to transport or deliver fissile material.** A general license is issued to any licensee of the commissioner to transport fissile material, or to deliver fissile material to a carrier for transport, if the material is shipped according to this part. The fissile material need not be contained in a package that meets the standards of part 4731.0412 and Code of Federal Regulations, title 10, sections 71.41 to 71.77, if the material is shipped according to this part. However, the material must be contained in a Type A package. The Type A package must also meet the DOT requirements in Code of Federal Regulations, title 49, section 173.417(a).

Subp. 2. **Approved quality assurance program.** The general license issued under subpart 1 applies only to a licensee who has a quality assurance program approved by the NRC as complying with Code of Federal Regulations, title 10, part 71, subpart H.

Subp. 3. **Type A quantity limits.** The general license issued under subpart 1 applies only when a package's contents:

A. contain less than a Type A quantity of fissile material; and

B. contain less than 500 total grams of beryllium, graphite, or hydrogenous material enriched in deuterium.

Subp. 4. **Fissile material labeled with a criticality safety index.**

A. The general license applies only to packages containing fissile material that are labeled with a criticality safety index that:

(1) has been determined according to subpart 7; and

(2) has a value less than or equal to ten.

B. For a shipment of multiple packages containing fissile material, the sum of the criticality safety indices must be less than or equal to 50 for shipment on a nonexclusive use conveyance and less than or equal to 100 for shipment on an exclusive use conveyance.

Subp. 5. [Repealed, 32 SR 831]

Subp. 6. [Repealed, 32 SR 831]

Subp. 7. **Criticality safety index values.**

A. The value for the criticality safety index must be greater than or equal to the number calculated by the following equation:

$$\text{CSI} = 10 \left[\frac{\text{grams of } ^{235}\text{U}}{\text{X}} + \frac{\text{grams of } ^{233}\text{U}}{\text{Y}} + \frac{\text{grams of Pu}}{\text{Z}} \right]$$

B. The calculated criticality safety index must be rounded up to the first decimal place.

C. The values of X, Y, and Z used in the criticality safety index equation must be taken from subpart 8 or 9, as appropriate.

D. If subpart 9 is used to obtain the value of X, then the values for the terms in the equation for uranium-233 and plutonium must be assumed to be zero.

E. The values in subpart 8 for X, Y, and Z must be used to determine the criticality safety index if:

(1) uranium-233 is present in the package;

(2) the mass of plutonium exceeds one percent of the mass of uranium-235;

(3) the uranium is of unknown uranium-235 enrichment or greater than 24 weight percent enrichment; or

(4) substances having a moderating effectiveness, that is, an average hydrogen density greater than H_20, for example certain hydrocarbon oils or plastics, are present in any form, except as polyethylene used for packing or wrapping.

Subp. 8. **Mass limits for general license packages containing mixed quantities of fissile material of uranium-235 of unknown enrichment.**

	Fissile material mass mixed with moderating substances having an average hydrogen density less than or equal to H_2O (grams)	Fissile material mass mixed with moderating substances having an average hydrogen density greater than H_2O[a] (grams)
^{235}U (X)	60	38
^{233}U (Y)	43	27
^{239}Pu or ^{241}Pu (Z)	37	24

[a]When mixtures of moderating substances are present, the lower mass limits shall be used if more than 15 percent of the moderating substance has an average hydrogen density greater than H_2O.

Subp. 9. **Mass limits for general license packages containing uranium-235 of known enrichment.**

Uranium enrichment in weight percent of ^{235}U not exceeding	Fissile material mass of ^{235}U (X) (grams)
24	60
20	63
15	67
11	72
10	76
9.5	78
9	81
8.5	82
8	85
7.5	88
7	90
6.5	93
6	97
5.5	102
5	108
4.5	114
4	120
3.5	132
3	150
2.5	180
2	246
1.5	408
1.35	480

1	1,020
0.92	1,800

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*

Published Electronically: *May 26, 2022*

4731.0411 GENERAL LICENSE; PLUTONIUM-BERYLLIUM SPECIAL FORM MATERIAL.

Subpart 1. **Transport of plutonium-beryllium.** A general license is issued to any licensee of the commissioner to transport fissile material in the form of plutonium-beryllium (Pu-Be) special form sealed sources, or to deliver Pu-Be sealed sources to a carrier for transport, if the material is shipped according to this part. The material need not be contained in a package that meets the requirements of part 4731.0412 and Code of Federal Regulations, title 10, sections 71.41 to 71.77; however, the material must be contained in a Type A package. The Type A package must also meet the DOT requirements of Code of Federal Regulations, title 49, section 173.417(a).

Subp. 2. **Approved quality assurance program.** The general license issued under subpart 1 applies only to a licensee who has a quality assurance program approved by the NRC as complying with part 4731.0412 and Code of Federal Regulations, title 10, part 71, subpart H.

Subp. 3. **Package contents.** The general license issued under subpart 1 applies only when a package's contents:

A. contain no more than a Type A quantity of radioactive material; and

B. contain less than 1,000 grams of plutonium, provided that plutonium-239, plutonium-241, or any combination of these radionuclides, constitutes less than 240 grams of total quantity of plutonium in the package.

Subp. 4. **Packages labeled with criticality safety index.** The general license issued under subpart 1 applies only to packages labeled with a criticality safety index that:

A. has been determined according to subpart 5;

B. has a value less than or equal to 100; and

C. for a shipment of multiple packages containing Pu-Be sealed sources, the sum of the criticality safety indices must be less than or equal to 50 (for shipment on a nonexclusive use conveyance) and less than or equal to 100 (for shipment on an exclusive use conveyance).

Subp. 5. **Criticality safety index.**

A. The value for the criticality safety index must be greater than or equal to the number calculated by the following equation:

$$\text{CSI} = 10 \left[\frac{\text{grams of } {}^{239}\text{Pu} + \text{grams of } {}^{241}\text{Pu}}{24} \right]$$

B. The calculated criticality safety index must be rounded up to the first decimal place.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*

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4731.0412 EXTERNAL RADIATION STANDARDS FOR ALL PACKAGES.

Subpart 1. **Radiation level limit.** Except as provided in subpart 2, a package of radioactive material offered for transportation must be designed and prepared for shipment so that under conditions normally incident to transportation, the radiation level does not exceed 200 millirems per hour (2 mSv/hr) at any point on the external surface of the package and the transport index does not exceed ten.

Subp. 2. **Packages in excess of limit.** A package that exceeds the radiation level limits under subpart 1 must be transported by exclusive use shipment only and the radiation levels for such shipment must not exceed the following during transportation:

A. 200 millirems per hour (2 mSv/hr) on the external surface of the package, unless the following conditions are met, in which case the limit is 1,000 millirems per hour (10 mSv/hr):

(1) the shipment is made in a closed transport vehicle;

(2) the package is secured within the vehicle so that its position remains fixed during transportation; and

(3) there are no loading or unloading operations between the beginning and end of transportation;

B. 200 millirems per hour (2 mSv/hr) at any point on the outer surface of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure, if used, and on the lower external surface of the vehicle;

C. ten millirems per hour (0.1 mSv/hr) at any point 80 inches (2 meters) from the outer lateral surfaces of the vehicle, excluding the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point 6.6 feet (2 meters) from the vertical planes projected by the outer edges of the vehicle, excluding the top and underside of the vehicle; and

D. two millirems per hour (0.02 mSv/hr) in any normally occupied space, except that this item does not apply to private carriers, if exposed personnel under their control wear radiation dosimetry devices according to part 4731.2210.

Subp. 3. **Written instructions.**

A. For shipments made under subpart 2, the shipper must provide specific written instructions to the carrier for maintenance of the exclusive use shipment controls. The instructions must be included with the shipping paper information.

B. The written instructions required for exclusive use shipments must be sufficient so that, when followed, they will cause the carrier to avoid actions that will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0413 ASSUMPTIONS AS TO UNKNOWN PROPERTIES.

When the isotopic abundance, mass, concentration, degree of irradiation, degree of moderation, or other pertinent property of fissile material in any package is not known, the licensee must package the fissile material as if the unknown properties have credible values that will cause the maximum neutron multiplication.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0414 PRELIMINARY DETERMINATIONS.

Before the first use of any packaging for the shipment of licensed material, the licensee must ascertain that the determinations in Code of Federal Regulations, title 10, section 71.85, have been made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0415 ROUTINE DETERMINATIONS.

Before each shipment of licensed material, a licensee must ensure that the package with its contents satisfies the applicable requirements of the license and parts 4731.0400 to 4731.0424. The licensee must determine that:

A. the package is proper for the contents to be shipped;

B. the package is in an unimpaired physical condition, except for superficial defects such as marks or dents;

C. each closure device of the packaging, including any required gasket, is properly installed and secured and free of defects;

D. any system for containing liquid is adequately sealed and has adequate space or other specified provision for expansion of the liquid;

E. any pressure relief device is operable and set according to written procedures;

F. the package has been loaded and closed according to written procedures;

G. for fissile material, any moderator or neutron absorber, if required, is present and in proper condition;

H. any structural part of the package that could be used to lift or tie down the package during transport is rendered inoperable for that purpose, unless it satisfies the design requirements under Code of Federal Regulations, title 10, section 71.45;

I. the level of nonfixed (removable) radioactive contamination on the external surfaces of each package offered for shipment is as low as reasonably achievable and within the limits specified in DOT regulations under Code of Federal Regulations, title 49, section 173.443;

J. external radiation levels around the package and around the vehicle, if applicable, will not exceed the limits specified in part 4731.0412 at any time during transportation; and

K. accessible package surface temperatures will not exceed the limits specified in Code of Federal Regulations, title 10, section 71.43, paragraph (g), at any time during transportation.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

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4731.0416 AIR TRANSPORT OF PLUTONIUM.

Subpart 1. **Limitations for plutonium transport.** Notwithstanding the provisions of any general license and notwithstanding any exemptions stated directly in parts 4731.0400 to 4731.0424 or included indirectly by citation to Code of Federal Regulations, title 49, chapter I, as may be applicable, a licensee must ensure that plutonium in any form, whether for import, export, or domestic shipment, is not transported by air, or delivered to a carrier for air transport, unless:

A. the plutonium is contained in a medical device designed for individual human application;

B. the plutonium is contained in a material in which the specific activity is less than or equal to the activity concentration values for plutonium specified in part 4731.0422, subpart 3, and in which the radioactivity is essentially uniformly distributed;

C. the plutonium is shipped in a single package containing no more than an A_2 quantity of plutonium in any isotope or form and is shipped according to part 4731.0402; or

D. the plutonium is shipped in a package specifically authorized for shipment of plutonium by air in the certificate of compliance for that package issued by the NRC.

Subp. 2. **Federal law.**

A. Nothing in subpart 1 is to be interpreted as removing or diminishing the requirements of Code of Federal Regulations, title 10, section 73.24.

B. For a shipment of plutonium by air that is subject to subpart 1, item D, a licensee must, through special arrangement with the carrier, require compliance with the DOT regulations applicable to the air transport of plutonium under Code of Federal Regulations, title 49, section 175.704.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0417 OPENING INSTRUCTIONS.

Before delivery of a package to a carrier for transport, a licensee must ensure that any special instructions needed to safely open the package have been sent to, or otherwise made available to, the consignee for the consignee's use, according to part 4731.2350, subpart 5.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0418 RECORDS AND REPORTS.

Subpart 1. **Record of shipment.** Each licensee must maintain, for a period of three years after shipment, a record of each shipment of licensed material that is not exempt under part 4731.0403, subpart 2, showing, where applicable:

A. identification of the packaging by model number and serial number;

B. verification that there are no significant defects in the packaging, as shipped;

C. volume and identification of coolant;

D. type and quantity of licensed material in each package, and the total quantity of each shipment;

E. for each item of irradiated fissile material:

(1) identification by model number and serial number;

(2) irradiation and decay history to the extent appropriate to demonstrate that its nuclear and thermal characteristics comply with license conditions; and

(3) any abnormal or unusual condition relevant to radiation safety;

F. date of the shipment;

G. for fissile packages and for Type B packages, any special controls exercised;

H. name and address of the transferee;

I. address to which the shipment was made; and

J. results of the determinations required by part 4731.0415 and by the conditions of the package approval.

Subp. 2. **Record availability.** The licensee must make available to the commissioner for inspection, upon reasonable notice, all records required by parts 4731.0400 to 4731.0424. Records are only valid if stamped, initialed, or signed and dated by authorized personnel, or otherwise authenticated.

Subp. 3. **Record of package quality.** The licensee must maintain sufficient written records to furnish evidence of the quality of packaging. The records to be maintained include results of the determinations required by Code of Federal Regulations, title 10, part 71.85; design, fabrication, and assembly records; results of reviews, inspections, tests, and audits; results of monitoring work performance and materials analyses; and results of maintenance, modification, and repair activities. Inspection, test, and audit records must identify the inspector or data recorder, the type of observation, the results, the acceptability, and the action taken in connection with any deficiencies noted. These records must be retained for three years after the life of the packaging to which they apply.

Subp. 4. **Reports.** A licensee must report to the commissioner within 30 days:

A. any instance in which there is significant reduction in the effectiveness of any approved Type B or fissile packaging during use;

B. details of any defects with safety significance in Type B or fissile packaging after first use, with the means employed to repair the defects and prevent their recurrence; and

C. instances in which the conditions of approval in the certificate of compliance were not observed in making a shipment.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

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4731.0419 ADVANCE NOTIFICATION OF SHIPMENT OF IRRADIATED REACTOR FUEL AND NUCLEAR WASTE.

Subpart 1. **Notice required.** As specified in subparts 2 to 4, a licensee must provide advance notification to:

A. the commissioner, the governor of the state or the governor's designee, and the NRC of a shipment of licensed material through or across the boundary of the state before the transport, or

delivery to a carrier for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage; and

B. the Tribal official of participating Tribes referenced in subpart 3, item B, or the official's designee, of the shipment of licensed material, within or across the boundary of the Tribe's reservation, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

Subp. 2. **Shipments requiring notice.** Advance notification is required under this part for shipments of licensed material, other than irradiated fuel, meeting the following three conditions:

A. the licensed material is required by parts 4731.0400 to 4731.0424 to be in Type B packaging for transportation;

B. the licensed material is being transported to or across the state boundary enroute to a disposal facility or to a collection point for transport to a disposal facility; and

C. the quantity of licensed material in a single package exceeds the least of the following:

(1) 3,000 times the A_1 value of radionuclides as specified in part 4731.0422 for special form radioactive material;

(2) 3,000 times the A_2 value of radionuclides as specified in part 4731.0422 for normal form radioactive material; or

(3) 27,000 Ci (1,000 TBq).

Subp. 3. **Procedures for submitting notification.**

A. The notification required under this part must:

(1) be made in writing to the commissioner, the office of each appropriate state governor or governor's designee, the office of each appropriate Tribal official or Tribal official's designee, and to the director, Office of Nuclear Security and Incident Response, NRC;

(2) if delivered by mail, be postmarked at least seven days before the beginning of the seven-day period during which departure of the shipment is estimated to occur; and

(3) if delivered by any other means than mail, reach the office of the commissioner and the governor or governor's designee or the Tribal official or Tribal official's designee at least four days before the beginning of the seven-day period during which departure of the shipment is estimated to occur.

B. Contact information, including telephone and mailing addresses of the governors' designees and Tribal officials' designees of participating Tribes is available on the NRC website at: https://scp.nrc.gov/special/designee.pdf. The information is also available on request from the Director, Division of Materials Safety, Security, State, and Tribal Programs, Office of Nuclear Material Safety and Safeguards, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

C. The licensee must retain a copy of the notification as a record for three years.

Subp. 4. **Information to be furnished in advance notification of shipment.** An advance notification of shipment of irradiated reactor fuel or nuclear waste must contain the following information:

A. the name, address, and telephone number of the shipper, carrier, and receiver of the irradiated reactor fuel or nuclear waste shipment;

B. a description of the irradiated reactor fuel or nuclear waste contained in the shipment according to DOT regulations in Code of Federal Regulations, title 49, sections 172.202 and 172.203, paragraph (d);

C. the point of origin of the shipment and the seven-day period during which departure of the shipment is estimated to occur;

D. the seven-day period during which arrival of the shipment at state boundaries or Tribal reservation boundaries is estimated to occur;

E. the destination of the shipment and the seven-day period during which arrival of the shipment is estimated to occur; and

F. a point of contact, with a telephone number, for current shipment information.

Subp. 5. **Revision notice.** A licensee who finds that schedule information, previously furnished under this part to the commissioner and a governor or governor's designee or a Tribal official or Tribal official's designee, will not be met must telephone a responsible individual in the commissioner's office and the governor or governor's designee or the Tribal official or the Tribal official's designee and inform the individual of the extent of the delay beyond the schedule originally reported.

Subp. 5a. **Record retained.** The licensee must maintain a record of the name of the individual contacted for three years.

Subp. 6. **Cancellation notice.**

A. A licensee who cancels an irradiated reactor fuel or nuclear waste shipment for which advance notification has been sent must send a cancellation notice to the commissioner, the governor of each state or the governor's designee previously notified, each Tribal official or the Tribal official's designee previously notified, and the director, Office of Nuclear Security and Incident Response, NRC.

B. The licensee must state in the notice that it is a cancellation and identify the advance notification that is being canceled.

C. The licensee must retain a copy of the notice as a record for three years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 40 SR 145; 44 SR 239; 46 SR 791*
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4731.0420 QUALITY ASSURANCE REQUIREMENTS.

Subpart 1. **Program requirement.**

A. A licensee who uses a general license under part 4731.0406, 4731.0409, 4731.0410, or 4731.0411 must establish, maintain, and execute a quality assurance program satisfying each of the applicable criteria of this part.

B. As used in this subpart, "quality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that a system or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to control of the physical characteristics and quality of the material or component to predetermined requirements.

C. Before the use of any package for the shipment of licensed material subject to this part, a licensee must obtain the commissioner's approval of its quality assurance program. The licensee must file a description of its quality assurance program, including a discussion of which requirements of this part are applicable and how they will be satisfied.

D. A program for transport container inspection and maintenance limited to radiographic exposure devices, source changers, or packages transporting these devices and meeting the requirements of part 4731.4090, subpart 2, items A to C, or an equivalent requirement of the NRC or an agreement state, is deemed to satisfy the requirements of subpart 1 and part 4731.0406, subpart 2.

Subp. 2. **Quality assurance organization.**

A. A licensee is responsible for the establishment and execution of the quality assurance program. The licensee may delegate to others, such as contractors, agents, or consultants, the work of establishing and executing the quality assurance program, or any part of the quality assurance program, but must retain responsibility for the program. These activities include performing the functions associated with attaining quality objectives and the quality assurance functions.

B. The quality assurance functions are:

(1) assuring that an appropriate quality assurance program is established and effectively executed; and

(2) verifying, by procedures such as checking, auditing, and inspection, that activities affecting the functions important to safety have been correctly performed.

Subp. 3. **Quality assurance program.**

A. The licensee must document the quality assurance program by written procedures or instructions and carry out the program according to those procedures throughout the period during which the packaging is used. The licensee must identify the material and components to be covered

by the quality assurance program, the major organizations participating in the program, and the designated functions of these organizations.

B. The licensee, through its quality assurance program, must provide control over activities affecting the quality of the identified materials and components to an extent consistent with their importance to safety, and as necessary to ensure conformance to the approved design of each individual package used for the shipment of radioactive material. The licensee must ensure that activities affecting quality are accomplished under suitably controlled conditions. Controlled conditions include the use of appropriate equipment; suitable environmental conditions for accomplishing the activity, such as adequate cleanliness; and assurance that all prerequisites for the given activity have been satisfied. The licensee must take into account the need for special controls, processes, test equipment, tools, and skills to attain the required quality and the need for verification of quality by inspection and test.

C. The licensee must base the requirements and procedures of its quality assurance program on the following considerations concerning the complexity and proposed use of the package and its components:

(1) the impact of malfunction or failure of the item to safety;

(2) the design and fabrication complexity or uniqueness of the item;

(3) the need for special controls and surveillance over processes and equipment;

(4) the degree to which functional compliance can be demonstrated by inspection or test; and

(5) the quality history and degree of standardization of the item.

D. The licensee must provide for the indoctrination and training of personnel who perform activities that affect quality, as necessary to ensure that suitable proficiency is achieved and maintained. The licensee must review the status and adequacy of the quality assurance program at established intervals. Management of other organizations participating in the quality assurance program shall review regularly the status and adequacy of that part of the quality assurance program that a participating organization is executing.

Subp. 4. **Changes to quality assurance program.**

A. A quality assurance program approval holder must submit a description of a proposed change to its commissioner-approved quality assurance program that will reduce commitments in the program description as approved by the commissioner. The quality assurance program approval holder shall not implement the change before receiving commissioner approval. The description of a proposed change to the commissioner-approved quality assurance program must identify the change, the reason for the change, and the basis for concluding that the revised program incorporating the change continues to satisfy the applicable requirements of this part.

B. Each quality assurance program approval holder may change a previously approved quality assurance program without prior approval from the commissioner if the change does not

reduce the commitments in the quality assurance program previously approved by the commissioner. Changes to the quality assurance program that do not reduce the commitments must be submitted to the commissioner every 24 months. In addition to quality assurance program changes involving administrative improvements and clarifications, spelling corrections, and nonsubstantive changes to punctuation or editorial items, the following changes are not considered reductions in commitment:

(1) the use of a quality assurance standard approved by the commissioner that is more recent than the quality assurance standard in the certificate holder's or applicant's current quality assurance program at the time of the change;

(2) the use of generic organizational position titles that clearly denote the position function, supplemented as necessary by descriptive text rather than specific titles, provided that there is no substantive change to either the functions of the position or reporting responsibilities;

(3) the use of generic organizational charts to indicate functional relationships, authorities, and responsibilities or, alternatively, the use of descriptive text, provided that there is no substantive change to the functional relationships, authorities, or responsibilities;

(4) the elimination of quality assurance program information that duplicates language in quality assurance regulatory guides and quality assurance standards that the quality assurance program approval holder has committed to on record; and

(5) organizational revisions that ensure persons and organizations performing quality assurance functions continue to have the requisite authority and organizational freedom, including sufficient independence from cost and schedule when opposed to safety considerations.

C. Each quality assurance program approval holder must maintain records of quality assurance program changes.

Subp. 5. **Handling, storage, and shipping control.** The licensee must establish measures to control, according to instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration. When necessary for particular products, special protective environments, such as inert gas atmosphere, and specific moisture content and temperature levels must be specified and provided.

Subp. 6. **Inspection, test, and operating status.**

A. The licensee must establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging. These measures must provide for the identification of items that have satisfactorily passed required inspections and tests, where necessary, to preclude inadvertent bypassing of the inspections and tests.

B. The licensee must establish measures to identify the operating status of components of the packaging, such as tagging valves and switches, to prevent inadvertent operation.

Subp. 7. **Nonconforming materials, parts, or components.** The licensee must establish measures to control materials, parts, or components that do not conform to the licensee's requirements

to prevent inadvertent use or installation. These measures must include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items must be reviewed and accepted, rejected, repaired, or reworked according to documented procedures.

Subp. 8. **Corrective action.** The licensee must establish measures to ensure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformances, are promptly identified and corrected. In the case of a significant condition that is adverse to quality, the measures must ensure that the cause of the condition is determined and corrective action is taken to preclude repetition. The identification of the significant condition that is adverse to quality, the cause of the condition, and the corrective action taken must be documented and reported to appropriate levels of management.

Subp. 9. **Quality assurance records.** The licensee must maintain sufficient written records to describe the activities affecting quality. These records must include changes to the quality assurance program as required by subpart 4, and closely related specifications, such as required qualifications of personnel, procedures, and equipment. The records must include the instructions or procedures that establish a records retention program that is consistent with applicable regulations and that designates factors such as duration, location, and assigned responsibility for the records. The licensee must retain these records for three years beyond the date when the licensee last engages in the activity for which the quality assurance program was developed. If any portion of the quality assurance program, written procedures, or instructions is superseded, the licensee must retain the superseded material for three years.

Subp. 10. **Audits.** The licensee must carry out a comprehensive system of planned and periodic audits to verify compliance with all aspects of the quality assurance program and determine the effectiveness of the program. The audits must be performed according to written procedures or checklists by appropriately trained personnel who do not have direct responsibilities in the areas being audited. Audited results must be documented and reviewed by management having responsibility in the area audited. Follow-up action, including reaudit of deficient areas, must be taken where indicated.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

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4731.0421 [Repealed, 44 SR 239]

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4731.0422 A_1 AND A_2 VALUES FOR RADIONUCLIDES.

Subpart 1. [Repealed, 32 SR 831]

Subp. 1a. **A_1 and A_2 values.**

Element and atomic number and symbol of radionuclide	A_1 (TBq)	A_1 (Ci)[b]	A_2 (TBq)	A_2 (Ci)[b]
Actinium (89)				
Ac-225[a]	8.0×10^{-1}	2.2×10^{1}	6.0×10^{-3}	1.6×10^{-1}
Ac-227[a]	9.0×10^{-1}	2.4×10^{1}	9.0×10^{-5}	2.4×10^{-3}
Ac-228	6.0×10^{-1}	1.6×10^{1}	5.0×10^{-1}	1.4×10^{1}
Silver (47)				
Ag-105	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Ag-108m[a]	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Ag-110m[a]	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Ag-111	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Aluminum (13)				
Al-26	1.0×10^{-1}	2.7	1.0×10^{-1}	2.7
Americium (95)				
Am-241	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Am-242m[a]	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Am-243[a]	5.0	1.4×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Argon (18)				
Ar-37	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Ar-39	4.0×10^{1}	1.1×10^{3}	2.0×10^{1}	5.4×10^{2}
Ar-41	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Arsenic (33)				
As-72	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1

As-73	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
As-74	1.0	2.7×10^{1}	9.0×10^{-1}	2.4×10^{1}
As-76	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
As-77	2.0×10^{1}	5.4×10^{2}	7.0×10^{-1}	1.9×10^{1}
Astatine (85)				
At-211[a]	2.0×10^{1}	5.4×10^{2}	5.0×10^{-1}	1.4×10^{1}
Gold (79)				
Au-193	7.0	1.9×10^{2}	2.0	5.4×10^{1}
Au-194	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Au-195	1.0×10^{1}	2.7×10^{2}	6.0	1.6×10^{2}
Au-198	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
Au-199	1.0×10^{1}	2.7×10^{2}	6.0×10^{-1}	1.6×10^{1}
Barium (56)				
Ba-131[a]	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Ba-133	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Ba-133m	2.0×10^{1}	5.4×10^{2}	6.0×10^{-1}	1.6×10^{1}
Ba-140[a]	5.0×10^{-1}	1.4×10^{1}	3.0×10^{-1}	8.1
Beryllium (4)				
Be-7	2.0×10^{1}	5.4×10^{2}	2.0×10^{1}	5.4×10^{2}
Be-10	4.0×10^{1}	1.1×10^{3}	6.0×10^{-1}	1.6×10^{1}
Bismuth (83)				
Bi-205	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Bi-206	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Bi-207	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Bi-210	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
Bi-210m[a]	6.0×10^{-1}	1.6×10^{1}	2.0×10^{-2}	5.4×10^{-1}

Bi-212[a]	7.0×10^{-1}	1.9×10^{1}	6.0×10^{-1}	1.6×10^{1}
Berkelium (97)				
Bk-247	8.0	2.2×10^{2}	8.0×10^{-4}	2.2×10^{-2}
Bk-249[a]	4.0×10^{1}	1.1×10^{3}	3.0×10^{-1}	8.1
Bromine (35)				
Br-76	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Br-77	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Br-82	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Carbon (6)				
C-11	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
C-14	4.0×10^{1}	1.1×10^{3}	3.0	8.1×10^{1}
Calcium (20)				
Ca-41	Unlimited	Unlimited	Unlimited	Unlimited
Ca-45	4.0×10^{1}	1.1×10^{3}	1.0	2.7×10^{1}
Ca-47[a]	3.0	8.1×10^{1}	3.0×10^{-1}	8.1
Cadmium (48)				
Cd-109	3.0×10^{1}	8.1×10^{2}	2.0	5.4×10^{1}
Cd-113m	4.0×10^{1}	1.1×10^{3}	5.0×10^{-1}	1.4×10^{1}
Cd-115[a]	3.0	8.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Cd-115m	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Cerium (58)				
Ce-139	7.0	1.9×10^{2}	2.0	5.4×10^{1}
Ce-141	2.0×10^{1}	5.4×10^{2}	6.0×10^{-1}	1.6×10^{1}
Ce-143	9.0×10^{-1}	2.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Ce-144[a]	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4

Californium (98)				
Cf-248	4.0×10^{1}	1.1×10^{3}	6.0×10^{-3}	1.6×10^{-1}
Cf-249	3.0	8.1×10^{1}	8.0×10^{-4}	2.2×10^{-2}
Cf-250	2.0×10^{1}	5.4×10^{2}	2.0×10^{-3}	5.4×10^{-2}
Cf-251	7.0	1.9×10^{2}	7.0×10^{-4}	1.9×10^{-2}
Cf-252	1.0×10^{-1}	2.7	3.0×10^{-3}	8.1×10^{-2}
Cf-253[a]	4.0×10^{1}	1.1×10^{3}	4.0×10^{-2}	1.1
Cf-254	1.0×10^{-3}	2.7×10^{-2}	1.0×10^{-3}	2.7×10^{-2}
Chlorine (17)				
Cl-36	1.0×10^{1}	2.7×10^{2}	6.0×10^{-1}	1.6×10^{1}
Cl-38	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4
Curium (96)				
Cm-240	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}
Cm-241	2.0	5.4×10^{1}	1.0	2.7×10^{1}
Cm-242	4.0×10^{1}	1.1×10^{3}	1.0×10^{-2}	2.7×10^{-1}
Cm-243	9.0	2.4×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Cm-244	2.0×10^{1}	5.4×10^{2}	2.0×10^{-3}	5.4×10^{-2}
Cm-245	9.0	2.4×10^{2}	9.0×10^{-4}	2.4×10^{-2}
Cm-246	9.0	2.4×10^{2}	9.0×10^{-4}	2.4×10^{-2}
Cm-247[a]	3.0	8.1×10^{1}	1.0×10^{-3}	2.7×10^{-2}
Cm-248	2.0×10^{-2}	5.4×10^{-1}	3.0×10^{-4}	8.1×10^{-3}
Cobalt (27)				
Co-55	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Co-56	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Co-57	1.0×10^{1}	2.7×10^{2}	1.0×10^{1}	2.7×10^{2}
Co-58	1.0	2.7×10^{1}	1.0	2.7×10^{1}

Co-58m	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Co-60	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Chromium (24)				
Cr-51	3.0×10^{1}	8.1×10^{2}	3.0×10^{1}	8.1×10^{2}
Cesium (55)				
Cs-129	4.0	1.1×10^{2}	4.0	1.1×10^{2}
Cs-131	3.0×10^{1}	8.1×10^{2}	3.0×10^{1}	8.1×10^{2}
Cs-132	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Cs-134	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Cs-134m	4.0×10^{1}	1.1×10^{3}	6.0×10^{-1}	1.6×10^{1}
Cs-135	4.0×10^{1}	1.1×10^{3}	1.0	2.7×10^{1}
Cs-136	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Cs-137[a]	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Copper (29)				
Cu-64	6.0	1.6×10^{2}	1.0	2.7×10^{1}
Cu-67	1.0×10^{1}	2.7×10^{2}	7.0×10^{-1}	1.9×10^{1}
Dysprosium (66)				
Dy-159	2.0×10^{1}	5.4×10^{2}	2.0×10^{1}	5.4×10^{2}
Dy-165	9.0×10^{-1}	2.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Dy-166[a]	9.0×10^{-1}	2.4×10^{1}	3.0×10^{-1}	8.1
Erbium (68)				
Er-169	4.0×10^{1}	1.1×10^{3}	1.0	2.7×10^{1}
Er-171	8.0×10^{-1}	2.2×10^{1}	5.0×10^{-1}	1.4×10^{1}
Europium (63)				
Eu-147	2.0	5.4×10^{1}	2.0	5.4×10^{1}

Eu-148	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Eu-149	2.0×10^{1}	5.4×10^{2}	2.0×10^{1}	5.4×10^{2}
Eu-150 (short-lived)	2.0	5.4×10^{1}	7.0×10^{-1}	1.9×10^{1}
Eu-150 (long-lived)	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Eu-152	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Eu-152m	8.0×10^{-1}	2.2×10^{1}	8.0×10^{-1}	2.2×10^{1}
Eu-154	9.0×10^{-1}	2.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Eu-155	2.0×10^{1}	5.4×10^{2}	3.0	8.1×10^{1}
Eu-156	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Fluorine (9)				
F-18	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
Iron (26)				
Fe-52[a]	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Fe-55	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Fe-59	9.0×10^{-1}	2.4×10^{1}	9.0×10^{-1}	2.4×10^{1}
Fe-60[a]	4.0×10^{1}	1.1×10^{3}	2.0×10^{-1}	5.4
Gallium (31)				
Ga-67	7.0	1.9×10^{2}	3.0	8.1×10^{1}
Ga-68	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Ga-72	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Gadolinium (64)				
Gd-146[a]	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Gd-148	2.0×10^{1}	5.4×10^{2}	2.0×10^{-3}	5.4×10^{-2}
Gd-153	1.0×10^{1}	2.7×10^{2}	9.0	2.4×10^{2}
Gd-159	3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}
Germanium (32)				

Ge-68[a]	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Ge-71	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Ge-77	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Hafnium (72)				
Hf-172[a]	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Hf-175	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Hf-181	2.0	5.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Hf-182	Unlimited	Unlimited	Unlimited	Unlimited
Mercury (80)				
Hg-194[a]	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Hg-195m[a]	3.0	8.1×10^{1}	7.0×10^{-1}	1.9×10^{1}
Hg-197	2.0×10^{1}	5.4×10^{2}	1.0×10^{1}	2.7×10^{2}
Hg-197m	1.0×10^{1}	2.7×10^{2}	4.0×10^{-1}	1.1×10^{1}
Hg-203	5.0	1.4×10^{2}	1.0	2.7×10^{1}
Holmium (67)				
Ho-166	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Ho-166m	6.0×10^{-1}	1.6×10^{1}	5.0×10^{-1}	1.4×10^{1}
Iodine (53)				
I-123	6.0	1.6×10^{2}	3.0	8.1×10^{1}
I-124	1.0	2.7×10^{1}	1.0	2.7×10^{1}
I-125	2.0×10^{1}	5.4×10^{2}	3.0	8.1×10^{1}
I-126	2.0	5.4×10^{1}	1.0	2.7×10^{1}
I-129	Unlimited	Unlimited	Unlimited	Unlimited
I-131	3.0	8.1×10^{1}	7.0×10^{-1}	1.9×10^{1}
I-132	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
I-133	7.0×10^{-1}	1.9×10^{1}	6.0×10^{-1}	1.6×10^{1}

I-134	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
I-135[a]	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Indium (49)				
In-111	3.0	8.1×10^{1}	3.0	8.1×10^{1}
In-113m	4.0	1.1×10^{2}	2.0	5.4×10^{1}
In-114m[a]	1.0×10^{1}	2.7×10^{2}	5.0×10^{-1}	1.4×10^{1}
In-115m	7.0	1.9×10^{2}	1.0	2.7×10^{1}
Iridium (77)				
Ir-189[a]	1.0×10^{1}	2.7×10^{2}	1.0×10^{1}	2.7×10^{2}
Ir-190	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Ir-192	1.0[c]	2.7×10^{1}[c]	6.0×10^{-1}	1.6×10^{1}
Ir-194	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Potassium (19)				
K-40	9.0×10^{-1}	2.4×10^{1}	9.0×10^{-1}	2.4×10^{1}
K-42	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4
K-43	7.0×10^{-1}	1.9×10^{1}	6.0×10^{-1}	1.6×10^{1}
Krypton (36)				
Kr-79	4.0	1.1×10^{2}	2.0	5.4×10^{1}
Kr-81	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Kr-85	1.0×10^{1}	2.7×10^{2}	1.0×10^{1}	2.7×10^{2}
Kr-85m	8.0	2.2×10^{2}	3.0	8.1×10^{1}
Kr-87	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4
Lanthanum (57)				
La-137	3.0×10^{1}	8.1×10^{2}	6.0	1.6×10^{2}
La-140	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}

Lutetium (71)				
Lu-172	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Lu-173	8.0	2.2×10^{2}	8.0	2.2×10^{2}
Lu-174	9.0	2.4×10^{2}	9.0	2.4×10^{2}
Lu-174m	2.0×10^{1}	5.4×10^{2}	1.0×10^{1}	2.7×10^{2}
Lu-177	3.0×10^{1}	8.1×10^{2}	7.0×10^{-1}	1.9×10^{1}
Magnesium (12)				
Mg-28[a]	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Manganese (25)				
Mn-52	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Mn-53	Unlimited	Unlimited	Unlimited	Unlimited
Mn-54	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Mn-56	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Molybdenum (42)				
Mo-93	4.0×10^{1}	1.1×10^{3}	2.0×10^{1}	5.4×10^{2}
Mo-99[a, h]	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
Nitrogen (7)				
N-13	9.0×10^{-1}	2.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Sodium (11)				
Na-22	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Na-24	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4
Niobium (41)				
Nb-93m	4.0×10^{1}	1.1×10^{3}	3.0×10^{1}	8.1×10^{2}
Nb-94	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Nb-95	1.0	2.7×10^{1}	1.0	2.7×10^{1}

Nb-97	9.0×10^{-1}	2.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Neodymium (60)				
Nd-147	6.0	1.6×10^{2}	6.0×10^{-1}	1.6×10^{1}
Nd-149	6.0×10^{-1}	1.6×10^{1}	5.0×10^{-1}	1.4×10^{1}
Nickel (28)				
Ni-59	Unlimited	Unlimited	Unlimited	Unlimited
Ni-63	4.0×10^{1}	1.1×10^{3}	3.0×10^{1}	8.1×10^{2}
Ni-65	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Neptunium (93)				
Np-235	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Np-236 (short-lived)	2.0×10^{1}	5.4×10^{2}	2.0	5.4×10^{1}
Np-236 (long-lived)	9.0×10^{0}	2.4×10^{2}	2.0×10^{-2}	5.4×10^{-1}
Np-237	2.0×10^{1}	5.4×10^{2}	2.0×10^{-3}	5.4×10^{-2}
Np-239	7.0	1.9×10^{2}	4.0×10^{-1}	1.1×10^{1}
Osmium (76)				
Os-185	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Os-191	1.0×10^{1}	2.7×10^{2}	2.0	5.4×10^{1}
Os-191m	4.0×10^{1}	1.1×10^{3}	3.0×10^{1}	8.1×10^{2}
Os-193	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Os-194[a]	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Phosphorus (15)				
P-32	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
P-33	4.0×10^{1}	1.1×10^{3}	1.0	2.7×10^{1}
Protactinium (91)				
Pa-230[a]	2.0	5.4×10^{1}	7.0×10^{-2}	1.9

Pa-231	4.0	1.1×10^{2}	4.0×10^{-4}	1.1×10^{-2}
Pa-233	5.0	1.4×10^{2}	7.0×10^{-1}	1.9×10^{1}
Lead (82)				
Pb-201	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Pb-202	4.0×10^{1}	1.1×10^{3}	2.0×10^{1}	5.4×10^{2}
Pb-203	4.0	1.1×10^{2}	3.0	8.1×10^{1}
Pb-205	Unlimited	Unlimited	Unlimited	Unlimited
Pb-210[a]	1.0	2.7×10^{1}	5.0×10^{-2}	1.4
Pb-212[a]	7.0×10^{-1}	1.9×10^{1}	2.0×10^{-1}	5.4
Palladium (46)				
Pd-103[a]	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Pd-107	Unlimited	Unlimited	Unlimited	Unlimited
Pd-109	2.0	5.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Promethium (61)				
Pm-143	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Pm-144	7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}
Pm-145	3.0×10^{1}	8.1×10^{2}	1.0×10^{1}	2.7×10^{2}
Pm-147	4.0×10^{1}	1.1×10^{3}	2.0	5.4×10^{1}
Pm-148m[a]	8.0×10^{-1}	2.2×10^{1}	7.0×10^{-1}	1.9×10^{1}
Pm-149	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Pm-151	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Polonium (84)				
Po-210	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}
Praseodymium (59)				
Pr-142	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Pr-143	3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}

Platinum (78)				
Pt-188[a]	1.0	2.7×10^{1}	8.0×10^{-1}	2.2×10^{1}
Pt-191	4.0	1.1×10^{2}	3.0	8.1×10^{1}
Pt-193	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Pt-193m	4.0×10^{1}	1.1×10^{3}	5.0×10^{-1}	1.4×10^{1}
Pt-195m	1.0×10^{1}	2.7×10^{2}	5.0×10^{-1}	1.4×10^{1}
Pt-197	2.0×10^{1}	5.4×10^{2}	6.0×10^{-1}	1.6×10^{1}
Pt-197m	1.0×10^{1}	2.7×10^{2}	6.0×10^{-1}	1.6×10^{1}
Plutonium (94)				
Pu-236	3.0×10^{1}	8.1×10^{2}	3.0×10^{-3}	8.1×10^{-2}
Pu-237	2.0×10^{1}	5.4×10^{2}	2.0×10^{1}	5.4×10^{2}
Pu-238	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Pu-239	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Pu-240	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Pu-241[a]	4.0×10^{1}	1.1×10^{3}	6.0×10^{-2}	1.6
Pu-242	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Pu-244[a]	4.0×10^{-1}	1.1×10^{1}	1.0×10^{-3}	2.7×10^{-2}
Radium (88)				
Ra-223[a]	4.0×10^{-1}	1.1×10^{1}	7.0×10^{-3}	1.9×10^{-1}
Ra-224[a]	4.0×10^{-1}	1.1×10^{1}	2.0×10^{-2}	5.4×10^{-1}
Ra-225[a]	2.0×10^{-1}	5.4	4.0×10^{-3}	1.1×10^{-1}
Ra-226[a]	2.0×10^{-1}	5.4	3.0×10^{-3}	8.1×10^{-2}
Ra-228[a]	6.0×10^{-1}	1.6×10^{1}	2.0×10^{-2}	5.4×10^{-1}
Rubidium (37)				
Rb-81	2.0	5.4×10^{1}	8.0×10^{-1}	2.2×10^{1}
Rb-83[a]	2.0	5.4×10^{1}	2.0	5.4×10^{1}

Rb-84	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Rb-86	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Rb-87	Unlimited	Unlimited	Unlimited	Unlimited
Rb (nat)	Unlimited	Unlimited	Unlimited	Unlimited
Rhenium (75)				
Re-184	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Re-184m	3.0	8.1×10^{1}	1.0	2.7×10^{1}
Re-186	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
Re-187	Unlimited	Unlimited	Unlimited	Unlimited
Re-188	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Re-189[a]	3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}
Re (nat)	Unlimited	Unlimited	Unlimited	Unlimited
Rhodium (45)				
Rh-99	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Rh-101	4.0	1.1×10^{2}	3.0	8.1×10^{1}
Rh-102	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Rh-102m	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Rh-103m	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Rh-105	1.0×10^{1}	2.7×10^{2}	8.0×10^{-1}	2.2×10^{1}
Radon (86)				
Rn-222[a]	3.0×10^{-1}	8.1	4.0×10^{-3}	1.1×10^{-1}
Ruthenium (44)				
Ru-97	5.0	1.4×10^{2}	5.0	1.4×10^{2}
Ru-103[a]	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Ru-105	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
Ru-106[a]	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4

Sulphur (16)				
S-35	4.0×10^{1}	1.1×10^{3}	3.0	8.1×10^{1}
Antimony (51)				
Sb-122	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Sb-124	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Sb-125	2.0	5.4×10^{1}	1.0	2.7×10^{1}
Sb-126	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Scandium (21)				
Sc-44	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Sc-46	5.0×10^{-1}	1.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Sc-47	1.0×10^{1}	2.7×10^{2}	7.0×10^{-1}	1.9×10^{1}
Sc-48	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Selenium (34)				
Se-75	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Se-79	4.0×10^{1}	1.1×10^{3}	2.0	5.4×10^{1}
Silicon (14)				
Si-31	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Si-32	4.0×10^{1}	1.1×10^{3}	5.0×10^{-1}	1.4×10^{1}
Samarium (62)				
Sm-145	1.0×10^{1}	2.7×10^{2}	1.0×10^{1}	2.7×10^{2}
Sm-147	Unlimited	Unlimited	Unlimited	Unlimited
Sm-151	4.0×10^{1}	1.1×10^{3}	1.0×10^{1}	2.7×10^{2}
Sm-153	9.0	2.4×10^{2}	6.0×10^{-1}	1.6×10^{1}
Tin (50)				
Sn-113[a]	4.0	1.1×10^{2}	2.0	5.4×10^{1}

Sn-117m	7.0	1.9×10^{2}	4.0×10^{-1}	1.1×10^{1}
Sn-119m	4.0×10^{1}	1.1×10^{3}	3.0×10^{1}	8.1×10^{2}
Sn-121m[a]	4.0×10^{1}	1.1×10^{3}	9.0×10^{-1}	2.4×10^{1}
Sn-123	8.0×10^{-1}	2.2×10^{1}	6.0×10^{-1}	1.6×10^{1}
Sn-125	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Sn-126[a]	6.0×10^{-1}	1.6×10^{1}	4.0×10^{-1}	1.1×10^{1}
Strontium (38)				
Sr-82[a]	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4
Sr-85	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Sr-85m	5.0	1.4×10^{2}	5.0	1.4×10^{2}
Sr-87m	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Sr-89	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Sr-90[a]	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Sr-91[a]	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Sr-92[a]	1.0	2.7×10^{1}	3.0×10^{-1}	8.1
Tritium (1)				
T (H-3)	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Tantalum (73)				
Ta-178 (long-lived)	1.0	2.7×10^{1}	8.0×10^{-1}	2.2×10^{1}
Ta-179	3.0×10^{1}	8.1×10^{2}	3.0×10^{1}	8.1×10^{2}
Ta-182	9.0×10^{-1}	2.4×10^{1}	5.0×10^{-1}	1.4×10^{1}
Terbium (65)				
Tb-157	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Tb-158	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Tb-160	1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}
Technetium (43)				

Tc-95m[a]	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Tc-96	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Tc-96m[a]	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Tc-97	Unlimited	Unlimited	Unlimited	Unlimited
Tc-97m	4.0×10^{1}	1.1×10^{3}	1.0	2.7×10^{1}
Tc-98	8.0×10^{-1}	2.2×10^{1}	7.0×10^{-1}	1.9×10^{1}
Tc-99	4.0×10^{1}	1.1×10^{3}	9.0×10^{-1}	2.4×10^{1}
Tc-99m	1.0×10^{1}	2.7×10^{2}	4.0	1.1×10^{2}
Tellurium (52)				
Te-121	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Te-121m	5.0	1.4×10^{2}	3.0	8.1×10^{1}
Te-123m	8.0	2.2×10^{2}	1.0	2.7×10^{1}
Te-125m	2.0×10^{1}	5.4×10^{2}	9.0×10^{-1}	2.4×10^{1}
Te-127	2.0×10^{1}	5.4×10^{2}	7.0×10^{-1}	1.9×10^{1}
Te-127m[a]	2.0×10^{1}	5.4×10^{2}	5.0×10^{-1}	1.4×10^{1}
Te-129	7.0×10^{-1}	1.9×10^{1}	6.0×10^{-1}	1.6×10^{1}
Te-129m[a]	8.0×10^{-1}	2.2×10^{1}	4.0×10^{-1}	1.1×10^{1}
Te-131m[a]	7.0×10^{-1}	1.9×10^{1}	5.0×10^{-1}	1.4×10^{1}
Te-132[a]	5.0×10^{-1}	1.4×10^{1}	4.0×10^{-1}	1.1×10^{1}
Thorium (90)				
Th-227	1.0×10^{1}	2.7×10^{2}	5.0×10^{-3}	1.4×10^{-1}
Th-228[a]	5.0×10^{-1}	1.4×10^{1}	1.0×10^{-3}	2.7×10^{-2}
Th-229	5.0	1.4×10^{2}	5.0×10^{-4}	1.4×10^{-2}
Th-230	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
Th-231	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}
Th-232	Unlimited	Unlimited	Unlimited	Unlimited
Th-234[a]	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1

Th (nat)	Unlimited	Unlimited	Unlimited	Unlimited
Titanium (22)				
Ti-44[a]	5.0×10^{-1}	1.4×10^{1}	4.0×10^{-1}	1.1×10^{1}
Thallium (81)				
Tl-200	9.0×10^{-1}	2.4×10^{1}	9.0×10^{-1}	2.4×10^{1}
Tl-201	1.0×10^{1}	2.7×10^{2}	4.0	1.1×10^{2}
Tl-202	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Tl-204	1.0×10^{1}	2.7×10^{2}	7.0×10^{-1}	1.9×10^{1}
Thulium (69)				
Tm-167	7.0	1.9×10^{2}	8.0×10^{-1}	2.2×10^{1}
Tm-170	3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}
Tm-171	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Uranium (92)				
U-230 (fast lung absorption)[a,d]	4.0×10^{1}	1.1×10^{3}	1.0×10^{-1}	2.7
U-230 (medium lung absorption)[a,e]	4.0×10^{1}	1.1×10^{3}	4.0×10^{-3}	1.1×10^{-1}
U-230 (slow lung absorption)[a,f]	3.0×10^{1}	8.1×10^{2}	3.0×10^{-3}	8.1×10^{-2}
U-232 (fast lung absorption)[d]	4.0×10^{1}	1.1×10^{3}	1.0×10^{-2}	2.7×10^{-1}
U-232 (medium lung absorption)[e]	4.0×10^{1}	1.1×10^{3}	7.0×10^{-3}	1.9×10^{-1}
U-232 (slow lung absorption)[f]	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}
U-233 (fast lung absorption)[d]	4.0×10^{1}	1.1×10^{3}	9.0×10^{-2}	2.4
U-233 (medium lung absorption)[e]	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}

U-233 (slow lung absorption)[f]	4.0×10^{1}	1.1×10^{3}	6.0×10^{-3}	1.6×10^{-1}
U-234 (fast lung absorption)[d]	4.0×10^{1}	1.1×10^{3}	9.0×10^{-2}	2.4
U-234 (medium lung absorption)[e]	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}
U-234 (slow lung absorption)[f]	4.0×10^{1}	1.1×10^{3}	6.0×10^{-3}	1.6×10^{-1}
U-235 (all lung absorption types)[a,d,e,f]	Unlimited	Unlimited	Unlimited	Unlimited
U-236 (fast lung absorption)[d]	Unlimited	Unlimited	Unlimited	Unlimited
U-236 (medium lung absorption)[e]	4.0×10^{1}	1.1×10^{3}	2.0×10^{-2}	5.4×10^{-1}
U-236 (slow lung absorption)[f]	4.0×10^{1}	1.1×10^{3}	6.0×10^{-3}	1.6×10^{-1}
U-238 (all lung absorption types)[d,e,f]	Unlimited	Unlimited	Unlimited	Unlimited
U (nat)	Unlimited	Unlimited	Unlimited	Unlimited
U (enriched to 20% or less)[g]	Unlimited	Unlimited	Unlimited	Unlimited
U (dep)	Unlimited	Unlimited	Unlimited	Unlimited
Vanadium (23)				
V-48	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
V-49	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Tungsten (74)				
W-178[a]	9.0	2.4×10^{2}	5.0	1.4×10^{2}
W-181	3.0×10^{1}	8.1×10^{2}	3.0×10^{1}	8.1×10^{2}
W-185	4.0×10^{1}	1.1×10^{3}	8.0×10^{-1}	2.2×10^{1}
W-187	2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}
W-188[a]	4.0×10^{-1}	1.1×10^{1}	3.0×10^{-1}	8.1

Xenon (54)				
Xe-122[a]	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Xe-123	2.0	5.4×10^{1}	7.0×10^{-1}	1.9×10^{1}
Xe-127	4.0	1.1×10^{2}	2.0	5.4×10^{1}
Xe-131m	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}
Xe-133	2.0×10^{1}	5.4×10^{2}	1.0×10^{1}	2.7×10^{2}
Xe-135	3.0	8.1×10^{1}	2.0	5.4×10^{1}
Yttrium (39)				
Y-87[a]	1.0	2.7×10^{1}	1.0	2.7×10^{1}
Y-88	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}
Y-90	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Y-91	6.0×10^{-1}	1.6×10^{1}	6.0×10^{-1}	1.6×10^{1}
Y-91m	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Y-92	2.0×10^{-1}	5.4	2.0×10^{-1}	5.4
Y-93	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1
Ytterbium (70)				
Yb-169	4.0	1.1×10^{2}	1.0	2.7×10^{1}
Yb-175	3.0×10^{1}	8.1×10^{2}	9.0×10^{-1}	2.4×10^{1}
Zinc (30)				
Zn-65	2.0	5.4×10^{1}	2.0	5.4×10^{1}
Zn-69	3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}
Zn-69m[a]	3.0	8.1×10^{1}	6.0×10^{-1}	1.6×10^{1}
Zirconium (40)				
Zr-88	3.0	8.1×10^{1}	3.0	8.1×10^{1}
Zr-93	Unlimited	Unlimited	Unlimited	Unlimited

Zr-95[a]	2.0	5.4×10^{1}	8.0×10^{-1}	2.2×10^{1}
Zr-97[a]	4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}

[a]A_1 and A_2 values include contributions from daughter nuclides with half-lives less than ten days as listed in the following:

Mg-28	Al-28
Ca-47	Sc-47
Ti-44	Sc-44
Fe-52	Mn-52m
Fe-60	Co-60m
Zn-69m	Zn-69
Ge-68	Ga-68
Rb-83	Kr-83m
Sr-82	Rb-82
Sr-90	Y-90
Sr-91	Y-91m
Sr-92	Y-92
Y-87	Sr-87m
Zr-95	Nb-95m
Zr-97	Nb-97m, Nb-97
Mo-99	Tc-99m
Tc-95m	Tc-95
Tc-96m	Tc-96
Ru-103	Rh-103m
Ru-106	Rh-106
Pd-103	Rh-103m
Ag-108m	Ag-108
Ag-110m	Ag-110
Cd-115	In-115m

In-114m	In-114
Sn-113	In-113m
Sn-121m	Sn-121
Sn-126	Sb-126m
Te-127m	Te-127
Te-129m	Te-129
Te-131m	Te-131
Te-132	I-132
I-135	Xe-135m
Xe-122	I-122
Cs-137	Ba-137m
Ba-131	Cs-131
Ba-140	La-140
Ce-144	Pr-144m, Pr-144
Pm-148M	Pm-148
Gd-146	Eu-146
Dy-166	Ho-166
Hf-172	Lu-172
W-178	Ta-178
W-188	Re-188
Re-189	Os-189m
Os-194	Ir-194
Ir-189	Os-189m
Pt-188	Ir-188
Hg-194	Au-194
Hg-195m	Hg-195
Pb-210	Bi-210
Pb-212	Bi-212, Tl-208, Po-212

Bi-210m	Tl-206
Bi-212	Tl-208, Po-212
At-211	Po-211
Rn-222	Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Ra-225	Ac-225, Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ra-226	Rn-222, Po-218, Pb-214, At-218, Bi-214, Po-214
Ra-228	Ac-228
Ac-225	Fr-221, At-217, Bi-213, Tl-209, Po-213, Pb-209
Ac-227	Fr-223
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m, Pa-234
Pa-230	Ac-226, Th-226, Fr-222, Ra-222, Rn-218, Po-214
U-230	Th-226, Ra-222, Rn-218, Po-214
U-235	Th-231
Pu-241	U-237
Pu-244	U-240, Np-240m
Am-242m	Am-242, Np-238
Am-243	Np-239
Cm-247	Pu-243
Bk-249	Am-245
Cf-253	Cm-249

[b]The values of A_1 and A_2 in curies (Ci) are approximate and for information only; the regulatory standard units are Terabecquerels (TBq). See part 4731.0423, subpart 1 - Determination of A_1 and A_2.

[c]The activity of Ir-192 in special form may be determined from a measurement of the rate of decay or a measurement of the radiation level at a prescribed distance from the source.

[d]These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2, and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.

[e]These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, and UCl_4 and hexavalent compounds in both normal and accident conditions of transport.

[f]These values apply to all compounds of uranium other than those specified in notes d and e.

[g]These values apply to unirradiated uranium only.

[h]A_2 = 0.74 TBq (20 Ci) for Mo-99 for domestic use.

Subp. 2. **Specific activity.** This subpart specifies specific activity for individual radionuclides.

Element and Atomic Number and Symbol of Radionuclide	Specific Activity (TBq/g)	Specific Activity (Ci/g)
Actinium (89)		
Ac-225	2.1×10^{3}	5.8×10^{4}
Ac-227	2.7	7.2×10^{1}
Ac-228	8.4×10^{4}	2.2×10^{6}
Silver (47)		
Ag-105	1.1×10^{3}	3.0×10^{4}
Ag-108m	9.7×10^{-1}	2.6×10^{1}
Ag-110m	1.8×10^{2}	4.7×10^{3}
Ag-111	5.8×10^{3}	1.6×10^{5}
Aluminum (13)		
Al-26	7.0×10^{-4}	1.9×10^{-2}
Americium (95)		
Am-241	1.3×10^{-1}	3.4
Am-242m	3.6×10^{-1}	1.0×10^{1}
Am-243	7.4×10^{-3}	2.0×10^{-1}

Argon (18)		
Ar-37	3.7×10^{3}	9.9×10^{4}
Ar-39	1.3	3.4×10^{1}
Ar-41	1.5×10^{6}	4.2×10^{7}
Ar-42	9.6	2.6×10^{2}
Arsenic (33)		
As-72	6.2×10^{4}	1.7×10^{6}
As-73	8.2×10^{2}	2.2×10^{4}
As-74	3.7×10^{3}	9.9×10^{4}
As-76	5.8×10^{4}	1.6×10^{6}
As-77	3.9×10^{4}	1.0×10^{6}
Astatine (85)		
At-211	7.6×10^{4}	2.1×10^{6}
Gold (79)		
Au-193	3.4×10^{4}	9.2×10^{5}
Au-194	1.5×10^{4}	4.1×10^{5}
Au-195	1.4×10^{2}	3.7×10^{3}
Au-196	4.0×10^{3}	1.1×10^{5}
Au-198	9.0×10^{3}	2.4×10^{5}
Au-199	7.7×10^{3}	2.1×10^{5}
Barium (56)		
Ba-131	3.1×10^{3}	8.4×10^{4}
Ba-133m	2.2×10^{4}	6.1×10^{5}
Ba-133	9.4	2.6×10^{2}
Ba-140	2.7×10^{3}	7.3×10^{4}
Beryllium (4)		

Be-7	1.3×10^{4}	3.5×10^{5}
Be-10	8.3×10^{-4}	2.2×10^{-2}
Bismuth (83)		
Bi-205	1.5×10^{3}	4.2×10^{4}
Bi-206	3.8×10^{3}	1.0×10^{5}
Bi-207	1.9	5.2×10^{1}
Bi-210m	2.1×10^{-5}	5.7×10^{-4}
Bi-210	4.6×10^{3}	1.2×10^{5}
Bi-212	5.4×10^{5}	1.5×10^{7}
Berkelium (97)		
Bk-247	3.8×10^{-2}	1.0
Bk-249	6.1×10^{1}	1.6×10^{3}
Bromine (35)		
Br-76	9.4×10^{4}	2.5×10^{6}
Br-77	2.6×10^{4}	7.1×10^{5}
Br-82	4.0×10^{4}	1.1×10^{6}
Carbon (6)		
C-11	3.1×10^{7}	8.4×10^{8}
C-14	1.6×10^{-1}	4.5
Calcium (20)		
Ca-41	3.1×10^{-3}	8.5×10^{-2}
Ca-45	6.6×10^{2}	1.8×10^{4}
Ca-47	2.3×10^{4}	6.1×10^{5}
Cadmium (48)		
Cd-109	9.6×10^{1}	2.6×10^{3}

Cd-113m	8.3	2.2×10^{2}
Cd-115m	9.4×10^{2}	2.5×10^{4}
Cd-115	1.9×10^{4}	5.1×10^{5}
Cerium (58)		
Ce-139	2.5×10^{2}	6.8×10^{3}
Ce-141	1.1×10^{3}	2.8×10^{4}
Ce-143	2.5×10^{4}	6.6×10^{5}
Ce-144	1.2×10^{2}	3.2×10^{3}
Californium (98)		
Cf-248	5.8×10^{1}	1.6×10^{3}
Cf-249	1.5×10^{-1}	4.1
Cf-250	4.0	1.1×10^{2}
Cf-251	5.9×10^{-2}	1.6
Cf-252	2.0×10^{1}	5.4×10^{2}
Cf-253	1.1×10^{3}	2.9×10^{4}
Cf-254	3.1×10^{2}	8.5×10^{3}
Chlorine (17)		
Cl-36	1.2×10^{-3}	3.3×10^{-2}
Cl-38	4.9×10^{6}	1.3×10^{8}
Curium (96)		
Cm-240	7.5×10^{2}	2.0×10^{4}
Cm-241	6.1×10^{2}	1.7×10^{4}
Cm-242	1.2×10^{2}	3.3×10^{3}
Cm-243	1.9×10^{-3}	5.2×10^{1}
Cm-244	3.0	8.1×10^{1}
Cm-245	6.4×10^{-3}	1.7×10^{-1}

Cm-246	1.1×10^{-2}	3.1×10^{-1}
Cm-247	3.4×10^{-6}	9.3×10^{-5}
Cm-248	1.6×10^{-4}	4.2×10^{-3}
Cobalt (27)		
Co-55	1.1×10^{5}	3.1×10^{6}
Co-56	1.1×10^{3}	3.0×10^{4}
Co-57	3.1×10^{2}	8.4×10^{3}
Co-58m	2.2×10^{5}	5.9×10^{6}
Co-58	1.2×10^{3}	3.2×10^{4}
Co-60	4.2×10^{1}	1.1×10^{3}
Chromium (24)		
Cr-51	3.4×10^{3}	9.2×10^{4}
Cesium (55)		
Cs-129	2.8×10^{4}	7.6×10^{5}
Cs-131	3.8×10^{3}	1.0×10^{5}
Cs-132	5.7×10^{3}	1.5×10^{5}
Cs-134m	3.0×10^{5}	8.0×10^{6}
Cs-134	4.8×10^{1}	1.3×10^{3}
Cs-135	4.3×10^{-5}	1.2×10^{-3}
Cs-136	2.7×10^{3}	7.3×10^{4}
Cs-137	3.2	8.7×10^{1}
Copper (29)		
Cu-64	1.4×10^{5}	3.9×10^{6}
Cu-67	2.8×10^{4}	7.6×10^{5}
Dysprosium (66)		
Dy-159	2.1×10^{2}	5.7×10^{3}

Dy-165	3.0×10^5	8.2×10^6
Dy-166	8.6×10^3	2.3×10^5
Erbium (68)		
Er-169	3.1×10^3	8.3×10^4
Er-171	9.0×10^4	2.4×10^6
Einsteinium (99)		
Es-253	---	---
Es-254	---	---
Es-254m	---	---
Es-255	---	---
Europium (63)		
Eu-147	1.4×10^3	3.7×10^4
Eu-148	6.0×10^2	1.6×10^4
Eu-149	3.5×10^2	9.4×10^3
Eu-150	6.1×10^4	1.6×10^6
Eu-152m	8.2×10^4	2.2×10^6
Eu-152	6.5	1.8×10^2
Eu-154	9.8	2.6×10^2
Eu-155	1.8×10^1	4.9×10^2
Eu-156	2.0×10^3	5.5×10^4
Fluorine (9)		
F-18	3.5×10^6	9.5×10^7
Iron (26)		
Fe-52	2.7×10^5	7.3×10^6
Fe-55	8.8×10^1	2.4×10^3
Fe-59	1.8×10^3	5.0×10^4

Fe-60	7.4×10^{-4}	2.0×10^{-2}
Fermium (100)		
Fm-255	---	---
Fm-257	---	---
Gallium (31)		
Ga-67	2.2×10^{4}	6.0×10^{5}
Ga-68	1.5×10^{6}	4.1×10^{7}
Ga-72	1.1×10^{5}	3.1×10^{6}
Gadolinium (64)		
Gd-146	6.9×10^{2}	1.9×10^{4}
Gd-148	1.2	3.2×10^{1}
Gd-153	1.3×10^{2}	3.5×10^{3}
Gd-159	3.9×10^{4}	1.1×10^{6}
Germanium (32)		
Ge-68	2.6×10^{2}	7.1×10^{3}
Ge-71	5.8×10^{3}	1.6×10^{5}
Ge-77	1.3×10^{5}	3.6×10^{6}
Hydrogen (1)		
H-3 (T)	3.6×10^{2}	9.7×10^{3}
Hafnium (72)		
Hf-172	4.1×10^{1}	1.1×10^{3}
Hf-175	3.9×10^{2}	1.1×10^{4}
Hf-181	6.3×10^{2}	1.7×10^{4}
Hf-182	8.1×10^{-6}	2.2×10^{-4}
Mercury (80)		

Hg-194	1.3×10^{-1}	3.5
Hg-195m	1.5×10^{4}	4.0×10^{5}
Hg-197m	2.5×10^{4}	6.7×10^{5}
Hg-197	9.2×10^{3}	2.5×10^{5}
Hg-203	5.1×10^{2}	1.4×10^{4}
Holmium (67)		
Ho-163	2.7	7.6×10^{1}
Ho-166m	6.6×10^{-2}	1.8
Ho-166	2.6×10^{4}	7.0×10^{5}
Iodine (53)		
I-123	7.1×10^{4}	1.9×10^{6}
I-124	9.3×10^{3}	2.5×10^{5}
I-125	6.4×10^{2}	1.7×10^{4}
I-126	2.9×10^{3}	8.0×10^{4}
I-129	6.5×10^{-6}	1.8×10^{-4}
I-131	4.6×10^{3}	1.2×10^{5}
I-132	3.8×10^{5}	1.0×10^{7}
I-133	4.2×10^{4}	1.1×10^{6}
I-134	9.9×10^{5}	2.7×10^{7}
I-135	1.3×10^{5}	3.5×10^{6}
Indium (49)		
In-111	1.5×10^{4}	4.2×10^{5}
In-113m	6.2×10^{5}	1.7×10^{7}
In-114m	8.6×10^{2}	2.3×10^{4}
In-115m	2.2×10^{5}	6.1×10^{6}
Iridium (77)		

Ir-189	1.9×10^{3}	5.2×10^{4}
Ir-190	2.3×10^{3}	6.2×10^{4}
Ir-192	3.4×10^{2}	9.2×10^{3}
Ir-193m	2.4×10^{3}	6.4×10^{4}
Ir-194	3.1×10^{4}	8.4×10^{5}
Potassium (19)		
K-40	2.4×10^{-7}	6.4×10^{-6}
K-42	2.2×10^{5}	6.0×10^{6}
K-43	1.2×10^{5}	3.3×10^{6}
Krypton (36)		
Kr-79	4.2×10^{4}	1.1×10^{6}
Kr-81	7.8×10^{-4}	2.1×10^{-2}
Kr-85m	3.0×10^{5}	8.2×10^{6}
Kr-85	1.5×10^{1}	3.9×10^{2}
Kr-87	1.0×10^{6}	2.8×10^{7}
Lanthanum (57)		
La-137	1.6×10^{-3}	4.4×10^{-2}
La-140	2.1×10^{4}	5.6×10^{5}
Lutetium (71)		
Lu-172	4.2×10^{3}	1.1×10^{5}
Lu-173	5.6×10^{1}	1.5×10^{3}
Lu-174m	2.0×10^{2}	5.3×10^{3}
Lu-174	2.3×10^{1}	6.2×10^{2}
Lu-177	4.1×10^{3}	1.1×10^{5}
Magnesium (12)		
Mg-28	2.0×10^{5}	5.4×10^{6}

Manganese (25)		
Mn-52	1.6×10^{4}	4.4×10^{5}
Mn-53	6.8×10^{-5}	1.8×10^{-3}
Mn-54	2.9×10^{2}	7.7×10^{3}
Mn-56	8.0×10^{5}	2.2×10^{7}
Molybdenum (42)		
Mo-93	4.1×10^{-2}	1.1
Mo-99	1.8×10^{4}	4.8×10^{5}
Nitrogen (7)		
N-13	5.4×10^{7}	1.5×10^{9}
Sodium (11)		
Na-22	2.3×10^{2}	6.3×10^{3}
Na-24	3.2×10^{5}	8.7×10^{6}
Niobium (41)		
Nb-92m	5.2×10^{3}	1.4×10^{5}
Nb-93m	8.8	2.4×10^{2}
Nb-94	6.9×10^{-3}	1.9×10^{-1}
Nb-95	1.5×10^{3}	3.9×10^{4}
Nb-97	9.9×10^{5}	2.7×10^{7}
Neodymium (60)		
Nd-147	3.0×10^{3}	8.1×10^{4}
Nd-149	4.5×10^{5}	1.2×10^{7}
Nickel (28)		
Ni-59	3.0×10^{-3}	8.0×10^{-2}
Ni-63	2.1	5.7×10^{1}

Ni-65	7.1×10^{5}	1.9×10^{7}
Neptunium (93)		
Np-235	5.2×10^{1}	1.4×10^{3}
Np-236	4.7×10^{-4}	1.3×10^{-2}
Np-237	2.6×10^{-5}	7.1×10^{-4}
Np-239	8.6×10^{3}	2.3×10^{5}
Osmium (76)		
Os-185	2.8×10^{2}	7.5×10^{3}
Os-191m	4.6×10^{4}	1.3×10^{6}
Os-191	1.6×10^{3}	4.4×10^{4}
Os-193	2.0×10^{4}	5.3×10^{5}
Os-194	1.1×10^{1}	3.1×10^{2}
Phosphorus (15)		
P-32	1.1×10^{4}	2.9×10^{5}
P-33	5.8×10^{3}	1.6×10^{5}
Protactinium (91)		
Pa-230	1.2×10^{3}	3.3×10^{4}
Pa-231	1.7×10^{-3}	4.7×10^{-2}
Pa-233	7.7×10^{2}	2.1×10^{4}
Lead (82)		
Pb-201	6.2×10^{4}	1.7×10^{6}
Pb-202	1.2×10^{-4}	3.4×10^{-3}
Pb-203	1.1×10^{4}	3.0×10^{5}
Pb-205	4.5×10^{-6}	1.2×10^{-4}
Pb-210	2.8	7.6×10^{1}
Pb-212	5.1×10^{4}	1.4×10^{6}

Palladium (46)		
Pd-103	2.8×10^{3}	7.5×10^{4}
Pd-107	1.9×10^{-5}	5.1×10^{-4}
Pd-109	7.9×10^{4}	2.1×10^{6}
Promethium (61)		
Pm-143	1.3×10^{2}	3.4×10^{3}
Pm-144	9.2×10^{1}	2.5×10^{3}
Pm-145	5.2	1.4×10^{2}
Pm-147	3.4×10^{1}	9.3×10^{2}
Pm-148m	7.9×10^{2}	2.1×10^{4}
Pm-149	1.5×10^{4}	4.0×10^{5}
Pm-151	2.7×10^{4}	7.3×10^{5}
Polonium (84)		
Po-208	2.2×10^{1}	5.9×10^{2}
Po-209	6.2×10^{-1}	1.7×10^{1}
Po-210	1.7×10^{2}	4.5×10^{3}
Praseodymium (59)		
Pr-142	4.3×10^{4}	1.2×10^{6}
Pr-143	2.5×10^{3}	6.7×10^{4}
Platinum (78)		
Pt-188	2.5×10^{3}	6.8×10^{4}
Pt-191	8.7×10^{3}	2.4×10^{5}
Pt-193m	5.8×10^{3}	1.6×10^{5}
Pt-193	1.4	3.7×10^{1}
Pt-195m	6.2×10^{3}	1.7×10^{5}
Pt-197m	3.7×10^{5}	1.0×10^{7}

Pt-197	3.2×10^{4}	8.7×10^{5}
Plutonium (94)		
Pu-236	2.0×10^{1}	5.3×10^{2}
Pu-237	4.5×10^{2}	1.2×10^{4}
Pu-238	6.3×10^{-1}	1.7×10^{1}
Pu-239	2.3×10^{-3}	6.2×10^{-2}
Pu-240	8.4×10^{-3}	2.3×10^{-1}
Pu-241	3.8	1.0×10^{2}
Pu-242	1.5×10^{-4}	3.9×10^{-3}
Pu-244	6.7×10^{-7}	1.8×10^{-5}
Radium (88)		
Ra-223	1.9×10^{3}	5.1×10^{4}
Ra-224	5.9×10^{3}	1.6×10^{5}
Ra-225	1.5×10^{3}	3.9×10^{4}
Ra-226	3.7×10^{-2}	1.0
Ra-228	1.0×10^{1}	2.7×10^{2}
Rubidium (37)		
Rb-81	3.1×10^{5}	8.4×10^{6}
Rb-83	6.8×10^{2}	1.8×10^{4}
Rb-84	1.8×10^{3}	4.7×10^{4}
Rb-86	3.0×10^{3}	8.1×10^{4}
Rb-87	3.2×10^{-9}	8.6×10^{-8}
Rb (natural)	6.7×10^{6}	1.8×10^{8}
Rhenium (75)		
Re-183	3.8×10^{2}	1.0×10^{4}
Re-184m	1.6×10^{2}	4.3×10^{3}

Re-184	6.9×10^{2}	1.9×10^{4}
Re-186	6.9×10^{3}	1.9×10^{5}
Re-187	1.4×10^{-9}	3.8×10^{-8}
Re-188	3.6×10^{4}	9.8×10^{5}
Re-189	2.5×10^{4}	6.8×10^{5}
Re (natural)	---	2.4×10^{-8}
Rhodium (45)		
Rh-99	3.0×10^{3}	8.2×10^{4}
Rh-101	4.1×10^{1}	1.1×10^{3}
Rh-102m	2.3×10^{2}	6.2×10^{3}
Rh-102	4.5×10^{1}	1.2×10^{3}
Rh-103m	1.2×10^{6}	3.3×10^{7}
Rh-105	3.1×10^{4}	8.4×10^{5}
Radon (86)		
Rn-222	5.7×10^{3}	1.5×10^{5}
Ruthenium (44)		
Ru-97	1.7×10^{4}	4.6×10^{5}
Ru-103	1.2×10^{3}	3.2×10^{4}
Ru-105	2.5×10^{5}	6.7×10^{6}
Ru-106	1.2×10^{2}	3.3×10^{3}
Sulfur (16)		
S-35	1.6×10^{3}	4.3×10^{4}
Antimony (51)		
Sb-122	1.5×10^{4}	4.0×10^{5}
Sb-124	6.5×10^{2}	1.7×10^{4}
Sb-125	3.9×10^{1}	1.0×10^{3}

Sb-126	3.1×10^{3}	8.4×10^{4}
Scandium (21)		
Sc-44	6.7×10^{5}	1.8×10^{7}
Sc-46	1.3×10^{3}	3.4×10^{4}
Sc-47	3.1×10^{4}	8.3×10^{5}
Sc-48	5.5×10^{4}	1.5×10^{6}
Selenium (34)		
Se-75	5.4×10^{2}	1.5×10^{4}
Se-79	2.6×10^{-3}	7.0×10^{-2}
Silicon (14)		
Si-31	1.4×10^{6}	3.9×10^{7}
Si-32	3.9	1.1×10^{2}
Samarium (62)		
Sm-145	9.8×10^{1}	2.6×10^{3}
Sm-147	8.5×10^{-10}	2.3×10^{-8}
Sm-151	9.7×10^{-1}	2.6×10^{1}
Sm-153	1.6×10^{4}	4.4×10^{5}
Tin (50)		
Sn-113	3.7×10^{2}	1.0×10^{4}
Sn-117m	3.0×10^{3}	8.2×10^{4}
Sn-119m	1.4×10^{2}	3.7×10^{3}
Sn-121m	2.0	5.4×10^{1}
Sn-123	3.0×10^{2}	8.2×10^{3}
Sn-125	4.0×10^{3}	1.1×10^{5}
Sn-126	1.0×10^{-3}	2.8×10^{-2}

Strontium (38)		
Sr-82	2.3×10^{3}	6.2×10^{4}
Sr-85m	1.2×10^{6}	3.3×10^{7}
Sr-85	8.8×10^{2}	2.4×10^{4}
Sr-87m	4.8×10^{5}	1.3×10^{7}
Sr-89	1.1×10^{3}	2.9×10^{4}
Sr-90	5.1	1.4×10^{2}
Sr-91	1.3×10^{5}	3.6×10^{6}
Sr-92	4.7×10^{5}	1.3×10^{7}
Tritium (1)		
T (H-3)	3.6×10^{2}	9.7×10^{3}
Tantalum (73)		
Ta-178	4.2×10^{6}	1.1×10^{8}
Ta-179	4.1×10^{1}	1.1×10^{3}
Ta-182	2.3×10^{2}	6.2×10^{3}
Terbium (65)		
Tb-157	5.6×10^{-1}	1.5×10^{1}
Tb-158	5.6×10^{-1}	1.5×10^{1}
Tb-160	4.2×10^{2}	1.1×10^{4}
Technetium (43)		
Tc-95m	8.3×10^{2}	2.2×10^{4}
Tc-96m	1.4×10^{6}	3.8×10^{7}
Tc-96	1.2×10^{4}	3.2×10^{5}
Tc-97m	5.6×10^{2}	1.5×10^{4}
Tc-97	5.2×10^{-5}	1.4×10^{-3}
Tc-98	3.2×10^{-5}	8.7×10^{-4}

Tc-99m	1.9×10^{5}	5.3×10^{6}
Tc-99	6.3×10^{-4}	1.7×10^{-2}
Tellurium (52)		
Te-118	6.8×10^{3}	1.8×10^{5}
Te-121m	2.6×10^{2}	7.0×10^{3}
Te-121	2.4×10^{3}	6.4×10^{4}
Te-123m	3.3×10^{2}	8.9×10^{3}
Te-125m	6.7×10^{2}	1.8×10^{4}
Te-127m	3.5×10^{2}	9.4×10^{3}
Te-127	9.8×10^{4}	2.6×10^{6}
Te-129m	1.1×10^{3}	3.0×10^{4}
Te-129	7.7×10^{5}	2.1×10^{7}
Te-131m	3.0×10^{4}	8.0×10^{5}
Te-132	1.1×10^{4}	3.0×10^{5}
Thorium (90)		
Th-227	1.1×10^{3}	3.1×10^{4}
Th-228	3.0×10^{1}	8.2×10^{2}
Th-229	7.9×10^{-3}	2.1×10^{-1}
Th-230	7.6×10^{-4}	2.1×10^{-2}
Th-231	2.0×10^{4}	5.3×10^{5}
Th-232	4.0×10^{-9}	1.1×10^{-7}
Th-234	8.6×10^{2}	2.3×10^{4}
Th (natural)	8.1×10^{-9}	2.2×10^{-7}
Titanium (22)		
Ti-44	6.4	1.7×10^{2}
Thallium (81)		

Tl-200	2.2×10^{4}	6.0×10^{5}
Tl-201	7.9×10^{3}	2.1×10^{5}
Tl-202	2.0×10^{3}	5.3×10^{4}
Tl-204	1.7×10^{1}	4.6×10^{2}
Thulium (69)		
Tm-167	3.1×10^{3}	8.5×10^{4}
Tm-168	3.1×10^{2}	8.3×10^{3}
Tm-170	2.2×10^{2}	6.0×10^{3}
Tm-171	4.0×10^{1}	1.1×10^{3}
Uranium (92)		
U-230	1.0×10^{3}	2.7×10^{4}
U-232	8.3×10^{-1}	2.2×10^{1}
U-233	3.6×10^{-4}	9.7×10^{-3}
U-234	2.3×10^{-4}	6.2×10^{-3}
U-235	8.0×10^{-8}	2.2×10^{-6}
U-236	2.4×10^{-6}	6.5×10^{-5}
U-238	1.2×10^{-8}	3.4×10^{-7}
U (natural)	2.6×10^{-8}	7.1×10^{-7}
U (enriched 5% or less)	---	(See part 4731.0424)
U (enriched more than 5%)	---	(See part 4731.0424)
U (depleted)	---	(See part 4731.0424)
Vanadium (23)		
V-48	6.3×10^{3}	1.7×10^{5}
V-49	3.0×10^{2}	8.1×10^{3}
Tungsten (74)		
W-178	1.3×10^{3}	3.4×10^{4}

W-181	2.2×10^{2}	6.0×10^{3}
W-185	3.5×10^{2}	9.4×10^{3}
W-187	2.6×10^{4}	7.0×10^{5}
W-188	3.7×10^{2}	1.0×10^{4}
Xenon (54)		
Xe-122	4.8×10^{4}	1.3×10^{6}
Xe-123	4.4×10^{5}	1.2×10^{7}
Xe-127	1.0×10^{3}	2.8×10^{4}
Xe-131m	3.1×10^{3}	8.4×10^{4}
Xe-133	6.9×10^{3}	1.9×10^{5}
Xe-135	9.5×10^{4}	2.6×10^{6}
Yttrium (39)		
Y-87	1.7×10^{4}	4.5×10^{5}
Y-88	5.2×10^{2}	1.4×10^{4}
Y-90	2.0×10^{4}	5.4×10^{5}
Y-91m	1.5×10^{6}	4.2×10^{7}
Y-91	9.1×10^{2}	2.5×10^{4}
Y-92	3.6×10^{5}	9.6×10^{6}
Y-93	1.2×10^{5}	3.3×10^{6}
Ytterbium (70)		
Yb-169	8.9×10^{2}	2.4×10^{4}
Yb-175	6.6×10^{3}	1.8×10^{5}
Zinc (30)		
Zn-65	3.0×10^{2}	8.2×10^{3}
Zn-69m	1.2×10^{5}	3.3×10^{6}
Zn-69	1.8×10^{6}	4.9×10^{7}

Zirconium (40)		
Zr-88	6.6×10^{2}	1.8×10^{4}
Zr-93	9.3×10^{-5}	2.5×10^{-3}
Zr-95	7.9×10^{2}	2.1×10^{4}
Zr-97	7.1×10^{4}	1.9×10^{6}

Subp. 3. **Exempt material activity concentrations and exempt consignment activity limits.** This subpart specifies exempt material activity concentrations and exempt consignment activity levels for radionuclides.

Element and atomic number and symbol of radionuclide	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Actinium (89)				
Ac-225	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Ac-227	1.0×10^{-1}	2.7×10^{-12}	1.0×10^{3}	2.7×10^{-8}
Ac-228	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Silver (47)				
Ag-105	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ag-108m[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Ag-110m	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Ag-111	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Aluminum (13)				
Al-26	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Americium (95)				
Am-241	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Am-242m[a]	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Am-243[a]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}

Argon (18)				
Ar-37	1.0×10^{6}	2.7×10^{-5}	1.0×10^{8}	2.7×10^{-3}
Ar-39	1.0×10^{7}	2.7×10^{-4}	1.0×10^{4}	2.7×10^{-7}
Ar-41	1.0×10^{2}	2.7×10^{-9}	1.0×10^{9}	2.7×10^{-2}
Arsenic (33)				
As-72	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
As-73	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
As-74	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
As-76	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
As-77	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Astatine (85)				
At-211	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Gold (79)				
Au-193	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Au-194	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Au-195	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Au-198	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Au-199	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Barium (56)				
Ba-131	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ba-133	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ba-133m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ba-140[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Beryllium (4)				
Be-7	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Be-10	1.0×10^{4}	2.7×10^{-7}	1.0×10^{6}	2.7×10^{-5}

Bismuth (83)				
Bi-205	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Bi-206	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Bi-207	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Bi-210	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Bi-210m	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Bi-212[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Berkelium (97)				
Bk-247	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Bk-249	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Bromine (35)				
Br-76	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Br-77	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Br-82	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Carbon(6)				
C-11	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
C-14	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Calcium (20)				
Ca-41	$1.0x\ 10^{5}$	2.7×10^{-6}	1.0×10^{7}	2.7×10^{-4}
Ca-45	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Ca-47	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Cadmium (48)				
Cd-109	1.0×10^{4}	2.7×10^{-7}	1.0×10^{6}	2.7×10^{-5}
Cd-113m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Cd-115	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Cd-115m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}

Cerium (58)				
Ce-139	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ce-141	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Ce-143	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ce-144[a]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Californium (98)				
Cf-248	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Cf-249	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Cf-250	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Cf-251	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Cf-252	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Cf-253	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Cf-254	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Chlorine (17)				
Cl-36	1.0×10^{4}	2.7×10^{-7}	1.0×10^{6}	2.7×10^{-5}
Cl-38	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Curium (96)				
Cm-240	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Cm-241	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Cm-242	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Cm-243	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Cm-244	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Cm-245	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Cm-246	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Cm-247	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Cm-248	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}

Cobalt (27)				
Co-55	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Co-56	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Co-57	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Co-58	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Co-58m	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Co-60	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Chromium (24)				
Cr-51	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Cesium (55)				
Cs-129	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Cs-131	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Cs-132	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Cs-134	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Cs-134m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
Cs-135	$1.0x\ 10^{4}$	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Cs-136	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Cs-137[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Copper (29)				
Cu-64	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Cu-67	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Dysprosium (66)				
Dy-159	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Dy-165	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Dy-166	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}

Erbium (68)				
Er-169	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Er-171	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Europium (63)				
Eu-147	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Eu-148	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Eu-149	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Eu-150 (short-lived)	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Eu-150 (long-lived)	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Eu-152	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Eu-152m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Eu-154	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Eu-155	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Eu-156	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Fluorine (9)				
F-18	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Iron (26)				
Fe-52	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Fe-55	1.0×10^{4}	2.7×10^{-7}	1.0×10^{6}	2.7×10^{-5}
Fe-59	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Fe-60	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Gallium (31)				
Ga-67	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ga-68	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Ga-72	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Gadolinium (64)				

Gd-146	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Gd-148	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Gd-153	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Gd-159	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Germanium (32)				
Ge-68	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Ge-71	1.0×10^{4}	2.7×10^{-7}	1.0×10^{8}	2.7×10^{-3}
Ge-77	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Tritium (1)				
H-3 (T)	1.0×10^{6}	2.7×10^{-5}	1.0×10^{9}	2.7×10^{-2}
Hafnium (72)				
Hf-172	$1.0x\ 10^{1}$	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Hf-175	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Hf-181	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Hf-182	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Mercury (80)				
Hg-194	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Hg-195m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Hg-197	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Hg-197m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Hg-203	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Holmium (67)				
Ho-166	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
Ho-166m	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}

Iodine (53)				
I-123	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
I-124	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
I-125	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
I-126	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
I-129	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
I-131	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
I-132	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
I-133	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
I-134	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
I-135	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Indium (49)				
In-111	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
In-113m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
In-114m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
In-115m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Iridium (77)				
Ir-189	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Ir-190	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Ir-192	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Ir-194	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Potassium (19)				
K-40	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
K-42	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
K-43	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Krypton (36)				

Kr-79	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
Kr-81	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Kr-85	1.0×10^{5}	2.7×10^{-6}	1.0×10^{4}	2.7×10^{-7}
Kr-85m	$1.0x\ 10^{3}$	2.7×10^{-8}	1.0×10^{10}	2.7×10^{-1}
Kr-87	1.0×10^{2}	2.7×10^{-9}	1.0×10^{9}	2.7×10^{-2}
Lanthanum (57)				
La-137	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
La-140	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Lutetium (71)				
Lu-172	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Lu-173	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Lu-174	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Lu-174m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Lu-177	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Magnesium (12)				
Mg-28	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Manganese (25)				
Mn-52	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Mn-53	1.0×10^{4}	2.7×10^{-7}	1.0×10^{9}	2.7×10^{-2}
Mn-54	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Mn-56	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Molybdenum (42)				
Mo-93	1.0×10^{3}	2.7×10^{-8}	1.0×10^{8}	2.7×10^{-3}
Mo-99	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}

Nitrogen (7)				
N-13	1.0×10^{2}	2.7×10^{-9}	1.0×10^{9}	2.7×10^{-2}
Sodium (11)				
Na-22	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Na-24	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Niobium (41)				
Nb-93m	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Nb-94	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Nb-95	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Nb-97	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Neodymium (60)				
Nd-147	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Nd-149	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Nickel (28)				
Ni-59	1.0×10^{4}	2.7×10^{-7}	1.0×10^{8}	2.7×10^{-3}
Ni-63	1.0×10^{5}	2.7×10^{-6}	1.0×10^{8}	2.7×10^{-3}
Ni-65	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Neptunium (93)				
Np-235	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Np-236 (short-lived)	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Np-236 (long-lived)	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Np-237[a]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Np-239	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Osmium (76)				
Os-185	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}

Os-191	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Os-191m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Os-193	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Os-194	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Phosphorus (15)				
P-32	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
P-33	1.0×10^{5}	2.7×10^{-6}	1.0×10^{8}	2.7×10^{-3}
Protactinium (91)				
Pa-230	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Pa-231	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Pa-233	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Lead (82)				
Pb-201	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Pb-202	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Pb-203	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Pb-205	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Pb-210[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Pb-212[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Palladium (46)				
Pd-103	1.0×10^{3}	2.7×10^{-8}	1.0×10^{8}	2.7×10^{-3}
Pd-107	1.0×10^{5}	2.7×10^{-6}	1.0×10^{8}	2.7×10^{-3}
Pd-109	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Promethium (61)				
Pm-143	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Pm-144	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Pm-145	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}

Pm-147	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Pm-148m	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Pm-149	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Pm-151	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Polonium (84)				
Po-210	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Praseodymium (59)				
Pr-142	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Pr-143	1.0×10^{4}	2.7×10^{-7}	1.0×10^{6}	2.7×10^{-5}
Platinum (78)				
Pt-188	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Pt-191	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Pt-193	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Pt-193m	$1.0x\ 10^{3}$	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Pt-195m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Pt-197	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Pt-197m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Plutonium (94)				
Pu-236	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Pu-237	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Pu-238	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Pu-239	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Pu-240	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Pu-241	$1.0x\ 10^{2}$	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Pu-242	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Pu-244	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}

Radium (88)				
Ra-223[a]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Ra-224[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Ra-225	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Ra-226[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Ra-228[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Rubidium (37)				
Rb-81	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Rb-83	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Rb-84	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Rb-86	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Rb-87	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Rb (nat)	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Rhenium (75)				
Re-184	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Re-184m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Re-186	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Re-187	1.0×10^{6}	2.7×10^{-5}	1.0×10^{9}	2.7×10^{-2}
Re-188	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Re-189	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Re (nat)	1.0×10^{6}	2.7×10^{-5}	1.0×10^{9}	2.7×10^{-2}
Rhodium (45)				
Rh-99	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Rh-101	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Rh-102	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Rh-102m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}

Rh-103m	1.0×10^{4}	2.7×10^{-7}	1.0×10^{8}	2.7×10^{-3}
Rh-105	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Radon (86)				
Rn-222[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{8}	2.7×10^{-3}
Ruthenium (44)				
Ru-97	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Ru-103	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ru-105	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Ru-106[a]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Sulfur (16)				
S-35	1.0×10^{5}	2.7×10^{-6}	1.0×10^{8}	2.7×10^{-3}
Antimony (51)				
Sb-122	1.0×10^{2}	2.7×10^{-9}	1.0×10^{4}	2.7×10^{-7}
Sb-124	$1.0x\ 10^{1}$	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Sb-125	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Sb-126	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Scandium (21)				
Sc-44	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Sc-46	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Sc-47	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Sc-48	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Selenium (34)				
Se-75	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Se-79	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Silicon (14)				

Si-31	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Si-32	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Samarium (62)				
Sm-145	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Sm-147	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Sm-151	1.0×10^{4}	2.7×10^{-7}	1.0×10^{8}	2.7×10^{-3}
Sm-153	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Tin (50)				
Sn-113	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Sn-117m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Sn-119m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Sn-121m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Sn-123	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Sn-125	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Sn-126	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Strontium (38)				
Sr-82	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Sr-85	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Sr-85m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Sr-87m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Sr-89	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Sr-90[a]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{4}	2.7×10^{-7}
Sr-91	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Sr-92	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Tritium (1)				
T (H-3)	1.0×10^{6}	2.7×10^{-5}	1.0×10^{9}	2.7×10^{-2}

Tantalum (73)				
Ta-178 (long-lived)	$1.0x\ 10^{1}$	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Ta-179	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Ta-182	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Terbium (65)				
Tb-157	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Tb-158	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Tb-160	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Technetium (43)				
Tc-95m	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Tc-96	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Tc-96m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Tc-97	1.0×10^{3}	2.7×10^{-8}	1.0×10^{8}	2.7×10^{-3}
Tc-97m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Tc-98	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Tc-99	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Tc-99m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Tellurium (52)				
Te-121	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Te-121m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Te-123m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Te-125m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Te-127	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Te-127m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Te-129	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Te-129m	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}

Te-131m	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Te-132	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Thorium (90)				
Th-227	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Th-228[a]	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Th-229[a]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Th-230	1.0	2.7×10^{-11}	1.0×10^{4}	2.7×10^{-7}
Th-231	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Th-232	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
Th-234[a]	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
Th (nat)[a]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Titanium (22)				
Ti-44	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
Thallium (81)				
Tl-200	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Tl-201	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Tl-202	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Tl-204	$1.0x\ 10^{4}$	2.7×10^{-7}	1.0×10^{4}	2.7×10^{-7}
Thulium (69)				
Tm-167	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Tm-170	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Tm-171	1.0×10^{4}	2.7×10^{-7}	1.0×10^{8}	2.7×10^{-3}
Uranium (92)				
U-230 (fast lung absorption)[a,b]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}

U-230 (medium lung absorption)[c]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-230 (slow lung absorption)[d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-232 (fast lung absorption)[a,b]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
U-232 (medium lung absorption)[c]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-232 (slow lung absorption)[d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-233 (fast lung absorption)[b]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-233 (medium lung absorption)[c]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
U-233 (slow lung absorption)[d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
U-234 (fast lung absorption)[b]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-234 (medium lung absorption)[c]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
U-234 (slow lung absorption)[d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
U-235 (all lung absorption types)[a,b,c,d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-236 (fast lung absorption)[b]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-236 (medium lung absorption)[c]	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
U-236 (slow lung absorption)[d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U-238 (all lung absorption types)[a,b,c,d]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{4}	2.7×10^{-7}
U (nat)[a]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}

U (enriched to 20% or less)[e]	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
U (dep)	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Vanadium (23)				
V-48	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}
V-49	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
Tungsten (74)				
W-178	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
W-181	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
W-185	1.0×10^{4}	2.7×10^{-7}	1.0×10^{7}	2.7×10^{-4}
W-187	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
W-188	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Xenon (54)				
Xe-122	1.0×10^{2}	2.7×10^{-9}	1.0×10^{9}	2.7×10^{-2}
Xe-123	1.0×10^{2}	2.7×10^{-9}	1.0×10^{9}	2.7×10^{-2}
Xe-127	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
Xe-131m	1.0×10^{4}	2.7×10^{-7}	1.0×10^{4}	2.7×10^{-7}
Xe-133	1.0×10^{3}	2.7×10^{-8}	1.0×10^{4}	2.7×10^{-7}
Xe-135	1.0×10^{3}	2.7×10^{-8}	1.0×10^{10}	2.7×10^{-1}
Yttrium (39)				
Y-87	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Y-88	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Y-90	1.0×10^{3}	2.7×10^{-8}	1.0×10^{5}	2.7×10^{-6}
Y-91	1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
Y-91m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Y-92	1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}

Y-93	$1.0x\ 10^{2}$	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Ytterbium (70)				
Yb-169	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Yb-175	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Zinc (30)				
Zn-65	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Zn-69	1.0×10^{4}	2.7×10^{-7}	1.0×10^{6}	2.7×10^{-5}
Zn-69m	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Zirconium (40)				
Zr-88	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Zr-93[a]	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Zr-95	1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Zr-97[a]	1.0×10^{1}	2.7×10^{-10}	1.0×10^{5}	2.7×10^{-6}

[a]Parent nuclides and their progeny included in secular equilibrium are listed as follows:

Sr-90	Y-90
Zr-93	Nb-93m
Zr-97	Nb-97
Ru-106	Rh-106
Ag-108m	Ag-108
Cs-137	Ba-137m
Ce-144	Pr-144
Ba-140	La-140
Bi-212	Tl-208(0.36), Po-212(0.64)
Pb-210	Bi-210, Po-210
Pb-212	Bi-212, Tl-208 (0.36), Po-212 (0.64)
Rn-222	Po-218, Pb-214, Bi-214, Po-214

Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-224	Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-229	Ra-225, Ac-225, Fr-221, At-217, Bi-213, Po-213, Pb-209
Th (nat)	Ra-228, Ac-228, Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
Th-234	Pa-234m
U-230	Th-226, Ra-222, Rn-218, Po-214
U-232	Th-228, Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208 (0.36), Po-212 (0.64)
U-235	Th-231
U-238	Th-234, Pa-234m
U (nat)	Th-234, Pa-234m, U-234, Th-230, Ra-226, Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Np-237	Pa-233
Am-242m	Am-242
Am-243	Np-239

[b]These values apply only to compounds of uranium that take the chemical form of UF_6, UO_2F_2 and $UO_2(NO_3)_2$ in both normal and accident conditions of transport.

[c]These values apply only to compounds of uranium that take the chemical form of UO_3, UF_4, UCl_4 and hexavalent compounds in both normal and accident conditions of transport.

[d]These values apply to all compounds of uranium other than those specified in notes b and c of this table.

[e]These values apply to unirradiated uranium only.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 40 SR 145; 44 SR 239; 46 SR 791*

Published Electronically: *June 14, 2022*

4731.0423 DETERMINATION OF A_1 AND A_2.

Subpart 1. **Generally.** Values of A_1 and A_2 for individual radionuclides, which are the bases for many activity limits elsewhere in this chapter, are given in part 4731.0422, subpart 1a. The curie (Ci) values specified are obtained by converting from the Terabecquerel (TBq) values. The Terabecquerel values are the regulatory standard. The curie values are for information only and are not intended to be the regulatory standard. Where values of A_1 and A_2 are unlimited, it is for radiation control purposes only. For nuclear criticality safety, some materials are subject to controls placed on fissile material.

Subp. 2. **Individual radionuclides; not listed in part 4731.0422, subpart 1a.** For individual radionuclides whose identities are known, but which are not listed in part 4731.0422, subpart 1a, the A_1 and A_2 values contained in subpart 6 may be used. Otherwise, the licensee shall obtain prior commissioner, NRC, or agreement state approval of the radionuclides not listed in part 4731.0422, subpart 1a, before shipping the material.

Subp. 2a. **Individual radionuclides; not listed in part 4731.0422, subpart 3.** For individual radionuclides whose identities are known, but which are not listed in part 4731.0422, subpart 3, the exempt material activity concentration and exempt consignment activity values contained in subpart 6 may be used. Otherwise, the licensee shall obtain prior commissioner, NRC, or agreement state approval of the exempt material activity concentration and exempt consignment activity values for radionuclides not listed in part 4731.0422, subpart 3, before shipping the material.

Subp. 2b. **Prior approval.** The licensee must submit requests for prior approval, described under subparts 2 and 2a, to the commissioner, NRC, or agreement state, according to this chapter.

Subp. 3. **Radioactive decay chain.** In the calculations of A_1 and A_2 for a radionuclide not in part 4731.0422, subpart 1a, a single radioactive decay chain, in which radionuclides are present in their naturally occurring proportions and in which no daughter nuclide has a half-life longer than ten days or longer than that of the parent nuclide, shall be considered as a single radionuclide. The activity to be taken into account and the A_1 and A_2 value to be applied shall be those corresponding to the parent nuclide of the chain. In the case of radioactive decay chains in which any daughter nuclide has a half-life longer than ten days or greater than that of the parent radionuclide, the parent and those daughter radionuclides shall be considered as mixtures of different radionuclides.

Subp. 4. **Radionuclide mixture.** For mixtures of radionuclides whose identities and respective activities are known, the following conditions apply:

A. For special form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{\mathrm{B\,(i)}}{\mathrm{A_1\,(i)}} \leq 1$$

where B(i) is the activity of radionuclide i in special form and A_1(i) is the A_1 value for radionuclide i.

B. For normal form radioactive material, the maximum quantity transported in a Type A package:

$$\sum_i \frac{\mathrm{B\,(i)}}{\mathrm{A_2\,(i)}} \leq 1$$

where B(i) is the activity of radionuclide i in normal form and A_2(i) is the A_2 value for radionuclide i.

C. If the package contains both a special and normal form radioactive material, the activity that may be transported in a Type A package:

$$\sum_i \frac{B(i)}{A_1(\mathrm{i})} + \sum_j \frac{C(j)}{A_2(j)} \leq 1$$

where B(i) is the activity of radionuclide i in special form, A_1(i) is the A_1 value for radionuclide i, C(j) is the activity of radionuclide j in normal form, and A_2(j) is the A_2 value for radionuclide j.

D. Alternatively, an A_1 value for mixtures of special form material may be determined as follows:

$$\mathrm{A_1\ for\ mixture} = \frac{1}{\sum_i \frac{\mathrm{f(i)}}{\mathrm{A_1(i)}}}$$

where f(i) is the fraction of activity of radionuclide i in the mixture and A_1(i) is the appropriate A_1 value for radionuclide i.

E. Alternatively, the A_2 value for mixtures of normal form material may be determined as follows:

$$\mathrm{A_2\ for\ mixture} = \frac{1}{\sum_i \frac{\mathrm{f(i)}}{\mathrm{A_2(i)}}}$$

where f(i) is the fraction of activity of radionuclide i in the mixture and A_2(i) is the appropriate A_2 value for radionuclide i.

F. The exempt activity concentration for mixtures of radionuclides may be determined as follows:

$$\mathrm{Exempt\ activity\ concentration\ for\ mixture} = \frac{1}{\sum_i \frac{\mathrm{f(i)}}{\mathrm{[A](i)}}}$$

where f(i) is the fraction of activity concentration of radionuclide i in the mixture, and [A] (i) is the activity concentration for exempt material containing radionuclide i.

G. The activity limit for an exempt consignment for mixtures of radionuclides may be determined as follows:

$$\text{Exempt consignment activity limit for mixture} = \frac{1}{\sum_i \frac{f(i)}{A(i)}}$$

where f(i) is the fraction of activity of radionuclide i in the mixture, and A (i) is the activity limit for exempt consignments for radionuclide i.

Subp. 5. **Activities unknown.**

A. When the identity of each radionuclide is known, but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest A_1 or A_2 value, as appropriate, for the radionuclides in each group may be used in applying the formulas in subpart 4. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest A_1 or A_2 values for the alpha emitters and beta/gamma emitters.

B. When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the radionuclides may be grouped and the lowest [A] (activity concentration for exempt material) or A (activity limit for exempt consignment) value, as appropriate, for the radionuclides in each group may be used in applying the formulas in subpart 4. Groups may be based on the total alpha activity and the total beta/gamma activity when these are known, using the lowest [A] or A values for the alpha emitters and beta/gamma emitters, respectively.

Subp. 6. **General values for A_1 and A_2.**

	A_1		A_2	
Contents	(TBq)	(Ci)	(TBq)	(Ci)
Only beta- or gamma-emitting radionuclides are known to be present	1×10^{-1}	2.7	2×10^{-2}	5.4×10^{-1}
Alpha-emitting nuclides, but no neutron emitters are known to be present[a]	2×10^{-1}	5.4	9×10^{-5}	2.4×10^{-3}
Neutron-emitting nuclides are known to be present or no relevant data are available	1×10^{-3}	2.7×10^{-2}	9×10^{-5}	2.4×10^{-3}

[a] If beta- or gamma-emitting nuclides are known to be present, the A_1 value of 0.1TBq (2.7 Ci) should be used.

Contents	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limits for exempt consignments (Bq)	Activity limits for exempt consignments (Ci)
Only beta- or gamma-emitting radionuclides are known to be present	1×10^{1}	2.7×10^{-10}	1×10^{4}	2.7×10^{-7}
Alpha-emitting nuclides, but no neutron emitters are known to be present	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}
Neutron-emitting nuclides are known to be present or no relevant data are available	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

Published Electronically: *May 26, 2022*

4731.0424 ACTIVITY-MASS RELATIONSHIPS FOR URANIUM.

Uranium Enrichment[1] wt percent U-235 present	Specific Activity	
	Tbq/g	Ci/g
0.45	1.8×10^{-8}	5.0×10^{-7}
0.72	2.6×10^{-8}	7.1×10^{-7}
1.0	2.8×10^{-8}	7.6×10^{-7}
1.5	3.7×10^{-8}	1.0×10^{-6}
5.0	1.0×10^{-7}	2.7×10^{-6}
10.0	1.8×10^{-7}	4.8×10^{-6}
20.0	3.7×10^{-7}	1.0×10^{-5}
35.0	7.4×10^{-7}	2.0×10^{-5}

50.0	9.3×10^{-7}	2.5×10^{-5}
90.0	2.2×10^{-6}	5.8×10^{-5}
93.0	2.6×10^{-6}	7.0×10^{-5}
95.0	3.4×10^{-6}	9.1×10^{-5}

[1] The figures for uranium include representative values for the activity of the uranium-234 that is concentrated during the enrichment process.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0455 [Repealed, 44 SR 239]
Published Electronically: *September 13, 2019*

DOMESTIC LICENSING OF SPECIAL NUCLEAR MATERIAL

4731.0525 DOMESTIC LICENSING OF SPECIAL NUCLEAR MATERIAL.

Subpart 1. **Scope.** Parts 4731.0525 to 4731.0630 establish procedures and criteria for the issuance of licenses to receive title to, own, acquire, deliver, receive, possess, use, and transfer special nuclear material and establish and provide for the terms and conditions upon which the commissioner will issue such licenses.

Subp. 2. **Applicability.** Except as provided in part 4731.0535, parts 4731.0525 to 4731.0630 apply to all persons in the United States. Parts 4731.0525 to 4731.0630 give notice to all persons who knowingly provide to any licensee, applicant, contractor, or subcontractor, components, equipment, materials, or other goods or services that relate to a licensee's or applicant's activities subject to parts 4731.0525 to 4731.0630, that they may be individually subject to enforcement action for violation of part 4731.0280.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0530 LICENSE REQUIREMENT; SPECIAL NUCLEAR MATERIAL.

No person shall receive title to, own, acquire, deliver, receive, possess, use, or transfer special nuclear material, except as authorized in a license issued by the commissioner according to parts 4731.0525 to 4731.0630.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0535 EXEMPTION; CERTAIN FEDERAL CONTRACTS.

A. Except to the extent that United States Department of Energy (DOE) facilities or activities of the types subject to licensing under the federal Energy Reorganization Act of 1974, United States Code, title 42, section 5842, are involved, a prime contractor of the DOE is exempt from parts 4731.0525 to 4731.0630 to the extent that the contractor, under the prime contract with the DOE, receives title to, owns, acquires, delivers, receives, possesses, uses, or transfers special nuclear material for:

(1) the performance of work for the DOE at a United States government-owned or -controlled site, including the transportation of special nuclear material to or from the site and the performance of contract services during temporary interruptions of such transportation;

(2) research in or development, manufacture, storage, testing, or transportation of atomic weapons or components thereof; or

(3) the use or operation of nuclear reactors or other nuclear devices in a United States-owned vehicle or vessel.

B. Subject to the requirement for licensing of DOE facilities and activities according to United States Code, title 42, section 5842, a prime contractor or subcontractor of the DOE or the NRC is exempt from parts 4731.0525 to 4731.0630 to the extent that the prime contractor or subcontractor receives title to, owns, acquires, delivers, receives, possesses, uses, or transfers special nuclear material under the prime contract or subcontract when the NRC determines that the exemption is authorized by law and that under the terms of the contract or subcontract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0540 EXEMPTION; CARRIERS.

Common and contract carriers, freight forwarders, warehousers, and the United States Postal Service are exempt from parts 4731.0525 to 4731.0630 to the extent that they transport special nuclear material in the regular course of carriage for another or storage incident thereto. This exemption does not apply to the storage in transit or transport of material by persons covered by the general license issued under Code of Federal Regulations, title 10, sections 70.20a and 70.20b.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0550 TYPES OF LICENSES.

Licenses for special nuclear material are of two types: general and specific. A general license issued under parts 4731.0525 to 4731.0630 is effective without the filing of an application with the commissioner or the issuance of licensing documents to particular persons. Specific licenses are issued to named persons upon application filed according to parts 4731.0525 to 4731.0630.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0555 GENERAL LICENSE; CALIBRATION OR REFERENCE SOURCES.

Subpart 1. **Calibration or reference sources.** Persons listed in items A to C are issued a general license to receive title to, own, acquire, deliver, receive, possess, use, and transfer, according to subparts 2 to 4, plutonium in the form of calibration or reference sources:

A. a person who holds a specific license issued by the commissioner that authorizes the person to receive, possess, use, and transfer radioactive material, including source material and special nuclear material;

B. a person who holds a specific license issued by the NRC or an agreement state that authorizes the person to receive, possess, use, and transfer radioactive material, including source and special nuclear material; and

C. a government agency that holds a specific license issued by the NRC that authorizes the agency to receive, possess, use, or transfer by-product material, source material, or special nuclear material.

Subp. 2. **Applicability.** The general license issued under subpart 1 applies only to calibration or reference sources that have been manufactured or initially transferred according to a specific license issued under part 4731.0605 or according to a specific license issued by the commissioner, the NRC, or an agreement state that authorizes manufacture of the sources for distribution to persons generally licensed by the commissioner, the NRC, or an agreement state.

Subp. 3. **Other law.** The general license issued under subpart 1 is subject to the provisions of parts 4731.0260; 4731.0590; 4731.0620; 4731.0630; and 4731.1000 to 4731.2950 and the provisions of Code of Federal Regulations, title 10, part 21, and sections 70.62, 74.11, and 74.19.

Subp. 4. **Requirements.** Persons who receive title to, own, acquire, deliver, receive, possess, use, or transfer one or more calibration or reference sources under the general license issued under subpart 1:

A. shall not possess at any one time, at any one location of storage or use, more than five microcuries (185 kBq) of plutonium or five microcuries (185 kBq) of radium-226 in the sources;

B. shall not receive, possess, use, or transfer the source unless the source or storage container bears a label that includes the following statement or a substantially similar statement that contains the information called for in the following statement:

"The receipt, possession, use, and transfer of this source, Model No. ....., Serial No. ....., are subject to a general license and the regulations of the Minnesota commissioner of health, the Nuclear Regulatory Commission, or a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority. Do not remove this label.

CAUTION - RADIOACTIVE MATERIAL - THIS SOURCE CONTAINS PLUTONIUM. DO NOT TOUCH RADIOACTIVE PORTION OF THIS SOURCE.

(Name of manufacturer or initial transferor)";

C. shall not transfer, abandon, or dispose of the source except by transfer to a person authorized by a license from the commissioner, the NRC, the Atomic Energy Commission, or an agreement state to receive the source;

D. shall store the source, except when the source is being used, in a closed container adequately designed and constructed to contain plutonium or radium-226, which might otherwise escape during storage; and

E. shall not use the source for any purpose other than the calibration of radiation detectors or the standardization of other sources.

Subp. 5. **Limitation.** The general license issued under subpart 1 does not authorize the manufacture, import, or export of calibration or reference sources containing plutonium or radium-226.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0560 GENERAL LICENSE; OWNING SPECIAL NUCLEAR MATERIAL.

A general license is issued to receive title to and own special nuclear material without regard to quantity. Notwithstanding any other provision of this chapter, a general licensee under this part is not authorized to acquire, deliver, receive, possess, use, transfer, import, or export special nuclear material, except as authorized in a specific license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0565 APPLICATION; FILING.

Subpart 1. **Generally.**

A. A person may apply for a specific license issued under parts 4731.0525 to 4731.0630 by filing an application according to part 4731.0200, subpart 4.

B. Applications and documents submitted to the commissioner in connection with applications may be made available for public inspection according to part 4731.0240.

Subp. 2. **Fees.** An application for a special nuclear material license must be accompanied by the fee prescribed in Minnesota Statutes, section 144.1205.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0570 APPLICATION; CONTENTS.

Subpart 1. **Required information.**

A. An application for a license under parts 4731.0525 to 4731.0630 must contain:

(1) the applicant's full name and address;

(2) the applicant's age, if an individual;

(3) the applicant's citizenship; and

(4) the names and addresses of three personal references.

B. If the applicant is a corporation or other entity, the application must contain:

(1) the state where the entity was incorporated or organized;

(2) the location of the principal office;

(3) the names, addresses, and citizenship of the entity's principal officers; and

(4) information known to the applicant concerning the control or ownership, if any, exercised over the applicant by any alien, foreign corporation, or foreign government.

C. All applications must contain:

(1) a description of the activity for which the special nuclear material is requested, or in which special nuclear material will be produced, the place at which the activity is to be performed, and the general plan for carrying out the activity;

(2) the period of time for which the license is requested;

(3) the name, amount, and specifications, including the chemical and physical form and, where applicable, isotopic content, of the special nuclear material the applicant proposes to use or produce;

(4) the technical qualifications, including training and experience of the applicant and members of the applicant's staff, to engage in the proposed activities according to this chapter;

(5) a description of equipment and facilities that will be used by the applicant to protect health and minimize danger to life or property, such as handling devices, working areas, shields, measuring and monitoring instruments, devices for the disposal of radioactive effluents and wastes, storage facilities, and criticality accident alarm systems; and

(6) proposed procedures to protect health and minimize danger to life or property, such as procedures to avoid accidental criticality, procedures for personnel monitoring and waste disposal, and postcriticality accident emergency procedures.

D. Where the nature of the proposed activities is such as to require consideration of the applicant's financial qualifications to engage in the proposed activities according to this chapter, the commissioner may request the applicant to submit information regarding the applicant's financial qualifications.

E. As provided under part 4731.0580, certain applications for specific licenses filed under parts 4731.0525 to 4731.0630 must contain a proposed decommissioning funding plan or a certification of financial assurance for decommissioning.

F. Each application and statement must contain complete and accurate disclosure as to all matters and things required to be disclosed.

Subp. 2. **Additional information.** The commissioner may, at any time after the filing of the original application and before the expiration of the license, require further statements to enable the commissioner to determine whether an application should be granted or denied or whether a license should be modified or revoked. All applications and statements must be signed by the applicant or licensee or a corporate officer thereof.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0575 APPLICATION APPROVAL REQUIREMENTS.

An application for a license under parts 4731.0525 to 4731.0630 shall be approved if the commissioner determines that:

A. the special nuclear material is to be used for the conduct of research or development activities of a type specified in parts 4731.3200 to 4731.3245, in activities licensed by the commissioner, or for such other uses as the commissioner determines to be appropriate to carry out the purposes of this chapter. Types of research and development activities specified in parts 4731.3200 to 4731.3245 are those relating to:

(1) nuclear processes;

(2) the theory and production of atomic energy, including processes, materials, and devices related to such production;

(3) utilization of special nuclear material and radioactive material for medical, biological, agricultural, health, or military purposes;

(4) utilization of special nuclear material, atomic energy, and radioactive material and processes entailed in the utilization or production of atomic energy or such material for all other purposes, including industrial use, the generation of usable energy, and the demonstration of the practical value of utilization or production facilities for industrial or commercial purposes; and

(5) the protection of health and the promotion of safety during research and production activities;

B. the applicant is qualified by reason of training and experience to use the material for the purpose requested according to this chapter;

C. the applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life or property;

D. the applicant's proposed procedures to protect health and to minimize danger to life or property are adequate; and

E. where the nature of the proposed activities is such as to require consideration by the commissioner, the applicant appears to be financially qualified to engage in the proposed activities according to parts 4731.0525 to 4731.0630.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *October 3, 2013*

4731.0580 APPLICATION; FINANCIAL ASSURANCE AND RECORD KEEPING FOR DECOMMISSIONING.

Subpart 1. **Requirements.**

A. An applicant for a specific license authorizing possession and use of unsealed special nuclear material in quantities exceeding 10^5 times the applicable quantities under part 4731.3160 must submit a decommissioning funding plan according to subpart 4. A decommissioning funding plan must also be submitted when a combination of isotopes is involved if R divided by 10^5 is greater than 1 (unity rule), where R is the sum of the ratios of the quantity of each isotope to the applicable value in part 4731.3160.

B. An applicant for a specific license authorizing possession and use of unsealed special nuclear material in quantities specified in subpart 3 must:

(1) submit a decommissioning funding plan according to subpart 4; or

(2) submit a certification that financial assurance for decommissioning has been provided in the amount prescribed under subpart 3, using one of the methods described in subpart 5. The certification may state that the appropriate assurance will be obtained after the application has been approved and the license issued, but before the receipt of licensed material.

C. If an applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy the requirements of subpart 5 must be submitted to the commissioner before receipt of licensed material.

D. If the applicant does not defer execution of the financial instrument, the applicant must submit to the commissioner, as part of the certification, a signed original of the financial instrument obtained to satisfy the requirements of subpart 5.

Subp. 2. **Financial assurance required.** A holder of a specific license described in subpart 1 must provide financial assurance for decommissioning according to the criteria set forth in this part.

Subp. 3. **Financial assurance; amounts.** The following amounts of financial assurance are required for decommissioning by quantity of material:

Greater than 10^4 but less than or equal to 10^5 times the applicable quantities under part 4731.3160. For a combination of isotopes, if R, as defined in subpart 1, item A, divided by 10^4 is greater than 1 but R divided by 10^5 is less than or equal to 1.	$1,125,000
Greater than 10^3 but less than or equal to 10^4 times the applicable quantities under part 4731.3160. For a combination of isotopes, if R, as defined in subpart 1, item A, divided by 10^3 is greater than 1 but R divided by 10^4 is less than or equal to 1.	$225,000

Subp. 4. **Funding plan requirements.** Each decommissioning funding plan must be submitted for review and approval and must contain:

A. a detailed cost estimate for decommissioning, in an amount reflecting:

(1) the cost of an independent contractor to perform all decommissioning activities;

(2) the cost of meeting part 4731.2100, subpart 2, criteria for unrestricted use, provided that, if the applicant or licensee can demonstrate the ability to meet the provisions of part 4731.2100, subpart 3, the cost estimate may be based on meeting the part 4731.2100, subpart 3, criteria;

(3) the volume of on-site subsurface material containing residual radioactivity that will require remediation; and

(4) an adequate contingency factor;

B. identification of and justification for using the key assumptions contained in the DCE;

C. a description of the method of assuring funds for decommissioning from subpart 5, including the means for adjusting cost estimates and associated funding levels periodically over the life of the facility;

D. a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning; and

E. a signed original, or, if permitted, a copy, of the financial instrument obtained to satisfy the requirements of subpart 5, unless a previously submitted and accepted financial instrument continues to cover the cost estimate for decommissioning.

Subp. 4a. **Resubmittal of decommissioning funding plan.** At the time of license renewal and at intervals not to exceed three years, the decommissioning funding plan must be resubmitted with adjustments as necessary to account for changes in costs and the extent of contamination. If the amount of financial assurance will be adjusted downward, this cannot be done until the updated decommissioning funding plan is approved. The decommissioning funding plan must update the information submitted with the original or prior approved plan, and must specifically consider the effect of the following events on decommissioning costs:

A. spills of radioactive material producing additional residual radioactivity in on-site subsurface material;

B. waste inventory increasing above the amount previously estimated;

C. waste disposal costs increasing above the amount previously estimated;

D. facility modifications;

E. changes in authorized possession limits;

F. actual remediation costs that exceed the previous cost estimate;

G. on-site disposal; and

H. use of a settling pond.

Subp. 5. **Financial assurance requirements.**

A. Financial assurance for decommissioning must be provided by one of the methods described in items B to F.

B. Prepayment is the deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets such that the amount of funds would be sufficient to pay decommissioning costs. Prepayment may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

C. A surety method, insurance, or other guarantee method guarantees that decommissioning costs will be paid. A surety method may be in the form of a surety bond, letter of credit, or line of credit. A parent company guarantee of funds for decommissioning costs based on a financial test

may be used if the guarantee and test comply with part 4731.3155, but may not be used in combination with other financial methods to satisfy the requirements of this part. For commercial corporations that issue bonds, a guarantee of funds by the applicant or licensee for decommissioning costs based on a financial test may be used if the guarantee and test comply with part 4731.3165. For commercial corporations that do not issue bonds, a guarantee of funds by the applicant or licensee for decommissioning costs may be used if the guarantee and test comply with part 4731.3170. For nonprofit entities, such as colleges, universities, and nonprofit hospitals, a guarantee of funds by the applicant or licensee may be used if the guarantee and test comply with part 4731.3175. A guarantee by the applicant or licensee may not be used in combination with other financial methods used to satisfy this part or in any situation where the applicant or licensee has a parent company holding majority control of the voting stock of the company. Any surety method or insurance used to provide financial assurance for decommissioning must:

(1) be open-ended or, if written for a specified term, such as five years, must be renewed automatically unless 90 days or more before the renewal date, the issuer notifies the commissioner, the beneficiary, and the licensee of its intention not to renew;

(2) provide that the full face amount be paid to the beneficiary automatically before the expiration without proof of forfeiture if the licensee fails to provide a replacement acceptable to the commissioner within 30 days after receipt of notification of cancellation;

(3) be payable to a trust established for decommissioning costs. The trustee and trust must be acceptable to the commissioner. An acceptable trustee includes an appropriate state or federal government agency or an entity that has authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency; and

(4) remain in effect until the commissioner terminates the license.

D. An external sinking fund in which deposits are made at least annually, coupled with a surety method or insurance, the value of which may decrease by the amount being accumulated in the sinking fund, may be used as a method of financial assurance. The surety or insurance provisions must be as stated in item C. An external sinking fund:

(1) is a fund established and maintained by setting aside funds periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected; and

(2) may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

E. In the case of federal, state, or local government licensees, a statement of intent containing a cost estimate for decommissioning or an amount according to subpart 3 and indicating that funds for decommissioning will be obtained when necessary may be used as a method of financial assurance.

F. When a governmental entity assumes custody and ownership of a site, an arrangement that is deemed acceptable by the governmental entity may be used as a method of financial assurance.

Subp. 6. **Record keeping.** A licensee must keep records of information important to the decommissioning of a facility in an identified location until the site is released for unrestricted use. If records important to the decommissioning of a facility are kept for other purposes, reference to the records and their location may be used. Information the commissioner considers important to decommissioning includes:

A. records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site, which:

(1) may be limited to instances when contamination remains after cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas, as in the case of possible seepage into porous materials such as concrete; and

(2) must include any known information on identification of involved nuclides, quantities, forms, and concentrations;

B. as-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used or stored and of locations of possible inaccessible contamination, such as buried pipes, that may be subject to contamination. If required drawings are referenced, each relevant document need not be indexed individually. If drawings are not available, the licensee must substitute appropriate records of available information concerning these areas and locations;

C. a list of the following, contained in a single document and updated every two years. Areas containing only sealed sources, if the sources have not leaked or no contamination remains after cleanup of any leak, need not be included:

(1) all areas designated and formerly designated as restricted areas;

(2) all areas outside of restricted areas that require documentation under item A;

(3) all areas outside of restricted areas where current and previous wastes have been buried as documented under part 4731.2560; and

(4) all areas outside of restricted areas that contain material such that, if the license expired, the licensee would be required to either decontaminate the area to meet the criteria for decommissioning under part 4731.2100 or apply for approval for disposal under part 4731.2410; and

D. records of:

(1) the cost estimate performed for the decommissioning funding plan or of the amount certified for decommissioning; and

(2) the funding method used for assuring funds if either a funding plan or certification is used.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0585 ISSUANCE OF LICENSES.

Subpart 1. **Issuance.** Upon a determination that an application meets the requirements of this chapter, the commissioner shall issue a license in such form and containing such conditions and limitations as the commissioner deems appropriate or necessary to effectuate the purposes of this chapter.

Subp. 2. **Denial.** The commissioner shall not issue a license to any person if the commissioner finds that the issuance of the license would be inimical to the common defense and security or would constitute an unreasonable risk to the health and safety of the public.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0590 LICENSE CONDITIONS.

Subpart 1. **Required conditions.** A specific license issued under parts 4731.0525 to 4731.0630 must contain and be subject to the following conditions:

A. no right to the special nuclear material shall be conferred by the license except as defined by the license;

B. neither the license nor any right under the license shall be assigned or otherwise transferred in violation of this chapter; and

C. the license is subject to and the licensee must observe, all applicable rules and orders of the commissioner.

Subp. 2. **Bankruptcy.**

A. A licensee under parts 4731.0525 to 4731.0630 must notify the commissioner, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any chapter of United States Code, title 11, by or against:

(1) the licensee;

(2) an entity, as defined under United States Code, title 11, section 101, clause (15), that controls the licensee or lists the license or licensee as property of the estate; or

(3) an affiliate, as defined under United States Code, title 11, section 101, clause (2), of the licensee.

B. The bankruptcy notification must indicate the bankruptcy court in which the petition for bankruptcy was filed and the date of the filing of the petition.

Subp. 3. **Additional conditions.** The commissioner may incorporate in any license such additional conditions and requirements with respect to the licensee's ownership, receipt, possession,

use, and transfer of special nuclear material as the commissioner deems appropriate or necessary to protect health or to minimize danger to life or property.

Subp. 4. **Additional requirements.** The commissioner may require reports, record keeping, and inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 49 SR 1193*
Published Electronically: *May 28, 2025*

4731.0595 LICENSE RENEWAL AND AMENDMENT.

Subpart 1. **Renewal application.** Applications for renewal of a license must be filed according to parts 4731.0565 and 4731.0570. Information contained in previous applications, statements, or reports filed with the commissioner under the license may be incorporated by reference, if the references are clear and specific.

Subp. 2. **Extension; renewal pending.** If a licensee granted the extension under part 4731.0600, subpart 1, item B, has a currently pending renewal application for the extended license, the application is considered withdrawn by the licensee and any renewal fees paid by the licensee for the application shall be refunded.

Subp. 3. **Amendment applications.** Applications for amendment of a license must be filed according to part 4731.0565, subpart 1, and must specify the respects in which the licensee desires the license to be amended and the grounds for the amendment.

Subp. 4. **Consideration criteria.** In considering an application by a licensee to renew or amend a license, the commissioner shall apply the criteria under part 4731.0575.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0597 INALIENABILITY OF LICENSES.

A. No license granted under parts 4731.0525 to 4731.0630 and no right to possess or utilize special nuclear material granted by a license issued under parts 4731.0525 to 4731.0630 shall be transferred, assigned, or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of a license to a person unless the commissioner, after securing full information, finds that the transfer is in accordance with this chapter and gives consent in writing.

B. An application for transfer of license must include:

(1) the identity, technical, and financial qualifications of the proposed transferee; and

(2) financial assurance for decommissioning information required by part 4731.0580.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.0600 LICENSE EXPIRATION AND TERMINATION; DECOMMISSIONING.

Subpart 1. **Expiration.**

A. A specific license issued under parts 4731.0525 to 4731.0630 expires at the end of the day on the expiration date stated in the license, unless the licensee has filed an application for renewal under part 4731.0595 not less than 30 days before the expiration date stated in the existing license.

B. If an application for renewal has been filed at least 30 days before the expiration date stated in the existing license, the existing license expires at the end of the day on which the commissioner makes a final determination to deny the renewal application or, if the determination states an expiration date, the expiration date stated in the determination.

Subp. 1a. **Revocation.** A specific license revoked by the commissioner expires at the end of the day on the date of the commissioner's final determination to revoke the license, on the expiration date stated in the determination, or as otherwise provided by a commissioner's order.

Subp. 1b. **Termination notice.** A specific license continues in effect, beyond the expiration date if necessary, with respect to possession of special nuclear material until the commissioner notifies the licensee in writing that the license is terminated. During this time, the licensee must:

A. limit actions involving special nuclear material to those related to decommissioning; and

B. continue to control entry to restricted areas until they are suitable for release according to this chapter.

Subp. 2. **Decommissioning.**

A. Within 60 days of any of the occurrences under item B, and consistent with the administrative directions under part 4731.0200, subpart 3, a licensee must provide notification to the commissioner in writing of such occurrence and:

(1) begin decommissioning the licensee's site or any separate building or outdoor area that contains residual radioactivity so that the building or outdoor area is suitable for release according to this chapter; or

(2) submit within 12 months of notification a decommissioning plan, if required under item E, and begin decommissioning upon approval of that plan.

B. Notice under item A is required when:

(1) the license has expired under subpart 1, item A or C;

(2) the licensee has decided to permanently cease principal activities at the entire site or in any separate building or outdoor area;

(3) no principal activities have been conducted under the license for a period of 24 months; or

(4) no principal activities have been conducted for a period of 24 months in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release according to this chapter.

C. Coincident with the notification required under this subpart, the licensee must maintain in effect all decommissioning financial assurances established by the licensee under part 4731.0580 in conjunction with license issuance or renewal or as required under this part. The amount of the financial assurance must be increased, or may be decreased, as appropriate, to cover the detailed cost estimate for decommissioning established under item H, subitem (5). A licensee who has not provided financial assurance to cover the detailed cost estimate submitted with the decommissioning plan must do so when this chapter becomes effective. Following approval of the decommissioning plan, a licensee may reduce the amount of the financial assurance as decommissioning proceeds and radiological contamination is reduced at the site with the approval of the commissioner.

D. The commissioner may grant a request to delay or postpone initiation of the decommissioning process if the commissioner determines that this relief is not detrimental to the public health and safety and is otherwise in the public interest. The request must be submitted no later than 30 days before notification under this subpart. The schedule for decommissioning in this subpart may not commence until the commissioner has made a determination on the request.

E. A decommissioning plan must be submitted if:

(1) required by a license condition; or

(2) the procedures and activities necessary to carry out decommissioning of the site or separate building or outdoor area have not been previously approved by the commissioner and the procedures could increase potential health and safety impacts to workers or the public, such as in any of the following cases:

(a) procedures would involve techniques not routinely applied during cleanup and maintenance operations;

(b) workers would be entering areas not normally occupied where surface contamination and radiation levels are significantly higher than routinely encountered during operation;

(c) procedures could result in significantly greater airborne concentrations of radioactive materials than are present during operation; or

(d) procedures could result in significantly greater releases of radioactive material to the environment than those associated with operation.

F. The commissioner may approve an alternate schedule for submittal of a decommissioning plan required under this subpart if the commissioner determines that the alternative schedule is necessary to the effective conduct of decommissioning operations and presents no undue risk from the radiation to the public health and safety and is otherwise in the public interest.

G. The procedures under item E, subitem (2), may not be performed before approval of the decommissioning plan.

H. The proposed decommissioning plan for the site or separate building or outdoor area must include:

(1) a description of the conditions of the site or separate building or outdoor area sufficient to evaluate the acceptability of the plan;

(2) a description of planned decommissioning activities;

(3) a description of the methods used to ensure protection of workers and the environment against radiation hazards during decommissioning;

(4) a description of the planned final radiation survey;

(5) an updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for ensuring the availability of adequate funds for completion of decommissioning;

(6) a description of the physical security plan and material control and accounting plan provisions in place during decommissioning; and

(7) for decommissioning plans calling for completion of decommissioning later than 24 months after plan approval, a justification for the delay based on the criteria in item K.

I. The commissioner shall approve a proposed decommissioning plan if the information in the plan demonstrates that the decommissioning will be completed as soon as practicable and that the health and safety of workers and the public will be adequately protected.

J. Except as provided in item K, a licensee must:

(1) complete decommissioning of the site or separate building or outdoor area as soon as practicable but no later than 24 months following the initiation of decommissioning; and

(2) request license termination as soon as practicable but no later than 24 months following the initiation of decommissioning, when decommissioning involves the entire site.

K. The commissioner may approve a request for an alternative schedule for completion of decommissioning of the site or separate building or outdoor area, and license termination if appropriate, if the commissioner determines that the alternative is warranted by consideration of:

(1) whether it is technically feasible to complete decommissioning within the allotted 24-month period;

(2) whether sufficient waste disposal capacity is available to allow completion of decommissioning within the allotted 24-month period;

(3) whether a significant volume reduction in wastes requiring disposal will be achieved by allowing short-lived radionuclides to decay;

(4) whether a significant reduction in radiation exposure to workers can be achieved by allowing short-lived radionuclides to decay; and

(5) other site-specific factors that the commissioner may consider appropriate on a case-by-case basis, such as the regulatory requirements of other governmental agencies, lawsuits, groundwater treatment activities, monitored natural groundwater restoration, actions that could result in more environmental harm than deferring clean up, and other factors beyond the control of the licensee.

L. As the final step in decommissioning, the licensee must:

(1) certify the disposition of all licensed material, including accumulated wastes, by submitting a completed Form 314 or equivalent information; and

(2) conduct a radiation survey of the premises where the licensed activities were carried out and submit a report of the results of the survey, unless the licensee demonstrates in some other manner that the premises are suitable for release according to parts 4731.2100 and 4731.2150. The licensee must, as appropriate:

(a) for gamma radiation, report levels of radiation in units of microroentgens (millisieverts) per hour at one meter from surfaces;

(b) for radioactivity, including alpha and beta radiation, report levels of radiation in units of disintegrations per minute or microcuries (megabecquerels) per 100 square centimeters removable and fixed for surfaces, microcuries (megabecquerels) per milliliter for water, and picocuries (becquerels) per gram for solids such as soils or concrete; and

(c) specify the survey instruments used and certify that each instrument is properly calibrated and tested.

M. Specific licenses, including expired licenses, shall be terminated by written notice to the licensee when the commissioner determines that:

(1) special nuclear material has been properly disposed of;

(2) reasonable effort has been made to eliminate residual radioactive contamination, if present;

(3) a radiation survey has been performed that demonstrates, or other information submitted by the licensee is sufficient to demonstrate, that the premises are suitable for release according to parts 4731.2100 and 4731.2150; and

(4) records required by part 4731.0625 have been received.

Subp. 3. [Repealed, 44 SR 239]

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0605 SPECIFIC LICENSE; MANUFACTURE OR INITIAL TRANSFER OF CALIBRATION OR REFERENCE SOURCES.

Subpart 1. **Manufacture or initial transfer of certain calibration sources.** An application for a specific license to manufacture or initially transfer calibration and reference sources containing plutonium for distribution to persons generally licensed under part 4731.0555 shall be approved if:

A. the applicant satisfies the general requirements of part 4731.0575;

B. the applicant submits sufficient information regarding each type of calibration or reference source pertinent to evaluation of the potential radiation exposure, including:

(1) chemical and physical form and maximum quantity of plutonium in the source;

(2) details of construction and design;

(3) details of the method of incorporation and binding of the plutonium in the source;

(4) procedures for and results of prototype testing of sources that are designed to contain more than 0.005 microcurie of plutonium to demonstrate that the plutonium contained in each source will not be released or be removed from the source under normal conditions of use;

(5) details of quality control procedures to be followed in manufacture of the source;

(6) a description of labeling to be affixed to the source or the storage container for the source; and

(7) any additional information, including experimental studies and tests, required by the commissioner to facilitate a determination of the safety of the source;

C. each source contains no more than five microcuries of plutonium;

D. the commissioner determines, with respect to any type of source containing more than 0.005 microcurie of plutonium that:

(1) the method of incorporation and binding of the plutonium in the source is such that the plutonium will not be released or be removed from the source under normal conditions of use and handling of the source; and

(2) the source has been subjected to and has satisfactorily passed the prototype tests prescribed by item E; and

E. for any type of source that is designed to contain more than 0.005 microcurie of plutonium, the applicant has conducted prototype tests, in the order listed, on each of five prototypes of such source, which contains more than 0.005 microcurie of plutonium, as follows:

(1) an initial measurement. The quantity of radioactive material deposited on the source must be measured by direct counting of the source;

(2) a dry wipe test. The entire radioactive surface of the source must be wiped with filter paper with the application of moderate finger pressure. Removal of radioactive material from the source must be determined by measuring the radioactivity on the filter paper or by direct measurement of the radioactivity on the source following the dry wipe;

(3) a wet wipe test. The entire radioactive surface of the source must be wiped with filter paper, moistened with water, with the application of moderate finger pressure. Removal of radioactive material from the source must be determined by measuring the radioactivity on the filter paper after it has dried or by direct measurement of the radioactivity on the source following the wet wipe;

(4) a water soak test. The source must be immersed in water at room temperature for a period of 24 consecutive hours. The source must then be removed from the water. Removal of radioactive material from the source must be determined by direct measurement of the radioactivity on the source after it has dried or by measuring the radioactivity in the residue obtained by evaporation of the water in which the source was immersed;

(5) a dry wipe test. On completion of the preceding tests under subitems (1) to (4), the dry wipe test described in subitem (2) must be repeated; and

(6) observations. Removal of more than 0.005 microcurie of radioactivity in any test prescribed by this item is cause for rejection of the source design. Results of prototype tests submitted to the commissioner must be given in terms of radioactivity in microcuries and percent of removal from the total amount of radioactive material deposited on the source.

Subp. 2. **Labeling.** A person licensed under this part must affix to each source or storage container for the source a label that:

A. contains sufficient information relative to safe use and storage of the source; and

B. includes the following statement or a substantially similar statement containing the information called for:

"The receipt, possession, use, and transfer of this source, Model ..., Serial No. ..., are subject to a general license and the regulations of the Minnesota Department of Health, the Nuclear Regulatory Commission, or a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority. Do not remove this label.

CAUTION -- RADIOACTIVE MATERIAL -- THIS SOURCE CONTAINS

PLUTONIUM. DO NOT TOUCH RADIOACTIVE PORTION OF

THIS SOURCE.

(Name of manufacturer or initial transferor)".

Subp. 3. **Test before transfer.** A person licensed under this part must perform a dry wipe test upon each source containing more than 0.1 microcurie of plutonium before transferring the source to a general licensee under part 4731.0555. The test must be performed by wiping the entire radioactive surface of the source with a filter paper with the application of moderate finger pressure. The radioactivity on the paper must be measured by using radiation detection instrumentation capable of detecting 0.005 microcurie of plutonium. If the test discloses more than 0.005 microcurie of radioactive material, the source is deemed to be leaking or losing plutonium and must not be transferred to a general licensee under part 4731.0555.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0610 AUTHORIZED USE OF SPECIAL NUCLEAR MATERIAL.

Subpart 1. **Authority under license.** A licensee must confine the licensee's possession and use of special nuclear material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued under this chapter carries with it the right to receive title to, own, acquire, receive, possess, and use special nuclear material. Preparation for shipment and transport of special nuclear material must be according to parts 4731.0400 to 4731.0424.

Subp. 2. **Material produced under license.** The possession, use, and transfer of any special nuclear material produced by a licensee, in connection with or as a result of use of special nuclear material received under the license, is subject to the provisions of the license and this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0615 TRANSFER OF SPECIAL NUCLEAR MATERIAL.

Subpart 1. **Authorization required.** No licensee shall transfer special nuclear material except as authorized under this part.

Subp. 2. **Approved transfer.** Except as otherwise provided in a license and subject to subpart 3, a licensee may transfer special nuclear material:

A. to the commissioner after approval from the commissioner;

B. to the United States Department of Energy;

C. to the agency in an agreement state that regulates radioactive material according to an agreement with the NRC, if the quantity transferred is not sufficient to form critical mass;

D. to a person exempt from this chapter to the extent permitted under the exemption;

E. to a person in an agreement state, subject to the jurisdiction of that state, who has been exempted from licensing requirements of that state, to the extent permitted under the exemption;

F. to a person authorized to receive such material under terms of a specific license or a general license or their equivalents issued by the commissioner, the NRC, an agreement state, or a licensing state; or

G. as otherwise authorized by the commissioner in writing.

Subp. 3. **Verification for transfer.**

A. Before transferring special nuclear material to a specific licensee of the commissioner, the NRC, an agreement state, or a licensing state or to a general licensee who is required to register with the commissioner, the NRC, an agreement state, or a licensing state before receipt of the special nuclear material, the licensee transferring radioactive material must verify that the transferee's license authorizes the receipt of the type, form, and quantity of special nuclear material to be transferred.

B. Any of the following methods of verification are acceptable:

(1) the transferor may possess and read a current copy of the transferee's specific license or general license registration certificate. The transferor must retain a copy of each license or certificate until the next inspection;

(2) the transferor may possess a written certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of special nuclear material to be transferred, specifying:

(a) the license or registration certificate number;

(b) the issuing agency; and

(c) the expiration date.

The transferor must retain the written certification as a record for three years from the date of receipt of the certification; or

(3) for emergency shipments, the transferor may accept oral certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of special nuclear material to be transferred, specifying:

(a) the license or registration certificate number;

(b) the issuing agency; and

(c) the expiration date.

The oral certification must be confirmed in writing within ten days. The transferor must retain the written confirmation of the oral certification for three years from the date of receipt of the confirmation.

Subp. 4. **Other sources of information.** The transferor may obtain other information compiled by a reporting service from official records of the commissioner, the NRC, or the licensing agency of an agreement state regarding the identity of licensees or registrants and the scope and expiration dates of the licenses and registrations. The transferor must retain the compilation of information as a record for three years from the date that it was obtained.

Subp. 5. **Confirmation.** The transferor may obtain and record confirmation from the commissioner, the NRC, or the licensing agency of an agreement state or licensing state that the transferee is licensed to receive the special nuclear material:

A. when none of the methods of verification described in subparts 3 and 4 are readily available; or

B. when a transferor desires to verify that information received by one of the verification methods is correct or up-to-date.

The transferor must retain the record of confirmation for three years from the date the record is made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0620 REPORTING REQUIREMENTS.

Subpart 1. **Immediate notification required.** A licensee must notify the commissioner as soon as possible but not later than four hours after the discovery of an event that prevents immediate protective actions necessary to avoid exposures to radiation and radioactive materials that could exceed regulatory limits or releases of licensed material that could exceed regulatory limits. Reportable events under this subpart include fires, explosions, toxic gas release, or similar hazards.

Subp. 2. **24-hour notification required.** A licensee must notify the commissioner within 24 hours after discovery of any of the following events involving licensed material:

A. an unplanned contamination event that:

(1) requires access to the contaminated area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the areas;

(2) involves a quantity of material greater than five times the lowest annual limit on intake specified in part 4731.2750 for the material; and

(3) restricts access to the area for a reason other than to allow isotopes with a half-life of less than 24 hours to decay prior to decontamination;

B. an event in which equipment is disabled or fails to function as designed when:

(1) the equipment is required by rule or license condition to prevent releases exceeding regulatory limits, to prevent exposure to radiation and radioactive materials exceeding regulatory limits, or to mitigate the consequences of an accident;

(2) the equipment is required to be available and operable when it is disabled or fails to function; and

(3) no redundant equipment is available and operable to perform the required safety function;

C. an event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body; or

D. an unplanned fire or explosion that damages any licensed material or any device, container, or equipment containing licensed materials when:

(1) the quantity of material involved is greater than five times the lowest annual limit on intake under part 4731.2750 for the material; and

(2) the damage affects the integrity of the licensed material or its container.

Subp. 3. **Preparation and submission of reports.**

A. A licensee must make reports required under subparts 1 and 2 by telephone to the commissioner according to part 4731.0200, subpart 5. To the extent that the information is available at the time of notification, the information provided in the report must include:

(1) the caller's name, position, title, and call-back telephone number;

(2) the date, time, and exact location of the event;

(3) a description of the event, including:

(a) the radiological or chemical hazards involved, including isotopes, quantities, and chemical and physical form of any material released;

(b) the actual or potential health and safety consequences to the workers, the public, and the environment, including relevant chemical and radiation data for actual personnel exposures to radiation or radioactive materials or hazardous chemicals produced from licensed materials, for example, level of radiation exposure, concentration of chemicals, and duration of exposure;

(c) the sequence of occurrences leading to the event, including degradation or failure of structures, systems, equipment, components, and activities of personnel relied on to prevent potential accidents or mitigate their consequences; and

(d) whether the remaining structures, systems, equipment, components, and activities of personnel relied on to prevent potential accidents or mitigate their consequences are available and reliable to perform their function;

(4) any external conditions affecting the event;

(5) any additional actions taken by the licensee in response to the event;

(6) the status of the event, for example, whether the event is ongoing or was terminated;

(7) the current and planned site status, including any declared emergency class;

(8) any notifications related to the event that were made or are planned to be made to the commissioner or any local, state, or federal agencies; and

(9) the status of any press releases related to the event that were made or are planned.

B. A licensee that makes a report required under subpart 1 or 2 must submit a written follow-up report within 30 days of the initial notification. Written reports prepared as required by other rules may be submitted to fulfill this requirement if the reports contain all of the necessary information. The written reports must be sent to the commissioner. The reports must include:

(1) the probable cause of the event, including all factors that contributed to the event, and the manufacturer and model number, if applicable, of any equipment that failed or malfunctioned;

(2) the exact location of the event;

(3) the isotopes, quantities, and chemical and physical form of the licensed involved;

(4) the date and time of the event;

(5) corrective actions taken or planned to prevent the occurrence of similar or identical events in the future and the results of any evaluations or assessments; and

(6) the extent of exposure of individuals to radiation or to radioactive materials, without identification of the individuals by name.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0625 RECORD TRANSFER REQUIREMENTS.

Subpart 1. **Transfer to commissioner.** Prior to license termination, a licensee authorized to possess radioactive materials must forward the following records to the commissioner:

A. records of disposal of licensed material made under parts 4731.2410 to 4731.2440;

B. records required under part 4731.2510; and

C. records required under part 4731.0580.

Subp. 2. **Transfer to new licensee.** If licensed activities are transferred or assigned according to part 4731.0597, the licensee must transfer the following records to the new licensee and the new licensee is responsible for maintaining the records until the license is terminated:

A. records of disposal of licensed material made under parts 4731.2410 to 4731.2440;

B. records required under part 4731.2510; and

C. records required under part 4731.0580.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0630 INSPECTIONS AND TESTS.

Subpart 1. **Material and premises inspection.** A licensee must afford to the commissioner at all reasonable times opportunity to inspect special nuclear material and the premises and facilities wherein special nuclear material is used, produced, or stored.

Subp. 2. **Record inspection.** A licensee must make available to the commissioner for inspection, upon reasonable notice, records kept by the licensee pertaining to the licensee's receipt, possession, use, acquisition, import, export, or transfer of special nuclear material.

Subp. 3. **Testing.** A licensee must perform, or permit the commissioner to perform, such tests as the commissioner deems appropriate or necessary for the administration of parts 4731.0525 to 4731.0630, including tests of:

A. special nuclear material;

B. facilities wherein special nuclear material is utilized, produced, or stored;

C. radiation detection and monitoring instruments; and

D. other equipment and devices used in connection with the production, utilization, or storage of special nuclear material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

DOMESTIC LICENSING OF SOURCE MATERIAL

4731.0700 PURPOSE AND SCOPE.

Subpart 1. **Scope.** The purpose of parts 4731.0700 to 4731.0840 is to establish procedures and criteria for the issuance of licenses to receive title to, receive, possess, use, transfer, or deliver source and by-product materials and establish and provide for the terms and conditions upon which the commissioner will issue such licenses. Parts 4731.0700 to 4731.0840 also provide for the disposal of by-product material and for the long-term care and custody of by-product material and residual radioactive material.

Subp. 2. **Applicability; enforcement notice.** Except as provided in parts 4731.0715 to 4731.0730, parts 4731.0700 to 4731.0840 apply to all persons in the area in which the Department of Health maintains jurisdiction. Parts 4731.0700 to 4731.0840 give notice to all persons who knowingly provide to any licensee, applicant, contractor, or subcontractor, components, equipment, materials, or other goods or services that relate to a licensee's or applicant's activities subject to parts 4731.0700 to 4731.0840 that they may be individually subject to the commissioner's enforcement action for violation of part 4731.0260, subpart 3.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0705 INACTIVE TAILINGS SITES.

The NRC regulates by-product material that is located at a site where milling operations are no longer active, if the site is not covered by the remedial action program of title I of the Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604. Code of Federal Regulations, title 10, part 40, Appendix A, applies to such sites.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0710 LICENSE REQUIREMENT.

A person subject to parts 4731.0700 to 4731.0840 may not receive title to, own, receive, possess, use, transfer, provide for long-term care, deliver, or dispose of any source material after removal from its place of deposit in nature, unless authorized in a specific or general license issued by the commissioner under parts 4731.0700 to 4731.0840.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0715 EXEMPTION; USE OF SOURCE MATERIAL UNDER CERTAIN FEDERAL CONTRACTS.

A. Except to the extent that United States Department of Energy (DOE) facilities or activities of the types subject to licensing under United States Code, title 42, section 5842, the Energy Reorganization Act of 1974, or the Uranium Mill Tailings Radiation Control Act of 1978, Public Law 95-604, are involved, a prime contractor of the DOE is exempt from parts 4731.0700 to 4731.0840 to the extent that the contractor, under the prime contract with the DOE, receives, possesses, uses, transfers, or delivers source material for:

(1) the performance of work for the DOE at a United States government-owned or -controlled site, including the transportation of source material to or from such site and the performance of contract services during temporary interruptions of such transportation;

(2) research in or development, manufacture, storage, testing, or transportation of atomic weapons or components thereof; or

(3) the use or operation of nuclear reactors or other nuclear devices in United States government-owned vehicles or vessels.

B. In addition to the exemptions under item A, and subject to the requirement for licensing of DOE facilities and activities under the Energy Reorganization Act of 1974 or the Uranium Mill Tailings Radiation Control Act of 1980, a prime contractor or subcontractor of the DOE or the NRC is exempt from parts 4731.0700 to 4731.0840 to the extent that:

(1) the prime contractor or subcontractor receives, possesses, uses, transfers, or delivers source material under the prime contract or subcontract; and

(2) the NRC determines that:

(a) the exemption is authorized by law; and

(b) under the terms of the contract or subcontract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0720 EXEMPTION; CARRIERS.

Common and contract carriers, freight forwarders, warehousers, and the United States Postal Service are exempt from parts 4731.0700 to 4731.0840, to the extent that they transport or store source material in the regular course of the carriage for another or storage incident thereto.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0725 EXEMPTION; UNIMPORTANT QUANTITIES OF SOURCE MATERIAL.

Subpart 1. **Low percentage source material.** A person is exempt from parts 4731.0700 to 4731.0840 to the extent that the person receives, possesses, uses, transfers, or delivers source material in any chemical mixture, compound, solution, or alloy in which the source material is by weight less than 1/20 of one percent (0.05%) of the mixture, compound, solution, or alloy.

Subp. 2. **Ores containing source material.** A person is exempt from parts 4731.0700 to 4731.0840 to the extent that the person receives, possesses, uses, or transfers unrefined and

unprocessed ore containing source material, provided that, except as authorized in a specific license, the person does not refine or process the ore.

Subp. 3. **Certain items and materials.**

A. A person is exempt from parts 4731.0700 to 4731.2950 to the extent that the person receives, possesses, uses, or transfers:

(1) any quantities of thorium contained in:

(a) incandescent gas mantles;

(b) vacuum tubes;

(c) welding rods;

(d) electric lamps for illuminating purposes, provided that each lamp does not contain more than 50 milligrams of thorium;

(e) germicidal lamps, sunlamps, and lamps for outdoor or industrial lighting, provided that each lamp does not contain more than two grams of thorium;

(f) rare earth metals and compounds, mixtures, and products containing not more than 0.25 percent by weight thorium, uranium, or any combination of these; or

(g) personnel neutron dosimeters, provided that each dosimeter does not contain more than 50 milligrams of thorium;

(2) source material contained in the following products:

(a) glazed ceramic tableware manufactured before August 27, 2013, provided that the glaze contains not more than 20 percent by weight source material;

(b) piezoelectric ceramic containing not more than two percent by weight source material;

(c) glassware containing not more than two percent by weight source material or, for glassware manufactured before August 27, 2013, ten percent by weight source material, but not including commercially manufactured glass brick, pane glass, ceramic tile, or other glass or ceramic used in construction; or

(d) glass enamel or glass enamel frit containing not more than ten percent by weight source material imported or ordered for importation into the United States, or initially distributed by manufacturers in the United States, before July 25, 1983;

(3) photographic film, negatives, and prints containing uranium or thorium;

(4) any finished product or part fabricated of or containing tungsten or magnesium-thorium alloys, provided that the thorium content of the alloy does not exceed four percent by weight and that the exemption in this subitem shall not be deemed to authorize the chemical, physical, or metallurgical treatment of any such product or part;

(5) uranium contained in counterweights installed in aircraft, rockets, projectiles, and missiles or stored or handled in connection with installation or removal of such counterweights, provided that:

(a) each counterweight has been impressed with the following legend clearly legible through any plating or other covering: "Depleted Uranium." This subunit does not apply to counterweights manufactured before December 31, 1969, if the counterweights were manufactured under a specific license issued by the Atomic Energy Commission and were impressed with the legend required under Code of Federal Regulations, title 10, section 40.13, paragraph (c), clause (5), subclause (i), in effect June 30, 1969;

(b) each counterweight is durably and legibly labeled or marked with the identification of the manufacturer and the statement: "Unauthorized Alterations Prohibited." This subunit does not apply to counterweights manufactured before December 31, 1969, if the counterweights were manufactured under a specific license issued by the Atomic Energy Commission and were impressed with the legend required under Code of Federal Regulations, title 10, section 40.13, paragraph (c), clause (5), subclause (i), in effect June 30, 1969; and

(c) the exemption contained in this subitem shall not be deemed to authorize the chemical, physical, or metallurgical treatment or processing of any such counterweights other than repair or restoration of any plating or other covering;

(6) natural or depleted uranium metal used as shielding constituting part of a shipping container, provided that:

(a) the shipping container is conspicuously and legibly impressed with the legend "CAUTION - RADIOACTIVE SHIELDING - URANIUM"; and

(b) the uranium metal is encased in mild steel or equally fire-resistant metal of minimum wall thickness of one-eighth inch (3.2 mm);

(7) thorium or uranium contained in or on finished optical lenses or mirrors, provided that each does not contain more than ten percent by weight of thorium or uranium or for lenses manufactured before August 27, 2013, 30 percent by weight of thorium. The exemption in this subitem shall not be deemed to authorize:

(a) the shaping, grinding, or polishing of such lens or mirror or manufacturing processes other than the assembly of such lens or mirror into optical systems and devices without any alteration of the lens or mirror; or

(b) the receipt, possession, use, or transfer of thorium or uranium contained in contact lenses, spectacles, or eyepieces of binoculars or other optical instruments; or

(8) thorium contained in any finished aircraft engine part containing nickel-thoria alloy, provided that:

(a) the thorium is dispersed in the nickel-thoria alloy in the form of finely divided thoria (thorium dioxide); and

(b) the thorium content in the nickel-thoria alloy does not exceed four percent by weight.

B. The exemptions in this subpart do not authorize the manufacture of any of the products described.

C. No person may initially transfer for sale or distribution a product containing source material to persons exempt under this subpart, or equivalent regulations of the NRC or an agreement state, unless authorized by a license issued under Code of Federal Regulations, title 10, section 40.52, to initially transfer such products for sale or distribution.

(1) Persons initially distributing source material in products covered by the exemptions in this subpart before August 27, 2013, without specific authorization may continue distribution for one year beyond this date. Initial distribution may also be continued until the NRC takes final action on a pending application for license or license amendment to specifically authorize distribution submitted no later than one year beyond this date.

(2) Persons authorized to manufacture, process, or produce these materials or products containing source material by the NRC or an agreement state, and persons who import finished products or parts, for sale or distribution must be authorized by a license issued under Code of Federal Regulations, title 10, section 40.52, for distribution only and are exempt from the requirements of parts 4731.0765, items B and C, and 4731.1000 to 4731.2950.

Subp. 4. [Repealed, 40 SR 145]

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.0730 OTHER EXEMPTIONS.

A. The commissioner may, upon application of any interested person or upon the commissioner's own initiative, grant exemptions from parts 4731.0700 to 4731.0840 as the commissioner determines are authorized by law and will not endanger life or property and are otherwise in the public interest.

B. The United States Department of Energy is exempt from parts 4731.0700 to 4731.0840.

C. Except as specifically provided in Code of Federal Regulations, title 10, part 61, a licensee is exempt from parts 4731.0700 to 4731.0840 to the extent that the licensee's activities are subject to Code of Federal Regulations, title 10, part 61.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0735 TYPES OF LICENSES.

A. Licenses for radioactive material are of two types: general and specific.

B. Licenses for long-term care and custody of residual radioactive material at disposal sites are general licenses. The general licenses provided under parts 4731.0700 to 4731.0840 are effective without the filing of applications with the commissioner or the issuance of licensing documents to particular persons.

C. Licenses issued to named persons upon applications filed according to parts 4731.0700 to 4731.0840 are specific licenses.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0740 GENERAL LICENSE; TITLE TO SOURCE OR RADIOACTIVE MATERIAL.

A general license is issued authorizing the receipt of title to source or radioactive material without regard to quantity. This general license does not authorize any person to receive, possess, deliver, use, or transfer source or radioactive material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0745 GENERAL LICENSE; SMALL QUANTITIES OF SOURCE MATERIAL.

Subpart 1. **General license issued.** A general license is issued authorizing commercial and industrial firms; research, educational, and medical institutions; and state and local government agencies to receive, possess, use, and transfer uranium and thorium, in their natural isotopic concentrations and in the form of depleted uranium, for research, development, educational, commercial, or operational purposes in the following forms and quantities:

A. no more than 1.5 kg (3.3 lb) of uranium and thorium in dispersible forms, for example gaseous, liquid, or powder, at any one time. Any material processed by the general licensee that alters the chemical or physical form of the material containing source material must be accounted for as a dispersible form. A person authorized to possess, use, and transfer source material under this item may not receive more than a total of 7 kg (15.4 lb) of uranium and thorium in any one calendar year. Persons possessing source material in excess of these limits as of December 31, 2014, may continue to possess up to 7 kg (15.4 lb) of uranium and thorium at any one time for one year beyond this date, or until the commissioner takes final action on a pending application submitted on or before December 31, 2015, for a specific license for such material and receive up to 70 kg (154 lb) of uranium or thorium in any one calendar year until December 31, 2015, or until the commissioner takes final action on a pending application submitted on or before December 31, 2015, for a specific license for such material; and

B. no more than a total of 7 kg (15.4 lb) of uranium and thorium at any one time. A person authorized to possess, use, and transfer source material under this item may not receive more than a total of 70 kg (154 lb) of uranium and thorium in any one calendar year. A person may not alter the chemical or physical form of the source material possessed under this item unless it is accounted for under the limits of item A; or

C. no more than 7 kg (15.4 lb) of uranium, removed during the treatment of drinking water, at any one time. A person may not remove more than 70 kg (154 lb) of uranium from drinking water during a calendar year under this item; or

D. no more than 7 kg (15.4 lb) of uranium and thorium at laboratories for the purpose of determining the concentration of uranium and thorium contained within the material being analyzed at any one time. A person authorized to possess, use, and transfer source material under this item may not receive more than a total of 70 kg (154 lb) of source material in any one calendar year.

Subp. 2. **Other law.** A person who receives, possesses, uses, or transfers source material under the general license issued under subpart 1:

A. is prohibited from administering source material, or the radiation therefrom, either externally or internally, to human beings except as authorized by the commissioner in a specific license;

B. must not abandon the source material. Source material may be disposed of as follows:

(1) a cumulative total of 0.5 kg (1.1 lb) of source material in a solid, nondispersible form may be transferred each calendar year, by a person authorized to receive, possess, use, and transfer source material under this general license to persons receiving the material for permanent disposal. The recipient of source material transferred under the provisions of this subitem is exempt from the requirements to obtain a license under parts 4731.0700 to 4731.0840 to the extent the source material is permanently disposed. This provision does not apply to any person who is in possession of source material under a specific license issued under this chapter; or

(2) in accordance with part 4731.2400;

C. is subject to the provisions in parts 4731.0700 to 4731.0710, 4731.0785, and 4731.0810 to 4731.0840;

D. must respond to written requests from the commissioner to provide information relating to the general license within 30 calendar days of the date of the request, or other time specified in the request. If the person cannot provide the requested information within the allotted time, the person must, within that same time period, request a longer period to supply the information by providing the commissioner a written justification for the request; and

E. must not export such source material except in accordance with Code of Federal Regulations, title 10, section 110.

Subp. 2a. **Contamination.** Any person who receives, possesses, uses, or transfers source material in accordance with subpart 1 must conduct activities to minimize contamination of the

facility and the environment. When activities involving source material are permanently ceased at any site, if evidence of significant contamination is identified, the general licensee must notify the commissioner about the contamination and may consult with the commissioner as to the appropriateness of sampling and restoration activities to ensure that any contamination or residual source material remaining at the site where source material was used under this general license is not likely to result in exposures that exceed the limits in part 4731.2100.

Subp. 3. **Exemption.** A person who receives, possesses, uses, or transfers source material under the general license issued under subpart 1 is exempt from the provisions of parts 4731.1000 to 4731.2950 to the extent that receipt, possession, use, and transfer are within the terms of this general license, except that the person must comply with the provisions of parts 4731.2100, subpart 1, and 4731.2400 to the extent necessary to meet the provisions of subparts 2, item B, and 3. However, this exemption does not apply to any person who also holds a specific license issued under this chapter.

Subp. 4. **Transfer authorization required.** No person may initially transfer or distribute source material to persons generally licensed under subpart 1, item A or B, or equivalent regulations of the NRC or an agreement state, unless authorized by a specific license issued in accordance with part 4731.0816 or equivalent provisions of the NRC or an agreement state. This prohibition does not apply to analytical laboratories returning processed samples to the client who initially provided the sample. Initial distribution of source material to persons generally licensed by subpart 1 before December 31, 2014, without specific authorization may continue for one year beyond this date. Distribution may also be continued until the commissioner takes final action on a pending application for license or license amendment to specifically authorize distribution submitted on or before December 31, 2014.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.0750 GENERAL LICENSE; USE OF CERTAIN INDUSTRIAL PRODUCTS OR DEVICES.

Subpart 1. **General license issued.** A general license is issued to receive, acquire, possess, use, or transfer, according to this part, depleted uranium contained in industrial products or devices for the purpose of providing a concentrated mass in a small volume of the product or device.

Subp. 2. **Scope.** The general license issued under subpart 1 applies only to industrial products or devices that have been manufactured or initially transferred according to a specific license issued under part 4731.0770 or according to a specific license issued by the NRC or an agreement state that authorizes manufacture of the products or devices for distribution to persons generally licensed by the NRC or an agreement state.

Subp. 3. **Registration certificate.**

A. A person who receives, acquires, possesses, or uses depleted uranium under the general license issued under subpart 1 must submit to the commissioner a form for a registration certificate for use of depleted uranium under a general license, as prescribed by the commissioner. The form must be submitted within 30 days after the first receipt or acquisition of the depleted uranium.

B. A registrant must furnish the following information on the form and any other information as may be prescribed by the commissioner:

(1) the name and address of the registrant;

(2) a statement that the registrant has developed and will maintain procedures designed to establish physical control over the depleted uranium described in subpart 1 and to prevent transfer of the depleted uranium in any form, including metal scrap, to persons not authorized to receive the depleted uranium; and

(3) the name, title, address, and telephone number of the individual duly authorized to act for and on behalf of the registrant in supervising the procedures identified in subitem (2).

C. A registrant possessing or using depleted uranium under the general license issued under subpart 1 must report in writing to the commissioner any changes in information furnished by the registrant under item B. The report must be submitted within 30 days after the effective date of the change.

Subp. 4. **License requirements.**

A. A person who receives, acquires, possesses, or uses depleted uranium under the general license issued in subpart 1:

(1) must not introduce the depleted uranium, in any form, into a chemical, physical, or metallurgical treatment or process, except a treatment or process for repair or restoration of any plating or other covering of the depleted uranium;

(2) must not abandon the depleted uranium;

(3) must transfer or dispose of the depleted uranium only by transfer according to part 4731.0815 and:

(a) when the transferee receives the depleted uranium under the general license issued under subpart 1, the transferor must furnish the transferee a copy of this part and a copy of the registration certificate form required under subpart 3; or

(b) when the transferee receives the depleted uranium under a general license issued under an NRC or agreement state regulation equivalent to this part, the transferor must furnish the transferee a copy of this part and a copy of the registration certificate form required under subpart 3, accompanied by a note explaining that use of the product or device is regulated by the NRC or an agreement state under requirements substantially the same as those in this part; and

(4) within 30 days of any transfer, must report in writing to the commissioner the name and address of the person receiving the source material pursuant to the transfer.

B. A person receiving, acquiring, possessing, using, or transferring depleted uranium under the general license issued under subpart 1 is exempt from parts 4731.1000 to 4731.2950 with respect to the depleted uranium covered by the general license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0760 SPECIFIC LICENSE; APPLICATION.

Subpart 1. **Application generally.**

A. An application for a specific license must be filed on an application for radioactive material license form prescribed by the commissioner.

B. Applications and statements must be signed by the applicant or licensee or a person duly authorized to act for and on behalf of the applicant or licensee.

C. The commissioner may at any time after the filing of the original application, and before the expiration of the license, require further statements to enable the commissioner to determine whether the application should be granted or denied or whether a license should be modified or revoked.

D. An application for a source material license must be accompanied by the fee prescribed under Minnesota Statutes, section 144.1205.

Subp. 2. **Decommissioning requirements.** As provided under part 4731.0780, certain applications for specific licenses filed under this part must contain a proposed decommissioning funding plan or a certification of financial assurance for decommissioning.

Subp. 3. **Additional requirements; uranium hexafluoride.**

A. An application to possess uranium hexafluoride in excess of 50 kilograms in a single container or 1,000 kilograms total must contain:

(1) an evaluation showing that the maximum intake of uranium by a member of the public due to release would not exceed two milligrams; or

(2) an emergency plan for responding to the radiological hazards of an accidental release of source material and to any associated chemical hazards directly incident thereto.

B. One or more of the following factors may be used to support an evaluation submitted under item A, subitem (1):

(1) all or part of the radioactive material is not subject to release during an accident because of the way it is stored or packaged;

(2) facility design or engineered safety features in the facility would reduce the amount of the release; or

(3) other factors appropriate for the specific facility.

C. An emergency plan submitted under item A, subitem (2), must include:

(1) a brief description of the licensee's facility and area near the site;

(2) identification of each type of accident for which protective actions may be needed;

(3) a classification system for classifying accidents as alert or site area emergencies;

(4) identification of the means of detecting each type of accident in a timely manner;

(5) a brief description of the means and equipment for mitigating the consequences of each type of accident, including those provided to protect workers on-site, and a description of the program for maintaining the equipment;

(6) a brief description of the methods and equipment to assess releases of radioactive materials;

(7) a brief description of the responsibilities of licensee personnel should an accident occur, including identification of personnel responsible for promptly notifying off-site response organizations and the commissioner, and the responsibilities for developing, maintaining, and updating the plan;

(8) a commitment to and a brief description of the means to promptly notify the commissioner and off-site response personnel and request assistance, including medical assistance for the treatment of contaminated injured on-site workers when appropriate. A control point must be established. The notification and coordination must be planned so that unavailability of some personnel, parts of the facility, and equipment does not prevent notification and coordination. The licensee must also commit to notifying the commissioner immediately after the licensee has notified the off-site response organizations and not later than one hour after the licensee declares an emergency;

(9) a brief description of the types of information on facility status, radioactive releases, and recommended protective actions, if necessary, to be given to off-site response organizations and to the commissioner;

(10) a brief description of the frequency, performance objectives, and plans for the training that the licensee will provide workers on how to respond to an emergency, including any special instructions and orientation tours the licensee would offer to fire, police, medical, and other emergency personnel. The training must:

(a) familiarize personnel with site-specific emergency procedures;

(b) prepare site personnel for their responsibilities in the event of an accident; and

(c) use team training for accident scenarios postulated as the most probable accidents for the specific site;

(11) a brief description of the means of restoring the facility to a safe condition after an accident;

(12) provisions for conducting quarterly communications checks with off-site response organizations and biennial on-site exercises to test response to simulated emergencies. A quarterly communications check with off-site response organizations must include checking and updating all necessary telephone numbers. The licensee must invite off-site response organizations to participate in the biennial exercises. Participation of off-site response organizations in biennial exercises, although recommended, is not required. Exercises must use accident scenarios postulated as most probable for the specific site and the scenarios must not be known to most exercise participants. The licensee must critique each exercise using individuals not having direct implementation responsibility for the plan. Critiques of exercises must evaluate the appropriateness of the plan, emergency procedures, facilities, equipment, training of personnel, and overall effectiveness of the response. Deficiencies found by the critiques must be corrected; and

(13) a certification that the applicant has met its responsibilities under the Emergency Planning and Community Right-to-Know Act of 1986, title III, Public Law 99-499, if applicable to the applicant's activities at the proposed place of use of the source material.

Subp. 4. **Comments.** A licensee must:

A. allow the off-site response organizations expected to respond in case of an accident 60 days to comment on the licensee's emergency plan before submitting it to the commissioner; and

B. provide any comments received within the 60 days to the commissioner along with the emergency plan.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.0765 SPECIFIC LICENSE; APPROVAL.

The commissioner shall approve an application for a specific license if:

A. the application is for a purpose authorized under this chapter;

B. the applicant is qualified by reason of training and experience according to this chapter to use the source material for the purpose requested in such manner as to protect health and minimize danger to life and property;

C. the applicant's proposed equipment, facilities, and procedures are in accordance with this chapter and are adequate to protect health and minimize danger to life and property; and

D. the applicant satisfies any applicable special requirements under part 4731.0770.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0770 SPECIFIC LICENSE; CERTAIN INDUSTRIAL PRODUCTS AND DEVICES.

Subpart 1. **License requirements.** An application for a specific license to manufacture industrial products and devices containing depleted uranium or to initially transfer such products and devices, for use according to part 4731.0750 or equivalent regulations of the NRC or an agreement state, shall be approved if the applicant:

A. satisfies the general requirements under part 4731.0765;

B. submits sufficient information relating to the design, manufacture, prototype testing, quality control procedures, labeling or marking, proposed uses, and potential hazards of the industrial product or device to provide reasonable assurance that possession, use, or transfer of the depleted uranium in the product or device is not likely to cause any individual to receive in one year a radiation dose in excess of ten percent of the annual limits specified in part 4731.2020, subpart 1; and

C. submits sufficient information regarding the industrial product or device and the presence of depleted uranium for a mass-volume application in the product or device to provide reasonable assurance that unique benefits will accrue to the public because of the usefulness of the product or device.

Subp. 2. **Questionable benefits.** In the case of an industrial product or device whose unique benefits are questionable, the commissioner shall approve an application for a specific license under this part only if the product or device is found to combine a high degree of utility and low probability of uncontrolled disposal and dispersal of significant quantities of depleted uranium into the environment.

Subp. 3. **End uses unforeseeable.** The commissioner may deny an application for a specific license under this part if the end uses of the industrial product or device cannot be reasonably foreseen.

Subp. 4. **License conditions.** A person licensed under this part must:

A. maintain the level of quality control required by the license in the manufacture of the industrial product or device and in the installation of the depleted uranium into the product or device;

B. label or mark each unit to:

(1) identify:

(a) the manufacturer or initial transferor of the product or device;

(b) the number of the license under which the product or device was manufactured or initially transferred;

(c) the fact that the product or device contains depleted uranium; and

(d) the quantity of depleted uranium in each product or device; and

(2) state that receipt, possession, use, and transfer of the product or device are subject to a general license or the equivalent and to the regulations of the NRC or an agreement state;

C. ensure that the depleted uranium, before being installed in each product or device, has been impressed with the following legend clearly legible through any plating or other covering: "Depleted Uranium";

D. furnish a copy of:

(1) the general license issued under part 4731.0750 and a copy of NRC Form 244 to each person to whom the licensee transfers source material in a product or device for use according to the general license issued under part 4731.0750;

(2) the general license issued under an NRC or agreement state regulation equivalent to part 4731.0750 and a copy of the NRC or agreement state certificate; or

(3) the general license issued under part 4731.0750 and a copy of NRC Form 244 to each person to whom the licensee transfers source material in a product or device for use according to a general license of the NRC or an agreement state, accompanied by a note explaining that use of the product or device is regulated by the NRC or an agreement state under requirements substantially the same as those in part 4731.0750; and

E. report to the commissioner all transfers of industrial products or devices to persons for use under the general license issued under part 4731.0750. The report must be submitted within 30 days after the end of each calendar quarter in which the product or device is transferred to a generally licensed person. If no transfers have been made to a person generally licensed under part 4731.0750 during the reporting period, the report must so indicate. The report must identify:

(1) each general licensee by name and address;

(2) an individual by name or position who may constitute a point of contact between the commissioner and the general licensee;

(3) the type and model number of the device transferred; and

(4) the quantity of depleted uranium contained in the product or device.

Subp. 5. **Record keeping.** A licensee must keep records for three years from the date of transfer showing:

A. the name, address, and point of contact for each general licensee to whom the licensee transfers depleted uranium in industrial products or devices for use according to the general license issued under part 4731.0750 or equivalent regulations of the NRC or an agreement state;

B. the date of each transfer;

C. the quantity of depleted uranium in each product or device transferred; and

D. compliance with the report requirements of this part.

Subp. 6. **Emergency plan.** A licensee that is required to submit an emergency plan under part 4731.0760 must follow the emergency plan approved by the commissioner. The licensee:

A. may change the plan without commissioner approval if the changes do not decrease the effectiveness of the plan;

B. must furnish the change to the commissioner within six months after the change is made; and

C. may not implement proposed changes that decrease the effectiveness of the approved emergency plan without prior application to and prior approval by the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

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4731.0780 FINANCIAL ASSURANCE AND RECORD KEEPING FOR DECOMMISSIONING.

Subpart 1. **Applicability.** This part establishes criteria for providing financial assurance for decommissioning, except for licenses authorizing the receipt, possession, and use of source material for uranium or thorium milling or radioactive material at sites formerly associated with such milling, for which financial assurance requirements are set forth in part 4731.0580.

Subp. 2. **More than 100 mCi.** An applicant for a specific license authorizing the possession and use of more than 100 millicuries (3.7 GBq) of source material in a readily dispersible form must submit a decommissioning funding plan according to subpart 4.

Subp. 3. **Between ten mCi and 100 mCi.**

A. An applicant for a specific license authorizing possession and use of quantities of source material greater than ten millicuries (370 MBq) but less than or equal to 100 millicuries (3.7 GBq) in a readily dispersible form must:

(1) submit a decommissioning funding plan according to subpart 4; or

(2) submit a certification that financial assurance for decommissioning has been provided in the amount of $225,000, using one of the methods described under subpart 5. The certification may state that the appropriate assurance will be obtained after the application has been approved and the license issued but before the receipt of licensed material.

B. If an applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy the requirements of subpart 5 must be submitted to the commissioner before receipt of licensed material.

C. If an applicant does not defer execution of the financial instrument, the applicant must submit to the commissioner, as part of the certification, a signed original of the financial instrument obtained to satisfy the requirements of subpart 5.

D. A holder of a specific license:

(1) issued on or after July 27, 1990, which is covered by subpart 1 or 2, shall provide financial assurance for decommissioning according to this part; and

(2) issued before July 27, 1990, and of a type described in subpart 1 shall submit a decommissioning funding plan as described in subpart 5 or a certification of financial assurance for decommissioning in an amount at least equal to $1,125,000 according to this part. If the licensee submits the certificate of financial assurance rather than a decommissioning funding plan, the licensee shall include a decommissioning funding plan in any application for license renewal. Licensees required to submit the $1,125,000 amount must do so by December 2, 2004.

Subp. 4. **Funding plan requirements.**

A. Each decommissioning funding plan must be submitted for review and approval and must contain:

(1) a detailed cost estimate for decommissioning, in an amount reflecting:

(a) the cost of an independent contractor to perform all decommissioning activities;

(b) the cost of meeting the criteria in part 4731.2100, subpart 2, for unrestricted use, provided that, if the applicant or licensee can demonstrate its ability to meet the provisions of part 4731.2100, subpart 3, the cost estimate may be based on meeting the criteria in part 4731.2100, subpart 3;

(c) the volume of on-site subsurface material containing residual radioactivity that will require remediation; and

(d) an adequate contingency factor;

(2) identification of and justification for using the key assumptions contained in the DCE;

(3) a description of the method of assuring funds for decommissioning from subpart 5, including means for adjusting cost estimates and associated funding levels periodically over the life of the facility;

(4) a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning; and

(5) a signed original, or if permitted, a copy, of the financial instrument obtained to satisfy the requirements of subpart 5, unless a previously submitted and accepted financial instrument continues to cover the cost estimate for decommissioning.

B. At the time of license renewal and at intervals not to exceed three years, the decommissioning funding plan must be resubmitted with adjustments as necessary to account for changes in costs and the extent of contamination. If the amount of financial assurance will be adjusted downward, this cannot be done until the updated decommissioning funding plan is approved. The decommissioning funding plan must update the information submitted with the original or prior approved plan, and must specifically consider the effect of the following events on decommissioning costs:

(1) spills of radioactive material producing additional residual radioactivity in on-site subsurface material;

(2) waste inventory increasing above the amount previously estimated;

(3) waste disposal costs increasing above the amount previously estimated;

(4) facility modifications;

(5) changes in authorized possession limits;

(6) actual remediation costs that exceed the previous cost estimate;

(7) on-site disposal; and

(8) use of a settling pond.

Subp. 5. **Financial assurance requirements.**

A. Financial assurance for decommissioning must be provided by one of the methods described in items B to F.

B. Prepayment is the deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets such that the amount of funds would be sufficient to pay decommissioning costs. Prepayment may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

C. A surety method, insurance, or other guarantee method guarantees that decommissioning costs will be paid. A surety method may be in the form of a surety bond, letter of credit, or line of credit. A parent company guarantee of funds for decommissioning costs based on a financial test may be used if the guarantee and test comply with part 4731.3155, but may not be used in combination with other financial methods to satisfy the requirements of this part. For commercial corporations that issue bonds, a guarantee of funds by the applicant or licensee for decommissioning costs based on a financial test may be used if the guarantee and test comply with part 4731.3165. For commercial corporations that do not issue bonds, a guarantee of funds by the applicant or licensee for decommissioning costs may be used if the guarantee and test comply with part 4731.3170. For nonprofit entities, such as colleges, universities, and nonprofit hospitals, a guarantee of funds by the applicant or licensee may be used if the guarantee and test comply with part 4731.3175. A guarantee by the applicant or licensee may not be used in combination with other financial methods used to satisfy this part or in any situation where the applicant or licensee has a

parent company holding majority control of the voting stock of the company. Any surety method or insurance used to provide financial assurance for decommissioning must:

(1) be open-ended or, if written for a specified term, such as five years, must be renewed automatically unless 90 days or more before the renewal date, the issuer notifies the commissioner, the beneficiary, and the licensee of its intention not to renew;

(2) provide that the full face amount be paid to the beneficiary automatically before the expiration without proof of forfeiture if the licensee fails to provide a replacement acceptable to the commissioner within 30 days after receipt of notification of cancellation;

(3) be payable to a trust established for decommissioning costs. The trustee and trust must be acceptable to the commissioner. An acceptable trustee includes an appropriate state or federal government agency or an entity that has authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency; and

(4) remain in effect until the commissioner terminates the license.

D. An external sinking fund in which deposits are made at least annually, coupled with a surety method or insurance, the value of which may decrease by the amount being accumulated in the sinking fund, may be used as a method of financial assurance. The surety or insurance provisions must be as stated in item C. An external sinking fund:

(1) is a fund established and maintained by setting aside funds periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected; and

(2) may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

E. In the case of federal, state, or local government licensees, a statement of intent containing a cost estimate for decommissioning or an amount according to subpart 3 and indicating that funds for decommissioning will be obtained when necessary may be used as a method of financial assurance.

F. When a governmental entity assumes custody and ownership of a site, an arrangement that is deemed acceptable by the governmental entity may be used as a method of financial assurance.

Subp. 6. **Record keeping.**

A. A licensee must keep records of information important to the decommissioning of a facility in an identified location until the site is released for unrestricted use.

B. Before licensed activities are transferred or assigned according to part 4731.0785, subpart 1, item A, a licensee must transfer all records described in this subpart to the new licensee. The new licensee is responsible for maintaining the records until the license is terminated.

C. If records important to the decommissioning of a facility are kept for other purposes, reference to the records and their location may be used.

D. Information the commissioner considers important to decommissioning are:

(1) records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site, which:

(a) may be limited to instances when contamination remains after cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas, as in the case of possible seepage into porous materials such as concrete; and

(b) must include any known information on identification of involved nuclides, quantities, forms, and concentrations;

(2) as-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used or stored and of locations of possible inaccessible contamination, such as buried pipes, that may be subject to contamination. If required drawings are referenced, each relevant document need not be indexed individually. If drawings are not available, the licensee must substitute appropriate records of available information concerning these areas and locations;

(3) a list of the following, contained in a single document and updated every two years:

(a) all areas designated and formerly designated as restricted areas;

(b) all areas outside of restricted areas that require documentation under subitem (1);

(c) all areas outside of restricted areas where current and previous wastes have been buried as documented under part 4731.2560; and

(d) all areas outside of restricted areas that contain material such that, if the license expired, the licensee would be required to either decontaminate the area to meet the criteria for decommissioning under part 4731.2100 or apply for approval for disposal under part 4731.2410; and

(4) records of:

(a) the cost estimate performed for the decommissioning funding plan or of the amount certified for decommissioning; and

(b) the funding method used for assuring funds if either a funding plan or certification is used.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 40 SR 145*

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4731.0785 LICENSE CONDITIONS.

Subpart 1. **Required conditions.** A specific license issued under parts 4731.0700 to 4731.0840 must contain and be subject to the following conditions:

A. neither the license nor any right under the license shall be assigned or otherwise transferred in violation of this chapter; and

B. the license is subject to and the licensee must observe, all applicable rules and orders of the commissioner.

Subp. 2. **Scope of license.** A person licensed by the commissioner under parts 4731.0700 to 4731.0840 must confine the licensee's possession and use of radioactive material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued under parts 4731.0700 to 4731.0840 carries with it the right to receive, possess, and use radioactive material. Preparation for shipment and transport of radioactive material must be according to this chapter.

Subp. 3. **Bankruptcy.**

A. A licensee under parts 4731.0700 to 4731.0840 must notify the commissioner, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any chapter of United States Code, title 11, by or against:

(1) the licensee;

(2) an entity, which includes a person, estate, trust, governmental unit, or United States trustee, that controls the licensee or lists the license or licensee as property; or

(3) an affiliate of the licensee, as defined under United States Code, chapter 11, section 101, clause (2).

B. The bankruptcy notification must indicate the bankruptcy court in which the petition for bankruptcy was filed and the date of the filing of the petition.

Subp. 4. **Additional conditions.** The commissioner may incorporate in any license, at the time of issuance or thereafter by appropriate rule or order, such additional conditions and requirements with respect to the licensee's receipt, possession, use, and transfer of source or radioactive material as the commissioner deems appropriate or necessary to protect health or to minimize danger to life or property.

Subp. 5. **Additional requirements.** The commissioner may require reports, record keeping, and inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0790 LICENSE EXPIRATION AND TERMINATION; DECOMMISSIONING.

Subpart 1. **Expiration.**

A. A specific license issued under parts 4731.0700 to 4731.0840 expires at the end of the day on the expiration date stated in the license, unless the licensee has filed an application for renewal under part 4731.0795 not less than 30 days before the expiration date stated in the existing license.

B. If an application for renewal has been filed at least 30 days before the expiration date stated in the existing license, the existing license expires at the end of the day on which the commissioner makes a final determination to deny the renewal application or, if the determination states an expiration date, the expiration date stated in the determination.

Subp. 2. **Revocation.** A specific license revoked by the commissioner expires at the end of the day on the date of the commissioner's final determination to revoke the license, on the expiration date stated in the determination, or as otherwise provided by a commissioner's order.

Subp. 3. **Termination notice.** A specific license continues in effect, beyond the expiration date if necessary, with respect to possession of source material, until the commissioner notifies the licensee in writing that the license is terminated. During this time, the licensee must:

A. limit actions involving source material to those related to decommissioning; and

B. continue to control entry to restricted areas until they are suitable for release according to this chapter.

Subp. 4. **Decommissioning.**

A. Within 60 days of any of the occurrences under item B, a licensee must provide notification to the commissioner in writing of such occurrence and:

(1) begin decommissioning the licensee's site or any separate building or outdoor area that contains residual radioactivity so that the building or outdoor area is suitable for release according to this chapter; or

(2) submit within 12 months of notification a decommissioning plan, if required under item E or F, and begin decommissioning upon approval of that plan.

B. Notice under item A is required when:

(1) the license has expired under subpart 1 or 2;

(2) the licensee has decided to permanently cease principal activities at the entire site or in any separate building or outdoor area;

(3) no principal activities have been conducted under the license for a period of 24 months; or

(4) no principal activities have been conducted for a period of 24 months in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release according to this chapter.

C. Coincident with the notification required under item A, the licensee must maintain in effect all decommissioning financial assurances established by the licensee under part 4731.0780 in conjunction with license issuance or renewal or as required under this part. The amount of the financial assurance must be increased, or may be decreased, as appropriate, to cover the detailed cost estimate for decommissioning established under item H, subitem (5). Following approval of the decommissioning plan, a licensee may reduce the amount of the financial assurance as decommissioning proceeds and radiological contamination is reduced at the site with the approval of the commissioner.

D. The commissioner may grant a request to delay or postpone initiation of the decommissioning process if the commissioner determines that this relief is not detrimental to the public health and safety and is otherwise in the public interest. The request must be submitted no later than 30 days before notification under item A. The schedule for decommissioning in this subpart may not commence until the commissioner has made a determination on the request.

E. A decommissioning plan must be submitted if:

(1) required by a license condition; or

(2) the procedures and activities necessary to carry out decommissioning of the site or separate building or outdoor area have not been previously approved by the commissioner and the procedures could increase potential health and safety impacts to workers or the public, such as in any of the following cases:

(a) procedures would involve techniques not routinely applied during cleanup and maintenance operations;

(b) workers would be entering areas not normally occupied where surface contamination and radiation levels are significantly higher than routinely encountered during operation;

(c) procedures could result in significantly greater airborne concentrations of radioactive materials than are present during operation; or

(d) procedures could result in significantly greater releases of radioactive material to the environment than those associated with operation.

F. The commissioner may approve an alternate schedule for submittal of a decommissioning plan required under this subpart if the commissioner determines that the alternative schedule is necessary to the effective conduct of decommissioning operations and presents no undue risk from the radiation to the public health and safety and is otherwise in the public interest.

G. The procedures under item E, subitem (2), may not be performed before approval of the decommissioning plan.

H. The proposed decommissioning plan for the site or separate building or outdoor area must include:

(1) a description of the conditions of the site or separate building or outdoor area sufficient to evaluate the acceptability of the plan;

(2) a description of planned decommissioning activities;

(3) a description of the methods used to ensure protection of workers and the environment against radiation hazards during decommissioning;

(4) a description of the planned final radiation survey;

(5) an updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for ensuring the availability of adequate funds for completion of decommissioning; and

(6) for decommissioning plans calling for completion of decommissioning later than 24 months after plan approval, a justification for the delay based on the criteria in item K.

I. The commissioner shall approve a proposed decommissioning plan if the information in the plan demonstrates that the decommissioning will be completed as soon as practicable and that the health and safety of workers and the public will be adequately protected.

J. Except as provided in item K, a licensee must:

(1) complete decommissioning of the site or separate building or outdoor area as soon as practicable but no later than 24 months following the initiation of decommissioning; and

(2) request license termination as soon as practicable but no later than 24 months following the initiation of decommissioning, when decommissioning involves the entire site.

K. The commissioner may approve a request for an alternative schedule for completion of decommissioning of the site or separate building or outdoor area, and license termination if appropriate, if the commissioner determines that the alternative is warranted by consideration of:

(1) whether it is technically feasible to complete decommissioning within the allotted 24-month period;

(2) whether sufficient waste disposal capacity is available to allow completion of decommissioning within the allotted 24-month period;

(3) whether a significant volume reduction in wastes requiring disposal will be achieved by allowing short-lived radionuclides to decay;

(4) whether a significant reduction in radiation exposure to workers can be achieved by allowing short-lived radionuclides to decay; and

(5) other site-specific factors that the commissioner may consider appropriate on a case-by-case basis, such as the regulatory requirements of other governmental agencies, lawsuits, groundwater treatment activities, monitored natural groundwater restoration, actions that could

result in more environmental harm than deferring clean up, and other factors beyond the control of the licensee.

L. As the final step in decommissioning, the licensee must:

(1) certify the disposition of all licensed material, including accumulated wastes, by submitting a completed NRC Form 314 or equivalent information; and

(2) conduct a radiation survey of the premises where the licensed activities were carried out and submit a report of the results of the survey, unless the licensee demonstrates in some other manner that the premises are suitable for release according to part 4731.2100. The licensee must, as appropriate:

(a) for gamma radiation, report levels of radiation in units of microroentgens (millisieverts) per hour at one meter from surfaces;

(b) for radioactivity, including alpha and beta radiation, report levels of radiation in units of disintegrations per minute or microcuries (megabecquerels) per 100 square centimeters removable and fixed for surfaces, microcuries (megabecquerels) per milliliter for water, and picocuries (becquerels) per gram for solids such as soils or concrete; and

(c) specify the survey instruments used and certify that each instrument is properly calibrated and tested.

M. Specific licenses, including expired licenses, shall be terminated by written notice to the licensee when the commissioner determines that:

(1) source material has been properly disposed of;

(2) reasonable effort has been made to eliminate residual radioactive contamination, if present;

(3) a radiation survey has been performed that demonstrates, or other information submitted by the licensee is sufficient to demonstrate, that the premises are suitable for release according to part 4731.2100; and

(4) records required under part 4731.0825, subparts 4 and 6, have been received.

Subp. 5. **Exemptions.** Specific licenses for uranium and thorium milling are exempt from subpart 4, items B, subitem (4), and D to I, with respect to reclamation of tailings impoundments and waste disposal areas.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

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4731.0795 LICENSE RENEWAL AND AMENDMENT.

Subpart 1. **Renewal application.** Applications for renewal of a specific license must be filed on an application for radioactive material license form, as prescribed by the commissioner, according to part 4731.0760.

Subp. 2. **Amendment applications.** Applications for amendment of a license must be filed on an application for radioactive material license form, as prescribed by the commissioner, according to part 4731.0760 and must specify the respects in which the licensee desires the license to be amended and the grounds for the amendment.

Subp. 3. **Consideration criteria.** In considering an application by a licensee to renew or amend a license, the commissioner shall apply the criteria under part 4731.0765.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0810 INALIENABILITY OF LICENSES.

A. No license issued or granted under parts 4731.0700 to 4731.0840 shall be transferred, assigned, or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of a license to a person unless the commissioner, after securing full information, finds that the transfer is in accordance with this chapter and gives consent in writing.

B. An application for transfer of license must include:

(1) the identity, technical, and financial qualifications of the proposed transferee; and

(2) financial assurance for decommissioning information required by part 4731.0780, as applicable.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
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4731.0815 TRANSFER OF RADIOACTIVE MATERIAL.

Subpart 1. **Authorization required.** No licensee shall transfer radioactive material except as authorized under this part.

Subp. 2. **Approved transfer.** Except as otherwise provided in a license and subject to subpart 3, a licensee may transfer radioactive material:

A. to the United States Department of Energy;

B. to the agency in an agreement state that regulates radioactive material;

C. to a person exempt from parts 4731.0700 to 4731.0840, to the extent permitted under the exemption;

D. to a person in an agreement state, subject to the jurisdiction of that state, who has been exempted from licensing requirements of that state, to the extent permitted under the exemption;

E. to a person authorized to receive radioactive material under terms of a specific license or a general license or their equivalents issued by the commissioner, the NRC, or an agreement state; or

F. as otherwise authorized by the commissioner in writing.

Subp. 3. **Verification for transfer.**

A. Before transferring radioactive material to a specific licensee of the commissioner, the NRC, an agreement state, or a licensing state or to a general licensee who is required to register with the commissioner, the NRC, an agreement state, or a licensing state before receipt of the radioactive material, the licensee transferring radioactive material must verify that the transferee's license authorizes the receipt of the type, form, and quantity of radioactive material to be transferred.

B. Any of the following methods of verification are acceptable:

(1) the transferor may possess and read a current copy of the transferee's specific license or general license registration certificate. The transferor must retain a copy of each license or certificate until the next inspection;

(2) the transferor may possess a written certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of radioactive material to be transferred, specifying:

(a) the license or registration certificate number;

(b) the issuing agency; and

(c) the expiration date.

The transferor must retain the written certification as a record for three years from the date of receipt of the certification; or

(3) for emergency shipments, the transferor may accept oral certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of radioactive material to be transferred, specifying:

(a) the license or registration certificate number;

(b) the issuing agency; and

(c) the expiration date.

The oral certification must be confirmed in writing within ten days. The transferor must retain the written confirmation of the oral certification for three years from the date of receipt of the confirmation.

Subp. 4. **Other sources of information.** The transferor may obtain other information compiled by a reporting service from official records of the commissioner, the NRC, or the licensing agency of an agreement state or licensing state regarding the identity of licensees or registrants and the scope and expiration dates of the licenses and registrations, to verify that the transferee is licensed or registered to receive the radioactive material.

Subp. 5. **Confirmation.** The transferor may obtain and record confirmation from the commissioner, the NRC, or the licensing agency of an agreement state or licensing state that the transferee is licensed to receive the radioactive material:

A. when none of the methods of verification described in subparts 3 and 4 are readily available; or

B. when a transferor desires to verify that information received by one of the verification methods is correct or up-to-date.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.0816 LICENSE TO TRANSFER SOURCE MATERIAL.

An application for a specific license to initially transfer source material for use under part 4731.0745 or equivalent regulations of the NRC or an agreement state shall be approved if:

A. the applicant satisfies the general requirements specified in part 4731.0765; and

B. the applicant submits adequate information on, and the commission approves, the methods to be used for quality control, labeling, and providing safety instructions to recipients.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*
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4731.0817 REQUIREMENTS FOR LABELING SOURCE MATERIAL; INSTRUCTIONS.

Subpart 1. **Label required.** Each person licensed under part 4731.0816 must label the immediate container of each quantity of source material with the type of source material and quantity of material and the words "radioactive material."

Subp. 2. **Transfer records.** Each person licensed under part 4731.0816 must ensure that the quantities and concentrations of source material are as labeled and indicated in any transfer records.

Subp. 3. **Transfer information.** A person licensed under part 4731.0816 must provide the information specified in this subpart to each person to whom source material is transferred for use under part 4731.0745 or equivalent regulations of the NRC or an agreement state. This information must be transferred before the source material is transferred for the first time in each calendar year to the particular recipient. The required information includes:

A. a copy of parts 4731.0745 and 4731.0815 or equivalent regulations of the NRC or an agreement state; and

B. appropriate radiation safety precautions and instructions relating to handling, use, storage, and disposal of the material.

Subp. 4. **Transfer report.** Each person licensed under part 4731.0816 must report transfers as follows:

A. file a report with the commissioner. The report must include the following information:

(1) the name, address, and license number of the person who transferred the source material;

(2) for each general licensee under part 4731.0745 or equivalent NRC or agreement state regulations to whom greater than 50 grams (0.11 lb) of source material has been transferred in a single calendar quarter, the name and address of the general licensee to whom source material is distributed; a responsible agent, by name and position and telephone number, of the general licensee to whom the material was sent; and the type, physical form, and quantity of source material transferred; and

(3) the total quantity of each type and physical form of source material transferred in the reporting period to all generally licensed recipients;

B. file a report with the commissioner, NRC, and each responsible agreement state agency that identifies all persons operating under provisions equivalent to part 4731.0745 to whom greater than 50 grams (0.11 lb) of source material has been transferred within a single calendar quarter. The report must include the following information specific to those transfers made to the agreement state being reported to:

(1) the name, address, and license number of the person who transferred the source material; and

(2) the name and address of the general licensee to whom source material was distributed; a responsible agent, by name and position, and telephone number, of the general licensee to whom the material was sent; and the type, physical form, and quantity of source material transferred; and

(3) the total quantity of each type and physical form of source material transferred in the reporting period to all such generally licensed recipients within NRC jurisdiction or the agreement state;

C. submit each report by January 31 of each year covering all transfers for the previous calendar year. If no transfers were made to persons generally licensed under part 4731.0745 or

equivalent NRC or agreement state regulations during the current period, a report must be submitted to the commissioner indicating so. If no transfers have been made to general licensees in NRC jurisdiction or a particular agreement state during the reporting period, this information must be reported to the NRC or responsible agreement state agency upon request of the agency.

Subp. 5. **Records retention.** Each person licensed under part 4731.0816 must maintain all information that supports the reports required by this part concerning each transfer to a general licensee for a period of one year after the event is included in a report to the commissioner or to the NRC or an agreement state agency.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*
Published Electronically: *August 27, 2015*

4731.0820 REPORTING REQUIREMENTS.

Subpart 1. **Immediate notification required.** A licensee must notify the commissioner as soon as possible but not later than four hours after the discovery of an event that prevents immediate protective actions necessary to avoid exposures to radiation or radioactive materials that could exceed regulatory limits or releases of licensed material that could exceed regulatory limits. Reportable events under this subpart include fires, explosions, toxic gas release, or similar hazards.

Subp. 2. **24-hour notification required.** A licensee must notify the commissioner within 24 hours after discovery of any of the following events involving licensed material:

A. an unplanned contamination event that:

(1) requires access to the contaminated area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the areas;

(2) involves a quantity of material greater than five times the lowest annual limit on intake specified in part 4731.2750 for the material; and

(3) restricts access to the area for a reason other than to allow isotopes with a half-life of less than 24 hours to decay prior to decontamination;

B. an event in which equipment is disabled or fails to function as designed when:

(1) the equipment is required by rule or license condition to prevent releases exceeding regulatory limits, to prevent exposure to radiation and radioactive materials exceeding regulatory limits, or to mitigate the consequences of an accident;

(2) the equipment is required to be available and operable when it is disabled or fails to function; and

(3) no redundant equipment is available and operable to perform the required safety function;

C. an event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body; or

D. an unplanned fire or explosion that damages any licensed material or any device, container, or equipment containing licensed materials when:

(1) the quantity of material involved is greater than five times the lowest annual limit on intake under part 4731.2750 for the material; and

(2) the damage affects the integrity of the licensed material or its container.

Subp. 3. **Preparation and submission of reports.**

A. A licensee must make reports required under subparts 1 and 2 by telephone to the commissioner according to part 4731.0200, subpart 5. To the extent that the information is available at the time of notification, the information provided in the report must include:

(1) the caller's name and call-back telephone number;

(2) a description of the event, including date and time;

(3) the exact location of the event;

(4) the isotopes, quantities, and chemical and physical form of the licensed material involved; and

(5) any personnel radiation exposure data available.

B. A licensee that makes a report required under subpart 1 or 2 must submit a written follow-up report within 30 days of the initial notification. Written reports prepared as required by other rules may be submitted to fulfill this requirement if the reports contain all of the necessary information and the appropriate distribution is made. The written reports must be sent to the commissioner. The reports must include:

(1) a description of the event, including the probable cause of the event and the manufacturer and model number, if applicable, of any equipment that failed or malfunctioned;

(2) the exact location of the event;

(3) the isotopes, quantities, and chemical and physical form of the licensed material involved;

(4) the date and time of the event;

(5) corrective actions taken or planned and the results of any evaluations or assessments; and

(6) the extent of exposure of individuals to radiation or to radioactive materials, without identification of the individuals by name.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.0825 RECORDS.

Subpart 1. **Requirements.**

A. A person who receives radioactive material pursuant to a license issued under parts 4731.0700 to 4731.0840 must keep records showing the receipt, transfer, and disposal of the radioactive material according to this subpart.

B. A licensee must retain each record of receipt of radioactive material as long as the material is possessed and for three years following transfer or disposition of the source or radioactive material.

C. A licensee who transferred the material must retain each record of transfer of radioactive material until the commissioner terminates each license that authorizes the activity that is subject to the record-keeping requirement.

D. A licensee must retain each record of disposal of radioactive material until the commissioner terminates each license that authorizes the activity that is subject to the record-keeping requirement.

E. If radioactive material is combined or mixed with other licensed material and subsequently treated in a manner that makes direct correlation of a receipt record with a transfer, export, or disposition record impossible, a licensee may use evaluative techniques, such as first-in-first-out, to make the records that are required by this part account for 100 percent of the material received.

Subp. 2. **Retention.**

A. A licensee must retain each record that is required by this part or by license condition for the period specified by the appropriate rule or license condition. If a retention period is not otherwise specified by rule or license condition, each record must be maintained until the commissioner terminates the license that authorizes the activity that is subject to the record-keeping requirement.

B. If there is a conflict between this chapter, a license condition, or other written commissioner approval or authorization pertaining to the retention period for the same type of record, the retention period specified in this chapter applies unless the commissioner, under part 4731.0730, has granted a specific exemption from the record retention requirements specified in this chapter.

Subp. 3. **Format.**

A. Records that must be maintained according to this chapter may be the original or a reproduced copy or microform if the reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage for the period specified by this chapter.

B. Records may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period.

C. Records such as letters, drawings, or specifications must include all pertinent information such as stamps, initials, and signatures.

D. A licensee must maintain adequate safeguards against tampering with and loss of records.

Subp. 4. **Transfer to commissioner.** Prior to license termination, a licensee authorized to possess source material, in an unsealed form, must forward the following records to the commissioner:

A. records of disposal of licensed material made under parts 4731.2410 to 4731.2440; and

B. records required under part 4731.2510, subpart 2, item D.

Subp. 5. **Transfer to new licensee.** If licensed activities are transferred or assigned under part 4731.0785, a licensee authorized to possess source material in an unsealed form must transfer the following records to the new licensee and the new licensee is responsible for maintaining the records until the license is terminated:

A. records of disposal of licensed material made under parts 4731.2410 to 4731.2440; and

B. records required under part 4731.2510, subpart 2, item D.

Subp. 6. **Decommissioning records.** Prior to license termination, a licensee must forward the records required under part 4731.0780, subpart 6, to the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.0830 INSPECTIONS AND TESTS.

Subpart 1. **Material and premises inspection.** A licensee or registrant must afford to the commissioner at all reasonable times opportunity to inspect radioactive material and the premises and facilities wherein radioactive material is used or stored.

Subp. 2. **Record inspection.** A licensee or registrant must make available to the commissioner for inspection, upon reasonable notice, records kept by the licensee as required under this chapter.

Subp. 3. **Radioactive materials inspection.** The commissioner shall perform inspections to ensure the radiation sources and radioactive materials are used only as specified in this chapter. Inspections for radioactive materials may be announced or unannounced.

Subp. 4. **Testing.**

A. A licensee or registrant must perform, or permit the commissioner to perform, such tests as the commissioner deems appropriate or necessary for the administration of parts 4731.0700 to 4731.0840, including tests of:

(1) radioactive material;

(2) facilities wherein radioactive material is utilized or stored;

(3) radiation detection and monitoring instruments; and

(4) other equipment and devices used in connection with the utilization or storage of radioactive material.

B. A licensee or registrant must also permit the commissioner to perform such tests as are deemed necessary to determine compliance with this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.0840 MODIFICATION AND REVOCATION OF LICENSES.

The terms and conditions of each license issued under parts 4731.0700 to 4731.0840 are subject to amendment, revision, or modification by reason of this chapter or orders issued by the commissioner, according to part 4731.0270.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

STANDARDS FOR PROTECTION AGAINST RADIATION

4731.1000 SCOPE; NOTICES, INSTRUCTIONS, REPORTS.

Parts 4731.1000 to 4731.1090 apply to all persons who receive, possess, use, or transfer material licensed by the commissioner under this chapter. Parts 4731.1000 to 4731.1090 establish requirements for notices, instructions, and reports by licensees to individuals participating in licensed activities and options available to these individuals in connection with commissioner inspections of licensees to ascertain compliance with this chapter and orders and licenses issued thereunder regarding radiological working conditions. Parts 4731.1000 to 4731.1090 also establish the rights and responsibilities of the commissioner and individuals during interviews, inspections, or investigations according to part 4731.1060 on any matter within the commissioner's jurisdiction.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.1010 POSTING WORKER NOTICES.

Subpart 1. **Required postings.**

A. A licensee must post current copies of the following documents:

(1) parts 4731.2000 to 4731.2900;

(2) the license, license conditions, and documents incorporated into the license by reference and amendments thereto;

(3) the operating procedures applicable to licensed activities; and

(4) any correction order involving radiological working conditions, administrative penalty order (APO), and any response from the licensee.

B. If posting of a document specified in item A, subitems (1) to (3), is not practicable, a licensee may post a notice that describes the document and states where it may be examined.

Subp. 2. **Notice to employees.** Each licensee and each applicant for a specific license must prominently post a MDH Form 3, "Notice to Employees," provided by the commissioner. A copy of any revision of the Notice to Employees must be posted within 30 days of receiving the revised notice from the commissioner. Copies of the Notice to Employees may be obtained by writing to the Radioactive Materials Unit, Minnesota Department of Health, 625 Robert Street N, P.O. Box 64975, St. Paul, MN 55164-0975.

Subp. 3. **Posting locations.** Documents, notices, or forms posted according to this part must:

A. appear in a sufficient number of places to permit individuals engaged in licensed activities to observe them on the way to or from any particular licensed activity location to which the document applies;

B. be conspicuous; and

C. be replaced if defaced or altered.

Subp. 4. **Correction order and APO.** Documents posted according to subpart 1, item A, subitem (4), must be posted within two working days after receipt of the documents from the commissioner. A licensee's response, if any, must be posted within two working days after dispatch by the licensee. The documents must remain posted for a minimum of five working days or until action correcting the violation is completed, whichever is later.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.1020 WORKER INSTRUCTIONS.

Subpart 1. **Required instruction.** All individuals who, in the course of employment, are likely to receive in a year an occupational dose in excess of 100 millirems (1 mSv) must be:

A. kept informed of the storage, transfer, or use of radiation and radioactive material;

B. instructed in the health protection problems associated with exposure to radiation and radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed;

C. instructed in and required to observe, to the extent within the worker's control, the applicable provisions of this chapter and the license that protect personnel from exposure to radiation and radioactive material;

D. instructed of their responsibility to report promptly to the licensee any condition that may lead to or cause a violation of this chapter or the license or any unnecessary exposure to radiation or radioactive material;

E. instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and

F. advised as to the radiation exposure reports that workers may request according to part 4731.1030.

Subp. 2. **Applicability.** In determining which individuals are subject to subpart 1, a licensee must take into consideration an individual's assigned activities during normal and abnormal situations involving exposure to radiation or radioactive material that can reasonably be expected to occur during the life of a licensed facility. The extent of the instructions must be commensurate with potential radiological health protection problems present in the workplace.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.1030 EXPOSURE NOTIFICATIONS AND REPORTS.

Subpart 1. **Exposure data notification.**

A. Radiation exposure data for an individual and the results of any measurements, analyses, and calculations of radioactive material deposited or retained in the body of an individual must be reported to the individual as specified in this part.

B. The information reported must include data and results obtained pursuant to this chapter, commissioner's orders, or license conditions, as shown in records maintained by the licensee according to this chapter.

C. Each notification and report to the individual must:

(1) be in writing;

(2) include appropriate identifying data such as the name of the licensee, the name of the individual, and the individual's social security number;

(3) include the individual's exposure information; and

(4) contain the following statement: "This report is furnished to you under Minnesota Rules, chapter 4731. You should preserve this report for further reference."

Subp. 2. **Frequency of report.** Each licensee shall make dose information available to workers as shown in records maintained by the licensee under the provisions of part 4731.2540. The licensee shall provide an annual report to each individual monitored under part 4731.2210 of the dose received in that monitoring year if:

A. the individual's occupational dose exceeds 100 mrem (1 mSv) TEDE or 100 mrem (1 mSv) to any individual organ or tissue; or

B. the individual requests their report.

Subp. 3. **Report to former employee; report to commissioner.**

A. At the request of a worker formerly engaged in licensed activities controlled by the licensee, a licensee must furnish to the worker a report of the worker's exposure to radiation and radioactive material:

(1) as shown in records maintained by the licensee according to part 4731.2540 for each year the worker was required to be monitored under part 4731.2210; and

(2) for each year the worker was required to be monitored under the monitoring requirements in effect before January 1, 1994.

B. The report under item A must:

(1) be furnished within 30 days from the time the request is made or within 30 days after the exposure of the individual has been determined by the licensee, whichever is later;

(2) cover the period of time that the worker's activities involved exposure to radiation from radioactive material licensed by the commissioner; and

(3) include the dates and locations of licensed activities in which the worker participated during this period.

C. When a licensee is required under part 4731.2610, 4731.2620, or 4731.2630 to report to the commissioner any exposure of an individual to radiation or radioactive material, the licensee must also provide the individual a report on the individual's exposure data included in the report to the commissioner. The report must be transmitted to the individual no later than the transmittal to the commissioner.

Subp. 4. **Report upon termination.** At the request of a worker who is terminating employment with the licensee that involved exposure to radiation or radioactive materials during the current calendar quarter or the current year, a licensee must provide at termination to each worker, or to the worker's designee, a written report regarding the radiation dose received by that worker from operations of the licensee during the current year or fraction thereof. If the most recent individual monitoring results are not available at that time, a written estimate of the dose must be provided together with a clear indication that this is an estimate.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *October 3, 2013*

4731.1040 INSPECTIONS; PRESENCE OF REPRESENTATIVES.

A. A licensee must afford to the commissioner at all reasonable times opportunity to inspect materials, activities, facilities, premises, and records according to this chapter.

B. During an inspection, the commissioner's inspectors may consult privately with workers according to part 4731.1050. The licensee or licensee's representative may accompany the commissioner's inspectors during other phases of an inspection.

C. If, at the time of inspection, an individual has been authorized by the workers to represent them during commissioner's inspections, the licensee must notify the inspectors of such authorization and must give the workers' representative an opportunity to accompany the inspectors during the inspection of physical working conditions.

D. Each workers' representative must be routinely engaged in licensed activities under control of the licensee and must have received instruction according to part 4731.1020.

E. Different representatives of licensees and workers may accompany the inspectors during different phases of an inspection if there is no resulting interference with the conduct of the inspection. Only one workers' representative at a time may accompany the inspectors.

F. With the approval of the licensee and the workers' representative, an individual who is not routinely engaged in licensed activities under control of the licensee, for example, a consultant to the licensee or workers' representative, must be afforded the opportunity to accompany the commissioner's inspectors during the inspection of physical working conditions.

G. Notwithstanding other provisions of this part, inspectors may refuse to permit accompaniment by an individual who deliberately interferes with a fair and orderly inspection.

H. With regard to areas containing information classified by an agency of the federal government in the interest of national security, an individual who accompanies an inspector must be authorized to have access to such information.

I. With regard to an area containing proprietary information, the workers' representative for that area must be an individual previously authorized by the licensee to enter the area.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.1050 INSPECTIONS; CONSULTATION WITH WORKERS.

Subpart 1. **Consultation permitted.** The commissioner's inspectors may consult privately with workers concerning matters of occupational radiation protection and other matters related to

this chapter and to licenses to the extent the inspectors deem necessary for the conduct of an effective and thorough inspection.

Subp. 2. **Worker allegations and complaints.** During the course of an inspection, a worker may privately bring to the attention of the inspectors, either orally or in writing, any past or present condition that the worker has reason to believe may have contributed to or caused a violation of this chapter or a license condition or any unnecessary exposure of an individual to radiation from licensed radioactive material under the licensee's control. A written notice under this subpart must comply with part 4731.1060, subparts 1 and 2. This subpart must not be interpreted as authorization to disregard instructions under part 4731.1020.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.1060 INSPECTIONS; REQUESTS BY WORKERS.

Subpart 1. **Worker request for inspection.** A worker or representative of workers who believes that a violation of this chapter or a license condition exists or has occurred in licensed activities with regard to radiological working conditions in which the worker is engaged may request an inspection by giving notice of the alleged violation to the supervisor of the Radioactive Materials Unit of the Department of Health or to the commissioner's inspectors.

Subp. 2. **Requirements.** A notice under subpart 1 must be in writing, must set forth the specific grounds for the notice, and must be signed by the worker or workers' representative. A copy of the notice must be provided to the licensee by the Radioactive Materials Unit supervisor or the inspector no later than at the time of inspection, except that upon the request of the worker giving the notice, the worker's name and the name of individuals referred to in the notice must not appear in the copy or on any record published, released, or made available by the commissioner, except for good cause shown.

Subp. 3. **Inspection required.** If, upon receipt of a notice, the Radioactive Materials Unit supervisor determines that the complaint meets the requirements of subparts 1 and 2, and that there are reasonable grounds to believe that the alleged violation exists or has occurred, the supervisor must require an inspection to be made as soon as practicable to determine if the alleged violation exists or has occurred. Inspections under this subpart need not be limited to matters referred to in the complaint.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.1070 INSPECTION NOT WARRANTED; INFORMAL REVIEW.

Subpart 1. **Review of inspection denial.**

A. If the Radioactive Materials Unit supervisor determines, with respect to a complaint under part 4731.1060, that an inspection is not warranted because there are no reasonable grounds to believe that a violation exists or has occurred, the supervisor must notify the complainant in writing of the determination.

B. The complainant may obtain review of the determination under item A by submitting a written statement of position to the commissioner, who shall provide the licensee with a copy of the statement by certified mail, excluding at the request of the complainant the name of the complainant. The licensee may submit an opposing written statement of position to the commissioner, who shall provide the complainant with a copy of the statement by certified mail.

C. Upon the request of the complainant, the commissioner may hold an informal conference in which the complainant and the licensee may orally present their views.

D. An informal conference may also be held at the request of the licensee, but disclosure of the identity of the complainant shall be made only following receipt of written authorization from the complainant.

E. After considering all written and oral views presented, the commissioner must affirm, modify, or reverse the determination of the supervisor of the Radioactive Materials Unit and furnish the complainant and the licensee a written notification of the commissioner's decision and the reason therefore.

Subp. 2. **Procedural defects.** If the commissioner determines that an inspection is not warranted because the requirements of part 4731.1060, subparts 1 and 2, have not been met, the commissioner must notify the complainant in writing of the determination. The determination must be without prejudice to the filing of a new complaint meeting the requirements of part 4731.1060, subparts 1 and 2.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.1080 VARIANCES.

The commissioner may grant a variance to this chapter, except parts 4731.3000 to 4731.3175, only according to parts 4717.7000 to 4717.7050.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.1090 DISCRIMINATION PROHIBITED.

No person, on the grounds of race, color, creed, religion, national origin, sex, disability, sexual orientation, or age, shall be excluded from participation in; denied the benefits of; or subjected to discrimination under any program or activity licensed by the commissioner. This part shall be enforced according to Minnesota Statutes, sections 181.931 to 181.935.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2000 GENERAL PROVISIONS.

Subpart 1. **Scope.** Parts 4731.2000 to 4731.2950 establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the commissioner. Parts 4731.2000 to 4731.2950 apply to persons licensed by the commissioner to receive, possess, use, transfer, or dispose of radioactive, source, or special nuclear material under this chapter.

Subp. 2. **Purpose.** It is the purpose of parts 4731.2000 to 4731.2950 to control the receipt, possession, use, transfer, and disposal of licensed material by a licensee so that the total dose to an individual, including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation, does not exceed the standards for protection against radiation prescribed in parts 4731.2000 to 4731.2950.

Subp. 3. **Exclusions.** The limits in parts 4731.2000 to 4731.2950 do not apply to doses due to background radiation, exposure of patients to radiation for the purpose of medical diagnosis or therapy, exposure from individuals administered radioactive material and released under part 4731.4427, or exposure from voluntary participation in medical research programs.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2010 RADIATION PROTECTION PROGRAMS.

Subpart 1. **General requirements.** A licensee must develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with parts 4731.2000 to 4731.2950. Records of the program must be kept according to part 4731.2500.

Subp. 2. **Protection methods.** A licensee must use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as reasonably achievable (ALARA).

Subp. 3. **Review.** A licensee must periodically, at least annually, review the radiation protection program content and implementation.

Subp. 4. **Air emissions.**

A. To implement the ALARA requirement of subpart 2, and notwithstanding part 4731.2090, a constraint on air emissions of radioactive material to the environment, excluding radon-222 and its daughter, must be established by the licensee, other than those subject to Code of Federal Regulations, title 10, section 50.34a, such that the individual member of the public likely to receive the highest dose is not expected to receive a total effective dose equivalent in excess of ten millirems (0.1 mSv) per year from these emissions.

B. If a licensee exceeds the dose constraint under item A, the licensee must report the exceedance according to part 4731.2620 and promptly take appropriate corrective action to ensure against recurrence.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2020 OCCUPATIONAL DOSE LIMITS FOR ADULTS.

Subpart 1. **Dose limits.** Except for planned special exposures according to part 4731.2060, a licensee must control the occupational dose to individual adults to the following dose limits:

A. an annual limit, which is the more limiting of:

(1) the total effective dose equivalent being equal to five rems (0.05 Sv); or

(2) the sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue other than the lens of the eye being equal to 50 rems (0.5 Sv); and

B. the annual limits to the lens of the eye, to the skin of the whole body, and to the skin of the extremities, which are:

(1) a lens dose equivalent of 15 rems (0.15 Sv); and

(2) a shallow dose equivalent of 50 rems (0.5 Sv) to the skin of the whole body or to the skin of any extremity.

Subp. 2. **Excess doses.** Doses received in excess of the annual limits, including doses received during accidents, emergencies, and planned special exposures, must be subtracted from the limits for planned special exposures that the individual may receive during the current year as specified under part 4731.2060, item E, subitem (1), and during the individual's lifetime as specified under part 4731.2060, item E, subitem (2).

Subp. 3. **Assessing dose.** When the external exposure is determined by measurement with an external personal monitoring device, the deep-dose equivalent must be used in place of the effective dose equivalent, unless the effective dose equivalent is determined by a dosimetry method approved by the commissioner. The assigned deep dose equivalent must be for the part of the body receiving the highest exposure. The assigned shallow dose equivalent must be the dose averaged over the contiguous ten square centimeters of skin receiving the highest exposure. The deep dose equivalent,

lens dose equivalent, and shallow dose equivalent may be assessed from surveys or other radiation measurements to demonstrate compliance with the occupational dose limits if the individual monitoring device was not in the region of highest potential exposure or if the results of individual monitoring are unavailable.

Subp. 4. **DAC and ALI values.** Derived air concentration (DAC) and annual limit on intake (ALI) values in part 4731.2750 may be used by the licensee to determine an individual's dose according to part 4731.2540 and to demonstrate compliance with the occupational dose limits.

Subp. 5. **Soluble uranium intake.** In addition to the annual dose limits, a licensee must limit the soluble uranium intake by an individual to ten milligrams in a week in consideration of chemical toxicity according to part 4731.2750, subpart 7, footnote 3.

Subp. 6. **Other employment.** A licensee must reduce the dose that an individual may be allowed to receive in the current year by the amount of occupational dose received while employed by any other person according to part 4731.2520, subpart 5.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.2030 SUMMATION OF EXTERNAL AND INTERNAL DOSES.

Subpart 1. **Summation required.** If a licensee is required to monitor under part 4731.2210, subparts 2 and 3, the licensee must demonstrate compliance with the dose limits by summing external and internal doses.

Subp. 2. **Summation not required.** If a licensee is required to monitor only under part 4731.2210, subpart 2, or only under part 4731.2210, subpart 3, then summation is not required to demonstrate compliance with the dose limits. The licensee may demonstrate compliance with the requirements for summation of external and internal doses by meeting one of the conditions specified under subpart 3 and the conditions specified under subparts 4 and 5. The dose equivalents for the lens of the eye, the skin, and the extremities are not included in the summation, but are subject to separate limits.

Subp. 3. **Intake by inhalation.** If the only intake of radionuclides is by inhalation, the total effective dose equivalent (TEDE) limit is not exceeded if the sum of the deep dose equivalent divided by the total effective dose equivalent limit, and one of the following, does not exceed unity:

A. the sum of the fractions of the inhalation ALI for each radionuclide;

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

C. the sum of the calculated committed effective dose equivalents to all significantly irradiated organs or tissues (T) calculated from bioassay data using appropriate biological models and expressed as a fraction of the annual limit. For purposes of this item, an organ or tissue is considered significantly irradiated if, for that organ or tissue, the product of the weighting factors,

W_T, and the committed dose equivalent, $H_{T,50}$, per unit intake is greater than ten percent of the maximum weighted value of $H_{T,50}$ per unit intake for any organ or tissue.

Subp. 4. **Intake by oral ingestion.** If the occupationally exposed individual also receives an intake of radionuclides by oral ingestion greater than ten percent of the applicable oral ALI, a licensee must account for this intake and include it in demonstrating compliance with the limits.

Subp. 5. **Intake by wound or absorption.** A licensee must evaluate and, to the extent practical, account for intakes through wounds or skin absorption. The intake through intact skin is included in the calculation of DAC for hydrogen-3 and does not need to be further evaluated.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

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4731.2040 DETERMINATION OF EXTERNAL DOSE; AIRBORNE RADIOACTIVE MATERIAL.

A. When determining the dose from airborne radioactive material, a licensee must include the contribution to the deep dose equivalent, lens dose equivalent, and shallow dose equivalent from external exposure to the radioactive cloud according to part 4731.2750, subpart 7, footnotes 1 and 2.

B. Airborne radioactivity measurements and DAC values must not be used as the primary means to assess the deep dose equivalent when the airborne radioactive material includes radionuclides other than noble gases or if the cloud of airborne radioactive material is not relatively uniform. The determination of the deep dose equivalent to an individual must be based upon measurements using instruments or individual monitoring devices.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

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4731.2050 DETERMINATION OF INTERNAL EXPOSURE.

Subpart 1. **Required measurements.** For purposes of assessing dose used to determine compliance with occupational dose equivalent limits, a licensee must, when required under part 4731.2210, take suitable and timely measurements of:

A. concentrations of radioactive materials in air in work areas;

B. quantities of radionuclides in the body;

C. quantities of radionuclides excreted from the body; or

D. a combination of the measurements in items A to C.

Subp. 2. **Assumption.** Unless respiratory protective equipment is used according to part 4731.2260 or the assessment of intake is based on bioassays, a licensee must assume that an individual inhales radioactive material at the airborne concentration in which the individual is present.

Subp. 3. **Alternative assessment.** When specific information on the physical and biochemical properties of the radionuclides taken into the body or the behavior or the material in an individual is known, a licensee may:

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

B. upon prior approval of the commissioner, adjust the DAC or ALI values to reflect the actual physical and chemical characteristics of airborne radioactive material, for example, aerosol size distribution or density; and

C. separately assess the contribution of fractional intakes of Class D, W, or Y compounds of a given radionuclide as listed in part 4731.2750 to the committed effective dose equivalent.

Subp. 4. **Delayed recording.** If a licensee chooses to assess intakes of Class Y material using the measurements given in subpart 1, item B or C, the licensee may delay the recording and reporting of the assessments for periods up to seven months, unless otherwise required under part 4731.2610 or 4731.2620, to permit the licensee to make additional measurements basic to the assessments.

Subp. 5. **Mixture; identity and concentration known.** If the identity and concentration of each radionuclide in a mixture are known, the fraction of the DAC applicable to the mixture for use in calculating DAC-hours must be:

A. the sum of the ratios of the concentration to the appropriate DAC value, for example, D, W, Y, from part 4731.2750, for each radionuclide in the mixture; or

B. the ratio of the total concentration for all radionuclides in the mixture to the most restrictive DAC value for any radionuclide in the mixture.

Subp. 6. **Mixture; identity known.** If the identity of each radionuclide in a mixture is known, but the concentration of one or more of the radionuclides in the mixture is not known, the DAC for the mixture must be the most restrictive DAC of any radionuclide in the mixture.

Subp. 7. **Mixture in air.** When a mixture of radionuclides in air exists, a licensee may disregard certain radionuclides in the mixture if:

A. the licensee uses the total activity of the mixture in demonstrating compliance with the dose limits in part 4731.2020 and in complying with the monitoring requirements in part 4731.2210, subpart 2;

B. the concentration of any radionuclide disregarded is less than ten percent of its DAC; and

C. the sum of these percentages for all of the radionuclides disregarded in the mixture does not exceed 30 percent.

Subp. 8. **Committed effective dose equivalent considerations.** When determining the committed effective dose equivalent, the following information may be considered:

A. to calculate the committed effective dose equivalent, the licensee may assume that the inhalation of one ALI, or an exposure of 2,000 DAC-hours, results in a committed effective dose equivalent of five rems (0.05 Sv) for radionuclides that have their ALIs or DACs based on the committed effective dose equivalent; and

B. when the ALI and the associated DAC are determined by the nonstochastic organ dose limit of 50 rems (0.5 Sv), the intake of radionuclides that would result in a committed effective dose equivalent of five rems (0.05 Sv), the stochastic ALI, is listed in parentheses in part 4731.2750, subpart 7, Table 1. In this case, the licensee may, as a simplifying assumption, use the stochastic ALIs to determine committed effective dose equivalent. However, if the licensee uses the stochastic ALIs, the licensee must also demonstrate that the limit in part 4731.2020, subpart 1, item A, subitem (2), is met.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

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4731.2060 PLANNED SPECIAL EXPOSURES.

A licensee may authorize an adult worker to receive doses in addition to, and accounted for separately from, the doses received under the limits specified in part 4731.2020, provided that each of the following conditions is satisfied:

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

B. the licensee and employer, if the employer is not the licensee, specifically authorizes the planned special exposure, in writing, before the exposure occurs;

C. before a planned special exposure, the licensee ensures that the individuals involved are:

(1) informed of the purpose of the planned operation;

(2) informed of the estimated doses and associated potential risks and specific radiation levels or other conditions that might be involved in performing the task; and

(3) instructed in the measures to be taken to keep the dose ALARA considering other risks that may be present;

D. before permitting an individual to participate in a planned special exposure, the licensee ascertains prior doses as required under part 4731.2520, subpart 2, during the lifetime of the individual for each individual involved;

E. subject to part 4731.2020, subpart 2, the licensee does not authorize a planned special exposure that would cause an individual to receive a dose from all planned exposures and all doses in excess of the limits to exceed:

(1) the numerical values of any of the dose limits under part 4731.2020, subpart 1, in any year; and

(2) five times the annual dose limits under part 4731.2020, subpart 1, during the individual's lifetime;

F. the licensee maintains records of the conduct of a planned special exposure according to part 4731.2530 and submits a written report according to part 4731.2630; and

G. the licensee records the best estimate of the dose resulting from the planned special exposure in the individual's record and informs the individual, in writing, of the dose within 30 days from the date of the planned special exposure. The dose from planned special exposures is not to be considered in controlling future occupational dose of the individual under part 4731.2020, subpart 1, but is to be included in evaluations required under items D and E.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2070 OCCUPATIONAL DOSE LIMITS FOR MINORS.

The annual occupational dose limits for minors are ten percent of the annual dose limits specified for adult workers under part 4731.2020.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2080 DOSE EQUIVALENT TO EMBRYO/FETUS.

Subpart 1. **Dose limit.** A licensee must ensure that the dose equivalent to an embryo/fetus during the entire pregnancy due to occupational exposure of a declared pregnant woman does not exceed 0.5 rem (5 mSv). Records must be kept according to part 4731.2540.

Subp. 2. **Uniform exposure.** A licensee must make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in subpart 1.

Subp. 3. **Dose equivalent.** The dose to an embryo/fetus is the sum of:

A. the deep dose equivalent to the declared pregnant woman; and

B. the dose equivalent to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

Subp. 4. **Dose after pregnancy declaration.** If the dose equivalent to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with subpart 1 if the additional dose equivalent to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2090 RADIATION DOSE LIMITS FOR THE PUBLIC.

Subpart 1. **Dose limits.** A licensee must conduct operations so that:

A. the total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 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 according to part 4731.4427, from voluntary participation in medical research programs, and from the licensee's disposal of radioactive material into sanitary sewerage according to part 4731.2420; and

B. the dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released according to part 4731.4427, does not exceed 0.002 rem (0.02 mSv) in any one hour.

Subp. 2. **Access to controlled areas.** If a licensee permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

Subp. 3. **Exception.** Notwithstanding subpart 1, item A, a licensee may permit visitors to an individual who cannot be released under part 4731.4427 to receive a radiation dose greater than 0.1 rem (1 mSv) if:

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

B. the authorized user under part 4731.4427 has determined before the visit that the visit is appropriate.

Subp. 4. **Prior authorization.** A licensee or license applicant may apply for prior authorization from the commissioner to operate up to an annual dose limit for an individual member of the public of 0.5 rem (5 mSv). The licensee or applicant must include in the application for prior authorization:

A. a demonstration of the need for and the expected duration of operations in excess of the limit under subpart 1;

B. a description of the licensee's program to assess and control the dose within the 0.5 rem (5 mSv) annual limit; and

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

Subp. 5. **Federal law.** In addition to the requirements of this part, a licensee subject to Code of Federal Regulations, title 40, part 190, must comply with those standards.

Subp. 6. **Additional restrictions.** The commissioner may impose additional restrictions on radiation levels in unrestricted areas and on the total quantity of radionuclides that a licensee may release in effluents in order to restrict the collective dose to individual members of the public.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2095 COMPLIANCE; DOSE LIMITS FOR THE PUBLIC.

Subpart 1. **Surveys required.** A licensee must make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public under part 4731.2090.

Subp. 2. **Showing compliance.** A licensee must show compliance with the annual dose limit under part 4731.2090 by:

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

B. demonstrating that:

(1) the annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values under part 4731.2750, subpart 7, Table 2; and

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

Subp. 3. **Adjustments.** Upon approval from the commissioner, a licensee may adjust the effluent concentration values under part 4731.2750, subpart 7, Table 2, for members of the public, to take into account the actual physical and chemical characteristics of the effluents, for example, aerosol size distribution, solubility, density, radioactive decay equilibrium, or chemical form.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2100 RADIOLOGICAL CRITERIA FOR LICENSE TERMINATION.

Subpart 1. **General provisions and applicability.**

A. This part applies to the decommissioning of facilities licensed under this chapter and to facilities subject to the NRC's jurisdiction under the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended. This part does not apply to uranium and thorium recovery facilities already subject to Code of Federal Regulations, title 10, part 40, Appendix A, or to uranium solution extraction facilities.

B. This part does not apply to sites that:

(1) have been decommissioned before January 3, 2005, according to criteria identified in the Site Decommissioning Management Plan (SDMP) Action Plan of April 16, 1992, as listed in the Federal Register, volume 57, page 13389;

(2) have previously submitted and received the commissioner's approval on a license termination plan or decommissioning plan that is compatible with the SDMP Action Plan criteria; or

(3) submit a sufficient license termination plan or decommissioning plan before August 20, 1998, that is approved by the commissioner before August 20, 1999, and is according to the criteria identified in the SDMP Action Plan, except that if an environmental impact statement is required in the submittal, there will be a provision for day-for-day extension.

C. After a site has been decommissioned and the license terminated according to this part, the commissioner shall require additional cleanup only if, based on new information, the commissioner determines that the criteria of this part were not met and residual radioactivity remaining at the site could result in a significant threat to public health and safety.

D. When calculating the TEDE to the average member of the critical group, the licensee must determine the peak annual TEDE expected within the first 1,000 years after decommissioning.

Subp. 2. **Radiological criteria for unrestricted use.** A site is considered acceptable for unrestricted use if:

A. the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 millirems (0.25 mSv) per year, including that from groundwater sources of drinking water; and

B. the residual radioactivity has been reduced to levels that are ALARA. Determination of levels that are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal.

Subp. 3. **Criteria for termination under restricted conditions.** A site is considered acceptable for license termination under restricted conditions, if the licensee:

A. can demonstrate that further reductions in residual radioactivity necessary to comply with subpart 2:

(1) would result in net public or environmental harm; or

(2) are not being made because the residual levels associated with restricted conditions are ALARA. Determination of the levels that are ALARA must take into account consideration of any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal;

B. has made provisions for legally enforceable institutional controls that provide reasonable assurance that the TEDE from residual radioactivity, distinguishable from background radiation, will not exceed 25 millirems (0.25 mSv) per year to the average member of the critical group;

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

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

(2) a statement of intent, in the case of federal, state, or local government licensees, as described under part 4731.3080, subpart 6, item E; or

(3) when a governmental entity is assuming custody and ownership of a site, an arrangement that is deemed acceptable by the governmental entity;

D. has submitted a decommissioning plan or a license termination plan to the commissioner indicating the licensee's intent to decommission according to part 4731.0600, subpart 2, 4731.0790, subpart 4, or 4731.3085, subpart 4, or Code of Federal Regulations, title 10, section 50.82, paragraphs (a) and (b), or 72.54, and specifying that the licensee intends to decommission by restricting use of the site. The licensee must document in the license termination plan or decommissioning plan how the advice of individuals and institutions in the community has been sought according to items E and F and incorporated, as appropriate, following analysis of that advice;

E. if proposing to decommission by restricting use of the site, seeks advice from individuals and institutions in the community who may be affected by the decommissioning regarding whether:

(1) institutional controls proposed by the licensee:

(a) will provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background radiation to the average member of the critical group will not exceed 25 millirems (0.25 mSv) TEDE per year;

(b) will be enforceable; and

(c) will not impose undue burdens on the local community or other affected parties; and

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

F. while seeking advice under item E, provides for:

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

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

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

G. reduces residual radioactivity at the site so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background radiation to the average member of the critical group is as low as reasonably achievable and would not exceed:

(1) 100 millirems (1 mSv) per year; or

(2) 500 millirems (5 mSv) per year, if the licensee:

(a) demonstrates that further reductions in residual radioactivity necessary to comply with subitem (1) are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm;

(b) makes provisions for durable institutional controls; and

(c) provides sufficient financial assurance, according to item C, to enable a responsible governmental entity or independent third party, including a governmental custodian of a site, to carry out periodic rechecks of the site no less frequently than every five years to ensure that the institutional controls remain in place as necessary to meet the criteria of item B and to assume and carry out responsibilities for any necessary control and maintenance of those controls.

Subp. 4. **Alternative criteria for license termination.**

A. The commissioner may terminate a license using alternative criteria greater than the dose criterion of subparts 2 and 3, items B and E, subitem (1), unit (a), if the licensee:

(1) provides assurance that public health and safety would continue to be protected and that it is unlikely that the dose from all man-made sources combined, other than medical, would be more than the 100 millirems per year (1 mSv per year) limit under part 4731.2090, by submitting an analysis of possible sources of exposure;

(2) employs, to the extent practical, restrictions on site use according to subpart 3, in minimizing exposures at the site;

(3) reduces doses to ALARA levels, taking into consideration any detriments, such as traffic accidents, expected to potentially result from decontamination and waste disposal;

(4) submits a decommissioning plan or license termination plan to the commissioner indicating the licensee's intent to decommission according to part 4731.0600, subpart 2; 4731.0790, subpart 4; or 4731.3085, subpart 4, or Code of Federal Regulations, title 10, section 50.82, paragraphs (a) and (b), or 72.54, and specifying that the licensee proposes to decommission by use of alternate criteria. The licensee must document in the decommissioning plan or license termination plan how the advice of individuals and institutions in the community who may be affected by the decommissioning has been sought and addressed, as appropriate, following analysis of that advice. In seeking such advice, the licensee must provide for:

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

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

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

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

B. The use of alternate criteria to terminate a license requires the approval of the commissioner after consideration of staff recommendations of the Radioactive Materials Unit of the Department of Health that address any comments provided by the Environmental Protection Agency or the Pollution Control Agency and any public comments submitted under subpart 5.

Subp. 5. **Public notification and public participation.** Upon receipt of a license termination plan or decommissioning plan from a licensee or a proposal by a licensee for release of a site according to subpart 3 or 4, or whenever the commissioner deems such notice to be in the public interest, the commissioner must:

A. notify and solicit comments from:

(1) local and state governments in the vicinity of the site and any Indian nation or other indigenous people that have treaty or statutory rights that could be affected by the decommissioning; and

(2) the Environmental Protection Agency for cases when the licensee proposes to release a site according to subpart 4; and

B. publish a notice in the State Register and in a forum, such as local newspapers, letters to state and local organizations, or other appropriate forum, that is readily accessible to individuals in the vicinity of the site and solicit comments from affected parties.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

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4731.2150 MINIMIZATION OF CONTAMINATION.

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

B. Licensees must, to the extent practical, conduct operations to minimize the introduction of residual radioactivity into the site, including the subsurface, in accordance with the existing radiation protection requirements in part 4731.2010 and radiological criteria for license termination in item A and part 4731.2100.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

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4731.2200 SURVEYS AND MONITORING.

Subpart 1. **Required surveys.** A licensee must make or cause to be made, surveys of areas, including the subsurface, that:

A. may be necessary for the licensee to comply with this chapter; and

B. are reasonable under the circumstances to evaluate:

(1) the magnitude and extent of radiation levels;

(2) concentrations or quantities of residual radioactivity; and

(3) potential radiological hazards of the radiation levels and residual radioactivity detected.

Subp. 1a. **Records.** Notwithstanding part 4731.2510, subpart 1, records from surveys describing the location and amount of subsurface residual radioactivity identified at the site must be kept with records important for decommissioning, and must be retained according to part 4731.0580, subpart 6; 4731.0780, subpart 6; or 4731.3080, subpart 7, as applicable.

Subp. 2. **Calibration required.** Except as otherwise required in this chapter, a licensee must ensure that instruments and equipment used for quantitative radiation measurements, for example, dose rate and effluent monitoring, are calibrated at intervals not to exceed 12 months for the radiation measured.

Subp. 3. **Dosimeter processing.** All personnel dosimeters, except for direct and indirect reading pocket ionization chambers and those dosimeters used to measure the dose to the extremities, that

require processing to determine the radiation dose and that are used by a licensee to comply with part 4731.2020, with other applicable provisions of this chapter, or with conditions specified in a license, must be processed and evaluated by a dosimetry processor that:

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

B. is approved in the accreditation process for the type of radiation or radiations included in the NVLAP program that most closely approximates the type of radiation or radiations for which the individual wearing the dosimeter is monitored.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 33 SR 1440; 40 SR 145*
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4731.2210 INDIVIDUAL MONITORING; EXTERNAL AND INTERNAL OCCUPATIONAL DOSE.

Subpart 1. **General requirement.** A licensee must monitor exposures to radiation and radioactive material at levels sufficient to demonstrate compliance with the occupational dose limits of parts 4731.2000 to 4731.2950. At a minimum, a licensee must comply with this part.

Subp. 2. **External dose.** A licensee must monitor occupational exposure to radiation from licensed and unlicensed radiation sources under the control of the licensee and must supply and require the use of individual monitoring devices by:

A. adults likely to receive, in one year from sources external to the body, a dose in excess of ten percent of the limits in part 4731.2020, subpart 1;

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

C. declared pregnant women likely to receive, during the entire pregnancy from radiation sources external to the body, a deep dose equivalent in excess of 0.1 rem (1 mSv). All of the occupational doses under part 4731.2020 continue to be applicable to the declared pregnant worker as long as the embryo/fetus dose limit is not exceeded; and

D. individuals entering a high or very high radiation area.

Subp. 3. **Internal dose.** A licensee must monitor, as required under part 4731.2050, the occupational intake of radioactive material by and assess the committed effective dose equivalent to:

A. adults likely to receive, in one year, an intake in excess of ten percent of the applicable ALIs in part 4731.2750, subpart 7, Table 1, columns 1 and 2;

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

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

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2220 HIGH RADIATION AREAS; CONTROL OF ACCESS.

Subpart 1. **Entrance controls required.**

A. A licensee must ensure that each entrance or access point to a high radiation area has one or more of the following features:

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

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

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

B. In place of the controls required under item A for a high radiation area, a licensee may substitute continuous direct or electronic surveillance that is capable of preventing unauthorized entry.

C. A licensee may apply to the commissioner for approval of alternative methods for controlling access to high radiation areas.

Subp. 2. **Egress required.** A licensee must establish the controls required under subpart 1 in a way that does not prevent individuals from leaving a high radiation area.

Subp. 3. **Exception; package for transport.** Control is not required for each entrance or access point to a room or other area that is a high radiation area solely because of the presence of radioactive materials prepared for transport and packaged and labeled according to the regulations of the DOT, provided that:

A. the packages do not remain in the area longer than three days; and

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

Subp. 4. **Exception; hospitals.** Control of entrance or access to rooms or other areas in hospitals is not required solely because of the presence of patients containing radioactive materials, provided that there are personnel in attendance who will take the necessary precautions to:

A. prevent the exposure of individuals to radiation or radioactive material in excess of the limits established under parts 4731.2000 to 4731.2950; and

B. operate within the ALARA provisions of the licensee's radiation protection program.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2230 VERY HIGH RADIATION AREAS; CONTROL OF ACCESS.

In addition to the requirements under part 4731.2220, a licensee must institute additional measures to ensure that an individual is not able to gain unauthorized or inadvertent access to areas in which radiation levels could be encountered at 500 rads (5 Gy) or more in one hour at one meter from a radiation source or any surface through which the radiation penetrates.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2240 CONTROLLING CONCENTRATION OF RADIOACTIVE MATERIAL IN AIR.

Subpart 1. **Process or other engineering controls.** A licensee must use, to the extent practical, process or other engineering controls, such as containment, decontamination, or ventilation, to control the concentrations of radioactive material in air.

Subp. 2. **Other controls.**

A. When it is not practical to apply process or other engineering controls to control the concentrations of radioactive material in air to values below those that define an airborne radioactivity area, a licensee must, consistent with maintaining the total effective dose equivalent ALARA, increase monitoring and limit intakes by one or more of the following means:

(1) control of access;

(2) limitation of exposure times;

(3) use of respiratory protection equipment; or

(4) other controls.

B. If a licensee performs an ALARA analysis to determine whether or not respirators should be used, the licensee may consider safety factors other than radiological factors. The licensee must also consider the impact of respirator use on workers' industrial health and safety.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2260 USE OF INDIVIDUAL RESPIRATORY PROTECTION EQUIPMENT.

Subpart 1. **Applicability.** This part applies if a licensee assigns or permits the use of respiratory protection equipment to limit intake of radioactive material.

Subp. 2. **NIOSH certification.** A licensee must use only respiratory protection equipment that is tested and certified by the National Institute for Occupational Safety and Health (NIOSH), except as otherwise noted in this part.

Subp. 3. **Alternative equipment.** If a licensee wishes to use equipment that has not been tested or certified by NIOSH, or for which there is no schedule for testing or certification, the licensee must submit an application to the commissioner for authorized use of the equipment, except as provided in this part. The application must include evidence that the material and performance characteristics of the equipment are capable of providing the proposed degree of protection under anticipated conditions of use. This must be demonstrated by licensee testing or on the basis of reliable test information.

Subp. 4. **Respiratory protection program.** A licensee must implement and maintain a respiratory protection program that includes:

A. air sampling sufficient to identify a potential hazard, permit proper equipment selection, and estimate doses;

B. surveys and bioassays, as necessary, to evaluate actual intakes;

C. testing of respirators for operability and user seal check for face sealing devices and functional check for others immediately prior to each use;

D. written procedures regarding:

(1) monitoring, including air sampling and bioassays;

(2) supervision and training of respirator users;

(3) fit testing;

(4) respirator selection;

(5) breathing air quality;

(6) inventory and control;

(7) storage, issuance, maintenance, repair, testing, and quality assurance of respiratory protection equipment;

(8) record keeping; and

(9) limitations on periods of respirator use and relief from respirator use;

E. a determination by a physician that an individual user is medically fit to use the respiratory protection equipment:

(1) before the initial fitting of a face sealing respirator;

(2) before the first field use of nonface sealing respirators; and

(3) either every 12 months thereafter or periodically at a frequency determined by a physician; and

F. fit testing, with a fit factor greater than or equal to 10 times the APF for negative pressure devices and a fit factor greater than or equal to 500 for any positive pressure, continuous flow, and pressure-demand devices, before the first field use of tight fitting, face-sealing respirators and periodically thereafter at a frequency not to exceed one year. Fit testing must be performed with the facepiece operating in the negative pressure mode.

Subp. 5. **User advise.** A licensee must advise each respirator user that the user may leave the area at any time for relief from respirator use in the event of equipment malfunction, physical or psychological distress, procedural or communication failure, significant deterioration of operating conditions, or any other conditions that might require such relief.

Subp. 6. **Equipment limitations.** A licensee must consider limitations appropriate to the type and mode of use. When selecting respiratory devices, a licensee must provide for vision correction, adequate communication, low temperature work environments, and the concurrent use of other safety or radiological protection equipment. A licensee must use the equipment in such a way as not to interfere with the proper operation of the respirator.

Subp. 7. **Standby rescue persons.**

A. Standby rescue persons are required whenever one-piece atmosphere-supplying suits or any combination of supplied-air respiratory protection device and personnel protective equipment are used from which an unaided individual would have difficulty extricating himself or herself.

B. The standby persons must be equipped with respiratory protection devices or other apparatus appropriate for the potential hazards.

C. The standby rescue persons must observe or otherwise maintain continuous communication with the workers, by voice, visual, signal line, telephone, radio, or other suitable means, and be immediately available to assist them in case of a failure of the air supply or for any other reason that requires relief from distress.

D. A sufficient number of standby rescue persons must be immediately available to assist all users of this type of equipment and to provide effective emergency rescue if needed.

Subp. 8. **Respirator requirements.**

A. Atmosphere-supplying respirators must be supplied with respirable air of Grade D quality or better as defined in "Commodity Specification for Air G-7.1," Compressed Gas Association

(1997), as included in Code of Federal Regulations, title 29, section 1910.134. Grade D quality air criteria include:

(1) oxygen content (v/v) of 19.5 to 23.5 percent;

(2) hydrocarbon (condensed) content of five milligrams per cubic meter of air or less;

(3) carbon monoxide content of ten parts per million or less;

(4) carbon dioxide content of 1,000 parts per million or less; and

(5) lack of noticeable odor.

B. A licensee must ensure that no objects, materials or substances, such as facial hair, or conditions that interfere with the face-facepiece seal or valve function and that are under the control of the respirator wearer are present between the skin of the wearer's face and the sealing surface of a tight-fitting respirator facepiece.

Subp. 9. **Dose calculation.** In estimating the dose to individuals from intake of airborne radioactive materials, the concentration of radioactive material in the air that is inhaled when respirators are worn is initially assumed to be the ambient concentration in air without respiratory protection, divided by the assigned protection factor. If the dose is later found to be greater than the estimated dose, the corrected value must be used. If the dose is later found to be less than the estimated dose, the corrected value may be used.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2270 RESPIRATORY PROTECTION EQUIPMENT RESTRICTIONS.

The commissioner may impose restrictions in addition to those under parts 4731.2240, 4731.2260, and 4731.2700 to:

A. ensure that the respiratory protection program of the licensee is adequate to limit doses to individuals from intakes of airborne radioactive materials, consistent with maintaining total effective dose equivalent ALARA; and

B. limit the extent to which a licensee may use respiratory protection equipment instead of process or other engineering controls.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2280 USE OF HIGHER ASSIGNED PROTECTION FACTORS.

A licensee must obtain authorization from the commissioner before using assigned protection factors in excess of those specified in part 4731.2700. The commissioner may authorize a licensee to use higher assigned protection factors on receipt of an application that:

A. describes the situation for which a need exists for higher protection factors; and

B. demonstrates that the respiratory protection equipment provides these higher protection factors under the proposed conditions of use.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2290 STORAGE AND CONTROL OF LICENSED MATERIAL.

Subpart 1. **Security of stored material.** A licensee must secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.

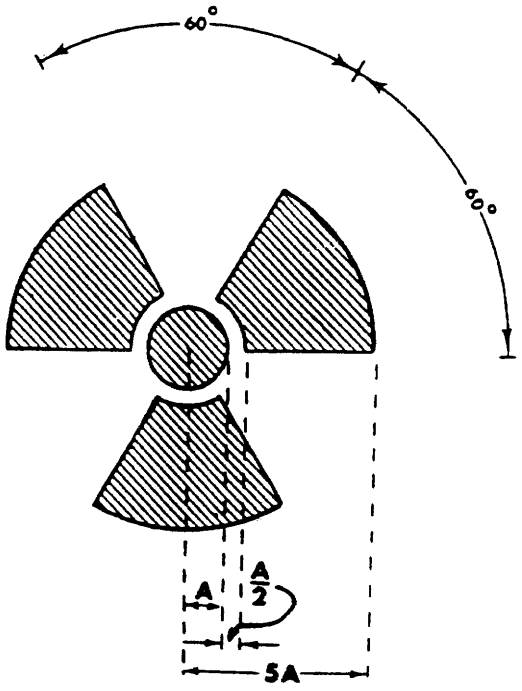
Subp. 2. **Control of material not in storage.** A licensee must control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2300 CAUTION SIGNS.

Subpart 1. **Radiation symbol.** Unless otherwise authorized by the commissioner, the standard radiation symbol used to designate a radiation hazard is as prescribed in this subpart. The radiation symbol is the three-bladed design:



A. the cross-hatched area must be magenta, purple, or black; and

B. the background must be yellow.

Subp. 2. **Exception; radiation symbol.** Notwithstanding the requirements of subpart 1, licensees may label sources, source holders, or device components containing sources of licensed materials that are subjected to high temperatures with conspicuously etched or stamped radiation caution symbols and without a color requirement.

Subp. 3. **Additional information.** In addition to the contents of signs and labels prescribed in this chapter, a licensee may provide, on or near the required signs and labels, additional information, as appropriate, to make individuals aware of potential radiation exposures and to minimize the exposures.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *May 26, 2022*

4731.2310 POSTING REQUIREMENTS.

Subpart 1. **Radiation area.** A licensee must post each radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIATION AREA."

Subp. 2. **High radiation area.** A licensee must post each high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, HIGH RADIATION AREA" or "DANGER, HIGH RADIATION AREA."

Subp. 3. **Very high radiation area.** A licensee must post each very high radiation area with a conspicuous sign or signs bearing the radiation symbol and the words "GRAVE DANGER, VERY HIGH RADIATION AREA."

Subp. 4. **Airborne radioactivity area.** A licensee must post each airborne radioactivity area with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA."

Subp. 5. **Use or storage area.** A licensee must post each area or room in which there is used or stored an amount of licensed material exceeding ten times the quantity of such material specified in part 4731.2800 with a conspicuous sign or signs bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL."

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2320 EXCEPTIONS TO POSTING REQUIREMENTS.

Subpart 1. **Short-term storage.** A licensee is not required to post a caution sign in areas or rooms containing radioactive materials for periods of less than eight hours, if:

A. the materials are constantly attended during these periods by an individual who takes the precautions necessary to prevent the exposure of individuals to radiation or radioactive materials in excess of the limits established in parts 4731.2000 to 4731.2950; and

B. the area or room is subject to the licensee's control.

Subp. 2. **Hospital; patient room.** A room or other area in a hospital that is occupied by a patient is not required to be posted with a caution sign if the patient could be released from licensee control under part 4731.4427.

Subp. 3. **Sealed sources.** A room or area is not required to be posted with a caution sign because of the presence of a sealed source if the radiation level at 30 centimeters from the surface of the source container or housing does not exceed 0.005 rem (0.05 mSv) per hour.

Subp. 4. **Hospital; teletherapy, remote afterloader, or gamma stereotactic radiosurgery units.** A room in a hospital or clinic that is used for teletherapy, remote afterloader, or gamma stereotactic radiosurgery units is exempt from the requirement to post a caution sign if:

A. access to the room is controlled according to part 4731.4467; and

B. personnel in attendance take necessary precautions to prevent the inadvertent exposure of workers, other patients, and members of the public to radiation in excess of the limits established in parts 4731.2000 to 4731.2950.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 36 SR 74*
Published Electronically: *August 15, 2011*

4731.2330 LABELING CONTAINERS.

Subpart 1. **Label requirements.** A licensee must ensure that each container of licensed material bears a durable, clearly visible label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL." The label must provide sufficient information, such as the radionuclides present, an estimate of the quantity of radioactivity, the date for which the activity is estimated, radiation levels, kinds of materials, and mass enrichment, to permit individuals handling or using the containers or working in the vicinity of the containers to take precautions to avoid or minimize exposures.

Subp. 2. **Label removal.** A licensee must, prior to removal or disposal of empty uncontaminated containers to unrestricted areas, remove or deface the radioactive material label or otherwise clearly indicate that the container no longer contains radioactive materials.

Statutory Authority: *MS s 144.1202; 144.1203*
History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2340 LABELING REQUIREMENTS; EXEMPTIONS.

A licensee is not required to label:

A. containers holding licensed material in quantities less than the quantities listed in part 4731.2800;

B. containers holding licensed material in concentrations less than those specified in part 4731.2750, subpart 7, Table 3;

C. containers attended to by an individual who takes the precautions necessary to prevent the exposure of individuals in excess of the limits established by parts 4731.2000 to 4731.2950;

D. containers when they are in transport and packaged and labeled according to DOT regulations. Labeling of packages containing radioactive materials is required by the DOT if the amount and type of radioactive material exceeds the limits for an excepted quantity or article as defined and limited under Code of Federal Regulations, title 49, sections 173.403 and 173.421 to 173.424;

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

F. installed manufacturing or process equipment, such as reactor components, piping, or tanks.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2350 PROCEDURES FOR RECEIVING AND OPENING PACKAGES.

Subpart 1. **Package receipt.** A licensee who expects to receive a package containing quantities of radioactive material in excess of a Type A quantity must make arrangements to receive:

A. the package when the carrier offers it for delivery; or

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

Subp. 2. **Monitoring requirements.** A licensee must:

A. monitor the external surfaces of a package with a Radioactive White I, Yellow II, or Yellow III label as specified in Code of Federal Regulations, title 49, sections 172.403 and 172.436 to 172.440, for radioactive contamination unless the package contains only radioactive material in the form of a gas or in special form;

B. monitor the external surfaces of a package with a Radioactive White I, Yellow II, or Yellow III label as specified in Code of Federal Regulations, title 49, sections 172.403 and 172.436 to 172.440, for radiation levels unless the package contains quantities of radioactive material that are less than or equal to a Type A quantity; and

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

Subp. 3. **Timing.** A licensee must perform the monitoring required under subpart 2 as soon as practical after receipt of the package, but not later than three hours after the package is received at the licensee's facility if it is received during the licensee's normal working hours, or not later than three hours from the beginning of the next working day if it is received after working hours.

Subp. 4. **Immediate notification.** A licensee must immediately notify the final delivery carrier and the commissioner, by telephone, when:

A. removable radioactive surface contamination exceeds the limits of part 4731.0415, item I; or

B. external radiation levels exceed the limits under part 4731.0412.

The telephone notification to the commissioner required under this subpart must be made according to part 4731.0200, subpart 5.

Subp. 5. **Procedures required.** A licensee must:

A. establish, maintain, and retain written procedures for safely opening packages in which radioactive material is received; and

B. ensure that the procedures are followed and that due consideration is given to special instructions for the type of package being opened.

Subp. 6. **Exemption.** A licensee transferring special form sources in licensee-owned or licensee-operated vehicles to and from a work site is exempt from the contamination monitoring requirements under subpart 2, but is not exempt from the survey requirement under subpart 2 for measuring radiation levels that is required to ensure that the source is still properly lodged in its shield.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.2360 LEAK TEST REQUIREMENTS.

Subpart 1. **Sealed sources.** Except as otherwise required, sealed sources must be tested for leakage at intervals not to exceed the intervals specified in the certificate of registration issued by the NRC or an agreement state.

Subp. 2. **Sealed source received from another person.** In the absence of a certificate from a transferor indicating that a leak test has been made within the intervals specified in the certificate of registration issued by the NRC or an agreement state, prior to the transfer, a sealed source received from another person must not be put into use until tested and the test results received.

Subp. 3. **Storage of sealed sources.** Sealed sources, except those containing radium, may be stored for a period of no more than three years without being tested for leakage and contamination. When sealed sources are removed from storage for use or for transfer to another person and have not been tested within the required leak test interval, they must be tested and test results received before use or transfer.

Subp. 4. **Test samples.** Test samples must be taken from the source or from the surfaces of the device in which the source is mounted or stored on which radioactive contamination might be expected to accumulate.

Subp. 5. **Level of detection.** The leak test must be capable of detecting the presence of 0.005 microcurie (185 becquerel) of radioactive material on the test sample.

A. If the test reveals the presence of 0.005 microcurie (185 becquerel) or more of removable contamination, the source must be removed immediately from service and decontaminated, repaired, or disposed of according to this chapter.

B. The licensee must file a report with the commissioner within five days. The report must include:

(1) the model number and serial number, if assigned, of the leaking source;

(2) the identity of the radionuclide and its estimated activity;

(3) the results of the test;

(4) the date of the test; and

(5) the action taken.

Subp. 6. **Tests administered by.** Tests for leakage must be performed by the licensee or by other persons specifically licensed by the NRC or an agreement state to perform these services.

Subp. 7. **Retention of leak test records.** A licensee shall retain leak test records for three years. The records must contain the model number and serial number, if assigned, of each source tested, the identity of each source radionuclide and its estimated activity, the measured activity of each test sample expressed in microcuries (becquerel), the date of the test, and the name or initials of the individual who performed the test.

Subp. 8. **Sources exempt from testing.** A licensee need not perform a leak test on the following sources:

A. sources containing only radioactive material with a half-life of less than 30 days;

B. sources containing only radioactive material as a gas;

C. sources containing 100 microcuries (3.7 MBq) or less of beta or photon-emitting material or ten microcuries (0.37 MBq) or less of alpha-emitting material; and

D. seeds of iridium-192 encased in nylon ribbon.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *33 SR 1440; 36 SR 74*

Published Electronically: *August 15, 2011*

4731.2400 WASTE DISPOSAL.

Subpart 1. **General requirements.** A licensee must dispose of licensed material only:

A. by transfer to an authorized recipient as provided under parts 4731.0525 to 4731.0840, 4731.2450, and 4731.3000 to 4731.3175 or in Code of Federal Regulations, title 10, parts 60, 63, and 72;

B. by decay in storage;

C. by release in effluents within the limits under part 4731.2090; or

D. as authorized under parts 4731.2410 to 4731.2440 or 4731.2460.

Subp. 2. **Waste receipt.** A person must be specifically licensed to receive waste containing licensed material from other persons for:

A. treatment prior to disposal;

B. treatment or disposal by incineration; or

C. decay in storage.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.2405 DECAY-IN-STORAGE.

Subpart 1. **Disposal in ordinary trash.** A licensee may hold radioactive material with half-lives of less than or equal to 120 days for decay-in-storage before disposal in ordinary trash if the licensee:

A. monitors radioactive material at the surface before disposal;

B. determines that its radioactivity cannot be distinguished from the background radiation level with an appropriate radiation detection survey meter set on its most sensitive scale and with no interposed shielding; and

C. removes or obliterates all radiation labels, except for radiation labels on materials that are within containers and that will be managed as biomedical waste after they are released from the licensee.

Subp. 2. **Record retention.** The licensee shall retain a record of each disposal for three years. The record must include:

A. the date of the disposal;

B. the date on which the radioactive material was placed in storage;

C. the radionuclide with the longest half-life;

D. the manufacturer's name, model number, and serial number of the survey instrument used, or a unique survey meter identification that can be cross-referenced to a specific manufacturer, model, and serial number;

E. the background radiation level;

F. the radiation level measured at the surface of each waste container; and

G. the name of the individual who performed the disposal.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *33 SR 1440*

Published Electronically: *March 12, 2009*

4731.2410 APPROVAL OF PROPOSED DISPOSAL PROCEDURES.

A licensee or applicant for a license may apply to the commissioner for approval of proposed procedures, not otherwise authorized in this chapter, to dispose of licensed material generated in the licensee's or applicant's activities. An application must include:

A. a description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal;

B. an analysis and evaluation of pertinent information on the nature of the environment;

C. the nature and location of other potentially affected licensed and unlicensed facilities; and

D. analyses and procedures to ensure that doses are maintained ALARA and within the dose limits under parts 4731.2000 to 4731.2950.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2420 DISPOSAL BY RELEASE INTO SANITARY SEWERAGE.

Subpart 1. **Discharge limitations.** A licensee may discharge licensed material into sanitary sewerage if:

A. the material is readily soluble in water or is a biological material that readily disperses in water;

B. the quantity of licensed or other radioactive material that the licensee releases into the sewer in one month divided by the average monthly volume of water released into the sewer by the licensee does not exceed the concentration listed in part 4731.2750, subpart 7, Table 3;

C. if more than one radionuclide is released, the following conditions are also satisfied:

(1) the licensee determines the fraction of the limit in part 4731.2750, subpart 7, Table 3, represented by discharges into sanitary sewerage by dividing the actual monthly average concentration of each radionuclide released by the licensee into the sewer by the concentration of that radionuclide in part 4731.2750, subpart 7, Table 3; and

(2) the sum of the fractions for each radionuclide under subitem (1) does not exceed unity; and

D. the total quantity of licensed and other radioactive material that the licensee releases into the sanitary sewerage system in a year does not exceed five curies (185 GBq) of hydrogen-3, one curie (37 GBq) of carbon-14, and one curie (37 GBq) of all other radioactive materials combined.

Subp. 2. **Excreta exemption.** Excreta from individuals undergoing medical diagnosis or therapy with radioactive material are not subject to subpart 1.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2430 TREATMENT OR DISPOSAL BY INCINERATION.

A licensee may treat or dispose of licensed material by incineration only:

A. if the material is in a form and concentration specified in part 4731.2440; or

B. as specifically approved by the commissioner according to part 4731.2410.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2440 DISPOSAL OF SPECIFIC WASTES.

A. A licensee may dispose of the following licensed material as if it were not radioactive:

(1) 0.05 microcurie (1.85 kBq) or less of hydrogen-3 or carbon-14 per gram of medium used for liquid scintillation counting; and

(2) 0.05 microcurie (1.85 kBq) or less of hydrogen-3 or carbon-14 per gram of animal tissue, averaged over the weight of the entire animal.

B. A licensee may not dispose of tissue under item A, subitem (2), in a manner that would permit its use as food for humans or as animal feed.

C. A licensee must maintain records of disposal under this part according to part 4731.2560.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.2450 TRANSFER FOR DISPOSAL; MANIFESTS.

Subpart 1. **Purpose.** The requirements of this part and part 4731.2950 are designed to:

A. control transfers of low-level radioactive waste by any waste generator, waste collector, or waste processor licensee who ships low-level waste directly or indirectly through a waste collector or waste processor to a licensed low-level waste land disposal facility;

B. establish a manifest tracking system; and

C. supplement existing requirements concerning transfers and record keeping for those wastes.

Subp. 2. **Manifest required.**

A. A licensee shipping radioactive waste intended for ultimate disposal at a licensed land disposal facility must document the information required by the NRC's Uniform Low-Level Radioactive Waste Manifest and transfer the manifest information to the intended consignee according to part 4731.2950.

B. A shipment manifest must include a certification by the waste generator according to part 4731.2950, subpart 9.

Subp. 3. **Control and tracking.** A person involved in the transfer for disposal and disposal of waste, including a waste generator, waste collector, waste processor, and disposal facility operator, must comply with part 4731.2950, subparts 10 to 14.

Subp. 4. **Shipping byproduct material.** Any licensee shipping byproduct material, as defined in part 4731.0100, subpart 32, items C and D, intended for ultimate disposal at a land disposal facility licensed under Code of Federal Regulations, title 10, part 61, must document the information on the NRC's Uniform Low-Level Radioactive Waste Manifest and transfer this recorded manifest information to the intended consignee according to part 4731.2950.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*
Published Electronically: *March 12, 2009*

4731.2460 DISPOSAL OF CERTAIN BYPRODUCT MATERIAL.

Subpart 1. **Disposal of licensed material.** Licensed material as defined in part 4731.0100, subpart 32, items C and D, may be disposed of according to Code of Federal Regulations, title 10, part 61, even though it is not defined as low-level radioactive waste. Therefore, any licensed byproduct material being disposed of at a facility, or transferred for ultimate disposal under Code of Federal Regulations, title 10, part 61, must meet the requirements of part 4731.2450.

Subp. 2. **Disposal of byproduct material.** A licensee may dispose of byproduct material as defined in part 4731.0100, subpart 32, items C and D, at a disposal facility authorized to dispose of such material according to federal or state solid or hazardous waste law, including the Solid Waste Disposal Act, as authorized under the Energy Policy Act of 2005.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *33 SR 1440*
Published Electronically: *March 12, 2009*

4731.2500 RECORDS; RADIATION PROTECTION PROGRAMS.

A. A licensee must maintain records of the radiation protection program, including:

(1) the provisions of the program; and

(2) audits and other reviews of the program content and implementation.

B. A licensee must retain the records under item A, subitem (1), until the commissioner terminates each pertinent license requiring the record. The licensee must retain the records under item A, subitem (2), for three years after the record is made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2510 RECORDS; SURVEYS.

Subpart 1. **Record maintenance; three years.** A licensee must maintain records showing the results of surveys and calibrations required under parts 4731.2200 and 4731.2350, subpart 2, for three years after the record is made. The record must include:

A. the date of the measurements;

B. the manufacturer's name, model number, and serial number for the instrument used to measure radiation or contamination levels;

C. the radiation or contamination level; and

D. the name or initials of the individual who performed the surveys or calibrations.

Subp. 2. **Record maintenance; license termination.** A licensee must retain the following records until the commissioner terminates each pertinent license requiring the record:

A. records of the results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of the individual dose equivalents. This includes those records of results of surveys to determine the dose from external sources and used, in the absence of or in combination with individual monitoring data, in the assessment of individual dose equivalents required under the standards for protection against radiation in effect prior to January 1, 1994;

B. records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose. This includes those records of the results of measurements and calculations used to determine individual intakes of radioactive material and used in the assessment of internal dose required under the standards for protection against radiation in effect prior to January 1, 1994;

C. records showing the results of air sampling, surveys, and bioassays required under part 4731.2260, subpart 4, items A and B. This includes those records showing the results of air sampling, surveys, and bioassays required under the standards for protection against radiation in effect prior to January 1, 1994; and

D. records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment. This includes the records of the results of measurements and calculations used to evaluate the release of radioactive effluents to the environment required under the standards for protection against radiation in effect before January 1, 1994.

Subp. 3. **Instrument identification.** To satisfy the requirements in subpart 1, item B, licensees may assign a unique identification to an instrument provided:

A. the manufacturer's name, model number, and serial number for each instrument is maintained and available for inspection by the department; and

B. the unique identification is indicated on each instrument.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440; 36 SR 74*

Published Electronically: *August 15, 2011*

4731.2520 DETERMINATION OF PRIOR OCCUPATIONAL DOSE.

Subpart 1. **Determining occupational dose.** For each individual who is likely to receive in a year an occupational dose requiring monitoring under part 4731.2210, a licensee must determine the occupational radiation dose received during the current year.

Subp. 2. **Planned special exposures.** Before permitting an individual to participate in a planned special exposure, a licensee must determine:

A. the internal and external doses from all previous planned special exposures; and

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

Subp. 3. **Compliance methods.** In complying with the requirements of subparts 1 and 2, a licensee may:

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

B. accept, as the record of cumulative radiation dose, an up-to-date cumulative occupational exposure form as described under subpart 4, or its equivalent, signed by the individual and countersigned by an appropriate official of the most recent employer for work involving radiation exposure, or the individual's current employer if the individual is not employed by the licensee; and

C. obtain reports of the individual's dose equivalent from the most recent employer for work involving radiation exposure, or the individual's current employer if the individual is not employed by the licensee, by telephone, telegram, electronic media, or letter. The licensee must

request a written verification of the dose data if the authenticity of the transmitted report cannot be established.

Subp. 4. **Record keeping.** A licensee must record the exposure history of each individual, as required by subpart 1 or 2, on a cumulative occupational exposure record form prescribed by the commissioner, or other clear and legible record including all of the information required by the commissioner's form. The form or record must show each period in which the individual received occupational exposure to radiation or radioactive material and must be signed by the individual who received the exposure. For each period for which the licensee obtains reports, the licensee must use the dose shown in the report in preparing the exposure record. For any period in which the licensee does not obtain a report, the licensee must place a notation on the record indicating the periods and time for which data are not available.

Subp. 5. **Assumptions.** If a licensee is unable to obtain a complete record of an individual's current and previously accumulated occupational dose, the licensee must assume:

A. in establishing administrative controls under part 4731.2020, subpart 6, for the current year, that the allowable dose limit for the individual is reduced by 1.25 rems (12.5 mSv) for each quarter for which records are unavailable and the individual was engaged in activities that could have resulted in occupational radiation exposure; and

B. that the individual is not available for planned special exposures.

Subp. 6. **Record retention.** A licensee must retain the records under subpart 4 until the commissioner terminates each pertinent license requiring the records. A licensee must retain records used in preparing the cumulative occupational exposure record form, or its equivalent, for three years after the record was made. This includes records required under the standards for protection against radiation in effect prior to January 1, 1994.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440; 36 SR 74*
Published Electronically: *August 15, 2011*

4731.2530 RECORDS; PLANNED SPECIAL EXPOSURES.

Subpart 1. **Required records.** For each planned special exposure under part 4731.2060, a licensee must maintain records that describe:

A. the exceptional circumstances requiring the use of a planned special exposure;

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

C. what actions were necessary;

D. why the actions were necessary;

E. how doses were maintained ALARA; and

F. what individual and collective doses were expected to result and the doses actually received in the planned special exposure.

Subp. 2. **Retention period.** A licensee must retain records under this part until the commissioner terminates each pertinent license requiring the records.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2540 RECORDS; INDIVIDUAL MONITORING RESULTS.

Subpart 1. **Required records.** A licensee must maintain records of doses received by all individuals for whom monitoring is required under part 4731.2210 and records of doses received during planned special exposures, accidents, and emergency conditions. Assessments of dose equivalent and records made using units in effect before January 3, 2005, need not be changed. The records must include, when applicable:

A. the deep dose equivalent to the whole body, lens dose equivalent, shallow dose equivalent to the skin, and shallow dose equivalent to the extremities;

B. the estimated intake of radionuclides according to part 4731.2030;

C. the committed effective dose equivalent assigned to the intake of radionuclides;

D. the specific information used to assess the committed effective dose equivalent according to part 4731.2050, subparts 1 and 3, and, when required, part 4731.2210;

E. the total effective dose equivalent, when required under part 4731.2030; and

F. the total of the deep dose equivalent and the committed dose to the organ receiving the highest total dose.

Subp. 2. **Record keeping frequency.** A licensee must make entries of the records required under subpart 1 at least annually.

Subp. 3. **Record format.** A licensee must maintain the records required under subpart 1 on the NRC's Form 5, or its equivalent, according to the instructions for the form, or in clear and legible records containing all the information required by the NRC form.

Subp. 4. **Privacy protection.** The records required under this part must be protected from public disclosure because of their personal privacy nature. The records are protected by most state privacy laws and, when transferred to the commissioner, are protected by the Minnesota Data Practices Act, Minnesota Statutes, chapter 13.

Subp. 5. **Embryo/fetus records.** A licensee must maintain the records of dose to an embryo/fetus with the records of dose to the declared pregnant woman. The declaration of pregnancy must be kept on file, but may be maintained separately from the dose records.

Subp. 6. **Retention period.** A licensee must retain the records required under this part until the commissioner terminates each pertinent license requiring the record. This includes records required under the standards for protection against radiation in effect prior to January 1, 1994.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2550 RECORDS; DOSE TO INDIVIDUAL MEMBERS OF THE PUBLIC.

A licensee must maintain records sufficient to demonstrate compliance with the dose limit for individual members of the public under part 4731.2090. A licensee must retain the records required under this part until the commissioner terminates each pertinent license requiring the record.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2560 RECORDS; WASTE DISPOSAL.

A. A licensee must maintain records of:

(1) the disposal of licensed materials made under part 4731.2410, 4731.2420, 4731.2430, or 4731.2440; and

(2) disposal by burial in soil, including burials authorized before January 28, 1981.

B. A licensee must retain the records required under this part until the commissioner terminates each pertinent license requiring the record. Requirements for disposition of the records, before license termination, are found in parts 4731.0625, 4731.0825, and 4731.3115, and in Code of Federal Regulations, title 10, section 72.80, for activities licensed under this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2600 REPORTS; THEFT OR LOSS OF LICENSED MATERIAL.

Subpart 1. **Telephone reports.** A licensee must report to the commissioner by telephone, according to part 4731.0200, subpart 5, as follows:

A. immediately after its occurrence becomes known to the licensee, any lost, stolen, or missing licensed material in an aggregate quantity equal to or greater than 1,000 times the quantity under part 4731.2800, under such circumstances that it appears to the licensee that an exposure could result to persons in unrestricted areas; or

B. within 30 days after an occurrence of any lost, stolen, or missing licensed material becomes known to the licensee, all licensed material in a quantity greater than ten times the quantity under part 4731.2800 that is still missing at the time of the report.

Subp. 2. **Written reports.** A licensee required to make a report under subpart 1 must, within 30 days after making the telephone report, make a written report to the commissioner that includes:

A. a description of the licensed material involved, including kind, quantity, and chemical and physical form;

B. a description of the circumstances under which the loss or theft occurred;

C. a statement of disposition, or probable disposition, of the licensed material involved;

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

E. actions that have been taken, or will be taken, to recover the material; and

F. procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

Subp. 3. [Repealed, 44 SR 239]

Subp. 4. **Additional information.** Subsequent to filing a written report, a licensee must report any additional substantive information on the loss or theft within 30 days after the licensee learns of the information.

Subp. 5. **Individual names.** A licensee must prepare any report filed with the commissioner under this part so that names of individuals who may have received exposure to radiation are stated in a separate and detachable part of the report.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.2610 NOTIFICATION OF INCIDENTS.

Subpart 1. **Immediate notification required.** Notwithstanding any other requirements for notification, a licensee must immediately report any event involving radioactive material possessed by the licensee that may have caused or threatens to cause:

A. an individual to receive:

(1) a total effective dose equivalent of 25 rems (0.25 Sv) or more;

(2) a lens dose equivalent of 75 rems (0.75 Sv) or more; or

(3) a shallow dose equivalent to the skin or extremities of 250 rads (2.5 Gy) or more; or

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

Subp. 2. **24-hour notification required.** A licensee must, within 24 hours of discovery of the event, report any event involving loss of control of a licensed material possessed by the licensee that may have caused or threatens to cause:

A. an individual to receive in a period of 24 hours:

(1) a total effective dose equivalent exceeding five rems (0.05 Sv);

(2) a lens dose equivalent exceeding 15 rems (0.15 Sv); or

(3) a shallow dose equivalent to the skin or extremities exceeding 50 rems (0.5 Sv); or

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

Subp. 3. **Individual names.** A licensee must prepare any report filed with the commissioner under this part so that names of individuals who have received exposure to radiation or radioactive material are stated in a separate and detachable part of the report.

Subp. 4. **Reporting method.** Licensees must make the reports required under this part to the commissioner by telephone according to part 4731.0200, subpart 5.

Subp. 5. **Exception.** This part does not apply to doses that result from planned special exposures, that are within the limits for planned special exposures, and that are reported under part 4731.2630.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.2620 REPORTS; RADIATION EXPOSURES, LEVELS, AND CONCENTRATIONS EXCEEDING CONSTRAINTS OR LIMITS.

Subpart 1. **Reportable events.** In addition to the notification required under part 4731.2610, a licensee must submit a written report within 30 days after learning of:

A. an incident for which notification is required under part 4731.2610;

B. doses in excess of:

(1) the occupational dose limits for adults under part 4731.2020;

(2) the occupational dose limits for a minor under part 4731.2070;

(3) the limits for an embryo/fetus of a declared pregnant woman under part 4731.2080;

(4) the limits for an individual member of the public under part 4731.2090;

(5) any applicable limit in the license; or

(6) the ALARA constraints for air emissions established under part 4731.2010, subpart 4;

C. levels of radiation or concentrations of radioactive material in:

(1) a restricted area in excess of applicable limits in the license; or

(2) an unrestricted area in excess of ten times any applicable limit under this chapter or in the license, whether or not involving exposure of any individual in excess of the limits under part 4731.2090; or

D. for licensees subject to the provisions of the Environmental Protection Agency's generally applicable environmental radiation standards under Code of Federal Regulations, title 40, part 190, levels of radiation or releases of radioactive material in excess of those standards or of license conditions related to those standards.

Subp. 2. **Contents of reports.** A report required under subpart 1 must describe the extent of exposure of individuals to radiation and radioactive material, including, as appropriate:

A. estimates of each individual's dose;

B. the levels of radiation and concentrations of radioactive material involved;

C. the cause of the elevated exposures, dose rates, or concentrations; and

D. corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards, and associated license conditions.

Subp. 3. **Individual information.**

A. A report filed under subpart 1 must include, for each occupationally overexposed individual:

(1) the name; and

(2) date of birth.

B. With respect to the limit for the embryo/fetus under part 4731.2080, the identifiers must be those of the declared pregnant woman.

C. The report must be prepared so that the information under this subpart is stated in a separate and detachable part of the report.

Subp. 4. **Reporting method.** All licensees, other than those holding an operating license for a nuclear power plant, who make reports according to this part must submit the report in writing to the commissioner according to part 4731.2610.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.2630 REPORTS; PLANNED SPECIAL EXPOSURES.

A licensee must submit a written report to the commissioner within 30 days following any planned special exposure conducted according to part 4731.2060. The report must inform the commissioner that a planned special exposure was conducted, indicate the date the planned special exposure occurred, and provide the information required under part 4731.2530.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.2640 REPORTS TO INDIVIDUALS; DOSE LIMITS EXCEEDED.

When a licensee is required, under part 4731.2620 or 4731.2630 to report to the commissioner any exposure of an identified occupationally exposed individual or an identified member of the public to radiation or radioactive material, the licensee must also provide the individual a report on the individual's exposure data included in the report to the commissioner. The report must be transmitted at a time no later than the transmittal to the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*
Published Electronically: *March 12, 2009*

4731.2650 [Repealed, 40 SR 145]
Published Electronically: *August 27, 2015*

4731.2700 ASSIGNED PROTECTION FACTORS FOR RESPIRATORS.

Subpart 1. **Applicability.**

A. The assigned protection factors in subpart 2 apply only in a respiratory protection program that meets the requirements of this chapter. They are applicable only to airborne radiological hazards and may not be appropriate to circumstances when chemical or other respiratory hazards exist instead of, or in addition to, radioactive hazards. Selection and use of respirators for such circumstances must also comply with United States Department of Labor regulations.

B. Radioactive contaminants for which the concentration values in part 4731.2750, subpart 7, Table 1, column 3, are based on internal dose due to inhalation may, in addition, present external

exposure hazards at higher concentrations. Under these circumstances, limitations on occupancy may have to be governed by external dose limits.

Subp. 2. **Table of protection factors.**

A. Air purifying respirators [particulate only]

	Operating Mode	Assigned Protection Factors
(1) Filtering facepiece disposable	Negative pressure	-
(2) Facepiece, half	Negative pressure	10
(3) Facepiece, full	Negative pressure	100
(4) Facepiece, half	Powered air-purifying respirators	50
(5) Facepiece, full	Powered air-purifying respirators	1000
(6) Helmet/hood	Powered air-purifying respirators	1000
(7) Facepiece, loose-fitting	Powered air-purifying respirators	25

B. Atmosphere supplying respirators [particulate, gases and vapors]:

(1) Air-line respirator:

(a) Facepiece, half	Demand	10
(b) Facepiece, half	Continuous flow	50
(c) Facepiece, half	Pressure demand	50
(d) Facepiece, full	Demand	100
(e) Facepiece, full	Continuous flow	1000
(f) Facepiece, full	Pressure demand	1000
(g) Helmet/hood	Continuous flow	1000
(h) Facepiece, loose-fitting	Continuous flow	25
(i) Suit	Continuous flow	-

(2) Self-contained breathing apparatus (SCBA):

(a) Facepiece, full	Demand	100
(b) Facepiece, full	Pressure demand	10,000

(c) Facepiece, full	Demand, recirculating	100
(d) Facepiece, full	Positive pressure recirculating	10,000

C. Combination respirators:

Any combination of air-purifying and atmosphere-supplying respirators	Assigned protection factor for type and mode of operation as listed above

Subp. 3. **Explanations.**

A. Subpart 2, item A: Air purifying respirators with APF<100 must be equipped with particulate filters that are at least 95 percent efficient. Air purifying respirators with APF=100 must be equipped with particulate filters that are at least 99 percent efficient. Air purifying respirators with APF> 100 must be equipped with particulate filters that are at least 99.97 percent efficient.

B. Subpart 2, item A: A licensee may apply to the commissioner for the use of an APF greater than 1 for sorbent cartridges as protection against airborne radioactive gases and vapors, such as radioiodine.

C. Subpart 2, item A, subitem (1): Licensees may permit individuals to use this type of respirator who have not been medically screened or fit tested on the device, provided that no credit be taken for their use in estimating intake or dose. It is also recognized that it is difficult to perform an effective positive or negative pressure pre-use user seal check on this type of device. All other respiratory protection program requirements under part 4731.2260 apply. An assigned protection factor has not been assigned for these devices. However, an APF equal to ten may be used if the licensee can demonstrate a fit factor of at least 100 by use of a validated or evaluated, qualitative or quantitative fit test.

D. Subpart 2, item A, subitem (2): Under-chin type only. No distinction is made in this part between elastomeric half-masks with replaceable cartridges and those designed with the filter medium as an integral part of the facepiece, for example, disposable or reusable disposable. Both types are acceptable so long as the seal area of the latter contains some substantial type of seal-enhancing material such as rubber or plastic, the two or more suspension straps are adjustable, the filter medium is at least 95 percent efficient, and all other requirements of this chapter are met.

E. Subpart 2, item B: The assigned protection factors for gases and vapors are not applicable to radioactive contaminants that present an absorption or submersion hazard. For tritium oxide vapor, approximately one-third of the intake occurs by absorption through the skin so that an overall protection factor of 3 is appropriate when atmosphere-supplying respirators are used to protect against tritium oxide. Exposure to radioactive noble gases is not considered a significant respiratory hazard and protective actions for these contaminants should be based on external (submersion) dose considerations.

F. Subpart 2, item B, subitem (1), unit (i): A National Institute for Occupational Safety and Health approval schedule is currently not available for atmosphere supplying suits. This equipment may be used in an acceptable respiratory protection program as long as all the other minimum program requirements under part 4731.2260, with the exception of fit testing, are met.

G. Subpart 2, item B, subitem (2), units (a) and (c): A licensee should implement institutional controls to ensure that these devices are not used in areas immediately dangerous to life or health.

H. Subpart 2, item B, subitem (2), units (b) and (d): This type of respirator may be used as an emergency device in unknown concentrations for protection against inhalation hazards. External radiation hazards and other limitations to permitted exposure such as skin absorption must be taken into account in these circumstances. The device may not be used by any individual who experiences perceptible outward leakage of breathing gas while wearing the device.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.2705 NATIONAL SOURCE TRACKING TRANSACTION REPORTING.

Subpart 1. **Report required.** Each licensee who manufactures, transfers, receives, disassembles, or disposes of a nationally tracked source must complete and submit a National Source Tracking Transaction Report as specified in subparts 2 to 6 for each type of transaction.

Subp. 2. **Manufacturing report requirements.** Each licensee who manufactures a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

A. the name, address, and license number of the reporting licensee;

B. the name of the individual preparing the report;

C. the manufacturer, model, and serial number of the source;

D. the radioactive material in the source;

E. the initial source strength in becquerels or curies at the time of manufacture; and

F. the manufacture date of the source.

Subp. 3. **Transfer report requirements.** Each licensee that transfers a nationally tracked source to another person must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

A. the name, address, and license number of the reporting licensee;

B. the name of the individual preparing the report;

C. the name and license number of the recipient facility and the shipping address;

D. the manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

E. the radioactive material in the source;

F. the initial or current source strength in becquerels or curies;

G. the date for which the source strength is reported;

H. the shipping date;

I. the estimated arrival date; and

J. for nationally tracked sources transferred as waste under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification of the container with the nationally tracked source.

Subp. 4. **Material received report requirements.** Each licensee that receives a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

A. the name, address, and license number of the reporting licensee;

B. the name of the individual preparing the report;

C. the name, address, and license number of the person that provided the source;

D. the manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

E. the radioactive material in the source;

F. the initial or current source strength in becquerels or curies;

G. the date for which the source strength is reported;

H. the date of receipt; and

I. for material received under a Uniform Low-Level Radioactive Waste Manifest, the waste manifest number and the container identification with the nationally tracked source.

Subp. 5. **Disassemble report requirements.** Each licensee that disassembles a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

A. the name, address, and license number of the reporting licensee;

B. the name of the individual preparing the report;

C. the manufacturer, model, and serial number of the source or, if not available, other information to uniquely identify the source;

D. the radioactive material in the source;

E. the initial or current source strength in becquerels or curies;

F. the date for which the source strength is reported; and

G. the disassemble date of the source.

Subp. 6. **Disposal report requirements.** Each licensee who disposes of a nationally tracked source must complete and submit a National Source Tracking Transaction Report. The report must include the following information:

A. the name, address, and license number of the reporting licensee;

B. the name of the individual preparing the report;

C. the waste manifest number;

D. the container identification with the nationally tracked source;

E. the date of disposal; and

F. the method of disposal.

Subp. 7. **Report submission.** The reports discussed in subparts 2 to 6 must be submitted by the close of the next business day after the transaction. A single report may be submitted for multiple sources and transactions. The reports must be submitted to the National Source Tracking System by:

A. using the online National Source Tracking System;

B. electronically using a computer-readable format;

C. facsimile;

D. mail to the address on the National Source Tracking Transaction Report Form (NRC Form 748); or

E. telephone with follow-up by facsimile or mail.

Subp. 8. **Report corrections.** Each licensee must correct any error in previously filed reports or file a new report for any missed transaction within five business days of the discovery of the error or missed transaction. Errors may be detected by a variety of methods including administrative reviews or by physical inventories required by regulation. In addition, each licensee must reconcile the inventory of nationally tracked sources possessed by the licensee against that licensee's data in the National Source Tracking System. The reconciliation must be conducted during the month of January in each year. The reconciliation process must include resolving any discrepancies between the National Source Tracking System and the actual inventory by filing the reports identified by subparts 2 to 6. By January 31 of each year, each licensee must submit to the National Source Tracking System confirmation that the data in the National Source Tracking System is correct.

Subp. 9. [Repealed, 49 SR 1193]

Statutory Authority: *MS s 144.1202; 144.1203*

History: *33 SR 1440*

Published Electronically: *May 28, 2025*

4731.2750 ANNUAL LIMITS ON INTAKE AND DERIVED AIR CONCENTRATIONS.

Subpart 1. **General explanation.** For each radionuclide, subpart 7, Table 1, indicates the chemical form that is to be used for selecting the appropriate annual limit on intake (ALI) or derived air concentration (DAC) value. The ALIs and DACs for inhalation are given for an aerosol with an activity median aerodynamic diameter (AMAD) of 1 μm and for three classes (D,W,Y) of radioactive material, which refer to their retention (approximately days, weeks, or years) in the pulmonary region of the lung. This classification applies to a range of clearance half-times for D of less than ten days, for W from ten to 100 days, and for Y greater than 100 days. The class (D, W, or Y) given in the column headed "Atomic Number (AN), Radionuclide, and Class" applies only to the inhalation ALIs and DACs given in subpart 7, Table 1, columns 2 and 3. Subpart 7, Table 2, provides concentration limits for airborne and liquid effluents released to the general environment. Subpart 7, Table 3, provides concentration limits for discharges to sanitary sewer systems.

Subp. 2. **Notation.** The values in subpart 7, Tables 1, 2, and 3, are presented in the computer "E" notation. In this notation, a value of 6E-02 represents a value of 6×10^{-2} or 0.06, 6E+2 represents 6×10^{2} or 600, and 6E+0 represents 6×10^{0} or 6.

Subp. 3. **Table 1 explanation; occupational values.**

A. The columns in subpart 7, Table 1, are applicable to occupational exposure to radioactive material. Column 1 is the oral ingestion ALI, expressed in μCi. Column 2 is the inhalation ALI, expressed in μCi. Column 3 is the inhalation DAC, expressed in μCi/ml.

B. The ALIs in this part are the annual intakes of a given radionuclide by reference man that would result in:

(1) a committed effective dose equivalent of five rems (stochastic ALI); or

(2) a committed dose equivalent of 50 rems to an organ or tissue (nonstochastic ALI).

C. The stochastic ALIs were derived to result in a risk, due to irradiation of organs and tissues, comparable to the risk associated with deep dose equivalent to the whole body of five rems.

D. The derivation includes multiplying the committed dose equivalent to an organ or tissue by a weighting factor, W_T. This weighting factor is the proportion of the risk of stochastic effects resulting from irradiation of the organ or tissue, T, to the total risk of stochastic effects when the whole body is irradiated uniformly. The values of W_T are listed under part 4731.0100, subpart 261. The nonstochastic ALIs were derived to avoid nonstochastic effects, such as prompt damage to tissue or reduction in organ function.

E. A value of W_T=0.06 is applicable to each of the five organs or tissues in the "remainder" category receiving the highest dose equivalents and the dose equivalents of all other remaining tissues may be disregarded.

F. The following parts of the gastrointestinal tract are to be treated as four separate organs: stomach, small intestine, upper large intestine, and lower large intestine.

G. The dose equivalents for extremities (hands and forearms, feet and lower legs), skin, and lens of the eye are not considered in computing the committed effective dose equivalent, but are subject to limits that must be met separately.

H. When an ALI is defined by the stochastic dose limit, this value alone is given. When an ALI is determined by the nonstochastic dose limit to an organ, the organ or tissue to which the limit applies is shown, and the ALI for the stochastic limit is shown in parentheses. Abbreviated organ or tissue designations are used:

LLI = lower large intestine wall;

Stom = stomach wall;

Blad = bladder wall;

Bone = bone surface;

Kid = kidneys; and

Thyr = thyroid.

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

J. The DAC values are derived limits intended to control chronic occupational exposures. The relationship between the DAC and the ALI is given by:

DAC = ALI(in μCi)/(2000 hours per working year x 60 minutes/hour x 2 x 10^4 ml per minute) = [ALI/2.4 x 10^9] μCi/ml

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

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

L. The ALI and DAC values relate to exposure to the single radionuclide named, but also include contributions from the in-growth of any daughter radionuclide produced in the body by the decay of the parent. However, intakes that include both the parent and daughter radionuclides should be treated by the general method appropriate for mixtures.

M. The values of ALI and DAC do not apply directly when the individual both ingests and inhales a radionuclide, when the individual is exposed to a mixture of radionuclides by either inhalation or ingestion or both, or when the individual is exposed to both internal and external irradiation.

N. When an individual is exposed to radioactive materials that fall under several of the translocation classifications (Class D, W, or Y) of the same radionuclide, the exposure may be evaluated as if it were a mixture of different radionuclides.

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

Subp. 4. **Table 2 explanation; effluent concentrations.**

A. The columns in subpart 7, Table 2, are applicable to the assessment and control of dose to the public, particularly in the implementation of part 4731.2095. Column 1 is the effluent concentration limit for air, expressed in μCi/ml. Column 2 is the effluent concentration limit for water, expressed in μCi/ml. The concentration values given in subpart 7, Table 2, columns 1 and 2, are equivalent to the radionuclide concentrations that, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 0.05 rem (50 mrem or 0.5 mSv).

B. Consideration of nonstochastic limits has not been included in deriving the air and water effluent concentration limits because nonstochastic effects are presumed not to occur at the dose levels established for individual members of the public. For radionuclides, where the nonstochastic limit was governing in deriving the occupational DAC, the stochastic ALI was used in deriving the corresponding airborne effluent limit in subpart 7, Table 2. For this reason, the DAC and airborne effluent limits are not always proportional as they were in previous Code of Federal Regulations, title 10, sections 20.1 to 20.602, Appendix B.

C. The air concentration values in subpart 7, Table 2, column 1, were derived by one of two methods. For those radionuclides for which the stochastic limit is governing, the occupational stochastic inhalation ALI was divided by 2.4×10^9 (ml), relating the inhalation ALI to the DAC, and then divided by a factor of 300. The factor of 300 includes the following components: a factor of 50 to relate the five-rem annual occupational dose limit to the 0.1-rem limit for members of the

public; a factor of three to adjust for the difference in exposure time and inhalation rate for a worker and for members of the public; and a factor of two to adjust the occupational values derived for adults so that they are applicable to other age groups.

D. For those radionuclides for which submersion (external dose) is limiting, the occupational DAC in subpart 7, Table 1, column 3, was divided by 219. The factor of 219 is composed of a factor of 50, according to item C, and a factor of 4.38 relating occupational exposure for 2,000 hours per year to full-time exposure (8,760 hours per year). An additional factor of two for age considerations is not warranted in the submersion case.

E. The water concentrations were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^7. The factor of 7.3×10^7(ml) includes the following components: the factors of 50 and two, according to item C, and a factor of 7.3×10^5(ml), which is the annual water intake of reference man.

F. Subpart 8 provides groupings of radionuclides that are applicable to unknown mixtures of radionuclides. These groupings, including occupational inhalation ALIs and DACs, air and water effluent concentrations and sewerage, require demonstrating that the most limiting radionuclides in successive classes are absent. The limit for the unknown mixture is defined when the presence of one of the listed radionuclides cannot be definitely excluded, either from knowledge of the radionuclide composition of the source or from actual measurements.

Subp. 5. **Table 3 explanation; releases to sewers.** Subpart 7, Table 3, gives the monthly average concentrations for release to sanitary sewers, expressed in µCi/ml. The monthly average concentrations for release to sanitary sewers are applicable to part 4731.2420. The concentration values were derived by taking the most restrictive occupational stochastic oral ingestion ALI and dividing by 7.3×10^6(ml). The factor of 7.3×10^6(ml) is composed of a factor of 7.3×10^5(ml), the annual water intake by reference man, and a factor of ten, such that the concentrations, if the sewage released by the licensee were the only source of water ingested by a reference man during a year, would result in a committed effective dose equivalent of 0.5 rem.

Subp. 6. **List of elements.**

Name	Symbol	Atomic Number (AN)
Actinium	Ac	89
Aluminum	Al	13
Americium	Am	95
Antimony	Sb	51
Argon	Ar	18
Arsenic	As	33
Astatine	At	85

Barium	Ba	56
Berkelium	Bk	97
Beryllium	Be	4
Bismuth	Bi	83
Bromine	Br	35
Cadmium	Cd	48
Calcium	Ca	20
Californium	Cf	98
Carbon	C	6
Cerium	Ce	58
Cesium	Cs	55
Chlorine	Cl	17
Chromium	Cr	24
Cobalt	Co	27
Copper	Cu	29
Curium	Cm	96
Dysprosium	Dy	66
Einsteinium	Es	99
Erbium	Er	68
Europium	Eu	63
Fermium	Fm	100
Fluorine	F	9
Francium	Fr	87
Gadolinium	Gd	64
Gallium	Ga	31
Germanium	Ge	32

Gold	Au	79
Hafnium	Hf	72
Holmium	Ho	67
Hydrogen	H	1
Indium	In	49
Iodine	I	53
Iridium	Ir	77
Iron	Fe	26
Krypton	Kr	36
Lanthanum	La	57
Lead	Pb	82
Lutetium	Lu	71
Magnesium	Mg	12
Manganese	Mn	25
Mendelevium	Md	101
Mercury	Hg	80
Molybdenum	Mo	42
Neodymium	Nd	60
Neptunium	Np	93
Nickel	Ni	28
Niobium	Nb	41
Nitrogen	N	7
Osmium	Os	76
Oxygen	O	8

Palladium	Pd	46
Phosphorus	P	15
Platinum	Pt	78
Plutonium	Pu	94
Polonium	Po	84
Potassium	K	19
Praseodymium	Pr	59
Promethium	Pm	61
Protactinium	Pa	91
Radium	Ra	88
Radon	Rn	86
Rhenium	Re	75
Rhodium	Rh	45
Rubidium	Rb	37
Ruthenium	Ru	44
Samarium	Sm	62
Scandium	Sc	21
Selenium	Se	34
Silicon	Si	14
Silver	Ag	47
Sodium	Na	11
Strontium	Sr	38
Sulfur	S	16
Tantalum	Ta	73
Technetium	Tc	43
Tellurium	Te	52

Terbium	Tb	65
Thallium	Tl	81
Thorium	Th	90
Thulium	Tm	69
Tin	Sn	50
Titanium	Ti	22
Tungsten	W	74
Uranium	U	92
Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40

Subp. 7. **Table of ALIs and DACs.**

	Table 1			Table 2		Table 3
Atomic Number (AN), Radionuclide, and Class	1	2	3	1	2	
AN 1						
Hydrogen-3						
Water, DAC includes skin absorption	8E+4	8E+4	2E-5	1E-7	1E-3	1E-2
Gas (HT or T_2) submersion[1]: Use above values as HT and T_2						

oxidize in air and in the body to HTO.

AN 4

Beryllium-7

W, all compounds except those given for Y	4E+4	2E+4	9E-6	3E-8	6E-4	6E-3
Y, oxides, halides, and nitrates	---	2E+4	8E-6	3E-8	---	---

Beryllium-10

W, see ^{7}Be	1E+3	2E+2	6E-8	2E-10	---	---
	LLI (1E+3)	---	---	2E-5	2E-4	---
Y, see ^{7}Be	---	1E+1	6E-9	2E-11	---	---

AN 6

Carbon-11[2]

Monoxide	---	1E+6	5E-4	2E-6	---	---
Dioxide	---	6E+5	3E-4	9E-7	---	---
Compounds	4E+5	4E+5	2E-4	6E-7	6E-3	6E-2

Carbon-14

Monoxide	---	2E+6	7E-4	2E-6	---	---
Dioxide	---	2E+5	9E-5	3E-7	---	---
Compounds	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4

AN 7

Nitrogen-13[2]

Submersion[1]	---	---	4E-6	2E-8	---	---

AN 8						
Oxygen-15[2]						
Submersion[1]	---	---	4E-6	2E-8	---	---
AN 9						
Fluorine-18[2]						
D, fluorides of H, Li, Na, K, Rb, Cs, and Fr	5E+4	7E+4	3E-5	1E-7	---	---
	Stom (5E+4)	---	---	---	7E-4	7E-3
W, fluorides of Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, As, Sb, Bi, Fe, Ru, Os, Co, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, V, Nb, Ta, Mn, Tc, and Re	---	9E+4	4E-5	1E-7	---	---
Y, lanthanum fluoride	---	8E+4	3E-5	1E-7	---	---
AN 11						
Sodium-22						
D, all compounds	4E+2	6E+2	3E-7	9E-10	6E-6	6E-5
Sodium-24						
D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
AN 12						
Magnesium-28						
D, all compounds except those given for W	7E+2	2E+3	7E-7	2E-9	9E-6	9E-5
W, oxides, hydroxides, carbides, halides, and nitrates	---	1E+3	5E-7	2E-9	---	---

AN 13

Aluminum-26

D, all compounds except those given for W	4E+2	6E+1	3E-8	9E-11	6E-6	6E-5
W, oxides, hydroxides, carbides, halides, and nitrates	---	9E+1	4E-8	1E-10	---	---

AN 14

Silicon-31

D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
W, oxides, hydroxides, carbides, and nitrates	---	3E+4	1E-5	5E-8	---	---
Y, aluminosilicate glass	---	3E+4	1E-5	4E-8	---	---

Silicon-32

D, see ^{31}Si	2E+3	2E+2	1E-7	3E-10	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
W, see ^{31}Si	---	1E+2	5E-8	2E-10	---	---
Y, see ^{31}Si	---	5E+0	2E-9	7E-12	---	---

AN 15

Phosphorus-32

D, all compounds except phosphates given for W	6E+2	9E+2	4E-7	1E-9	9E-6	9E-5
W, phosphates of Zn^{2+}, S^{3+}, Mg^{2+}, Fe^{3+}, Bi^{3+}, and lanthanides	---	4E+2	2E-7	5E-10	---	---

Phosphorus-33

D, see ^{32}P	6E+3	8E+3	4E-6	1E-8	8E-5	8E-4
W, see ^{32}P	---	3E+3	1E-6	4E-9	---	---
AN 16						
Sulfur-35						
Vapor	1E+4	6E-6	2E-8	---	---	---
D, sulfides and sulfates except those given for W	1E+4	2E+4	7E-6	2E-8	---	---
	LLI (8E+3)	---	---	---	1E-4	1E-3
	6E+3	---	---	---	---	---
W, elemental sulfur, sulfides of Sr, Ba, Ge, Sn, Pb, As, Sb, Bi, Cu, Ag, Au, Zn, Cd, Hg, W, and Mo. Sulfates of Ca, Sr, Ba, Ra, As, Sb, and Bi	---	2E+3	9E-7	3E-9	---	---
AN 17						
Chlorine-36						
D, chlorides of H, Li, Na, K, Rb, Cs, and Fr	2E+3	2E+3	1E-6	3E-9	2E-5	2E-4
W, chlorides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Mn, Tc, and Re	---	2E+2	1E-7	3E-10	---	---
Chlorine-38[2]						
D, see ^{36}Cl	2E+4	4E+4	2E-5	6E-8	---	---
	Stom (3E+4)	---	---	---	3E-4	3E-3
W, see ^{36}Cl	---	5E+4	2E-5	6E-8	---	---

Chlorine-39[2]						
D, see ^{36}Cl	2E+4	5E+4	2E-5	7E-8	---	---
	Stom (4E+4)	---	---	---	5E-4	5E-3
W, see ^{36}Cl	---	6E+4	2E-5	8E-8	---	---
AN 18						
Argon-37						
Submersion[1]	---	---	1E+0	6E-3	---	---
Argon-39						
Submersion[1]	---	---	2E-4	8E-7	---	---
Argon-41						
Submersion[1]	---	---	3E-6	1E-8	---	---
AN 19						
Potassium-40						
D, all compounds	3E+2	4E+2	2E-7	6E-10	4E-6	4E-5
Potassium-42						
D, all compounds	5E+3	5E+3	2E-6	7E-9	6E-5	6E-4
Potassium-43						
D, all compounds	6E+3	9E+3	4E-6	1E-8	9E-5	9E-4
Potassium-44[2]						
D, all compounds	2E+4	7E+4	3E-5	9E-8	---	---
	Stom (4E+4)	---	---	5E-4	5E-3	---

Potassium-45[2]						
D, all compounds	3E+4	1E+5	5E-5	2E-7	---	---
	Stom (5E+4)	---	---	---	7E-4	7E-3
AN 20						
Calcium-41						
W, all compounds	3E+3	4E+3	2E-6	---	---	---
	Bone (4E+3)	Bone (4E+3)	---	5E-9	6E-5	6E-4
Calcium-45						
W, all compounds	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
Calcium-47						
W, all compounds	8E+2	9E+2	4E-7	1E-9	1E-5	1E-4
AN 21						
Scandium-43						
Y, all compounds	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
Scandium-44m						
Y, all compounds	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
Scandium-44						
Y, all compounds	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
Scandium-46						
Y, all compounds	9E+2	2E+2	1E-7	3E-10	1E-5	1E-4

Scandium-47						
Y, all compounds	2E+3	3E+3	1E-6	4E-9	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
Scandium-48						
Y, all compounds	8E+2	1E+3	6E-7	2E-9	1E-5	1E-4
Scandium-49[2]						
Y, all compounds	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3

AN 22

Titanium-44						
D, all compounds except those given for W and Y	3E+2	1E+1	5E-9	2E-11	4E-6	4E-5
W, oxides, hydroxides, carbides, halides, and nitrates	---	3E+1	1E-8	4E-11	---	---
Y, $SrTiO_3$	---	6E+0	2E-9	8E-12	---	---
Titanium-45						
D, see ^{44}Ti	9E+3	3E+4	1E-5	3E-8	1E-4	1E-3
W, see ^{44}Ti	---	4E+4	1E-5	5E-8	---	---
Y, see ^{44}Ti	---	3E+4	1E-5	4E-8	---	---

AN 23

Vanadium-47[2]						
D, all compounds except those given for W	3E+4	8E+4	3E-5	1E-7	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3

W, oxides hydroxides, carbides, and halides	---	1E+5	4E-5	1E-7	---	---
Vanadium-48						
D, see ^{47}V	6E+2	1E+3	5E-7	2E-9	9E-6	9E-5
W, see ^{47}V	---	6E+2	3E-7	9E-10	---	---
Vanadium-49						
D, see ^{47}V	7E+4	3E+4	1E-5	---	---	---
	LLI (9E+4)	Bone (3E+4)	---	5E-8	1E-3	1E-2
W, see ^{47}V	---	2E+4	8E-6	2E-8	---	---

AN 24

Chromium-48						
D, all compounds except those given for W and Y	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
W, halides and nitrates	---	7E+3	3E-6	1E-8	---	---
Y, oxides hydroxides	---	7E+3	3E-6	1E-8	---	---
Chromium-49[2]						
D, see ^{48}Cr	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
W, see ^{48}Cr	---	1E+5	4E-5	1E-7	---	---
Y, see ^{48}Cr	---	9E+4	4E-5	1E-7	---	---
Chromium-51						
D, see ^{48}Cr	4E+4	5E+4	2E-5	6E-8	5E-4	5E-3
W, see ^{48}Cr	---	2E+4	1E-5	3E-8	---	---
Y, see ^{48}Cr	---	2E+4	8E-6	3E-8	---	---

AN 25

Manganese-51[2]						
D, all compounds except those given for W	2E+4	5E+4	2E-5	7E-8	3E-4	3E-3
W, oxides, hydroxides halides, and nitrates	---	6E+4	3E-5	8E-8	---	---
Manganese-52m[2]						
D, see ^{51}Mn	3E+4	9E+4	4E-5	1E-7	---	---
	Stom (4E+4)	---	---	---	5E-4	5E-3
W, see ^{51}Mn	---	1E+5	4E-5	1E-7	---	---
Manganese-52						
D, see ^{51}Mn	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
W, see ^{51}Mn	---	9E+2	4E-7	1E-9	---	---
Manganese-53						
D, see ^{51}Mn	5E+4	1E+4	5E-6	---	7E-4	7E-3
	---	Bone (2E+4)	---	3E-8	---	---
W, see ^{51}Mn	---	1E+4	5E-6	2E-8	---	---
Manganese-54						
D, see ^{51}Mn	2E+3	9E+2	4E-7	1E-9	3E-5	3E-4
W, see ^{51}Mn	---	8E+2	3E-7	1E-9	---	---
Manganese-56						
D, see ^{51}Mn	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
W, see ^{51}Mn	---	2E+4	9E-6	3E-8	---	---

AN 26

Iron-52						
D, all compounds except those given for W	9E+2	3E+3	1E-6	4E-9	1E-5	1E-4
W, oxides, hydroxides, and halides	---	2E+3	1E-6	3E-9	---	---
Iron-55						
D, see ^{52}Fe	9E+3	2E+3	8E-7	3E-9	1E-4	1E-3
W, see ^{52}Fe	---	4E+3	2E-6	6E-9	---	---
Iron-59						
D, see ^{52}Fe	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
W, see ^{52}Fe	---	5E+2	2E-7	7E-10	---	---
Iron-60						
D, see ^{52}Fe	3E+1	6E+0	3E-9	9E-12	4E-7	4E-6
W, see ^{52}Fe	---	2E+1	8E-9	3E-11	---	---

AN 27

Cobalt-55						
W, all compounds except those given for Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
Y, oxides, hydroxides, halides, and nitrates	---	3E+3	1E-6	4E-9	---	---
Cobalt-56						
W, see ^{55}Co	5E+2	3E+2	1E-7	4E-10	6E-6	6E-5
Y, see ^{55}Co	4E+2	2E+2	8E-8	3E-10	---	---
Cobalt-57						

W, see ^{55}Co	8E+3	3E+3	1E-6	4E-9	6E-5	6E-4
Y, see ^{55}Co	4E+3	7E+2	3E-7	9E-10	---	---
Cobalt-58m						
W, see ^{55}Co	6E+4	9E+4	4E-5	1E-7	8E-4	8E-3
Y, see ^{55}Co	---	6E+4	3E-5	9E-8	---	---
Cobalt-58						
W, see ^{55}Co	2E+3	1E+3	5E-7	2E-9	2E-5	2E-4
Y, see ^{55}Co	1E+3	7E+2	3E-7	1E-9	---	---
Cobalt-60m[2]						
W, see ^{55}Co	1E+6	4E+6	2E-3	6E-6	---	---
	Stom (1E+6)	---	---	---	2E-2	2E-1
Y, see ^{55}Co	---	3E+6	1E-3	4E-6	---	---
Cobalt-60						
W, see ^{55}Co	5E+2	2E+2	7E-8	2E-10	3E-6	3E-5
Y, see ^{55}Co	2E+2	3E+1	1E-8	5E-11	---	---
Cobalt-61[2]						
W, see ^{55}Co	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
Y, see ^{55}Co	2E+4	6E+4	2E-5	8E-8	---	---
Cobalt-62m[2]						
W, see ^{55}Co	4E+4	2E+5	7E-5	2E-7	---	---
	Stom (5E+4)	---	---	---	7E-4	7E-3
Y, see ^{55}Co	---	2E+5	6E-5	2E-7	---	---

AN 28

Nickel-56						
D, all compounds except those given for W	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
W, oxides, hydroxides, and carbides	---	1E+3	5E-7	2E-9	---	---
Vapor	---	1E+3	5E-7	2E-9	---	---
Nickel-57						
D, see ^{56}Ni	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4
W, see ^{56}Ni	---	3E+3	1E-6	4E-9	---	---
Vapor	---	6E+3	3E-6	9E-9	---	---
Nickel-59						
D, see ^{56}Ni	2E+4	4E+3	2E-6	5E-9	3E-4	3E-3
W, see ^{56}Ni	---	7E+3	3E-6	1E-8	---	---
Vapor	---	2E+3	8E-7	3E-9	---	---
Nickel-63						
D, see ^{56}Ni	9E+3	2E+3	7E-7	2E-9	1E-4	1E-3
W, see ^{56}Ni	---	3E+3	1E-6	4E-9	---	---
Vapor	---	8E+2	3E-7	1E-9	---	---
Nickel-65						
D, see ^{56}Ni	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
W, see ^{56}Ni	---	3E+4	1E-5	4E-8	---	---
Vapor	---	2E+4	7E-6	2E-8	---	---
Nickel-66						

D, see ^{56}Ni	4E+2	2E+3	7E-7	2E-9	---	---
	LLI (5E+2)	---	---	---	6E-6	6E-5
W, see ^{56}Ni	---	6E+2	3E-7	9E-10	---	---
Vapor	---	3E+3	1E-6	4E-9	---	---

AN 29

Copper-60[2]

D, all compounds except those given for W and Y	3E+4	9E+4	4E-5	1E-7	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
W, sulfides, halides, and nitrates	---	1E+5	5E-5	2E-7	---	---
Y, oxides and hydroxides	---	1E+5	4E-5	1E-7	---	---

Copper-61

D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
W, see ^{60}Cu	---	4E+4	2E-5	6E-8	---	---
Y, see ^{60}Cu	---	4E+4	1E-5	5E-8	---	---

Copper-64

D, see ^{60}Cu	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
W, see ^{60}Cu	---	2E+4	1E-5	3E-8	---	---
Y, see ^{60}Cu	---	2E+4	9E-6	3E-8	---	---

Copper-67

D, see ^{60}Cu	5E+3	8E+3	3E-6	1E-8	6E-5	6E-4
W, see ^{60}Cu	---	5E+3	2E-6	7E-9	---	---
Y, see ^{60}Cu	---	5E+3	2E-6	6E-9	---	---

AN 30

Zinc-62						
Y, all compounds	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
Zinc-63[2]						
Y, all compounds	2E+4	7E+4	3E-5	9E-8	---	---
	Stom (3E+4)	---	---	---	3E-4	3E-3
Zinc-65						
Y, all compounds	4E+2	3E+2	1E-7	4E-10	5E-6	5E-5
Zinc-69m						
Y, all compounds	4E+3	7E+3	3E-6	1E-8	6E-5	6E-4
Zinc-69[2]						
Y, all compounds	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
Zinc-71m						
Y, all compounds	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
Zinc-72						
Y, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4

AN 31

Gallium-65[2]						
D, all compounds except those given for W	5E+4	2E+5	7E-5	2E-7	---	---
	Stom (6E+4)	---	---	---	9E-4	9E-3

W, oxides, hydroxides, carbides, halides, and nitrates	---	2E+5	8E-5	3E-7	---	---
Gallium-66						
D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	1E-5	1E-4
W, see ^{65}Ga	---	3E+3	1E-6	4E-9	---	---
Gallium-67						
D, see ^{65}Ga	7E+3	1E+4	6E-6	2E-8	1E-4	1E-3
W, see ^{65}Ga	---	1E+4	4E-6	1E-8	---	---
Gallium-68[2]						
D, see ^{65}Ga	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{65}Ga	---	5E+4	2E-5	7E-8	---	---
Gallium-70[2]						
D, see ^{65}Ga	5E+4	2E+5	7E-5	2E-7	---	---
	Stom (7E+4)	---	---	---	1E-3	1E-2
W, see ^{65}Ga	---	2E+5	8E-5	3E-7	---	---
Gallium-72						
D, see ^{65}Ga	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
W, see ^{65}Ga	---	3E+3	1E-6	4E-9	---	---
Gallium-73						
D, see ^{65}Ga	5E+3	2E+4	6E-6	2E-8	7E-5	7E-4
W, see ^{65}Ga	---	2E+4	6E-6	2E-8	---	---
AN 32						
Germanium-66						

D, all compounds except those given for W	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
W, oxides, sulfides, and halides	---	2E+4	8E-6	3E-8	---	---
Germanium-67[2]						
D, see ^{66}Ge	3E+4	9E+4	4E-5	1E-7	---	---
	Stom (4E+4)	---	---	6E-4	6E-3	---
W, see ^{66}Ge	---	1E+5	4E-5	1E-7	---	---
Germanium-68						
D, see ^{66}Ge	5E+3	4E+3	2E-6	5E-9	6E-5	6E-4
W, see ^{66}Ge	---	1E+2	4E-8	1E-10	---	---
Germanium-69						
D, see ^{66}Ge	1E+4	2E+4	6E-6	2E-8	2E-4	2E-3
W, see ^{66}Ge	---	8E+3	3E-6	1E-8	---	---
Germanium-71						
D, see ^{66}Ge	5E+5	4E+5	2E-4	6E-7	7E-3	7E-2
W, see ^{66}Ge	---	4E+4	2E-5	6E-8	---	---
Germanium-75[2]						
D, see ^{66}Ge	4E+4	8E+4	3E-5	1E-7	---	---
	Stom (7E+4)	---	---	---	9E-4	9E-3
W, see ^{66}Ge	---	8E+4	4E-5	1E-7	---	---
Germanium-77						
D, see ^{66}Ge	9E+3	1E+4	4E-6	1E-8	1E-4	1E-3

W, see ^{66}Ge	---	6E+3	2E-6	8E-9	---	---
Germanium-78[2]						
D, see ^{66}Ge	2E+4	2E+4	9E-6	3E-8	---	---
	Stom (2E+4)	---	---	---	3E-4	3E-3
W, see ^{66}Ge	---	2E+4	9E-6	3E-8	---	---
AN 33						
Arsenic-69[2]						
W, all compounds	3E+4	1E+5	5E-5	2E-7	---	---
	Stom (4E+4)	---	---	---	6E-4	6E-3
Arsenic-70[2]						
W, all compounds	1E+4	5E+4	2E-5	7E-8	2E-4	2E-3
Arsenic-71						
W, all compounds	4E+3	5E+3	2E-6	6E-9	5E-5	5E-4
Arsenic-72						
W, all compounds	9E+2	1E+3	6E-7	2E-9	1E-5	1E-4
Arsenic-73						
W, all compounds	8E+3	2E+3	7E-7	2E-9	1E-4	1E-3
Arsenic-74						
W, all compounds	1E+3	8E+2	3E-7	1E-9	2E-5	2E-4
Arsenic-76						

W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
Arsenic-77						
W, all compounds	4E+3	5E+3	2E-6	7E-9	---	---
	LLI (5E+3)	---	---	---	6E-5	6E-4
Arsenic-78[2]						
W, all compounds	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
AN 34						
Selenium-70[2]						
D, all compounds except those given for W	2E+4	4E+4	2E-5	5E-8	1E-4	1E-3
W, oxides, hydroxides, carbides, and elemental Se	1E+4	4E+4	2E-5	6E-8	---	---
Selenium-73m[2]						
D, see ^{70}Se	6E+4	2E+5	6E-5	2E-7	4E-4	4E-3
W, see ^{70}Se	3E+4	1E+5	6E-5	2E-7	---	---
Selenium-73						
D, see ^{70}Se	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
W, see ^{70}Se	---	2E+4	7E-6	2E-8	---	---
Selenium-75						
D, see ^{70}Se	5E+2	7E+2	3E-7	1E-9	7E-6	7E-5
W, see ^{70}Se	---	6E+2	3E-7	8E-10	---	---
Selenium-79						
D, see ^{70}Se	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5

W, see ^{70}Se	---	6E+2	2E-7	8E-10	---	---
Selenium-81m[2]						
D, see ^{70}Se	4E+4	7E+4	3E-5	9E-8	3E-4	3E-3
W, see ^{70}Se	2E+4	7E+4	3E-5	1E-7	---	---
Selenium-81[2]						
D, see ^{70}Se	6E+4	2E+5	9E-5	3E-7	---	---
	Stom (8E+4)	---	---	---	1E-3	1E-2
W, see ^{70}Se	---	2E+5	1E-4	3E-7	---	---
Selenium-83[2]						
D, see ^{70}Se	4E+4	1E+5	5E-5	2E-7	4E-4	4E-3
W, see ^{70}Se	3E+4	1E+5	5E-5	2E-7	---	---
AN 35						
Bromine-74m[2]						
D, bromides of H, Li, Na, K, Rb, Cs, and Fr	1E+4	4E+4	2E-5	5E-8	---	---
	Stom (2E+4)	---	---	---	3E-4	3E-3
W, bromides of lanthanides, Be, Mg, Ca, Sr, Ba, Ra, Al, Ga, In, Tl, Ge, Sn, Pb, As, Sb, Bi, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, Sc, Y, Ti, Zr, Hf, V, Nb, Ta, Mn, Tc, and Re	---	4E+4	2E-5	6E-8	---	---
Bromine-74[2]						
D, see ^{74m}Br	2E+4	7E+4	3E-5	1E-7	---	---

	Stom (4E+4)	---	---	---	5E-4	5E-3
W, see ^{74m}Br	---	8E+4	4E-5	1E-7	---	---
Bromine-75[2]						
D, see ^{74m}Br	3E+4	5E+4	2E-5	7E-8	---	---
	Stom (4E+4)	---	---	---	5E-4	5E-3
W, see ^{74m}Br	---	5E+4	2E-5	7E-8	---	---
Bromine-76						
D, see ^{74m}Br	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
W, see ^{74m}Br	---	4E+3	2E-6	6E-9	---	---
Bromine-77						
D, see ^{74m}Br	2E+4	2E+4	1E-5	3E-8	2E-4	2E-3
W, see ^{74m}Br	---	2E+4	8E-6	3E-8	---	---
Bromine-80m						
D, see ^{74m}Br	2E+4	2E+4	7E-6	2E-8	3E-4	3E-3
W, see ^{74m}Br	---	1E+4	6E-6	2E-8	---	---
Bromine-80[2]						
D, see ^{74m}Br	5E+4	2E+5	8E-5	3E-7	---	---
	Stom (9E+4)	---	---	---	1E-3	1E-2
W, see ^{74m}Br	---	2E+5	9E-5	3E-7	---	---
Bromine-82						
D, see ^{74m}Br	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4

W, see ^{74m}Br	---	4E+3	2E-6	5E-9	---	---
Bromine-83						
D, see ^{74m}Br	5E+4	6E+4	3E-5	9E-8	---	---
	Stom (7E+4)	---	---	---	9E-4	9E-3
W, see ^{74m}Br	---	6E+4	3E-5	9E-8	---	---
Bromine-84[2]						
D, see ^{74m}Br	2E+4	6E+4	2E-5	8E-8	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
W, see ^{74m}Br	---	6E+4	3E-5	9E-8	---	---
AN 36						
Krypton-74[2]						
Submersion[1]	---	---	3E-6	1E-8	---	---
Krypton-76						
Submersion[1]	---	---	9E-6	4E-8	---	---
Krypton-77[2]						
Submersion[1]	---	---	4E-6	2E-8	---	---
Krypton-79						
Submersion[1]	---	---	2E-5	7E-8	---	---
Krypton-81						
Submersion[1]	---	---	7E-4	3E-6	---	---
Krypton-83m[2]						

Submersion[1]	---	---	1E-2	5E-5	---	---
Krypton-85m						
Submersion[1]	---	---	2E-5	1E-7	---	---
Krypton-85						
Submersion[1]	---	---	1E-4	7E-7	---	---
Krypton-87[2]						
Submersion[1]	---	---	5E-6	2E-8	---	---
Krypton-88						
Submersion[1]	---	---	2E-6	9E-9	---	---
AN 37						
Rubidium-79[2]						
D, all compounds	4E+4	1E+5	5E-5	2E-7	---	---
	Stom (6E+4)	---	---	---	8E-4	8E-3
Rubidium-81m[2]						
D, all compounds	2E+5	3E+5	1E-4	5E-7	---	---
	Stom (3E+5)	---	---	---	4E-3	4E-2
Rubidium-81						
D, all compounds	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
Rubidium-82m						
D, all compounds	1E+4	2E+4	7E-6	2E-8	2E-4	2E-3

Rubidium-83						
D, all compounds	6E+2	1E+3	4E-7	1E-9	9E-6	9E-5
Rubidium-84						
D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
Rubidium-86						
D, all compounds	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
Rubidium-87						
D, all compounds	1E+3	2E+3	6E-7	2E-9	1E-5	1E-4
Rubidium-88[2]						
D, all compounds	2E+4	6E+4	3E-5	9E-8	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
Rubidium-89[2]						
D, all compounds	4E+4	1E+5	6E-5	2E-7	---	---
	Stom (6E+4)	---	---	---	9E-4	9E-3
AN 38						
Strontium-80[2]						
D, all soluble compounds except $SrTiO_3$	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
Y, all insoluble compounds and $SrTiO_3$	---	1E+4	5E-6	2E-8	---	---
Strontium-81[2]						
D, see ^{80}Sr	3E+4	8E+4	3E-5	1E-7	3E-4	3E-3

Y, see ^{80}Sr	2E+4	8E+4	3E-5	1E-7	---	---
Strontium-82						
D, see ^{80}Sr	3E+2	4E+2	2E-7	6E-10	---	---
	LLI (2E+2)	---	---	---	3E-6	3E-5
Y, see ^{80}Sr	2E+2	9E+1	4E-8	1E-10	---	---
Strontium-83						
D, see ^{80}Sr	3E+3	7E+3	3E-6	1E-8	3E-5	3E-4
Y, see ^{80}Sr	2E+3	4E+3	1E-6	5E-9	---	---
Strontium-85m^{2}						
D, see ^{80}Sr	2E+5	6E+5	3E-4	9E-7	3E-3	3E-2
Y, see ^{80}Sr	---	8E+5	4E-4	1E-6	---	---
Strontium-85						
D, see ^{80}Sr	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
Y, see ^{80}Sr	---	2E+3	6E-7	2E-9	---	---
Strontium-87m						
D, see ^{80}Sr	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
Y, see ^{80}Sr	4E+4	2E+5	6E-5	2E-7	---	---
Strontium-89						
D, see ^{80}Sr	6E+2	8E+2	4E-7	1E-9	---	---
	LLI (6E+2)	---	---	---	8E-6	8E-5
Y, see ^{80}Sr	5E+2	1E+2	6E-8	2E-10	---	---
Strontium-90						

D, see ^{80}Sr	3E+1	2E+1	8E-9	---	---	---
	Bone (4E+1)	Bone (2E+1)	---	3E-11	5E-7	5E-6
Y, see ^{80}Sr	---	4E+0	2E-9	6E-12	---	---
Strontium-91						
D, see ^{80}Sr	2E+3	6E+3	2E-6	8E-9	2E-5	2E-4
Y, see ^{80}Sr	---	4E+3	1E-6	5E-9	---	---
Strontium-92						
D, see ^{80}Sr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
Y, see ^{80}Sr	---	7E+3	3E-6	9E-9	---	---
AN 39						
Yttrium-86m[2]						
W, all compounds except those given for Y	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
Y, oxides and hydroxides	---	5E+4	2E-5	8E-8	---	---
Yttrium-86						
W, see ^{86m}Y	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4
Y, see ^{86m}Y	---	3E+3	1E-6	5E-9	---	---
Yttrium-87						
W, see ^{86m}Y	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
Y, see ^{86m}Y	---	3E+3	1E-6	5E-9	---	---
Yttrium-88						
W, see ^{86m}Y	1E+3	3E+2	1E-7	3E-10	1E-5	1E-4
Y, see ^{86m}Y	---	2E+2	1E-7	3E-10	---	---

Yttrium-90m						
W, see ^{86m}Y	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
Y, see ^{86m}Y	---	1E+4	5E-6	2E-8	---	---
Yttrium-90						
W, see ^{86m}Y	4E+2	7E+2	3E-7	9E-10	---	---
	LLI (5E+2)	---	---	---	7E-6	7E-5
Y, see ^{86m}Y	---	6E+2	3E-7	9E-10	---	---
Yttrium-91m[2]						
W, see ^{86m}Y	1E+5	2E+5	1E-4	3E-7	2E-3	2E-2
Y, see ^{86m}Y	---	2E+5	7E-5	2E-7	---	---
Yttrium-91						
W, see ^{86m}Y	5E+2	2E+2	7E-8	2E-10	---	---
	LLI (6E+2)	---	---	---	8E-6	8E-5
Y, see ^{86m}Y	---	1E+2	5E-8	2E-10	---	---
Yttrium-92						
W, see ^{86m}Y	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
Y, see ^{86m}Y	---	8E+3	3E-6	1E-8	---	---
Yttrium-93						
W, see ^{86m}Y	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
Y, see ^{86m}Y	---	2E+3	1E-6	3E-9	---	---
Yttrium-94[2]						
W, see ^{86m}Y	2E+4	8E+4	3E-5	1E-7	---	---

	Stom (3E+4)	---	---	---	4E-4	4E-3
Y, see ^{86m}Y	---	8E+4	3E-5	1E-7	---	---
Yttrium-95[2]						
W, see ^{86m}Y	4E+4	2E+5	6E-5	2E-7	---	---
	Stom (5E+4)	---	---	---	7E-4	7E-3
Y, see ^{86m}Y	---	1E+5	6E-5	2E-7	---	---

AN 40

Zirconium-86						
D, all compounds except those given for W and Y	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
W, oxides, hydroxides, halides, and nitrates	---	3E+3	1E-6	4E-9	---	---
Y, carbide	---	2E+3	1E-6	3E-9	---	---
Zirconium-88						
D, see ^{86}Zr	4E+3	2E+2	9E-8	3E-10	5E-5	5E-4
W, see ^{86}Zr	---	5E+2	2E-7	7E-10	---	---
Y, see ^{86}Zr	---	3E+2	1E-7	4E-10	---	---
Zirconium-89						
D, see ^{86}Zr	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
W, see ^{86}Zr	---	2E+3	1E-6	3E-9	---	---
Y, see ^{86}Zr	---	2E+3	1E-6	3E-9	---	---
Zirconium-93						
D, see ^{86}Zr	1E+3	6E+0	3E-9	---	---	---

	Bone (3E+3)	Bone (2E+1)	---	2E-11	4E-5	4E-4
W, see ^{86}Zr	---	2E+1	1E-8	---	---	---
	---	Bone (6E+1)	---	9E-11	---	---
Y, see ^{86}Zr	---	6E+1	2E-8	---	---	---
	---	Bone (7E+1)	---	9E-11	---	---
Zirconium-95						
D, see ^{86}Zr	1E+3	1E+2	5E-8	---	2E-5	2E-4
	---	Bone (3E+2)	---	4E-10	---	---
W, see ^{86}Zr	---	4E+2	2E-7	5E-10	---	---
Y, see ^{86}Zr	---	3E+2	1E-7	4E-10	---	---
Zirconium-97						
D, see ^{86}Zr	6E+2	2E+3	8E-7	3E-9	9E-6	9E-5
W, see ^{86}Zr	---	1E+3	6E-7	2E-9	---	---
Y, see ^{86}Zr	---	1E+3	5E-7	2E-9	---	---
AN 41						
Niobium-88[2]						
W, all compounds except those given for Y	5E+4	2E+5	9E-5	3E-7	---	---
	Stom (7E+4)	---	---	---	1E-3	1E-2
Y, oxides and hydroxides	---	2E+5	9E-5	3E-7	---	---
Niobium-89[2] (66 min)						
W, see ^{88}Nb	1E+4	4E+4	2E-5	6E-8	1E-4	1E-3

Y, see ^{88}Nb	---	4E+4	2E-5	5E-8	---	---
Niobium-89 (122 min)						
W, see ^{88}Nb	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
Y, see ^{88}Nb	---	2E+4	6E-6	2E-8	---	---
Niobium-90						
W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
Y, see ^{88}Nb	---	2E+3	1E-6	3E-9	---	---
Niobium-93m						
W, see ^{88}Nb	9E+3	2E+3	8E-7	3E-9	---	---
	LLI (1E+4)	---	---	---	2E-4	2E-3
Y, see ^{88}Nb	---	2E+2	7E-8	2E-10	---	---
Niobium-94						
W, see ^{88}Nb	9E+2	2E+2	8E-8	3E-10	1E-5	1E-4
Y, see ^{88}Nb	---	2E+1	6E-9	2E-11	---	---
Niobium-95m						
W, see ^{88}Nb	2E+3	3E+3	1E-6	4E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
Y, see ^{88}Nb	---	2E+3	9E-7	3E-9	---	---
Niobium-95						
W, see ^{88}Nb	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
Y, see ^{88}Nb	---	1E+3	5E-7	2E-9	---	---
Niobium-96						

W, see ^{88}Nb	1E+3	3E+3	1E-6	4E-9	2E-5	2E-4
Y, see ^{88}Nb	---	2E+3	1E-6	3E-9	---	---
Niobium-97[2]						
W, see ^{88}Nb	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
Y, see ^{88}Nb	---	7E+4	3E-5	1E-7	---	---
Niobium-98[2]						
W, see ^{88}Nb	1E+4	5E+4	2E-5	8E-8	2E-4	2E-3
Y, see ^{88}Nb	---	5E+4	2E-5	7E-8	---	---
AN 42						
Molybdenum-90						
D, all compounds except those given for Y	4E+3	7E+3	3E-6	1E-8	3E-5	3E-4
Y, oxides, hydroxides, and MoS_2	2E+3	5E+3	2E-6	6E-9	---	---
Molybdenum-93m						
D, see ^{90}Mo	9E+3	2E+4	7E-6	2E-8	6E-5	6E-4
Y, see ^{90}Mo	4E+3	1E+4	6E-6	2E-8	---	---
Molybdenum-93						
D, see ^{90}Mo	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
Y, see ^{90}Mo	2E+4	2E+2	8E-8	2E-10	---	---
Molybdenum-99						
D, see ^{90}Mo	2E+3	3E+3	1E-6	4E-9	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4
Y, see ^{90}Mo	1E+3	1E+3	6E-7	2E-9	---	---

Molybdenum-101[2]						
D, see ^{90}Mo	4E+4	1E+5	6E-5	2E-7	---	---
	Stom (5E+4)	---	---	---	7E-4	7E-3
Y, see ^{90}Mo	---	1E+5	6E-5	2E-7	---	---
AN 43						
Technetium-93m[2]						
D, all compounds except those given for W	7E+4	2E+5	6E-5	2E-7	1E-3	1E-2
W, oxides, hydroxides, halides, and nitrates	---	3E+5	1E-4	4E-7	---	---
Technetium-93						
D, see ^{93m}Tc	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
W, see ^{93m}Tc	---	1E+5	4E-5	1E-7	---	---
Technetium-94m[2]						
D, see ^{93m}Tc	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
W, see ^{93m}Tc	---	6E+4	2E-5	8E-8	---	---
Technetium-94						
D, see ^{93m}Tc	9E+3	2E+4	8E-6	3E-8	1E-4	1E-3
W, see ^{93m}Tc	---	2E+4	1E-5	3E-8	---	---
Technetium-95m						
D, see ^{93m}Tc	4E+3	5E+3	2E-6	8E-9	5E-5	5E-4
W, see ^{93m}Tc	---	2E+3	8E-7	3E-9	---	---
Technetium-95						

D, see ^{93m}Tc	1E+4	2E+4	9E-6	3E-8	1E-4	1E-3
W, see ^{93m}Tc	---	2E+4	8E-6	3E-8	---	---
Technetium-96m[2]						
D, see ^{93m}Tc	2E+5	3E+5	1E-4	4E-7	2E-3	2E-2
W, see ^{93m}Tc	---	2E+5	1E-4	3E-7	---	---
Technetium-96						
D, see ^{93m}Tc	2E+3	3E+3	1E-6	5E-9	3E-5	3E-4
W, see ^{93m}Tc	---	2E+3	9E-7	3E-9	---	---
Technetium-97m						
D, see ^{93m}Tc	5E+3	7E+3	3E-6	---	6E-5	6E-4
	---	Stom (7E+3)	---	1E-8	---	---
W, see ^{93m}Tc	---	1E+3	5E-7	2E-9	---	---
Technetium-97						
D, see ^{93m}Tc	4E+4	5E+4	2E-5	7E-8	5E-4	5E-3
W, see ^{93m}Tc	---	6E+3	2E-6	8E-9	---	---
Technetium-98						
D, see ^{93m}Tc	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
W, see ^{93m}Tc	---	3E+2	1E-7	4E-10	---	---
Technetium-99m						
D, see ^{93m}Tc	8E+4	2E+5	6E-5	2E-7	1E-3	1E-2
W, see ^{93m}Tc	---	2E+5	1E-4	3E-7	---	---
Technetium-99						

D, see ^{93m}Tc	4E+3	5E+3	2E-6	---	6E-5	6E-4
	---	Stom (6E+3)	---	8E-9	---	---
W, see ^{93m}Tc	---	7E+2	3E-7	9E-10	---	---
Technetium-101[2]						
D, see ^{93m}Tc	9E+4	3E+5	1E-4	5E-7	---	---
	Stom (1E+5)	---	---	---	2E-3	2E-2
W, see ^{93m}Tc	---	4E+5	2E-4	5E-7	---	---
Technetium-104[2]						
D, see ^{93m}Tc	2E+4	7E+4	3E-5	1E-7	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
W, see ^{93m}Tc	---	9E+4	4E-5	1E-7	---	---
AN 44						
Ruthenium-94[2]						
D, all compounds except those given for W and Y	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, halides	---	6E+4	3E-5	9E-8	---	---
Y, oxides and hydroxides	---	6E+4	2E-5	8E-8	---	---
Ruthenium-97						
D, see ^{94}Ru	8E+3	2E+4	8E-6	3E-8	1E-4	1E-3
W, see ^{94}Ru	---	1E+4	5E-6	2E-8	---	---
Y, see ^{94}Ru	---	1E+4	5E-6	2E-8	---	---
Ruthenium-103						

D, see ^{94}Ru	2E+3	2E+3	7E-7	2E-9	3E-5	3E-4
W, see ^{94}Ru	---	1E+3	4E-7	1E-9	---	---
Y, see ^{94}Ru	---	6E+2	3E-7	9E-10	---	---
Ruthenium-105						
D, see ^{94}Ru	5E+3	1E+4	6E-6	2E-8	7E-5	7E-4
W, see ^{94}Ru	---	1E+4	6E-6	2E-8	---	---
Y, see ^{94}Ru	---	1E+4	5E-6	2E-8	---	---
Ruthenium-106						
D, see ^{94}Ru	2E+2	9E+1	4E-8	1E-10	---	---
	LLI (2E+2)	---	---	---	3E-6	3E-5
W, see ^{94}Ru	---	5E+1	2E-8	8E-11	---	---
Y, see ^{94}Ru	---	1E+1	5E-9	2E-11	---	---

AN 45

Rhodium-99m						
D, all compounds except those given for W and Y	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3
W, halides	---	8E+4	3E-5	1E-7	---	---
Y, oxides and hydroxides	---	7E+4	3E-5	9E-8	---	---
Rhodium-99						
D, see ^{99m}Rh	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
W, see ^{99m}Rh	---	2E+3	9E-7	3E-9	---	---
Y, see ^{99m}Rh	---	2E+3	8E-7	3E-9	---	---
Rhodium-100						
D, see ^{99m}Rh	2E+3	5E+3	2E-6	7E-9	2E-5	2E-4

W, see ^{99m}Rh	---	4E+3	2E-6	6E-9	---	---
Y, see ^{99m}Rh	---	4E+3	2E-6	5E-9	---	---
Rhodium-101m						
D, see ^{99m}Rh	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
W, see ^{99m}Rh	---	8E+3	4E-6	1E-8	---	---
Y, see ^{99m}Rh	---	8E+3	3E-6	1E-8	---	---
Rhodium-101						
D, see ^{99m}Rh	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4
W, see ^{99m}Rh	---	8E+2	3E-7	1E-9	---	---
Y, see ^{99m}Rh	---	2E+2	6E-8	2E-10	---	---
Rhodium-102m						
D, see ^{99m}Rh	1E+3	5E+2	2E-7	7E-10	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4
W, see ^{99m}Rh	---	4E+2	2E-7	5E-10	---	---
Y, see ^{99m}Rh	---	1E+2	5E-8	2E-10	---	---
Rhodium-102						
D, see ^{99m}Rh	6E+2	9E+1	4E-8	1E-10	8E-6	8E-5
W, see ^{99m}Rh	---	2E+2	7E-8	2E-10	---	---
Y, see ^{99m}Rh	---	6E+1	2E-8	8E-11	---	---
Rhodium-103m^2						
D, see ^{99m}Rh	4E+5	1E+6	5E-4	2E-6	6E-3	6E-2
W, see ^{99m}Rh	---	1E+6	5E-4	2E-6	---	---
Y, see ^{99m}Rh	---	1E+6	5E-4	2E-6	---	---
Rhodium-105						

D, see ^{99m}Rh	4E+3	1E+4	5E-6	2E-8	---	---
	LLI (4E+3)	---	---	---	5E-5	5E-4
W, see ^{99m}Rh	---	6E+3	3E-6	9E-9	---	---
Y, see ^{99m}Rh	---	6E+3	2E-6	8E-9	---	---
Rhodium-106m						
D, see ^{99m}Rh	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3
W, see ^{99m}Rh	---	4E+4	2E-5	5E-8	---	---
Y, see ^{99m}Rh	---	4E+4	1E-5	5E-8	---	---
Rhodium-107[2]						
D, see ^{99m}Rh	7E+4	2E+5	1E-4	3E-7	---	---
	Stom (9E+4)	---	---	---	1E-3	1E-2
W, see ^{99m}Rh	---	3E+5	1E-4	4E-7	---	---
Y, see ^{99m}Rh	---	3E+5	1E-4	3E-7	---	---
AN 46						
Palladium-100						
D, all compounds except those given for W and Y	1E+3	1E+3	6E-7	2E-9	2E-5	2E-4
W, nitrates	---	1E+3	5E-7	2E-9	---	---
Y, oxides and hydroxides	---	1E+3	6E-7	2E-9	---	---
Palladium-101						
D, see ^{100}Pd	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
W, see ^{100}Pd	---	3E+4	1E-5	5E-8	---	---
Y, see ^{100}Pd	---	3E+4	1E-5	4E-8	---	---
Palladium-103						

D, see ^{100}Pd	6E+3	6E+3	3E-6	9E-9	---	---
	LLI (7E+3)	---	---	---	1E-4	1E-3
W, see ^{100}Pd	---	4E+3	2E-6	6E-9	---	---
Y, see ^{100}Pd	---	4E+3	1E-6	5E-9	---	---
Palladium-107						
D, see ^{100}Pd	3E+4	2E+4	9E-6	---	---	---
	LLI (4E+4)	Kid (2E+4)	---	3E-8	5E-4	5E-3
W, see ^{100}Pd	---	7E+3	3E-6	1E-8	---	---
Y, see ^{100}Pd	---	4E+2	2E-7	6E-10	---	---
Palladium-109						
D, see ^{100}Pd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
W, see ^{100}Pd	---	5E+3	2E-6	8E-9	---	---
Y, see ^{100}Pd	---	5E+3	2E-6	6E-9	---	---

AN 47

Silver-102[2]						
D, all compounds except those given for W and Y	5E+4	2E+5	8E-5	2E-7	---	---
	Stom (6E+4)	---	---	---	9E-4	9E-3
W, nitrates and sulfides	---	2E+5	9E-5	3E-7	---	---
Y, oxides and hydroxides	---	2E+5	8E-5	3E-7	---	---
Silver-103[2]						
D, see ^{102}Ag	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
W, see ^{102}Ag	---	1E+5	5E-5	2E-7	---	---
Y, see ^{102}Ag	---	1E+5	5E-5	2E-7	---	---

Silver-104m[2]						
D, see [102]Ag	3E+4	9E+4	4E-5	1E-7	4E-4	4E-3
W, see [102]Ag	---	1E+5	5E-5	2E-7	---	---
Y, see [102]Ag	---	1E+5	5E-5	2E-7	---	---
Silver-104[2]						
D, see [102]Ag	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
W, see [102]Ag	---	1E+5	6E-5	2E-7	---	---
Y, see [102]Ag	---	1E+5	6E-5	2E-7	---	---
Silver-105						
D, see [102]Ag	3E+3	1E+3	4E-7	1E-9	4E-5	4E-4
W, see [102]Ag	---	2E+3	7E-7	2E-9	---	---
Y, see [102]Ag	---	2E+3	7E-7	2E-9	---	---
Silver-106m						
D, see [102]Ag	8E+2	7E+2	3E-7	1E-9	1E-5	1E-4
W, see [102]Ag	---	9E+2	4E-7	1E-9	---	---
Y, see [102]Ag	---	9E+2	4E-7	1E-9	---	---
Silver-106[2]						
D, see [102]Ag	6E+4	2E+5	8E-5	3E-7	---	---
	Stom (6E+4)	---	---	---	9E-4	9E-3
W, see [102]Ag	---	2E+5	9E-5	3E-7	---	---
Y, see [102]Ag	---	2E+5	8E-5	3E-7	---	---
Silver-108m						
D, see [102]Ag	6E+2	2E+2	8E-8	3E-10	9E-6	9E-5

W, see ^{102}Ag	---	3E+2	1E-7	4E-10	---	---
Y, see ^{102}Ag	---	2E+1	1E-8	3E-11	---	---
Silver-110m						
D, see ^{102}Ag	5E+2	1E+2	5E-8	2E-10	6E-6	6E-5
W, see ^{102}Ag	---	2E+2	8E-8	3E-10	---	---
Y, see ^{102}Ag	---	9E+1	4E-8	1E-10	---	---
Silver-111						
D, see ^{102}Ag	9E+2	2E+3	6E-7	---	---	---
	LLI (1E+3)	Liver (2E+3)	---	2E-9	2E-5	2E-4
W, see ^{102}Ag	---	9E+2	4E-7	1E-9	---	---
Y, see ^{102}Ag	---	9E+2	4E-7	1E-9	---	---
Silver-112						
D, see ^{102}Ag	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
W, see ^{102}Ag	---	1E+4	4E-6	1E-8	---	---
Y, see ^{102}Ag	---	9E+3	4E-6	1E-8	---	---
Silver-115[2]						
D, see ^{102}Ag	3E+4	9E+4	4E-5	1E-7	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
W, see ^{102}Ag	---	9E+4	4E-5	1E-7	---	---
Y, see ^{102}Ag	---	8E+4	3E-5	1E-7	---	---

AN 48

Cadmium-104[2]

D, all compounds except those given for W and Y	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
W, sulfides, halides, and nitrates	---	1E+5	5E-5	2E-7	---	---
Y, oxides and hydroxides	---	1E+5	5E-5	2E-7	---	---
Cadmium-107						
D, see ^{104}Cd	2E+4	5E+4	2E-5	8E-8	3E-4	3E-3
W, see ^{104}Cd	---	6E+4	2E-5	8E-8	---	---
Y, see ^{104}Cd	---	5E+4	2E-5	7E-8	---	---
Cadmium-109						
D, see ^{104}Cd	3E+2	4E+1	1E-8	---	---	---
	Kid (4E+2)	Kid (5E+1)	---	7E-11	6E-6	6E-5
W, see ^{104}Cd	---	1E+2	5E-8	---	---	---
	---	Kid (1E+2)	---	2E-10	---	---
Y, see ^{104}Cd	---	1E+2	5E-8	2E-10	---	---
Cadmium-113m						
D, see ^{104}Cd	2E+1	2E+0	1E-9	---	---	---
	Kid (4E+1)	Kid (4E+0)	---	5E-12	5E-7	5E-6
W, see ^{104}Cd	---	8E+0	4E-9	---	---	---
	---	Kid (1E+1)	---	2E-11	---	---
Y, see ^{104}Cd	---	1E+1	5E-9	2E-11	---	---
Cadmium-113						
D, see ^{104}Cd	2E+1	2E+0	9E-10	---	---	---
	Kid (3E+1)	Kid (3E+0)	---	5E-12	4E-7	4E-6
W, see ^{104}Cd	---	8E+0	3E-9	---	---	---
	---	Kid (1E+1)	---	2E-11	---	---

Y, see ^{104}Cd	---	1E+1	6E-9	2E-11	---	---
Cadmium-115m						
D, see ^{104}Cd	3E+2	5E+1	2E-8	---	4E-6	4E-5
	---	Kid (8E+1)	---	1E-10	---	---
W, see ^{104}Cd	---	1E+2	5E-8	2E-10	---	---
Y, see ^{104}Cd	---	1E+2	6E-8	2E-10	---	---
Cadmium-115						
D, see ^{104}Cd	9E+2	1E+3	6E-7	2E-9	---	---
	LLI (1E+3)	---	---	---	1E-5	1E-4
W, see ^{104}Cd	---	1E+3	5E-7	2E-9	---	---
Y, see ^{104}Cd	---	1E+3	6E-7	2E-9	---	---
Cadmium-117m						
D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
W, see ^{104}Cd	---	2E+4	7E-6	2E-8	---	---
Y, see ^{104}Cd	---	1E+4	6E-6	2E-8	---	---
Cadmium-117						
D, see ^{104}Cd	5E+3	1E+4	5E-6	2E-8	6E-5	6E-4
W, see ^{104}Cd	---	2E+4	7E-6	2E-8	---	---
Y, see ^{104}Cd	---	1E+4	6E-6	2E-8	---	---
AN 49						
Indium-109						
D, all compounds except those given for W	2E+4	4E+4	2E-5	6E-8	3E-4	3E-3
W, oxides, hydroxides, halides, and nitrates	---	6E+4	3E-5	9E-8	---	---

Indium-110[2] (69.1 min)						
D, see ^{109}In	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{109}In	---	6E+4	2E-5	8E-8	---	---
Indium-110 (4.9 h)						
D, see ^{109}In	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4
W, see ^{109}In	---	2E+4	8E-6	3E-8	---	---
Indium-111						
D, see ^{109}In	4E+3	6E+3	3E-6	9E-9	6E-5	6E-4
W, see ^{109}In	---	6E+3	3E-6	9E-9	---	---
Indium-112[2]						
D, see ^{109}In	2E+5	6E+5	3E-4	9E-7	2E-3	2E-2
W, see ^{109}In	---	7E+5	3E-4	1E-6	---	---
Indium-113m[2]						
D, see ^{109}In	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
W, see ^{109}In	---	2E+5	8E-5	3E-7	---	---
Indium-114m						
D, see ^{109}In	3E+2	6E+1	3E-8	9E-11	---	---
	LLI (4E+2)	---	---	---	5E-6	5E-5
W, see ^{109}In	---	1E+2	4E-8	1E-10	---	---
Indium-115m						
D, see ^{109}In	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{109}In	---	5E+4	2E-5	7E-8	---	---

Indium-115						
D, see ^{109}In	4E+1	1E+0	6E-10	2E-12	5E-7	5E-6
W, see ^{109}In	---	5E+0	2E-9	8E-12	---	---
Indium-116m[2]						
D, see ^{109}In	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
W, see ^{109}In	---	1E+5	5E-5	2E-7	---	---
Indium-117m[2]						
D, see ^{109}In	1E+4	3E+4	1E-5	5E-8	2E-4	2E-3
W, see ^{109}In	---	4E+4	2E-5	6E-8	---	---
Indium-117[2]						
D, see ^{109}In	6E+4	2E+5	7E-5	2E-7	8E-4	8E-3
W, see ^{109}In	---	2E+5	9E-5	3E-7	---	---
Indium-119m[2]						
D, see ^{109}In	4E+4	1E+5	5E-5	2E-7	---	---
	Stom (5E+4)	---	---	---	7E-4	7E-3
W, see ^{109}In	---	1E+5	6E-5	2E-7	---	---
AN 50						
Tin-110						
D, all compounds except those given for W	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
W, sulfides, oxides, hydroxides, halides, nitrates, and stannic phosphate	---	1E+4	5E-6	2E-8	---	---
Tin-111[2]						

D, see ^{110}Sn	7E+4	2E+5	9E-5	3E-7	1E-3	1E-2
W, see ^{110}Sn	---	3E+5	1E-4	4E-7	---	---
Tin-113						
D, see ^{110}Sn	2E+3	1E+3	5E-7	2E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
W, see ^{110}Sn	---	5E+2	2E-7	8E-10	---	---
Tin-117m						
D, see ^{110}Sn	2E+3	1E+3	5E-7	---	---	---
	LLI (2E+3)	Bone (2E+3)	---	3E-9	3E-5	3E-4
W, see ^{110}Sn	---	1E+3	6E-7	2E-9	---	---
Tin-119m						
D, see ^{110}Sn	3E+3	2E+3	1E-6	3E-9	---	---
	LLI (4E+3)	---	---	---	6E-5	6E-4
W, see ^{110}Sn	---	1E+3	4E-7	1E-9	---	---
Tin-121m						
D, see ^{110}Sn	3E+3	9E+2	4E-7	1E-9	---	---
	LLI (4E+3)	---	---	---	5E-5	5E-4
W, see ^{110}Sn	---	5E+2	2E-7	8E-10	---	---
Tin-121						
D, see ^{110}Sn	6E+3	2E+4	6E-6	2E-8	---	---
	LLI (6E+3)	---	---	---	8E-5	8E-4
W, see ^{110}Sn	---	1E+4	5E-6	2E-8	---	---
Tin-123m^{2}						

D, see ^{110}Sn	5E+4	1E+5	5E-5	2E-7	7E-4	7E-3
W, see ^{110}Sn	---	1E+5	6E-5	2E-7	---	---
Tin-123						
D, see ^{110}Sn	5E+2	6E+2	3E-7	9E-10	---	----
	LLI (6E+2)	---	---	---	9E-6	9E-5
W, see ^{110}Sn	---	2E+2	7E-8	2E-10	---	---
Tin-125						
D, see ^{110}Sn	4E+2	9E+2	4E-7	1E-9	---	---
	LLI (5E+2)	---	---	---	6E-6	6E-5
W, see ^{110}Sn	---	4E+2	1E-7	5E-10	---	---
Tin-126						
D, see ^{110}Sn	3E+2	6E+1	2E-8	8E-11	4E-6	4E-5
W, see ^{110}Sn	---	7E+1	3E-8	9E-11	---	---
Tin-127						
D, see ^{110}Sn	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
W, see ^{110}Sn	---	2E+4	8E-6	3E-8	---	---
Tin-128[2]						
D, see ^{110}Sn	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
W, see ^{110}Sn	---	4E+4	1E-5	5E-8	---	---

AN 51

Antimony-115[2]						
D, all compounds except those given for W	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2

W, oxides, hydroxides, halides, sulfides, sulfates, and nitrates	---	3E+5	1E-4	4E-7	---	---
Antimony-116m[2]						
D, see ^{115}Sb	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
W, see ^{115}Sb	---	1E+5	6E-5	2E-7	---	---
Antimony-116[2]						
D, see ^{115}Sb	7E+4	3E+5	1E-4	4E-7	---	---
	Stom (9E+4)	---	---	---	1E-3	1E-2
W, see ^{115}Sb	---	3E+5	1E-4	5E-7	---	---
Antimony-117						
D, see ^{115}Sb	7E+4	2E+5	9E-5	3E-7	9E-4	9E-3
W, see ^{115}Sb	---	3E+5	1E-4	4E-7	---	---
Antimony-118m						
D, see ^{115}Sb	6E+3	2E+4	8E-6	3E-8	7E-5	7E-4
W, see ^{115}Sb	5E+3	2E+4	9E-6	3E-8	---	---
Antimony-119						
D, see ^{115}Sb	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{115}Sb	2E+4	3E+4	1E-5	4E-8	---	---
Antimony-120[2] (16 min)						
D, see ^{115}Sb	1E+5	4E+5	2E-4	6E-7	---	---
	Stom (2E+5)	---	---	---	2E-3	2E-2
W, see ^{115}Sb	---	5E+5	2E-4	7E-7	---	---

Antimony-120 (5.76 d)						
D, see ^{115}Sb	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
W, see ^{115}Sb	9E+2	1E+3	5E-7	2E-9	---	---
Antimony-122						
D, see ^{115}Sb	8E+2	2E+3	1E-6	3E-9	---	---
	LLI (8E+2)	---	---	---	1E-5	1E-4
W, see ^{115}Sb	7E+2	1E+3	4E-7	2E-9	---	---
Antimony-124m^2						
D, see ^{115}Sb	3E+5	8E+5	4E-4	1E-6	3E-3	3E-2
W, see ^{115}Sb	2E+5	6E+5	2E-4	8E-7	---	---
Antimony-124						
D, see ^{115}Sb	6E+2	9E+2	4E-7	1E-9	7E-6	7E-5
W, see ^{115}Sb	5E+2	2E+2	1E-7	3E-10	---	---
Antimony-125						
D, see ^{115}Sb	2E+3	2E+3	1E-6	3E-9	3E-5	3E-4
W, see ^{115}Sb	---	5E+2	2E-7	7E-10	---	---
Antimony-126m^2						
D, see ^{115}Sb	5E+4	2E+5	8E-5	3E-7	---	---
	Stom (7E+4)	---	---	---	9E-4	9E-3
W, see ^{115}Sb	---	2E+5	8E-5	3E-7	---	---
Antimony-126						
D, see ^{115}Sb	6E+2	1E+3	5E-7	2E-9	7E-6	7E-5

W, see ^{115}Sb	5E+2	5E+2	2E-7	7E-10	---	---
Antimony-127						
D, see ^{115}Sb	8E+2	2E+3	9E-7	3E-9	---	---
	LLI (8E+2)	---	---	---	1E-5	1E-4
W, see ^{115}Sb	7E+2	9E+2	4E-7	1E-9	---	---
Antimony-128[2] (10.4 min)						
D, see ^{115}Sb	8E+4	4E+5	2E-4	5E-7	---	---
	Stom (1E+5)	---	---	---	1E-3	1E-2
W, see ^{115}Sb	---	4E+5	2E-4	6E-7	---	---
Antimony-128 (9.01 h)						
D, see ^{115}Sb	1E+3	4E+3	2E-6	6E-9	2E-5	2E-4
W, see ^{115}Sb	---	3E+3	1E-6	5E-9	---	---
Antimony-129						
D, see ^{115}Sb	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
W, see ^{115}Sb	---	9E+3	4E-6	1E-8	---	---
Antimony-130[2]						
D, see ^{115}Sb	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
W, see ^{115}Sb	---	8E+4	3E-5	1E-7	---	---
Antimony-131[2]						
D, see ^{115}Sb	1E+4	2E+4	1E-5	---	---	---
	Thyr (2E+4)	Thyr (4E+4)	---	6E-8	2E-4	2E-3

W, see ^{115}Sb	---	2E+4	1E-5	---	---	---
	---	Thyr (4E+4)	---	6E-8	---	---

AN 52

Tellurium-116						
D, all compounds except those given for W	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
W, oxides, hydroxides, and nitrates	---	3E+4	1E-5	4E-8	---	---
Tellurium-121m						
D, see ^{116}Te	5E+2	2E+2	8E-8	---	---	---
	Bone (7E+2)	Bone (4E+2)	---	5E-10	1E-5	1E-4
W, see ^{116}Te	---	4E+2	2E-7	6E-10	---	---
Tellurium-121						
D, see ^{116}Te	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
W, see ^{116}Te	---	3E+3	1E-6	4E-9	---	---
Tellurium-123m						
D, see ^{116}Te	6E+2	2E+2	9E-8	---	---	---
	Bone (1E+3)	Bone (5E+2)	---	8E-10	1E-5	1E-4
W, see ^{116}Te	---	5E+2	2E-7	8E-10	---	---
Tellurium-123						
D, see ^{116}Te	5E+2	2E+2	8E-8	---	---	---
	Bone (1E+3)	Bone (5E+2)	---	7E-10	2E-5	2E-4

W, see ^{116}Te	---	4E+2	2E-7	---	---	---
	---	Bone (1E+3)	---	2E-9	---	---
Tellurium-125m						
D, see ^{116}Te	1E+3	4E+2	2E-7	---	---	---
	Bone (1E+3)	Bone (1E+3)	---	1E-9	2E-5	2E-4
W, see ^{116}Te	---	7E+2	3E-7	1E-9	---	---
Tellurium-127m						
D, see ^{116}Te	6E+2	3E+2	1E-7	---	9E-6	9E-5
	---	Bone (4E+2)	---	6E-10	---	---
W, see ^{116}Te	---	3E+2	1E-7	4E-10	---	---
Tellurium-127						
D, see ^{116}Te	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
W, see ^{116}Te	---	2E+4	7E-6	2E-8	---	---
Tellurium-129m						
D, see ^{116}Te	5E+2	6E+2	3E-7	9E-10	7E-6	7E-5
W, see ^{116}Te	---	2E+2	1E-7	3E-10	---	---
Tellurium-129[2]						
D, see ^{116}Te	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
W, see ^{116}Te	---	7E+4	3E-5	1E-7	---	---
Tellurium-131m						
D, see ^{116}Te	3E+2	4E+2	2E-7	---	---	---

	Thyr (6E+2)	Thyr (1E+3)	---	2E-9	8E-6	8E-5
W, see ^{116}Te	---	4E+2	2E-7	---	---	---
	---	Thyr (9E+2)	---	1E-9	---	---
Tellurium-131[2]						
D, see ^{116}Te	3E+3	5E+3	2E-6	---	---	---
	Thyr (6E+3)	Thyr (1E+4)	---	2E-8	8E-5	8E-4
W, see ^{116}Te	---	5E+3	2E-6	---	---	---
	---	Thyr (1E+4)	---	2E-8	---	---
Tellurium-132						
D, see ^{116}Te	2E+2	2E+2	9E-8	---	---	---
	Thyr (7E+2)	Thyr (8E+2)	---	1E-9	9E-6	9E-5
W, see ^{116}Te	---	2E+2	9E-8	---	---	---
	---	Thyr (6E+2)	---	9E-10	---	---
Tellurium-133m[2]						
D, see ^{116}Te	3E+3	5E+3	2E-6	---	---	---
	Thyr (6E+3)	Thyr (1E+4)	---	2E-8	9E-5	9E-4
W, see ^{116}Te	---	5E+3	2E-6	---	---	---
	---	Thyr (1E+4)	---	2E-8	---	---
Tellurium-133[2]						
D, see ^{116}Te	1E+4	2E+4	9E-6	---	---	---

	Thyr (3E+4)	Thyr (6E+4)	---	8E-8	4E-4	4E-3
W, see ^{116}Te	---	2E+4	9E-6	---	---	---
	---	Thyr (6E+4)	---	8E-8	---	---
Tellurium-134[2]						
D, see ^{116}Te	2E+4	2E+4	1E-5	---	---	---
	Thyr (2E+4)	Thyr (5E+4)	---	7E-8	3E-4	3E-3
W, see ^{116}Te	---	2E+4	1E-5	---	---	---
	---	Thyr (5E+4)	---	7E-8	---	---
AN 53						
Iodine-120m[2]						
D, all compounds	1E+4	2E+4	9E-6	3E-8	---	---
	Thyr (1E+4)	---	---	---	2E-4	2E-3
Iodine-120[2]						
D, all compounds	4E+3	9E+3	4E-6	---	---	---
	Thyr (8E+3)	Thyr (1E+4)	---	2E-8	1E-4	1E-3
Iodine-121						
D, all compounds	1E+4	2E+4	8E-6	---	---	---
	Thyr (3E+4)	Thyr (5E+4)	---	7E-8	4E-4	4E-3
Iodine-123						

D, all compounds	3E+3	6E+3	3E-6	---	---	---
	Thyr (1E+4)	Thyr (2E+4)	---	2E-8	1E-4	1E-3
Iodine-124						
D, all compounds	5E+1	8E+1	3E-8	---	---	---
	Thyr (2E+2)	Thyr (3E+2)	---	4E-10	2E-6	2E-5
Iodine-125						
D, all compounds	4E+1	6E+1	3E-8	---	---	---
	Thyr (1E+2)	Thyr (2E+2)	---	3E-10	2E-6	2E-5
Iodine-126						
D, all compounds	2E+1	4E+1	1E-8	---	---	---
	Thyr (7E+1)	Thyr (1E+2)	---	2E-10	1E-6	1E-5
Iodine-128[2]						
D, all compounds	4E+4	1E+5	5E-5	2E-7	---	---
	Stom (6E+4)	---	---	---	8E-4	8E-3
Iodine-129						
D, all compounds	5E+0	9E+0	4E-9	---	---	---
	Thyr (2E+1)	Thyr (3E+1)	---	4E-11	2E-7	2E-6
Iodine-130						
D, all compounds	4E+2	7E+2	3E-7	---	---	---

	Thyr (1E+3)	Thyr (2E+3)	---	3E-9	2E-5	2E-4
Iodine-131						
D, all compounds	3E+1	5E+1	2E-8	---	---	---
	Thyr (9E+1)	Thyr (2E+2)	---	2E-10	1E-6	1E-5
Iodine-132m[2]						
D, all compounds	4E+3	8E+3	4E-6	---	---	---
	Thyr (1E+4)	Thyr (2E+4)	---	3E-8	1E-4	1E-3
Iodine-132						
D, all compounds	4E+3	8E+3	3E-6	---	---	---
	Thyr (9E+3)	Thyr (1E+4)	---	2E-8	1E-4	1E-3
Iodine-133						
D, all compounds	1E+2	3E+2	1E-7	---	---	---
	Thyr (5E+2)	Thyr (9E+2)	---	1E-9	7E-6	7E-5
Iodine-134[2]						
D, all compounds	2E+4	5E+4	2E-5	6E-8	---	---
	Thyr (3E+4)	---	---	---	4E-4	4E-3
Iodine-135						
D, all compounds	8E+2	2E+3	7E-7	---	---	---
	Thyr (3E+3)	Thyr (4E+3)	---	6E-9	3E-5	3E-4

AN 54						
Xenon-120[2]						
Submersion[1]	---	---	1E-5	4E-8	---	---
Xenon-121[2]						
Submersion[1]	---	---	2E-6	1E-8	---	---
Xenon-122						
Submersion[1]	---	---	7E-5	3E-7	---	---
Xenon-123						
Submersion[1]	---	---	6E-6	3E-8	---	---
Xenon-125						
Submersion[1]	---	---	2E-5	7E-8	---	---
Xenon-127						
Submersion[1]	---	---	1E-5	6E-8	---	---
Xenon-129m						
Submersion[1]	---	---	2E-4	9E-7	---	---
Xenon-131m						
Submersion[1]	---	---	4E-4	2E-6	---	---
Xenon-133m						
Submersion[1]	---	---	1E-4	6E-7	---	---
Xenon-133						
Submersion[1]	---	---	1E-4	5E-7	---	---

Xenon-135m[2]						
Submersion[1]	---	---	9E-6	4E-8	---	---
Xenon-135						
Submersion[1]	---	---	1E-5	7E-8	---	---
Xenon-138[2]						
Submersion[1]	---	---	4E-6	2E-8	---	---
AN 55						
Cesium-125[2]						
D, all compounds	5E+4	1E+5	6E-5	2E-7	---	---
	Stom (9E+4)	---	---	---	1E-3	1E-2
Cesium-127						
D, all compounds	6E+4	9E+4	4E-5	1E-7	9E-4	9E-3
Cesium-129						
D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
Cesium-130[2]						
D, all compounds	6E+4	2E+5	8E-5	3E-7	---	---
	Stom (1E+5)	---	---	---	1E-3	1E-2
Cesium-131						
D, all compounds	2E+4	3E+4	1E-5	4E-8	3E-4	3E-3
Cesium-132						

D, all compounds	3E+3	4E+3	2E-6	6E-9	4E-5	4E-4
Cesium-134m						
D, all compounds	1E+5	1E+5	6E-5	2E-7	---	---
	Stom (1E+5)	---	---	---	2E-3	2E-2
Cesium-134						
D, all compounds	7E+1	1E+2	4E-8	2E-10	9E-7	9E-6
Cesium-135m[2]						
D, all compounds	1E+5	2E+5	8E-5	3E-7	1E-3	1E-2
Cesium-135						
D, all compounds	7E+2	1E+3	5E-7	2E-9	1E-5	1E-4
Cesium-136						
D, all compounds	4E+2	7E+2	3E-7	9E-10	6E-6	6E-5
Cesium-137						
D, all compounds	1E+2	2E+2	6E-8	2E-10	1E-6	1E-5
Cesium-138[2]						
D, all compounds	2E+4	6E+4	2E-5	8E-8	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
AN 56						
Barium-126[2]						
D, all compounds	6E+3	2E+4	6E-6	2E-8	8E-5	8E-4

Barium-128						
D, all compounds	5E+2	2E+3	7E-7	2E-9	7E-6	7E-5
Barium-131m[2]						
D, all compounds	4E+5	1E+6	6E-4	2E-6	---	---
	Stom (5E+5)	---	---	---	7E-3	7E-2
Barium-131						
D, all compounds	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
Barium-133m						
D, all compounds	2E+3	9E+3	4E-6	1E-8	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
Barium-133						
D, all compounds	2E+3	7E+2	3E-7	9E-10	2E-5	2E-4
Barium-135m						
D, all compounds	3E+3	1E+4	5E-6	2E-8	4E-5	4E-4
Barium-139[2]						
D, all compounds	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
Barium-140						
D, all compounds	5E+2	1E+3	6E-7	2E-9	---	---
	LLI (6E+2)	---	---	---	8E-6	8E-5
Barium-141[2]						
D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3

Barium-142[2]						
D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
AN 57						
Lanthanum-131[2]						
D, all compounds except those given for W	5E+4	1E+5	5E-5	2E-7	6E-4	6E-3
W, oxides and hydroxides	---	2E+5	7E-5	2E-7	---	---
Lanthanum-132						
D, see ^{131}La	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
W, see ^{131}La	---	1E+4	5E-6	2E-8	---	---
Lanthanum-135						
D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	5E-4	5E-3
W, see ^{131}La	---	9E+4	4E-5	1E-7	---	---
Lanthanum-137						
D, see ^{131}La	1E+4	6E+1	3E-8	---	2E-4	2E-3
	---	Liver (7E+1)	---	1E-10	---	---
W, see ^{131}La	---	3E+2	1E-7	---	---	---
	---	Liver (3E+2)	---	4E-10	---	---
Lanthanum-138						
D, see ^{131}La	9E+2	4E+0	1E-9	5E-12	1E-5	1E-4
W, see ^{131}La	---	1E+1	6E-9	2E-11	---	---
Lanthanum-140						

D, see ^{131}La	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
W, see ^{131}La	---	1E+3	5E-7	2E-9	---	---
Lanthanum-141						
D, see ^{131}La	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
W, see ^{131}La	---	1E+4	5E-6	2E-8	---	---
Lanthanum-142[2]						
D, see ^{131}La	8E+3	2E+4	9E-6	3E-8	1E-4	1E-3
W, see ^{131}La	---	3E+4	1E-5	5E-8	---	---
Lanthanum-143[2]						
D, see ^{131}La	4E+4	1E+5	4E-5	1E-7	---	---
	Stom (4E+4)	---	---	---	5E-4	5E-3
W, see ^{131}La	---	9E+4	4E-5	1E-7	---	---
AN 58						
Cerium-134						
W, all compounds except those given for Y	5E+2	7E+2	3E-7	1E-9	---	---
	LLI (6E+2)	---	---	---	8E-6	8E-5
Y, oxides, hydroxides, and fluorides	---	7E+2	3E-7	9E-10	---	---
Cerium-135						
W, see ^{134}Ce	2E+3	4E+3	2E-6	5E-9	2E-5	2E-4
Y, see ^{134}Ce	---	4E+3	1E-6	5E-9	---	---
Cerium-137m						

W, see ^{134}Ce	2E+3	4E+3	2E-6	6E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
Y, see ^{134}Ce	---	4E+3	2E-6	5E-9	---	---
Cerium-137						
W, see ^{134}Ce	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
Y, see ^{134}Ce	---	1E+5	5E-5	2E-7	---	---
Cerium-139						
W, see ^{134}Ce	5E+3	8E+2	3E-7	1E-9	7E-5	7E-4
Y, see ^{134}Ce	---	7E+2	3E-7	9E-10	---	---
Cerium-141						
W, see ^{134}Ce	2E+3	7E+2	3E-7	1E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
Y, see ^{134}Ce	---	6E+2	2E-7	8E-10	---	---
Cerium-143						
W, see ^{134}Ce	1E+3	2E+3	8E-7	3E-9	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4
Y, see ^{134}Ce	---	2E+3	7E-7	2E-9	---	---
Cerium-144						
W, see ^{134}Ce	2E+2	3E+1	1E-8	4E-11	---	---
	LLI (3E+2)	---	---	---	3E-6	3E-5
Y, see ^{134}Ce	---	1E+1	6E-9	2E-11	---	---

AN 59

Praseodymium-136[2]

W, all compounds except those given for Y	5E+4	2E+5	1E-4	3E-7	---	---
	Stom (7E+4)	---	---	---	1E-3	1E-2
Y, oxides, hydroxides, carbides, and fluorides	---	2E+5	9E-5	3E-7	---	---
Praseodymium-137[2]						
W, see ^{136}Pr	4E+4	2E+5	6E-5	2E-7	5E-4	5E-3
Y, see ^{136}Pr	---	1E+5	6E-5	2E-7	---	---
Praseodymium-138m						
W, see ^{136}Pr	1E+4	5E+4	2E-5	8E-8	1E-4	1E-3
Y, see ^{136}Pr	---	4E+4	2E-5	6E-8	---	---
Praseodymium-139						
W, see ^{136}Pr	4E+4	1E+5	5E-5	2E-7	6E-4	6E-3
Y, see ^{136}Pr	---	1E+5	5E-5	2E-7	---	---
Praseodymium-142m[2]						
W, see ^{136}Pr	8E+4	2E+5	7E-5	2E-7	1E-3	1E-2
Y, see ^{136}Pr	---	1E+5	6E-5	2E-7	---	---
Praseodymium-142						
W, see ^{136}Pr	1E+3	2E+3	9E-7	3E-9	1E-5	1E-4
Y, see ^{136}Pr	---	2E+3	8E-7	3E-9	---	---
Praseodymium-143						
W, see ^{136}Pr	9E+2	8E+2	3E-7	1E-9	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4

Y, see ^{136}Pr	---	7E+2	3E-7	9E-10	---	---
Praseodymium-144[2]						
W, see ^{136}Pr	3E+4	1E+5	5E-5	2E-7	---	---
	Stom (4E+4)	---	---	---	6E-4	6E-3
Y, see ^{136}Pr	---	1E+5	5E-5	2E-7	---	---
Praseodymium-145						
W, see ^{136}Pr	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
Y, see ^{136}Pr	---	8E+3	3E-6	1E-8	---	---
Praseodymium-147[2]						
W, see ^{136}Pr	5E+4	2E+5	8E-5	3E-7	---	---
	Stom (8E+4)	---	---	---	1E-3	1E-2
Y, see ^{136}Pr	---	2E+5	8E-5	3E-7	---	---
AN 60						
Neodymium-136[2]						
W, all compounds except those given for Y	1E+4	6E+4	2E-5	8E-8	2E-4	2E-3
Y, oxides, hydroxides, carbides, and fluorides	---	5E+4	2E-5	8E-8	---	---
Neodymium-138						
W, see ^{136}Nd	2E+3	6E+3	3E-6	9E-9	3E-5	3E-4
Y, see ^{136}Nd	---	5E+3	2E-6	7E-9	---	---
Neodymium-139m						
W, see ^{136}Nd	5E+3	2E+4	7E-6	2E-8	7E-5	7E-4

Y, see ^{136}Nd	---	1E+4	6E-6	2E-8	---	---
Neodymium-139[2]						
W, see ^{136}Nd	9E+4	3E+5	1E-4	5E-7	1E-3	1E-2
Y, see ^{136}Nd	---	3E+5	1E-4	4E-7	---	---
Neodymium-141						
W, see ^{136}Nd	2E+5	7E+5	3E-4	1E-6	2E-3	2E-2
Y, see ^{136}Nd	---	6E+5	3E-4	9E-7	---	---
Neodymium-147						
W, see ^{136}Nd	1E+3	9E+2	4E-7	1E-9	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4
Y, see ^{136}Nd	---	8E+2	4E-7	1E-9	---	---
Neodymium-149[2]						
W, see ^{136}Nd	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
Y, see ^{136}Nd	---	2E+4	1E-5	3E-8	---	---
Neodymium-151[2]						
W, see ^{136}Nd	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
Y, see ^{136}Nd	---	2E+5	8E-5	3E-7	---	---
AN 61						
Promethium-141[2]						
W, all compounds except those given for Y	5E+4	2E+5	8E-5	3E-7	---	---
	Stom (6E+4)	---	---	---	8E-4	8E-3

Y, oxides, hydroxides, carbides, and fluorides	---	2E+5	7E-5	2E-7	---	---
Promethium-143						
W, see ^{141}Pm	5E+3	6E+2	2E-7	8E-10	7E-5	7E-4
Y, see ^{141}Pm	---	7E+2	3E-7	1E-9	---	---
Promethium-144						
W, see ^{141}Pm	1E+3	1E+2	5E-8	2E-10	5E-5	2E-4
Y, see ^{141}Pm	---	1E+2	5E-8	2E-10	---	---
Promethium-145						
W, see ^{141}Pm	1E+4	2E+2	7E-8	---	1E-4	1E-3
	---	Bone (2E+2)	---	3E-10	---	---
Y, see ^{141}Pm	---	2E+2	8E-8	3E-10	---	---
Promethium-146						
W, see ^{141}Pm	2E+3	5E+1	2E-8	7E-11	2E-5	2E-4
Y, see ^{141}Pm	---	4E+1	2E-8	6E-11	---	---
Promethium-147						
W, see ^{141}Pm	4E+3	1E+2	5E-8	---	---	---
	LLI (5E+3)	Bone (2E+2)	---	3E-10	7E-5	7E-4
Y, see ^{141}Pm	---	1E+2	6E-8	2E-10	---	---
Promethium-148m						
W, see ^{141}Pm	7E+2	3E+2	1E-7	4E-10	1E-5	1E-4
Y, see ^{141}Pm	---	3E+2	1E-7	5E-10	---	---

Promethium-148						
W, see ^{141}Pm	4E+2	5E+2	2E-7	8E-10	---	---
	LLI (5E+2)	---	---	---	7E-6	7E-5
Y, see ^{141}Pm	---	5E+2	2E-7	7E-10	---	---
Promethium-149						
W, see ^{141}Pm	1E+3	2E+3	8E-7	3E-9	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4
Y, see ^{141}Pm	---	2E+3	8E-7	2E-9	---	---
Promethium-150						
W, see ^{141}Pm	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
Y, see ^{141}Pm	---	2E+4	7E-6	2E-8	---	---
Promethium-151						
W, see ^{141}Pm	2E+3	4E+3	1E-6	5E-9	2E-5	2E-4
Y, see ^{141}Pm	---	3E+3	1E-6	4E-9	---	---
AN 62						
Samarium-141m[2]						
W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
Samarium-141[2]						
W, all compounds	5E+4	2E+5	8E-5	2E-7	---	---
	Stom (6E+4)	---	---	---	8E-4	8E-3
Samarium-142[2]						
W, all compounds	8E+3	3E+4	1E-5	4E-8	1E-4	1E-3

Samarium-145						
W, all compounds	6E+3	5E+2	2E-7	7E-10	8E-5	8E-4
Samarium-146						
W, all compounds	1E+1	4E-2	1E-11	---	---	---
	Bone (3E+1)	Bone (6E-2)	---	9E-14	3E-7	3E-6
Samarium-147						
W, all compounds	2E+1	4E-2	2E-11	---	---	---
	Bone (3E+1)	Bone (7E-2)	---	1E-13	4E-7	4E-6
Samarium-151						
W, all compounds	1E+4	1E+2	4E-8	---	---	---
	LLI (1E+4)	Bone (2E+2)	---	2E-10	2E-4	2E-3
Samarium-153						
W, all compounds	2E+3	3E+3	1E-6	4E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
Samarium-155[2]						
W, all compounds	6E+4	2E+5	9E-5	3E-7	---	---
	Stom (8E+4)	---	---	---	1E-3	1E-2
Samarium-156						
W, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4

AN 63

Europium-145						
W, all compounds	2E+3	2E+3	8E-7	3E-9	2E-5	2E-4
Europium-146						
W, all compounds	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
Europium-147						
W, all compounds	3E+3	2E+3	7E-7	2E-9	4E-5	4E-4
Europium-148						
W, all compounds	1E+3	4E+2	1E-7	5E-10	1E-5	1E-4
Europium-149						
W, all compounds	1E+4	3E+3	1E-6	4E-9	2E-4	2E-3
Europium-150 (12.62 h)						
W, all compounds	3E+3	8E+3	4E-6	1E-8	4E-5	4E-4
Europium-150 (34.2 y)						
W, all compounds	8E+2	2E+1	8E-9	3E-11	1E-5	1E-4
Europium-152m						
W, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
Europium-152						
W, all compounds	8E+2	2E+1	1E-8	3E-11	1E-5	1E-4
Europium-154						
W, all compounds	5E+2	2E+1	8E-9	3E-11	7E-6	7E-5

Europium-155						
W, all compounds	4E+3	9E+1	4E-8	---	5E-5	5E-4
	---	Bone (1E+2)	---	2E-10	---	---
Europium-156						
W, all compounds	6E+2	5E+2	2E-7	6E-10	8E-6	8E-5
Europium-157						
W, all compounds	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
Europium-158[2]						
W, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
AN 64						
Gadolinium-145[2]						
D, all compounds except those given for W	5E+4	2E+5	6E-5	2E-7	---	---
	Stom (5E+4)	---	---	---	6E-4	6E-3
W, oxides, hydroxides, and fluorides	---	2E+5	7E-5	2E-7	---	---
Gadolinium-146						
D, see ^{145}Gd	1E+3	1E+2	5E-8	2E-10	2E-5	2E-4
W, see ^{145}Gd	---	3E+2	1E-7	4E-10	---	---
Gadolinium-147						
D, see ^{145}Gd	2E+3	4E+3	2E-6	6E-9	3E-5	3E-4
W, see ^{145}Gd	---	4E+3	1E-6	5E-9	---	---

Gadolinium-148						
D, see ^{145}Gd	1E+1	8E-3	3E-12	---	---	---
	Bone (2E+1)	Bone (2E-2)	---	2E-14	3E-7	3E-6
W, see ^{145}Gd	---	3E-2	1E-11	---	---	---
	---	Bone (6E-2)	---	8E-14	---	---
Gadolinium-149						
D, see ^{145}Gd	3E+3	2E+3	9E-7	3E-9	4E-5	4E-4
W, see ^{145}Gd	---	2E+3	1E-6	3E-9	---	---
Gadolinium-151						
D, see ^{145}Gd	6E+3	4E+2	2E-7	---	9E-5	9E-4
	---	Bone (6E+2)	---	9E-10	---	---
W, see ^{145}Gd	---	1E+3	5E-7	2E-9	---	---
Gadolinium-152						
D, see ^{145}Gd	2E+1	1E-2	4E-12	---	---	---
	Bone (3E+1)	Bone (2E-2)	---	3E-14	4E-7	4E-6
W, see ^{145}Gd	---	4E-2	2E-11	---	---	---
	---	Bone (8E-2)	---	1E-13	---	---
Gadolinium-153						
D, see ^{145}Gd	5E+3	1E+2	6E-8	---	6E-5	6E-4
	---	Bone (2E+2)	---	3E-10	---	---
W, see ^{145}Gd	---	6E+2	2E-7	8E-10	---	---

Gadolinium-159						
D, see ^{145}Gd	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
W, see ^{145}Gd	---	6E+3	2E-6	8E-9	---	---
AN 65						
Terbium-147[2]						
W, all compounds	9E+3	3E+4	1E-5	5E-8	1E-4	1E-3
Terbium-149						
W, all compounds	5E+3	7E+2	3E-7	1E-9	7E-5	7E-4
Terbium-150						
W, all compounds	5E+3	2E+4	9E-6	3E-8	7E-5	7E-4
Terbium-151						
W, all compounds	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
Terbium-153						
W, all compounds	5E+3	7E+3	3E-6	1E-8	7E-5	7E-4
Terbium-154						
W, all compounds	2E+3	4E+3	2E-6	6E-9	2E-5	2E-4
Terbium-155						
W, all compounds	6E+3	8E+3	3E-6	1E-8	8E-5	8E-4
Terbium-156m (5.0 h)						
W, all compounds	2E+4	3E+4	1E-5	4E-8	2E-4	2E-3
Terbium-156m (24.4 h)						

W, all compounds	7E+3	8E+3	3E-6	1E-8	1E-4	1E-3
Terbium-156						
W, all compounds	1E+3	1E+3	6E-7	2E-9	1E-5	1E-4
Terbium-157						
W, all compounds	5E+4	3E+2	1E-7	---	---	---
	LLI (5E+4)	Bone (6E+2)	---	8E-10	7E-4	7E-3
Terbium-158						
W, all compounds	1E+3	2E+1	8E-9	3E-11	2E-5	2E-4
Terbium-160						
W, all compounds	8E+2	2E+2	9E-8	3E-10	1E-5	1E-4
Terbium-161						
W, all compounds	2E+3	2E+3	7E-7	2E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
AN 66						
Dysprosium-155						
W, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
Dysprosium-157						
W, all compounds	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
Dysprosium-159						
W, all compounds	1E+4	2E+3	1E-6	3E-9	2E-4	2E-3
Dysprosium-165						

W, all compounds	1E+4	5E+4	2E-5	6E-8	2E-4	2E-3
Dysprosium-166						
W, all compounds	6E+2	7E+2	3E-7	1E-9	---	---
	LLI (8E+2)	---	---	---	1E-5	1E-4
AN 67						
Holmium-155[2]						
W, all compounds	4E+4	2E+5	6E-5	2E-7	6E-4	6E-3
Holmium-157[2]						
W, all compounds	3E+5	1E+6	6E-4	2E-6	4E-3	4E-2
Holmium-159[2]						
W, all compounds	2E+5	1E+6	4E-4	1E-6	3E-3	3E-2
Holmium-161						
W, all compounds	1E+5	4E+5	2E-4	6E-7	1E-3	1E-2
Holmium-162m[2]						
W, all compounds	5E+4	3E+5	1E-4	4E-7	7E-4	7E-3
Holmium-162[2]						
W, all compounds	5E+5	2E+6	1E-3	3E-6	---	---
	Stom (8E+5)	---	---	---	1E-2	1E-1
Holmium-164m[2]						
W, all compounds	1E+5	3E+5	1E-4	4E-7	1E-3	1E-2
Holmium-164[2]						

W, all compounds	2E+5	6E+5	3E-4	9E-7	---	---
	Stom (2E+5)	---	---	---	3E-3	3E-2
Holmium-166m						
W, all compounds	6E+2	7E+0	3E-9	9E-12	9E-6	9E-5
Holmium-166						
W, all compounds	9E+2	2E+3	7E-7	2E-9	---	---
	LLI (9E+2)	---	---	---	1E-5	1E-4
Holmium-167						
W, all compounds	2E+4	6E+4	2E-5	8E-8	2E-4	2E-3

AN 68

Erbium-161						
W, all compounds	2E+4	6E+4	3E-5	9E-8	2E-4	2E-3
Erbium-165						
W, all compounds	6E+4	2E+5	8E-5	3E-7	9E-4	9E-3
Erbium-169						
W, all compounds	3E+3	3E+3	1E-6	4E-9	---	---
	LLI (4E+3)	---	---	---	5E-5	5E-4
Erbium-171						
W, all compounds	4E+3	1E+4	4E-6	1E-8	5E-5	5E-4
Erbium-172						

W, all compounds	1E+3	1E+3	6E-7	2E-9	---	---
	LLI (E+3)	---	---	---	2E-5	2E-4
AN 69						
Thulium-162[2]						
W, all compounds	7E+4	3E+5	1E-4	4E-7	---	---
	Stom (7E+4)	---	---	---	1E-3	1E-2
Thulium-166						
W, all compounds	4E+3	1E+4	6E-6	2E-8	6E-5	6E-4
Thulium-167						
W, all compounds	2E+3	2E+3	8E-7	3E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
Thulium-170						
W, all compounds	8E+2	2E+2	9E-8	3E-10	---	---
	LLI (1E+3)	---	---	---	1E-5	1E-4
Thulium-171						
W, all compounds	1E+4	3E+2	1E-7	---	---	---
	LLI (1E+4)	Bone (6E+2)	---	8E-10	2E-4	2E-3
Thulium-172						
W, all compounds	7E+2	1E+3	5E-7	2E-9	---	---
	LLI (8E+2)	---	---	---	1E-5	1E-4
Thulium-173						
W, all compounds	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4

Thulium-175[2]						
W, all compounds	7E+4	3E+5	1E-4	4E-7	---	---
	Stom (9E+4)	---	---	---	1E-3	1E-2
AN 70						
Ytterbium-162[2]						
W, all compounds except those given for Y	7E+4	3E+5	1E-4	4E-7	1E-3	1E-2
Y, oxides, hydroxides, and fluorides	---	3E+5	1E-4	4E-7	---	---
Ytterbium-166						
W, see ^{162}Yb	1E+3	2E+3	8E-7	3E-9	2E-5	2E-4
Y, see ^{162}Yb	---	2E+3	8E-7	3E-9	---	---
Ytterbium-167[2]						
W, see ^{162}Yb	3E+5	8E+5	3E-4	1E-6	4E-3	4E-2
Y, see ^{162}Yb	---	7E+5	3E-4	1E-6	---	---
Ytterbium-169						
W, see ^{162}Yb	2E+3	8E+2	4E-7	1E-9	2E-5	2E-4
Y, see ^{162}Yb	---	7E+2	3E-7	1E-9	---	---
Ytterbium-175						
W, see ^{162}Yb	3E+3	4E+3	1E-6	5E-9	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
Y, see ^{162}Yb	---	3E+3	1E-6	5E-9	---	---
Ytterbium-177[2]						

W, see ^{162}Yb	2E+4	5E+4	2E-5	7E-8	2E-4	2E-3
Y, see ^{162}Yb	---	5E+4	2E-5	6E-8	---	---
Ytterbium-178[2]						
W, see ^{162}Yb	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
Y, see ^{162}Yb	---	4E+4	2E-5	5E-8	---	---
AN 71						
Lutetium-169						
W, all compounds except those given for Y	3E+3	4E+3	2E-6	6E-9	3E-5	3E-4
Y, oxides, hydroxides, and fluorides	---	4E+3	2E-6	6E-9	---	---
Lutetium-170						
W, see ^{169}Lu	1E+3	2E+3	9E-7	3E-9	2E-5	2E-4
Y, see ^{169}Lu	---	2E+3	8E-7	3E-9	---	---
Lutetium-171						
W, see ^{169}Lu	2E+3	2E+3	8E-7	3E-9	3E-5	3E-4
Y, see ^{169}Lu	---	2E+3	8E-7	3E-9	---	---
Lutetium-172						
W, see ^{169}Lu	1E+3	1E+3	5E-7	2E-9	1E-5	1E-4
Y, see ^{169}Lu	---	1E+3	5E-7	2E-9	---	---
Lutetium-173						
W, see ^{169}Lu	5E+3	3E+2	1E-7	---	7E-5	7E-4
	---	Bone (5E+2)	---	6E-10	---	---

Y, see ^{169}Lu	---	3E+2	1E-7	4E-10	---	---
Lutetium-174m						
W, see ^{169}Lu	2E+3	2E+2	1E-7	---	---	---
	LLI (3E+3)	Bone (3E+3)	---	5E-10	4E-5	4E-4
Y, see ^{169}Lu	---	2E+2	9E-8	3E-10	---	---
Lutetium-174						
W, see ^{169}Lu	5E+3	1E+2	5E-8	---	7E-5	7E-4
	---	Bone (2E+2)	---	3E-10	---	---
Y, see ^{176}Lu	---	2E+2	6E-8	2E-10	---	---
Lutetium-176m						
W, see ^{169}Lu	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
Y, see ^{169}Lu	---	2E+4	9E-6	3E-8	---	---
Lutetium-176						
W, see ^{169}Lu	7E+2	5E+0	2E-9	---	1E-5	1E-4
	---	Bone (1E+1)	---	2E-11	---	---
Y, see ^{169}Lu	---	8E+0	3E-9	1E-11	---	---
Lutetium-177m						
W, see ^{169}Lu	7E+2	1E+2	5E-8	---	1E-5	1E-4
	---	Bone (1E+2)	---	2E-10	---	---
Y, see ^{169}Lu	---	8E+1	3E-8	1E-10	---	---
Lutetium-177						

W, see ^{169}Lu	2E+3	2E+3	9E-7	3E-9	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
Y, see ^{169}Lu	---	2E+3	9E-7	3E-9	---	---
Lutetium-178m[2]						
W, see ^{169}Lu	5E+4	2E+5	8E-5	3E-7	---	---
	Stom (6E+4)	---	---	---	8E-4	8E-3
Y, see ^{169}Lu	---	2E+5	7E-5	2E-7	---	---
Lutetium-178[2]						
W, see ^{169}Lu	4E+4	1E+5	5E-5	2E-7	---	---
	Stom (4E+4)	---	---	---	6E-4	6E-3
Y, see ^{169}Lu	---	1E+5	5E-5	2E-7	---	---
Lutetium-179						
W, see ^{169}Lu	6E+3	2E+4	8E-6	3E-8	9E-5	9E-4
Y, see ^{169}Lu	---	2E+4	6E-6	3E-8	---	---
AN 72						
Hafnium-170						
D, all compounds except those given for W	3E+3	6E+3	2E-6	8E-9	4E-5	4E-4
W, oxides, hydroxides, carbides, and nitrates	---	5E+3	2E-6	6E-9	---	---
Hafnium-172						
D, see ^{170}Hf	1E+3	9E+0	4E-9	---	2E-5	2E-4
	---	Bone (2E+1)	---	3E-11	---	---

W, see ^{170}Hf	---	4E+1	2E-8	---	---	---
	---	Bone (6E+1)	---	8E-11	---	---
Hafnium-173						
D, see ^{170}Hf	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
W, see ^{170}Hf	---	1E+4	5E-6	2E-8	---	---
Hafnium-175						
D, see ^{170}Hf	3E+3	9E+2	4E-7	---	4E-5	4E-4
	---	Bone (1E+3)	---	1E-9	---	---
W, see ^{170}Hf	---	1E+3	5E-7	2E-9	---	---
Hafnium-177m^{2}						
D, see ^{170}Hf	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3
W, see ^{170}Hf	---	9E+4	4E-5	1E-7	---	---
Hafnium-178m						
D, see ^{170}Hf	3E+2	1E+0	5E-10	---	3E-6	3E-5
	---	Bone (2E+0)	---	3E-12	---	---
W, see ^{170} Hf	---	5E+0	2E-9	---	---	---
	---	Bone (9E+0)	---	1E-11	---	---
Hafnium-179m						
D, see ^{170}Hf	1E+3	3E+2	1E-7	---	1E-5	1E-4
	---	Bone (6E+2)	---	8E-10	---	---
W, see ^{170}Hf	---	6E+2	3E-7	8E-10	---	---

Hafnium-180m						
D, see ^{170}Hf	7E+3	2E+4	9E-6	3E-8	1E-4	1E-3
W, see ^{170}Hf	---	3E+4	1E-5	4E-8	---	---
Hafnium-181						
D, see ^{170}Hf	1E+3	2E+2	7E-8	---	2E-5	2E-4
	---	Bone (4E+2)	---	6E-10	---	---
W, see ^{170}Hf	---	4E+2	2E-7	6E-10	---	---
Hafnium-182m[2]						
D, see ^{170}Hf	4E+4	9E+4	4E-5	1E-7	5E-4	5E-3
W, see ^{170}Hf	---	1E+5	6E-5	2E-7	---	---
Hafnium-182						
D, see ^{170}Hf	2E+2	8E-1	3E-10	---	---	---
	Bone (4E+2)	Bone (2E+0)	---	2E-12	5E-6	5E-5
W, see ^{170}Hf	---	3E+0	1E-9	---	---	---
	---	Bone (7E+0)	---	1E-11	---	---
Hafnium-183[2]						
D, see ^{170}Hf	2E+4	5E+4	2E-5	6E-8	3E-4	3E-3
W, see ^{170}Hf	---	6E+4	2E-5	8E-8	---	---
Hafnium-184						
D, see ^{170}Hf	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
W, see ^{170}Hf	---	6E+3	3E-6	9E-9	---	---

AN 73

Tantalum-172[2]						
W, all compounds except those given for Y	4E+4	1E+5	5E-5	2E-7	5E-4	5E-3
Y, elemental Ta, oxides, hydroxides, halides, carbides, nitrates, and nitrides	---	1E+5	4E-5	1E-7	---	---
Tantalum-173						
W, see ^{172}Ta	7E+3	2E+4	8E-6	3E-8	9E-5	9E-4
Y, see ^{172}Ta	---	2E+4	7E-6	2E-8	---	---
Tantalum-174[2]						
W, see ^{172}Ta	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
Y, see ^{172}Ta	---	9E+4	4E-5	1E-7	---	---
Tantalum-175						
W, see ^{172}Ta	6E+3	2E+4	7E-6	2E-8	8E-5	8E-4
Y, see ^{172}Ta	---	1E+4	6E-6	2E-8	---	---
Tantalum-176						
W, see ^{172}Ta	4E+3	1E+4	5E-6	2E-8	5E-5	5E-4
Y, see ^{172}Ta	---	1E+4	5E-6	2E-8	---	---
Tantalum-177						
W, see ^{172}Ta	1E+4	2E+4	8E-6	3E-8	2E-4	2E-3
Y, see ^{172}Ta	---	2E+4	7E-6	2E-8	---	---
Tantalum-178						
W, see ^{172}Ta	2E+4	9E+4	4E-5	1E-7	2E-4	2E-3

Y, see ^{172}Ta	---	7E+4	3E-5	1E-7	---	---
Tantalum-179						
W, see ^{172}Ta	2E+4	5E+3	2E-6	8E-9	3E-4	3E-3
Y, see ^{172}Ta	---	9E+2	4E-7	1E-9	---	---
Tantalum-180m						
W, see ^{172}Ta	2E+4	7E+4	3E-5	9E-8	3E-4	3E-3
Y, see ^{172}Ta	---	6E+4	2E-5	8E-8	---	---
Tantalum-180						
W, see ^{172}Ta	1E+3	4E+2	2E-7	6E-10	2E-5	2E-4
Y, see ^{172}Ta	---	2E+1	1E-8	3E-11	---	---
Tantalum-182m^{2}						
W, see ^{172}Ta	2E+5	5E+5	2E-4	8E-7	---	---
	Stom (2E+5)	---	---	---	3E-3	3E-2
Y, see ^{172}Ta	---	4E+5	2E-4	6E-7	---	---
Tantalum-182						
W, see ^{172}Ta	8E+2	3E+2	1E-7	5E-10	1E-5	1E-4
Y, see ^{172}Ta	---	1E+2	6E-8	2E-10	---	---
Tantalum-183						
W, see ^{172}Ta	9E+2	1E+3	5E-7	2E-9	---	---
	LLI (1E+3)	---	---	---	2E-5	2E-4
Y, see ^{172}Ta	---	1E+3	4E-7	1E-9	---	---
Tantalum-184						

W, see ^{172}Ta	2E+3	5E+3	2E-6	8E-9	3E-5	3E-4
Y, see ^{172}Ta	---	5E+3	2E-6	7E-9	---	---
Tantalum-185[2]						
W, see ^{172}Ta	3E+4	7E+4	3E-5	1E-7	4E-4	4E-3
Y, see ^{172}Ta	---	6E+4	3E-5	9E-8	---	---
Tantalum-186[2]						
W, see ^{172}Ta	5E+4	2E+5	1E-4	3E-7	---	---
	Stom (7E+4)	---	---	---	1E-3	1E-2
Y, see ^{172}Ta	---	2E+5	9E-5	3E-7	---	---
AN 74						
Tungsten-176						
D, all compounds	1E+4	5E+4	2E-5	7E-8	1E-4	1E-3
Tungsten-177						
D, all compounds	2E+4	9E+4	4E-5	1E-7	3E-4	3E-3
Tungsten-178						
D, all compounds	5E+3	2E+4	8E-6	3E-8	7E-5	7E-4
Tungsten-179[2]						
D, all compounds	5E+5	2E+6	7E-4	2E-6	7E-3	7E-2
Tungsten-181						
D, all compounds	2E+4	3E+4	1E-5	5E-8	2E-4	2E-3
Tungsten-185						

D, all compounds	2E+3	7E+3	3E-6	9E-9	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
Tungsten-187						
D, all compounds	2E+3	9E+3	4E-6	1E-8	3E-5	3E-4
Tungsten-188						
D, all compounds	4E+2	1E+3	5E-7	2E-9	---	---
	LLI (5E+2)	---	---	---	7E-6	7E-5

AN 75

Rhenium-177[2]						
D, all compounds except those given for W	9E+4	3E+5	1E-4	4E-7	---	---
	Stom (1E+5)	---	---	---	2E-3	2E-2
W, oxides, hydroxides, and nitrates	---	4E+5	1E-4	5E-7	---	---
Rhenium-178[2]						
D, see ^{177}Re	7E+4	3E+5	1E-4	4E-7	---	---
	Stom (1E+5)	---	---	---	1E-3	1E-2
W, see ^{177}Re	---	3E+5	1E-4	4E-7	---	---
Rhenium-181						
D, see ^{177}Re	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
W, see ^{177}Re	---	9E+3	4E-6	1E-8	---	---
Rhenium-182 (12.7 h)						
D, see ^{177}Re	7E+3	1E+4	5E-6	2E-8	9E-5	9E-4

W, see ^{177}Re	---	2E+4	6E-6	2E-8	---	---
Rhenium-182 (64.0 h)						
D, see ^{177}Re	1E+3	2E+3	1E-6	3E-9	2E-5	2E-4
W, see ^{177}Re	---	2E+3	9E-7	3E-9	---	---
Rhenium-184m						
D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
W, see ^{177}Re	---	4E+2	2E-7	6E-10	---	---
Rhenium-184						
D, see ^{177}Re	2E+3	4E+3	1E-6	5E-9	3E-5	3E-4
W, see ^{177}Re	---	1E+3	6E-7	2E-9	---	---
Rhenium-186m						
D, see ^{177}Re	1E+3	2E+3	7E-7	---	---	---
	Stom (2E+3)	Stom (2E+3)	---	3E-9	2E-5	2E-4
W, see ^{177}Re	---	2E+2	6E-8	2E-10	---	---
Rhenium-186						
D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
W, see ^{177}Re	---	2E+3	7E-7	2E-9	---	---
Rhenium-187						
D, see ^{177}Re	6E+5	8E+5	4E-4	---	8E-3	8E-2
	---	Stom (9E+5)	---	1E-6	---	---
W, see ^{177}Re	---	1E+5	4E-5	1E-7	---	---
Rhenium-188m^{2}						

D, see ^{177}Re	8E+4	1E+5	6E-5	2E-7	1E-3	1E-2
W, see ^{177}Re	---	1E+5	6E-5	2E-7	---	---
Rhenium-188						
D, see ^{177}Re	2E+3	3E+3	1E-6	4E-9	2E-5	2E-4
W, see ^{177}Re	---	3E+3	1E-6	4E-9	---	---
Rhenium-189						
D, see ^{177}Re	3E+3	5E+3	2E-6	7E-9	4E-5	4E-4
W, see ^{177}Re	---	4E+3	2E-6	6E-9	---	---
AN 76						
Osmium-180[2]						
D, all compounds except those given for W and Y	1E+5	4E+5	2E-4	5E-7	1E-3	1E-2
W, halides and nitrates	---	5E+5	2E-4	7E-7	---	---
Y, oxides and hydroxides	---	5E+5	2E-4	6E-7	---	---
Osmium-181[2]						
D, see ^{180}Os	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{180}Os	---	5E+4	2E-5	6E-8	---	---
Y, see ^{180}Os	---	4E+4	2E-5	6E-8	---	---
Osmium-182						
D, see ^{180}Os	2E+3	6E+3	2E-6	8E-9	3E-5	3E-4
W, see ^{180}Os	---	4E+3	2E-6	6E-9	---	---
Y, see ^{180}Os	---	4E+3	2E-6	6E-9	---	---
Osmium-185						
D, see ^{180}Os	2E+3	5E+2	2E-7	7E-10	3E-5	3E-4

W, see ^{180}Os	---	8E+2	3E-7	1E-9	---	---
Y, see ^{180}Os	---	8E+2	3E-7	1E-9	---	---
Osmium-189m						
D, see ^{180}Os	8E+4	2E+5	1E-4	3E-7	1E-3	1E-2
W, see ^{180}Os	---	2E+5	9E-5	3E-7	---	---
Y, see ^{180}Os	---	2E+5	7E-5	2E-7	---	---
Osmium-191m						
D, see ^{180}Os	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
W, see ^{180}Os	---	2E+4	8E-6	3E-8	---	---
Y, see ^{180}Os	---	2E+4	7E-6	2E-8	---	---
Osmium-191						
D, see ^{180}Os	2E+3	2E+3	9E-7	3E-9	---	---
	LLI (3E+3)	---	---	---	3E-5	3E-4
W, see ^{180}Os	---	2E+3	7E-7	2E-9	---	---
Y, see ^{180}Os	---	1E+3	6E-7	2E-9	---	---
Osmium-193						
D, see ^{180}Os	2E+3	5E+3	2E-6	6E-9	---	---
	LLI (2E+3)	---	---	---	2E-5	2E-4
W, see ^{180}Os	---	3E+3	1E-6	4E-9	---	---
Y, see ^{180}Os	---	3E+3	1E-6	4E-9	---	---
Osmium-194						
D, see ^{180}Os	4E+2	4E+1	2E-8	6E-11	---	---
	LLI (6E+2)	---	---	---	8E-6	8E-5

W, see ^{180}Os	---	6E+1	2E-8	8E-11	---	---
Y, see ^{180}Os	---	8E+0	3E-9	1E-11	---	---

AN 77

Iridium-182[2]

D, all compounds except those given for W and Y	4E+4	1E+5	6E-5	2E-7	---	---
	Stom (4E+4)	---	---	---	6E-4	6E-3
W, halides, nitrates, and metallic iridium	---	2E+5	6E-5	2E-7	---	---
Y, oxides and hydroxides	---	1E+5	5E-5	2E-7	---	---

Iridium-184

D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
W, see ^{182}Ir	---	3E+4	1E-5	5E-8	---	---
Y, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---

Iridium-185

D, see ^{182}Ir	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
W, see ^{182}Ir	---	1E+4	5E-6	2E-8	---	---
Y, see ^{182}Ir	---	1E+4	4E-6	1E-8	---	---

Iridium-186

D, see ^{182}Ir	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
W, see ^{182}Ir	---	6E+3	3E-6	9E-9	---	---
Y, see ^{182}Ir	---	6E+3	2E-6	8E-9	---	---

Iridium-187

D, see ^{182}Ir	1E+4	3E+4	1E-5	5E-8	1E-4	1E-3

W, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---
Y, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---
Iridium-188						
D, see ^{182}Ir	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
W, see ^{182}Ir	---	4E+3	1E-6	5E-9	---	---
Y, see ^{182}Ir	---	3E+3	1E-6	5E-9	---	---
Iridium-189						
D, see ^{182}Ir	5E+3	5E+3	2E-6	7E-9	---	---
	LLI (5E+3)	---	---	---	7E-5	7E-4
W, see ^{182}Ir	---	4E+3	2E-6	5E-9	---	---
Y, see ^{182}Ir	---	4E+3	1E-6	5E-9	---	---
Iridium-190m^{2}						
D, see ^{182}Ir	2E+5	2E+5	8E-5	3E-7	2E-3	2E-2
W, see ^{182}Ir	---	2E+5	9E-5	3E-7	---	---
Y, see ^{182}Ir	---	2E+5	8E-5	3E-7	---	---
Iridium-190						
D, see ^{182}Ir	1E+3	9E+2	4E-7	1E-9	1E-5	1E-4
W, see ^{182}Ir	---	1E+3	4E-7	1E-9	---	---
Y, see ^{182}Ir	---	9E+2	4E-7	1E-9	---	---
Iridium-192m						
D, see ^{182}Ir	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
W, see ^{182}Ir	---	2E+2	9E-8	3E-10	---	---
Y, see ^{182}Ir	---	2E+1	6E-9	2E-11	---	---
Iridium-192						

D, see ^{182}Ir	9E+2	3E+2	1E-7	4E-10	1E-5	1E-4
W, see ^{182}Ir	---	4E+2	2E-7	6E-10	---	---
Y, see ^{182}Ir	---	2E+2	9E-8	3E-10	---	---
Iridium-194m						
D, see ^{182}Ir	6E+2	9E+1	4E-8	1E-10	9E-6	9E-5
W, see ^{182}Ir	---	2E+2	7E-8	2E-10	---	---
Y, see ^{182}Ir	---	1E+2	4E-8	1E-10	---	---
Iridium-194						
D, see ^{182}Ir	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
W, see ^{182}Ir	---	2E+3	9E-7	3E-9	---	---
Y, see ^{182}Ir	---	2E+3	8E-7	3E-9	---	---
Iridium-195m						
D, see ^{182}Ir	8E+3	2E+4	1E-5	3E-8	1E-4	1E-3
W, see ^{182}Ir	---	3E+4	1E-5	4E-8	---	---
Y, see ^{182}Ir	---	2E+4	9E-6	3E-8	---	---
Iridium-195						
D, see ^{182}Ir	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{182}Ir	---	5E+4	2E-5	7E-8	---	---
Y, see ^{182}Ir	---	4E+4	2E-5	6E-8	---	---
AN 78						
Platinum-186						
D, all compounds	1E+4	4E+4	2E-5	5E-8	2E-4	2E-3
Platinum-188						

D, all compounds	2E+3	2E+3	7E-7	2E-9	2E-5	2E-4
Platinum-189						
D, all compounds	1E+4	3E+4	1E-5	4E-8	1E-4	1E-3
Platinum-191						
D, all compounds	4E+3	8E+3	4E-6	1E-8	5E-5	5E-4
Platinum-193m						
D, all compounds	3E+3	6E+3	3E-6	8E-9	---	---
	LLI (3E+4)	---	---	---	4E-5	4E-4
Platinum-193						
D, all compounds	4E+4	2E+4	1E-5	3E-8	---	---
	LLI (5E+4)	---	---	---	6E-4	6E-3
Platinum-195m						
D, all compounds	2E+3	4E+3	2E-6	6E-9	---	---
	LLI (2E+3)	---	---	---	3E-5	3E-4
Platinum-197m[2]						
D, all compounds	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
Platinum-197						
D, all compounds	3E+3	1E+4	4E-6	1E-8	4E-5	4E-4
Platinum-199[2]						
D, all compounds	5E+4	1E+5	6E-5	2E-7	7E-4	7E-3
Platinum-200						

D, all compounds	1E+3	3E+3	1E-6	5E-9	2E-5	2E-4

AN 79

Gold-193

D, all compounds except those given for W and Y	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
W, halides and nitrates	---	2E+4	9E-6	3E-8	---	---
Y, oxides and hydroxides	---	2E+4	8E-6	3E-8	---	---

Gold-194

D, see ^{193}Au	3E+3	8E+3	3E-6	1E-8	4E-5	4E-4
W, see ^{193}Au	---	5E+3	2E-6	8E-9	---	---
Y, see ^{193}Au	---	5E+3	2E-6	7E-9	---	---

Gold-195

D, see ^{193}Au	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
W, see ^{193}Au	---	1E+3	6E-7	2E-9	---	---
Y, see ^{193}Au	---	4E+2	2E-7	6E-10	---	---

Gold-198m

D, see ^{193}Au	1E+3	3E+3	1E-6	4E-9	1E-5	1E-4
W, see ^{193}Au	---	1E+3	5E-7	2E-9	---	---
Y, see ^{193}Au	---	1E+3	5E-7	2E-9	---	---

Gold-198

D, see ^{193}Au	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
W, see ^{193}Au	---	2E+3	8E-7	3E-9	---	---
Y, see ^{193}Au	---	2E+3	7E-7	2E-9	---	---

Gold-199

D, see ^{193}Au	3E+3	9E+3	4E-6	1E-8	---	---
	LLI (3E+3)	---	---	---	4E-5	4E-4
W, see ^{193}Au	---	4E+3	2E-6	6E-9	---	---
Y, see ^{193}Au	---	4E+3	2E-6	5E-9	---	---
Gold-200m						
D, see ^{193}Au	1E+3	4E+3	1E-6	5E-9	2E-5	2E-4
W, see ^{193}Au	---	3E+3	1E-6	4E-9	---	---
Y, see ^{193}Au	---	2E+4	1E-6	3E-9	---	---
Gold-200[2]						
D, see ^{193}Au	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
W, see ^{193}Au	---	8E+4	3E-5	1E-7	---	---
Y, see ^{193}Au	---	7E+4	3E-5	1E-7	---	---
Gold-201[2]						
D, see ^{193}Au	7E+4	2E+5	9E-5	3E-7	---	---
	Stom (9E+4)	---	---	---	1E-3	1E-2
W, see ^{193}Au	---	2E+5	1E-4	3E-7	---	---
Y, see ^{193}Au	---	2E+5	9E-5	3E-7	---	---
AN 80						
Mercury-193m						
Vapor	---	8E+3	4E-6	1E-8	---	---
Organic D	4E+3	1E+4	5E-6	2E-8	6E-5	6E-4
D, sulfates	3E+3	9E+3	4E-6	1E-8	4E-5	4E-4
W, oxides, hydroxides, halides, nitrates, and sulfides	---	8E+3	3E-6	1E-8	---	---

Mercury-193						
Vapor	---	3E+4	1E-5	4E-8	---	---
Organic D	2E+4	6E+4	3E-5	9E-8	3E-4	3E-3
D, see ^{193m}Hg	2E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{193m}Hg	---	4E+4	2E-5	6E-8	---	---
Mercury-194						
Vapor	---	3E+1	1E-8	4E-11	---	---
Organic D	2E+1	3E+1	1E-8	4E-11	2E-7	2E-6
D, see ^{193m}Hg	8E+2	4E+1	2E-8	6E-11	1E-5	1E-4
W, see ^{193m}Hg	---	1E+2	5E-8	2E-10	---	---
Mercury-195m						
Vapor	---	4E+3	2E-6	6E-9	---	---
Organic D	3E+3	6E+3	3E-6	8E-9	4E-5	4E-4
D, see ^{193m}Hg	2E+3	5E+3	2E-6	7E-9	3E-5	3E-4
W, see ^{193m}Hg	---	4E+3	2E-6	5E-9	---	---
Mercury-195						
Vapor	---	3E+4	1E-5	4E-8	---	---
Organic D	2E+4	5E+4	2E-5	6E-8	2E-4	2E-3
D, see ^{193m}Hg	1E+4	4E+4	1E-5	5E-8	2E-4	2E-3
W, see ^{193m}Hg	---	3E+4	1E-5	5E-8	---	---
Mercury-197m						
Vapor	---	5E+3	2E-6	7E-9	---	---
Organic D	4E+3	9E+3	4E-6	1E-8	5E-5	5E-4
D, see ^{193m}Hg	3E+3	7E+3	3E-6	1E-8	4E-5	4E-4

W, see ^{193m}Hg	---	5E+3	2E-6	7E-9	---	---
Mercury-197						
Vapor	---	8E+3	4E-6	1E-8	---	---
Organic D	7E+3	1E+4	6E-6	2E-8	9E-5	9E-4
D, see ^{193m}Hg	6E+3	1E+4	5E-6	2E-8	8E-5	8E-4
W, see ^{193m}Hg	---	9E+3	4E-6	1E-8	---	---
Mercury-199m[2]						
Vapor	---	8E+4	3E-5	1E-7	---	---
Organic D	6E+4	2E+5	7E-5	2E-7	---	---
	Stom (1E+5)	---	---	---	1E-3	1E-2
D, see ^{193m}Hg	6E+4	1E+5	6E-5	2E-7	8E-4	8E-3
W, see ^{193m}Hg	---	2E+5	7E-5	2E-7	---	---
Mercury-203						
Vapor	---	8E+2	4E-7	1E-9	---	---
Organic D	5E+2	8E+2	3E-7	1E-9	7E-6	7E-5
D, see ^{193m}Hg	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
W, see ^{193m}Hg	---	1E+3	5E-7	2E-9	---	---
AN 81						
Thallium-194m[2]						
D, all compounds	5E+4	2E+5	6E-5	2E-7	---	---
	Stom (7E+4)	---	---	---	1E-3	1E-2
Thallium-194[2]						
D, all compounds	3E+5	6E+5	2E-4	8E-7	---	---

	Stom (3E+5)	---	---	---	4E-3	4E-2
Thallium-195[2]						
D, all compounds	6E+4	1E+5	5E-5	2E-7	9E-4	9E-3
Thallium-197						
D, all compounds	7E+4	1E+5	5E-5	2E-7	1E-3	1E-2
Thallium-198m[2]						
D, all compounds	3E+4	5E+4	2E-5	8E-8	4E-4	4E-3
Thallium-198						
D, all compounds	2E+4	3E+4	1E-5	5E-8	3E-4	3E-3
Thallium-199						
D, all compounds	6E+4	8E+4	4E-5	1E-7	9E-4	9E-3
Thallium-200						
D, all compounds	8E+3	1E+4	5E-6	2E-8	1E-4	1E-3
Thallium-201						
D, all compounds	2E+4	2E+4	9E-6	3E-8	2E-4	2E-3
Thallium-202						
D, all compounds	4E+3	5E+3	2E-6	7E-9	5E-5	5E-4
Thallium-204						
D, all compounds	2E+3	2E+3	9E-7	3E-9	2E-5	2E-4

AN 82						
Lead-195m[2]						
D, all compounds	6E+4	2E+5	8E-5	3E-7	8E-4	8E-3
Lead-198						
D, all compounds	3E+4	6E+4	3E-5	9E-8	4E-4	4E-3
Lead-199[2]						
D, all compounds	2E+4	7E+4	3E-5	1E-7	3E-4	3E-3
Lead-200						
D, all compounds	3E+3	6E+3	3E-6	9E-9	4E-5	4E-4
Lead-201						
D, all compounds	7E+3	2E+4	8E-6	3E-8	1E-4	1E-3
Lead-202m						
D, all compounds	9E+3	3E+4	1E-5	4E-8	1E-4	1E-3
Lead-202						
D, all compounds	1E+2	5E+1	2E-8	7E-11	2E-6	2E-5
Lead-203						
D, all compounds	5E+3	9E+3	4E-6	1E-8	7E-5	7E-4
Lead-205						
D, all compounds	4E+3	1E+3	6E-7	2E-9	5E-5	5E-4
Lead-209						
D, all compounds	2E+4	6E+4	2E-5	8E-8	3E-4	3E-3

Lead-210						
D, all compounds	6E-1	2E-1	1E-10	---	---	---
	Bone (1E+0)	Bone (4E-1)	---	6E-13	1E-8	1E-7
Lead-211[2]						
D, all compounds	1E+4	6E+2	3E-7	9E-10	2E-4	2E-3
Lead-212						
D, all compounds	8E+1	3E+1	1E-8	5E-11	---	---
	Bone (1E+2)	---	---	---	2E-6	2E-5
Lead-214[2]						
D, all compounds	9E+3	8E+2	3E-7	1E-9	1E-4	1E-3
AN 83						
Bismuth-200[2]						
D, nitrates	3E+4	8E+4	4E-5	1E-7	4E-4	4E-3
W, all other compounds	---	1E+5	4E-5	1E-7	---	---
Bismuth-201[2]						
D, see ^{200}Bi	1E+4	3E+4	1E-5	4E-8	2E-4	2E-3
W, see ^{200}Bi	---	4E+4	2E-5	5E-8	---	---
Bismuth-202[2]						
D, see ^{200}Bi	1E+4	4E+4	2E-5	6E-8	2E-4	2E-3
W, see ^{200}Bi	---	8E+4	3E-5	1E-7	---	---
Bismuth-203						

D, see ^{200}Bi	2E+3	7E+3	3E-6	9E-9	3E-5	3E-4
W, see ^{200}Bi	---	6E+3	3E-6	9E-9	---	---
Bismuth-205						
D, see ^{200}Bi	1E+3	3E+3	1E-6	3E-9	2E-5	2E-4
W, see ^{200}Bi	---	1E+3	5E-7	2E-9	---	---
Bismuth-206						
D, see ^{200}Bi	6E+2	1E+3	6E-7	2E-9	9E-6	9E-5
W, see ^{200}Bi	---	9E+2	4E-7	1E-9	---	---
Bismuth-207						
D, see ^{200}Bi	1E+3	2E+3	7E-7	2E-9	1E-5	1E-4
W, see ^{200}Bi	---	4E+2	1E-7	5E-10	---	---
Bismuth-210m						
D, see ^{200}Bi	4E+1	5E+0	2E-9	---	---	---
	Kid (6E+1)	Kid (6E+0)	---	9E-12	8E-7	8E-6
W, see ^{200}Bi	---	7E-1	3E-10	9E-13	---	---
Bismuth-210						
D, see ^{200}Bi	8E+2	2E+2	1E-7	---	1E-5	1E-4
	---	Kid (4E+2)	---	5E-10	---	---
W, see ^{200}Bi	---	3E+1	1E-8	4E-11	---	---
Bismuth-212[2]						
D, see ^{200}Bi	5E+3	2E+2	1E-7	3E-10	7E-5	7E-4
W, see ^{200}Bi	---	3E+2	1E-7	4E-10	---	---
Bismuth-213[2]						

D, see ^{200}Bi	7E+3	3E+2	1E-7	4E-10	1E-4	1E-3
W, see ^{200}Bi	---	4E+2	1E-7	5E-10	---	---
Bismuth-214[2]						
D, see ^{200}Bi	2E+4	8E+2	3E-7	1E-9	---	---
	Stom (2E+4)	---	---	---	3E-4	3E-3
W, see ^{200}Bi	---	9E-2	4E-7	1E-9	---	---
AN 84						
Polonium-203[2]						
D, all compounds except those given for W	3E+4	6E+4	3E-5	9E-8	3E-4	3E-3
W, oxides, hydroxides, and nitrates	---	9E+4	4E-5	1E-7	---	---
Polonium-205[2]						
D, see ^{203}Po	2E+4	4E+4	2E-5	5E-8	3E-4	3E-3
W, see ^{203}Po	---	7E+4	3E-5	1E-7	---	---
Polonium-207						
D, see ^{203}Po	8E+3	3E+4	1E-5	3E-8	1E-4	1E-3
W, see ^{203}Po	---	3E+4	1E-5	4E-8	---	---
Polonium-210						
D, see ^{203}Po	3E+0	6E-1	3E-10	9E-13	4E-8	4E-7
W, see ^{203}Po	---	6E-1	3E-10	9E-13	---	---
AN 85						
Astatine-207[2]						

D, halides	6E+3	3E+3	1E-6	4E-9	8E-5	8E-4
W	---	2E+3	9E-7	3E-9	---	---
Astatine-211						
D, halides	1E+2	8E+1	3E-8	1E-10	2E-6	2E-5
W	---	5E+1	2E-8	8E-11	---	---
AN 86						
Radon-220						
With daughters removed	---	2E+4	7E-6	2E-8	---	---
With daughters present	---	2E+1 (or 12 working level months)	9E-9 (or 1.0 working level)	3E-11	---	---
Radon-222						
With daughters removed	---	1E+4	4E-6	1E-8	---	---
With daughters present	---	1E+2 (or 4 working level months)	3E-8 (or 0.33 working level)	1E-10	---	---
AN 87						
Francium-222[2]						
D, all compounds	2E+3	5E+2	2E-7	6E-10	3E-5	3E-4
Francium-223[2]						
D, all compounds	6E+2	8E+2	3E-7	1E-9	8E-6	8E-5
AN 88						
Radium-223						

W, all compounds	5E+0	7E-1	3E-10	9E-13	---	---
	Bone (9E+0)	---	---	---	1E-7	1E-6
Radium-224						
W, all compounds	8E+0	2E+0	7E-10	2E-12	---	---
	Bone (2E+1)	---	---	---	2E-7	2E-6
Radium-225						
W, all compounds	8E+0	7E-1	3E-10	9E-13	---	---
	Bone (2E+1)	---	---	---	2E-7	2E-6
Radium-226						
W, all compounds	2E+0	6E-1	3E-10	9E-13	---	---
	Bone (5E+0)	---	---	---	6E-8	6E-7
Radium-227[2]						
W, all compounds	2E+4	1E+4	6E-6	---	---	---
	Bone (2E+4)	Bone (2E+4)	---	3E-8	3E-4	3E-3
Radium-228						
W, all compounds	2E+0	1E+0	5E-10	2E-12	---	---
	Bone (4E+0)	---	---	---	6E-8	6E-7

AN 89

Actinium-224

D, all compounds except those given for W and Y	2E+3	3E+1	1E-8	---	---	---
	LLI (2E+3)	Bone (4E+1)	---	5E-11	3E-5	3E-4
W, halides and nitrates	---	5E+1	2E-8	7E-11	---	---
Y, oxides and hydroxides	---	5E+1	2E-8	6E-11	---	---
Actinium-225						
D, see ^{224}Ac	5E+1	3E-1	1E-10	---	---	---
	LLI (5E+1)	Bone (5E-1)	---	7E-13	7E-7	7E-6
W, see ^{224}Ac	---	6E-1	3E-10	9E-13	---	---
Y, see ^{224}Ac	---	6E-1	3E-10	9E-13	---	---
Actinium-226						
D, see ^{224}Ac	1E+2	3E+0	1E-9	---	---	---
	LLI (1E+2)	Bone (4E+0)	---	5E-12	2E-6	2E-5
W, see ^{224}Ac	---	5E+0	2E-9	7E-12	---	---
Y, see ^{224}Ac	---	5E+0	2E-9	6E-12	---	---
Actinium-227						
D, see ^{224}Ac	2E-1	4E-4	2E-13	---	---	---
	Bone (4E-1)	Bone (8E-4)	---	1E-15	5E-9	5E-8
W, see ^{224}Ac	---	2E-3	7E-13	---	---	---
	---	Bone (3E-3)	---	4E-15	---	---
Y, see ^{224}Ac	---	4E-3	2E-12	6E-15	---	---
Actinium-228						

D, see ^{224}Ac	2E+3	9E+0	4E-9	---	3E-5	3E-4
	---	Bone (2E+1)	---	2E-11	---	---
W, see ^{224}Ac	---	4E+1	2E-8	---	---	---
	---	Bone (6E+1)	---	8E-11	---	---
Y, see ^{224}Ac	---	4E+1	2E-8	6E-11	---	---
AN 90						
Thorium-226[2]						
W, all compounds except those given for Y	5E+3	2E+2	6E-8	2E-10	---	---
	Stom (5E+3)	---	---	---	7E-5	7E-4
Y, oxides and hydroxides	---	1E+2	6E-8	2E-10	---	---
Thorium-227						
W, see ^{226}Th	1E+2	3E-1	1E-10	5E-13	2E-6	2E-5
Y, see ^{226}Th	---	3E-1	1E-10	5E-13	---	---
Thorium-228						
W, see ^{226}Th	6E+0	1E-2	4E-12	---	---	---
	Bone (1E+1)	Bone (2E-2)	---	3E-14	2E-7	2E-6
Y, see ^{226}Th	---	2E-2	7E-12	2E-14	---	---
Thorium-229						
W, see ^{226}Th	6E-1	9E-4	4E-13	---	---	---
	Bone (1E+0)	Bone (2E-3)	---	3E-15	2E-8	2E-7
Y, see ^{226}Th	---	2E-3	1E-12	---	---	---

	---	Bone (3E-3)	---	4E-15	---	---
Thorium-230						
W, see ^{226}Th	4E+0	6E-3	3E-12	---	---	---
	Bone (9E+0)	Bone (2E-2)	---	2E-14	1E-7	1E-6
Y, see ^{226}Th	---	2E-2	6E-12	---	---	---
	---	Bone (2E-2)	---	3E-14	---	---
Thorium-231						
W, see ^{226}Th	4E+3	6E+3	3E-6	9E-9	5E-5	5E-4
Y, see ^{226}Th	---	6E+3	3E-6	9E-9	---	---
Thorium-232						
W, see ^{226}Th	7E-1	1E-3	5E-13	---	---	---
	Bone (2E+0)	Bone (3E-3)	---	4E-15	3E-8	3E-7
Y, see ^{226}Th	---	3E-3	1E-12	---	---	---
	---	Bone (4E-3)	---	6E-15	---	---
Thorium-234						
W, see ^{226}Th	3E+2	2E+2	8E-8	3E-10	---	---
	LLI (4E+2)	---	---	---	5E-6	5E-5
Y, see ^{226}Th	---	2E+2	6E-8	2E-10	---	---

AN 91

Protactinium-227[2]

W, all compounds except those given for Y	4E+3	1E+2	5E-8	2E-10	5E-5	5E-4
Y, oxides and hydroxides	---	1E+2	4E-8	1E-10	---	---
Protactinium-228						
W, see ^{227}Pa	1E+3	1E+1	5E-9	---	2E-5	2E-4
	---	Bone (2E+1)	---	3E-11	---	---
Y, see ^{226}Pa	---	1E+1	5E-9	2E-11	---	---
Protactinium-230						
W, see ^{227}Pa	6E+2	5E+0	2E-9	7E-12	---	---
	Bone (9E+2)	---	---	---	1E-5	1E-4
Y, see ^{227}Pa	---	4E+0	1E-9	5E-12	---	---
Protactinium-231						
W, see ^{227}Pa	2E-1	2E-3	6E-13	---	---	---
	Bone (5E-1)	Bone (4E-3)	---	6E-15	6E-9	6E-8
Y, see ^{227}Pa	---	4E-3	2E-12	---	---	---
	---	Bone (6E-3)	---	8E-15	---	---
Protactinium-232						
W, see ^{227}Pa	1E+3	2E+1	9E-9	---	2E-5	2E-4
	---	Bone (6E+1)	---	8E-11	---	---
Y, see ^{227}Pa	---	6E+1	2E-8	---	---	---
	---	Bone (7E+1)	---	1E-10	---	---

Protactinium-233						
W, see ^{227}Pa	1E+3	7E+2	3E-7	1E-9	---	---
	LLI (2E+3)	---	---	---	2E-5	2E-4
Y, see ^{227}Pa	---	6E+2	2E-7	8E-10	---	---
Protactinium-234						
W, see ^{227}Pa	2E+3	8E+3	3E-6	1E-8	3E-5	3E-4
Y, see ^{227}Pa	---	7E+3	3E-6	9E-9	---	---
AN 92						
Uranium-230						
D, UF_6, UO_2F_2, $UO_2(NO_3)_2$	4E+0	4E-1	2E-10	---	---	---
	Bone (6E+0)	Bone (6E-1)	---	8E-13	8E-8	8E-7
W, UO_3, UF_4, UCI_4	---	4E-1	1E-10	5E-13	---	---
Y, UO_2, U_3O_8	---	3E-1	1E-10	4E-13	---	---
Uranium-231						
D, see ^{230}U	5E+3	8E+3	3E-6	1E-8	---	---
	LLI (4E+3)	---	---	---	6E-5	6E-4
W, see ^{230}U	---	6E+3	2E-6	8E-9	---	---
Y, see ^{230}U	---	5E+3	2E-6	6E-9	---	---
Uranium-232						
D, see ^{230}U	2E+0	2E-1	9E-11	---	---	---
	Bone (4E+0)	Bone (4E-1)	---	6E-13	6E-8	6E-7
W, see ^{230}U	---	4E-1	2E-10	5E-13	---	---
Y, see ^{230}U	---	8E-3	3E-12	1E-14	---	---

Uranium-233						
D, see ^{230}U	1E+1	1E+0	5E-10	---	---	---
	Bone (2E+1)	Bone (2E+0)	---	3E-12	3E-7	3E-6
W, see ^{230}U	---	7E-1	3E-10	1E-12	---	---
Y, see ^{230}U	---	4E-2	2E-11	5E-14	---	---
Uranium-234[3]						
D, see ^{230}U	1E+1	1E+0	5E-10	---	---	---
	Bone (2E+1)	Bone (2E+0)	---	3E-12	3E-7	3E-6
W, see ^{230}U	---	7E-1	3E-10	1E-12	---	---
Y, see ^{230}U	---	4E-2	2E-11	5E-14	---	---
Uranium-235[3]						
D, see ^{230}U	1E+1	1E+0	6E-10	---	---	---
	Bone (2E+1)	Bone (2E+0)	---	3E-12	3E-7	3E-6
W, see ^{230}U	---	8E-1	3E-10	1E-12	---	---
Y, see ^{230}U	---	4E-2	2E-11	6E-14	---	---
Uranium-236						
D, see ^{230}U	1E+1	1E+0	5E-10	---	---	---
	Bone (2E+1)	Bone (2E+0)	---	3E-12	3E-7	3E-6
W, see ^{230}U	---	8E-1	3E-10	1E-12	---	---
Y, see ^{230}U	---	4E-2	2E-11	6E-14	---	---
Uranium-237						
D, see ^{230}U	2E+3	3E+3	1E-6	4E-9	---	---

	LLI (2E+3)	---	---	---	3E-5	3E-4
W, see ^{230}U	---	2E+3	7E-7	2E-9	---	---
Y, see ^{230}U	---	2E+3	6E-7	2E-9	---	---
Uranium-238[3]						
D, see ^{230}U	1E+1	1E+0	6E-10	---	---	---
	Bone (2E+1)	Bone (2E+0)	---	3E-12	3E-7	3E-6
W, see ^{230}U	---	8E-1	3E-10	1E-12	---	---
Y, see ^{230}U	---	4E-2	2E-11	6E-14	---	---
Uranium-239[2]						
D, see ^{230}U	7E+4	2E+5	8E-5	3E-7	9E-4	9E-3
W, see ^{230}U	---	2E+5	7E-5	2E-7	---	---
Y, see ^{230}U	---	2E+5	6E-5	2E-7	---	---
Uranium-240						
D, see ^{230}U	1E+3	4E+3	2E-6	5E-9	2E-5	2E-4
W, see ^{230}U	---	3E+3	1E-6	4E-9	---	---
Y, see ^{230}U	---	2E+3	1E-6	3E-9	---	---
Uranium-natural[3]						
D, see ^{230}U	1E+1	1E+0	5E-10	---	---	---
	Bone (2E+1)	Bone (2E+0)	---	3E-12	3E-7	3E-6
W, see ^{230}U	---	8E-1	3E-10	9E-13	---	---
Y, see ^{230}U	---	5E-2	2E-11	9E-14	---	---
AN 93						
Neptunium-232[2]						

W, all compounds	1E+5	2E+3	7E-7	---	2E-3	2E-2
	---	Bone (5E+2)	---	6E-9	---	---
Neptunium-233[2]						
W, all compounds	8E+5	3E+6	1E-3	4E-6	1E-2	1E-1
Neptunium-234						
W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
Neptunium-235						
W, all compounds	2E+4	8E+2	3E-7	---	---	---
	LLI (2E+4)	Bone (1E+3)	---	2E-9	3E-4	3E-3
Neptunium-236 (1.15E+5 y)						
W, all compounds	3E+0	2E-2	9E-12	---	---	---
	Bone (6E+0)	Bone (5E-2)	---	8E-14	9E-8	9E-7
Neptunium-236 (22.5 h)						
W, all compounds	3E+3	3E+1	1E-8	---	---	---
	Bone (4E+3)	Bone (7E+1)	---	1E-10	5E-5	5E-4
Neptunium-237						
W, all compounds	5E-1	4E-3	2E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	1E-14	2E-8	2E-7
Neptunium-238						

W, all compounds	1E+3	6E+1	3E-8	---	2E-5	2E-4
	---	Bone (2E+2)	---	2E-10	---	---
Neptunium-239						
W, all compounds	2E+3	2E+3	9E-7	3E-9	---	---
	LLI (2E+3)	---	---	---	2E-5	2E-4
Neptunium-240[2]						
W, all compounds	2E+4	8E+4	3E-5	1E-7	3E-4	3E-3
AN 94						
Plutonium-234						
W, all compounds except PuO_2	8E+3	2E+2	9E-8	3E-10	1E-4	1E-3
Y, PuO_2	---	2E+2	8E-8	3E-10	---	---
Plutonium-235[2]						
W, see ^{234}Pu	9E+5	3E+6	1E-3	4E-6	1E-2	1E-1
Y, see ^{234}Pu	---	3E+6	1E-3	3E-6	---	---
Plutonium-236						
W, see ^{234}Pu	2E+0	2E-2	8E-12	---	---	---
	Bone (4E+0)	Bone (4E-2)	---	5E-14	6E-8	6E-7
Y, see ^{234}Pu	---	4E-2	2E-11	6E-14	---	---
Plutonium-237						
W, see ^{234}Pu	1E+4	3E+3	1E-6	5E-9	2E-4	2E-3
Y, see ^{234}Pu	---	3E+3	1E-6	4E-9	---	---
Plutonium-238						

W, see ^{234}Pu	9E-1	7E-3	3E-12	---	---	---
	Bone (2E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Y, see ^{234}Pu	---	2E-2	8E-12	2E-14	---	---
Plutonium-239						
W, see ^{234}Pu	8E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Y, see ^{234}Pu	---	2E-2	7E-12	---	---	---
	---	Bone (2E-2)	---	2E-14	---	---
Plutonium-240						
W, see ^{234}Pu	8E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Y, see ^{234}Pu	---	2E-2	7E-12	---	---	---
	---	Bone (2E-2)	---	2E-14	---	---
Plutonium-241						
W, see ^{234}Pu	4E+1	3E-1	1E-10	---	---	---
	Bone (7E+1)	Bone (6E-1)	---	8E-13	1E-6	1E-5
Y, see ^{234}Pu	---	8E-1	3E-10	---	---	---
	---	Bone (1E+0)	---	1E-12	---	---
Plutonium-242						
W, see ^{234}Pu	8E-1	7E-3	3E-12	---	---	---

	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Y, see ^{234}Pu	---	2E-2	7E-12	---	---	---
	---	Bone (2E-2)	---	2E-14	---	---
Plutonium-243						
W, see ^{234}Pu	2E+4	4E+4	2E-5	5E-8	2E-4	2E-3
Y, see ^{234}Pu	---	4E+4	2E-5	5E-8	---	---
Plutonium-244						
W, see ^{234}Pu	8E-1	7E-3	3E-12	---	---	---
	Bone (2E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Y, see ^{234}Pu	---	2E-2	7E-12	---	---	---
	---	Bone (2E-2)	---	2E-14	---	---
Plutonium-245						
W, see ^{234}Pu	2E+3	5E+3	2E-6	6E-9	3E-5	3E-4
Y, see ^{234}Pu	---	4E+3	2E-6	6E-9	---	---
Plutonium-246						
W, see ^{234}Pu	4E+2	3E+2	1E-7	4E-10	---	---
	LLI (4E+2)	---	---	---	6E-6	6E-5
Y, see ^{234}Pu	---	3E+2	1E-7	4E-10	---	---
AN 95						
Americium-237[2]						
W, all compounds	8E+4	3E+5	1E-4	4E-7	1E-3	1E-2

Americium-238[2]						
W, all compounds	4E+4	3E+3	1E-6	---	5E-4	5E-3
	---	Bone (6E+3)	---	9E-9	---	---
Americium-239						
W, all compounds	5E+3	1E+4	5E-6	2E-8	7E-5	7E-4
Americium-240						
W, all compounds	2E+3	3E+3	1E-6	4E-9	3E-5	3E-4
Americium-241						
W, all compounds	8E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Americium-242m						
W, all compounds	8E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Americium-242						
W, all compounds	4E+3	8E+1	4E-8	---	5E-5	5E-4
	---	Bone (9E+1)	---	1E-10	---	---
Americium-243						
W, all compounds	8E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7

Americium-244m[2]						
W, all compounds	6E+4	4E+3	2E-6	---	---	---
	Stom (8E+4)	Bone (7E+3)	---	1E-8	1E-3	1E-2
Americium-244						
W, all compounds	3E+3	2E+2	8E-8	---	4E-5	4E-4
	---	Bone (3E+2)	---	4E-10	---	---
Americium-245						
W, all compounds	3E+4	8E+4	3E-5	1E-7	4E-4	4E-3
Americium-246m[2]						
W, all compounds	5E+4	2E+5	8E-5	3E-7	---	---
	Stom (6E+4)	---	---	---	8E-4	8E-3
Americium-246[2]						
W, all compounds	3E+4	1E+5	4E-5	1E-7	4E-4	4E-3
AN 96						
Curium-238						
W, all compounds	2E+4	1E+3	5E-7	2E-9	2E-4	2E-3
Curium-240						
W, all compounds	6E+1	6E-1	2E-10	---	---	---
	Bone (8E+1)	Bone (6E-1)	---	9E-13	1E-6	1E-5
Curium-241						

W, all compounds	1E+3	3E+1	1E-8	---	2E-5	2E-4
	---	Bone (4E+1)	---	5E-11	---	---
Curium-242						
W, all compounds	3E+1	3E-1	1E-10	---	---	---
	Bone (5E+1)	Bone (3E-1)	---	4E-13	7E-7	7E-6
Curium-243						
W, all compounds	1E+0	9E-3	4E-12	---	---	---
	Bone (2E+0)	Bone (2E-2)	---	2E-14	3E-8	3E-7
Curium-244						
W, all compounds	1E+0	1E-2	5E-12	---	---	---
	Bone (3E+0)	Bone (2E-2)	---	3E-14	3E-8	3E-7
Curium-245						
W, all compounds	7E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Curium-246						
W, all compounds	7E-1	6E-3	3E-12	---	---	---
	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Curium-247						
W, all compounds	8E-1	6E-3	3E-12	---	---	---

	Bone (1E+0)	Bone (1E-2)	---	2E-14	2E-8	2E-7
Curium-248						
W, all compounds	2E-1	2E-3	7E-13	---	---	---
	Bone (4E-1)	Bone (3E-3)	---	4E-15	5E-9	5E-8
Curium-249[2]						
W, all compounds	5E+4	2E+4	7E-6	---	7E-4	7E-3
	---	Bone (3E+4)	---	4E-8	---	---
Curium-250						
W, all compounds	4E-2	3E-4	1E-13	---	---	---
	Bone (6E-2)	Bone (5E-4)	---	8E-16	9E-10	9E-9
AN 97						
Berkelium-245						
W, all compounds	2E+3	1E+3	5E-7	2E-9	3E-5	3E-4
Berkelium-246						
W, all compounds	3E+3	3E+3	1E-6	4E-9	4E-5	4E-4
Berkelium-247						
W, all compounds	5E-1	4E-3	2E-12	---	---	---
	Bone (1E+0)	Bone (9E-0)	---	1E-14	2E-8	2E-7
Berkelium-249						

W, all compounds	2E+2	2E+0	7E-10	---	---	---
	Bone (5E+2)	Bone (4E+0)	---	5E-12	6E-6	6E-5
Berkelium-250						
W, all compounds	9E+3	3E+2	1E-7	---	1E-4	1E-3
	---	Bone (7E+2)	---	1E-9	---	---
AN 98						
Californium-244[2]						
W, all compounds except those given for Y	3E+4	6E+2	2E-7	8E-10	---	---
	Stom (3E+4)	---	---	---	4E-4	4E-3
Y, oxides and hydroxides	---	6E+2	2E-7	8E-10	---	---
Californium-246						
W, see ^{244}Cf	4E+2	9E+0	4E-9	1E-11	5E-6	5E-5
Y, see ^{244}Cf	---	9E+0	4E-9	1E-11	---	---
Californium-248						
W, see ^{244}Cf	8E+0	6E-2	3E-11	---	---	---
	Bone (2E+1)	Bone (1E-1)	---	2E-13	2E-7	2E-6
Y, see ^{244}Cf	---	1E-1	4E-11	1E-13	---	---
Californium-249						
W, see ^{244}Cf	5E-1	4E-3	24E-12	---	---	---
	Bone (1E+0)	Bone (9E-3)	---	1E-14	2E-8	2E-7

Y, see ^{244}Cf	---	1E-2	4E-12	---	---	---
	---	Bone (1E-2)	---	2E-14	---	---
Californium-250						
W, see ^{244}Cf	1E+0	9E-3	4E-12	---	---	---
	Bone (2E+0)	Bone (2E-2)	---	3E-14	3E-8	3E-7
Y, see ^{244}Cf	---	3E-2	1E-11	4E-14	---	---
Californium-251						
W, see ^{244}Cf	5E-1	4E-3	2E-12	---	---	---
	Bone (1E+0)	Bone (9E-3)	---	1E-14	2E-8	2E-7
Y, see ^{244}Cf	---	1E-2	4E-12	---	---	---
	---	Bone (1E-2)	---	2E-14	---	---
Californium-252						
W, see ^{244}Cf	2E+0	2E-2	8E-12	---	---	---
	Bone (5E+0)	Bone (4E-2)	---	5E-14	7E-8	7E-7
Y, see ^{244}Cf	---	3E-2	1E-11	5E-14	---	---
Californium-253						
W, see ^{244}Cf	2E+2	2E+0	8E-10	3E-12	---	---
	Bone (4E+2)	---	---	---	5E-6	5E-5
Y, see ^{244}Cf	---	2E+0	7E-10	2E-12	---	---
Californium-254						

W, see ^{244}Cf	2E+0	2E-2	9E-12	3E-14	3E-8	3E-7
Y, see ^{244}Cf	---	2E-2	7E-12	2E-14	---	---
AN 99						
Einsteinium-250						
W, all compounds	4E+4	5E+2	2E-7	---	6E-4	6E-3
	---	Bone (1E+3)	---	2E-9	---	---
Einsteinium-251						
W, all compounds	7E+3	9E+2	4E-7	---	1E-4	1E-3
	---	Bone (1E+3)	---	2E-9	---	---
Einsteinium-253						
W, all compounds	2E+2	1E+0	6E-10	2E-12	2E-6	2E-5
Einsteinium-254m						
W, all compounds	3E+2	1E+1	4E-9	1E-11	---	---
	LLI (3E+2)	---	---	---	4E-6	4E-5
Einsteinium-254						
W, all compounds	8E+0	7E-2	3E-11	---	---	---
	Bone (2E+1)	Bone (1E-1)	---	2E-13	2E-7	2E-6
AN 100						
Fermium-252						
W, all compounds	5E+2	1E+1	5E-9	2E-11	6E-6	6E-5
Fermium-253						

W, all compounds	1E+3	1E+1	4E-9	1E-11	1E-5	1E-4
Fermium-254						
W, all compounds	3E+3	9E+1	4E-8	1E-10	4E-5	4E-4
Fermium-255						
W, all compounds	5E+2	2E+1	9E-9	3E-11	7E-6	7E-5
Fermium-257						
W, all compounds	2E+1	2E-1	7E-11	---	---	---
	Bone (4E+1)	Bone (2E-1)	---	3E-13	5E-7	5E-6
AN 101						
Mendelevium-257						
W, all compounds	7E+3	8E+1	4E-8	---	1E-4	1E-3
	---	Bone (9E+1)	---	1E-10	---	---
Mendelevium-258						
W, all compounds	3E+1	2E-1	1E-10	---	---	---
	Bone (5E+1)	Bone (3E-1)	---	5E-13	6E-7	6E-6
---Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours						
Submersion[1]	---	2E+2	1E-7	1E-9	---	---

---Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life greater than 2 hours	---	2E-1	1E-10	1E-12	1E-8	1E-7
---Any single radionuclide not listed above that decays by alpha emission or spontaneous fission or any mixture for which either the identity or the concentration of any radionuclide in the mixture is not known	---	4E-4	2E-13	1E-15	2E-9	2E-8

FOOTNOTES:

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

[2] These radionuclides have radiological half-lives of less than two hours. The total effective dose equivalent received during operations with these radionuclides might include a significant contribution from external exposure. The DAC values for all radionuclides, other than those designated Class "Submersion," are based upon the committed effective dose equivalent due to the intake of the radionuclide into the body and do not include potentially significant contributions to dose equivalent from external exposures. The licensee may substitute 1E-7 μCi/ml for the listed DAC to account for the submersion dose prospectively, but must use individual monitoring devices or other radiation measuring instruments that measure external exposure to demonstrate compliance with the limits according to part 4731.2040.

[3] For soluble mixtures of U-238, U-234, and U-235 in air, chemical toxicity may be the limiting factor according to part 4731.2020, subpart 5. If the percent by weight (enrichment) of U-235 is not greater than five, the concentration value for a 40-hour work week is 0.2 milligrams uranium per cubic meter of air average. For any enrichment, the product of the average concentration and time of exposure during a 40-hour work week must not exceed 8E-3 (SA) μCi-hr/ml, where SA is the specific activity of the uranium inhaled. The specific activity for natural uranium is 6.77E-7 curies per gram U. The specific activity for other mixtures of U-238, U-235, and U-234, if not known, is:

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

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

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

Subp. 8. **Additional explanations.**

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

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

	Table 1			Table 2		Table 3
Radionuclide and Class	1	2	3	1	2	
If it is known that Ac-227-D and Cm-250-W are not present	---	7E-4	3E-13	---	---	---
If, in addition, it is known that Ac-227-W, Y; Th-229-W, Y; Th-230-W; Th-232-W, Y; Pa-231-W, Y; Np-237-W; Pu-239-W; Pu-240-W; Pu-242-W; Am-241-W; Am-242m-W; Am-243-W; Cm-245-W; Cm-246-W; Cm-247-W; Cm-248-W; Bk-247-W; Cf-249-W; and Cf-251-W are not present	---	7E-3	3E-12	---	---	---
If, in addition, it is known that Sm-146-W; Sm-147-W; Gd-148-D, W; Gd-152-D, W; Th-228-W, Y; Th-230-Y; U-232-Y; U-233-Y; U-234-Y; U-235-Y; U-236-Y; U-238-Y; Np-236-W; Pu-236-W, Y; Pu-238-W, Y; Pu-239-Y; Pu-240-Y; Pu-242-Y; Pu-244-W, Y; Cm-243-W; Cm-244-W; Cf-248-W; Cf-249-Y; Cf-250-W, Y; Cf-251-Y; Cf-252-W, Y; and Cf-254-W, Y are not present	---	7E-2	3E-11	---	---	---
If, in addition, it is known that Pb-210-D; Bi-210m-W; Po-210-D, W; Ra-223-W; Ra-225-W; Ra-226-W; Ac-225-D, W, Y; Th-227-W, Y; U-230-D, W, Y; U-232-D, W; Pu-241-W; Cm-240-W; Cm-242-W; Cf-248-Y; Es-254-W; Fm-257-W; and Md-258-W are not present	---	7E-1	3E-10	---	---	---

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

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

D. 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 this part 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 one.

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

$$\frac{C_A}{DAC_A} + \frac{C_B}{DAC_B} + \frac{C_C}{DAC_C} < 1$$

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440; 46 SR 791*

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4731.2800 QUANTITIES OF LICENSED MATERIAL REQUIRING LABELING.

Subpart 1. **Explanation.** The quantities listed in subpart 3 were derived by taking one-tenth of the most restrictive ALI listed in part 4731.2750, subpart 7, Table 1, columns 1 and 2, rounding to the nearest factor of ten, and arbitrarily constraining the values listed between 0.001 and 1,000 μCi. Values of 100 μCi have been assigned for radionuclides having a radioactive half-life in excess of 10^9 years (except rhenium, 1,000 μCi) to take into account their low specific activity.

Subp. 2. **Combination of radionuclides.** For purposes of parts 4731.2310, subpart 5; 4731.2340, item A; and 4731.2600, subpart 1, where there is involved a combination of radionuclides in known amounts, the limit for the combination should be derived as follows: determine, for each radionuclide in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific radionuclide when not in combination. The sum of such ratios for all radionuclides in the combination may not exceed one.

Subp. 3. **Quantities requiring labeling.** The following quantities of licensed material require labeling:

Radionuclide	Abbreviation	Quantity (μCi)
Hydrogen-3	H-3	1,000

Beryllium-7	Be-7	1,000
Beryllium-10	Be-10	1
Carbon-11	C-11	1,000
Carbon-14	C-14	100
Fluorine-18	F-18	1,000
Sodium-22	Na-22	10
Sodium-24	Na-24	100
Magnesium-28	Mg-28	100
Aluminum-26	Al-26	10
Silicon-31	Si-31	1,000
Silicon-32	Si-32	1
Phosphorus-32	P-32	10
Phosphorus-33	P-33	100
Sulfur-35	S-35	100
Chlorine-36	Cl-36	10
Chlorine-38	Cl-38	1,000
Chlorine-39	Cl-39	1,000
Argon-39	Ar-39	1,000
Argon-41	Ar-41	1,000
Potassium-40	K-40	100
Potassium-42	K-42	1,000
Potassium-43	K-43	1,000
Potassium-44	K-44	1,000
Potassium-45	K-45	1,000

Calcium-41	Ca-41	100
Calcium-45	Ca-45	100
Calcium-47	Ca-47	100
Scandium-43	Sc-43	1,000
Scandium-44m	Sc-44m	100
Scandium-44	Sc-44	100
Scandium-46	Sc-46	10
Scandium-47	Sc-47	100
Scandium-48	Sc-48	100
Scandium-49	Sc-49	1,000
Titanium-44	Ti-44	1
Titanium-45	Ti-45	1,000
Vanadium-47	V-47	1,000
Vanadium-48	V-48	100
Vanadium-49	V-49	1,000
Chromium-48	Cr-48	1,000
Chromium-49	Cr-49	1,000
Chromium-51	Cr-51	1,000
Manganese-51	Mn-51	1,000
Manganese-52m	Mn-52m	1,000
Manganese-52	Mn-52	100
Manganese-53	Mn-53	1,000
Manganese-54	Mn-54	100
Manganese-56	Mn-56	1,000
Iron-52	Fe-52	100

Iron-55	Fe-55	100
Iron-59	Fe-59	10
Iron-60	Fe-60	1
Cobalt-55	Co-55	100
Cobalt-56	Co-56	10
Cobalt-57	Co-57	100
Cobalt-58m	Co-58m	1,000
Cobalt-58	Co-58	100
Cobalt-60m	Co-60m	1,000
Cobalt-60	Co-60	1
Cobalt-61	Co-61	1,000
Cobalt-62m	Co-62m	1,000
Nickel-56	Ni-56	100
Nickel-57	Ni-57	100
Nickel-59	Ni-59	100
Nickel-63	Ni-63	100
Nickel-65	Ni-65	1,000
Nickel-66	Ni-66	10
Copper-60	Cu-60	1,000
Copper-61	Cu-61	1,000
Copper-64	Cu-64	1,000
Copper-67	Cu-67	1,000
Zinc-62	Zn-62	100
Zinc-63	Zn-63	1,000
Zinc-65	Zn-65	10
Zinc-69m	Zn-69m	100

Zinc-69	Zn-69	1,000
Zinc-71m	Zn-71m	1,000
Zinc-72	Zn-72	100
Gallium-65	Ga-65	1,000
Gallium-66	Ga-66	100
Gallium-67	Ga-67	1,000
Gallium-68	Ga-68	1,000
Gallium-70	Ga-70	1,000
Gallium-72	Ga-72	100
Gallium-73	Ga-73	1,000
Germanium-66	Ge-66	1,000
Germanium-67	Ge-67	1,000
Germanium-68	Ge-68	10
Germanium-69	Ge-69	1,000
Germanium-71	Ge-71	1,000
Germanium-75	Ge-75	1,000
Germanium-77	Ge-77	1,000
Germanium-78	Ge-78	1,000
Arsenic-69	As-69	1,000
Arsenic-70	As-70	1,000
Arsenic-71	As-71	100
Arsenic-72	As-72	100
Arsenic-73	As-73	100
Arsenic-74	As-74	100
Arsenic-76	As-76	100
Arsenic-77	As-77	100

Arsenic-78	As-78	1,000
Selenium-70	Se-70	1,000
Selenium-73m	Se-73m	1,000
Selenium-73	Se-73	100
Selenium-75	Se-75	100
Selenium-79	Se-79	100
Selenium-81m	Se-81m	1,000
Selenium-81	Se-81	1,000
Selenium-83	Se-83	1,000
Bromine-74m	Br-74m	1,000
Bromine-74	Br-74	1,000
Bromine-75	Br-75	1,000
Bromine-76	Br-76	100
Bromine-77	Br-77	1,000
Bromine-80m	Br-80m	1,000
Bromine-80	Br-80	1,000
Bromine-82	Br-82	100
Bromine-83	Br-83	1,000
Bromine-84	Br-84	1,000
Krypton-74	Kr-74	1,000
Krypton-76	Kr-76	1,000
Krypton-77	Kr-77	1,000
Krypton-79	Kr-79	1,000
Krypton-81	Kr-81	1,000
Krypton-83m	Kr-83m	1,000
Krypton-85m	Kr-85m	1,000

Krypton-85	Kr-85	1,000
Krypton-87	Kr-87	1,000
Krypton-88	Kr-88	1,000
Rubidium-79	Rb-79	1,000
Rubidium-81m	Rb-81m	1,000
Rubidium-81	Rb-81	1,000
Rubidium-82m	Rb-82m	1,000
Rubidium-83	Rb-83	100
Rubidium-84	Rb-84	100
Rubidium-86	Rb-86	100
Rubidium-87	Rb-87	100
Rubidium-88	Rb-88	1,000
Rubidium-89	Rb-89	1,000
Strontium-80	Sr-80	100
Strontium-81	Sr-81	1,000
Strontium-83	Sr-83	100
Strontium-85m	Sr-85m	1,000
Strontium-85	Sr-85	100
Strontium-87m	Sr-87m	1,000
Strontium-89	Sr-89	10
Strontium-90	Sr-90	0.1
Strontium-91	Sr-91	100
Strontium-92	Sr-92	100
Yttrium-86m	Y-86m	1,000
Yttrium-86	Y-86	100
Yttrium-87	Y-87	100

Yttrium-88	Y-88	10
Yttrium-90m	Y-90m	1,000
Yttrium-90	Y-90	10
Yttrium-91m	Y-91m	1,000
Yttrium-91	Y-91	10
Yttrium-92	Y-92	100
Yttrium-93	Y-93	100
Yttrium-94	Y-94	1,000
Yttrium-95	Y-95	1,000
Zirconium-86	Zr-86	100
Zirconium-88	Zr-88	10
Zirconium-89	Zr-89	100
Zirconium-93	Zr-93	1
Zirconium-95	Zr-95	10
Zirconium-97	Zr-97	100
Niobium-88	Nb-88	1,000
Niobium-89m (66 min)	Nb-89m	1,000
Niobium-89 (122 min)	Nb-89	1,000
Niobium-89	Nb-89	1,000
Niobium-90	Nb-90	100
Niobium-93m	Nb-93m	10
Niobium-94	Nb-94	1
Niobium-95m	Nb-95m	100
Niobium-95	Nb-95	100
Niobium-96	Nb-96	100
Niobium-97	Nb-97	1,000
Niobium-98	Nb-98	1,000

Molybdenum-90	Mo-90	100
Molybdenum-93m	Mo-93m	100
Molybdenum-93	Mo-93	10
Molybdenum-99	Mo-99	100
Molybdenum-101	Mo-101	1,000
Technetium-93m	Tc-93m	1,000
Technetium-93	Tc-93	1,000
Technetium-94m	Tc-94m	1,000
Technetium-94	Tc-94	1,000
Technetium-96m	Tc-96m	1,000
Technetium-96	Tc-96	100
Technetium-97m	Tc-97m	100
Technetium-97	Tc-97	1,000
Technetium-98	Tc-98	10
Technetium-99m	Tc-99m	1,000
Technetium-99	Tc-99	100
Technetium-101	Tc-101	1,000
Technetium-104	Tc-104	1,000
Ruthenium-94	Ru-94	1,000
Ruthenium-97	Ru-97	1,000
Ruthenium-103	Ru-103	100
Ruthenium-105	Ru-105	1,000
Ruthenium-106	Ru-106	1
Rhodium-99m	Rh-99m	1,000
Rhodium-99	Rh-99	100
Rhodium-100	Rh-100	100

Rhodium-101m	Rh-101m	1,000
Rhodium-101	Rh-101	10
Rhodium-102m	Rh-102m	10
Rhodium-102	Rh-102	10
Rhodium-103m	Rh-103m	1,000
Rhodium-105	Rh-105	100
Rhodium-106m	Rh-106m	1,000
Rhodium-107	Rh-107	1,000
Palladium-100	Pd-100	100
Palladium-101	Pd-101	1,000
Palladium-103	Pd-103	100
Palladium-107	Pd-107	10
Palladium-109	Pd-109	100
Silver-102	Ag-102	1,000
Silver-103	Ag-103	1,000
Silver-104m	Ag-104m	1,000
Silver-104	Ag-104	1,000
Silver-105	Ag-105	100
Silver-106m	Ag-106m	100
Silver-106	Ag-106	1,000
Silver-108m	Ag-108m	1
Silver-110m	Ag-110m	10
Silver-111	Ag-111	100
Silver-112	Ag-112	100
Silver-115	Ag-115	1,000

Cadmium-104	Cd-104	1,000
Cadmium-107	Cd-107	1,000
Cadmium-109	Cd-109	1
Cadmium-113m	Cd-113m	0.1
Cadmium-113	Cd-113	100
Cadmium-115m	Cd-115m	10
Cadmium-115	Cd-115	100
Cadmium-117m	Cd-117m	1,000
Cadmium-117	Cd-117	1,000
Indium-109	In-109	1,000
Indium-110 (69.1 min)	In-110	1,000
Indium-110 (4.9h)	In-110	1,000
Indium-111	In-111	100
Indium-112	In-112	1,000
Indium-113m	In-113m	1,000
Indium-114m	In-114m	10
Indium-115m	In-115m	1,000
Indium-115	In-115	100
Indium-116m	In-116m	1,000
Indium-117m	In-117m	1,000
Indium-117	In-117	1,000
Indium-119m	In-119m	1,000
Tin-110	Sn-110	100
Tin-111	Sn-111	1,000
Tin-113	Sn-113	100
Tin-117m	Sn-117m	100
Tin-119m	Sn-119m	100

Tin-121m	Sn-121m	100
Tin-121	Sn-121	1,000
Tin-123m	Sn-123m	1,000
Tin-123	Sn-123	10
Tin-125	Sn-125	10
Tin-126	Sn-126	10
Tin-127	Sn-127	1,000
Tin-128	Sn-128	1,000
Antimony-115	Sb-115	1,000
Antimony-116m	Sb-116m	1,000
Antimony-116	Sb-116	1,000
Antimony-117	Sb-117	1,000
Antimony-118m	Sb-118m	1,000
Antimony-119	Sb-119	1,000
Antimony-120 (16 min)	Sb-120	1,000
Antimony-120 (5.76d)	Sb-120	100
Antimony-122	Sb-122	100
Antimony-124m	Sb-124m	1,000
Antimony-124	Sb-124	10
Antimony-125	Sb-125	100
Antimony-126m	Sb-126m	1,000
Antimony-126	Sb-126	100
Antimony-127	Sb-127	100
Antimony-128 (10.4 min)	Sb-128	1,000
Antimony-128 (9.01h)	Sb-128	100
Antimony-129	Sb-129	100

Antimony-130	Sb-130	1,000
Antimony-131	Sb-131	1,000
Tellurium-116	Te-116	1,000
Tellurium-121m	Te-121m	10
Tellurium-121	Te-121	100
Tellurium-123m	Te-123m	10
Tellurium-123	Te-123	100
Tellurium-125m	Te-125m	10
Tellurium-127m	Te-127m	10
Tellurium-127	Te-127	1,000
Tellurium-129m	Te-129m	10
Tellurium-129	Te-129	1,000
Tellurium-131m	Te-131m	10
Tellurium-131	Te-131	100
Tellurium-132	Te-132	10
Tellurium-133m	Te-133m	100
Tellurium-133	Te-133	1,000
Tellurium-134	Te-134	1,000
Iodine-120m	I-120m	1,000
Iodine-120	I-120	100
Iodine-121	I-121	1,000
Iodine-123	I-123	100
Iodine-124	I-124	10
Iodine-125	I-125	1
Iodine-126	I-126	1
Iodine-128	I-128	1,000
Iodine-129	I-129	1

Iodine-130	I-130	10
Iodine-131	I-131	1
Iodine-132m	I-132m	100
Iodine-132	I-132	100
Iodine-133	I-133	10
Iodine-134	I-134	1,000
Iodine-135	I-135	100
Xenon-120	Xe-120	1,000
Xenon-121	Xe-121	1,000
Xenon-122	Xe-122	1,000
Xenon-123	Xe-123	1,000
Xenon-125	Xe-125	1,000
Xenon-127	Xe-127	1,000
Xenon-129m	Xe-129m	1,000
Xenon-131m	Xe-131m	1,000
Xenon-133m	Xe-133m	1,000
Xenon-133	Xe-133	1,000
Xenon-135m	Xe-135m	1,000
Xenon-135	Xe-135	1,000
Xenon-138	Xe-138	1,000
Cesium-125	Cs-125	1,000
Cesium-127	Cs-127	1,000
Cesium-129	Cs-129	1,000
Cesium-130	Cs-130	1,000
Cesium-131	Cs-131	1,000
Cesium-132	Cs-132	100
Cesium-134m	Cs-134m	1,000

Cesium-134	Cs-134	10
Cesium-135m	Cs-135m	1,000
Cesium-135	Cs-135	100
Cesium-136	Cs-136	10
Cesium-137	Cs-137	10
Cesium-138	Cs-138	1,000
Barium-126	Ba-126	1,000
Barium-128	Ba-128	100
Barium-131m	Ba-131m	1,000
Barium-131	Ba-131	100
Barium-133m	Ba-133m	100
Barium-133	Ba-133	100
Barium-135m	Ba-135m	100
Barium-139	Ba-139	1,000
Barium-140	Ba-140	100
Barium-141	Ba-141	1,000
Barium-142	Ba-142	1,000
Lanthanum-131	La-131	1,000
Lanthanum-132	La-132	100
Lanthanum-135	La-135	1,000
Lanthanum-137	La-137	10
Lanthanum-138	La-138	100
Lanthanum-140	La-140	100
Lanthanum-141	La-141	100
Lanthanum-142	La-142	1,000
Lanthanum-143	La-143	1,000

Cerium-134	Ce-134	100
Cerium-135	Ce-135	100
Cerium-137m	Ce-137m	100
Cerium-137	Ce-137	1,000
Cerium-139	Ce-139	100
Cerium-141	Ce-141	100
Cerium-143	Ce-143	100
Cerium-144	Ce-144	1
Praseodymium-136	Pr-136	1,000
Praseodymium-137	Pr-137	1,000
Praseodymium-138m	Pr-138m	1,000
Praseodymium-139	Pr-139	1,000
Praseodymium-142m	Pr-142m	1,000
Praseodymium-142	Pr-142	100
Praseodymium-143	Pr-143	100
Praseodymium-144	Pr-144	1,000
Praseodymium-145	Pr-145	100
Praseodymium-147	Pr-147	1,000
Neodymium-136	Nd-136	1,000
Neodymium-138	Nd-138	100
Neodymium-139m	Nd-139m	1,000
Neodymium-139	Nd-139	1,000
Neodymium-141	Nd-141	1,000
Neodymium-147	Nd-147	100
Neodymium-149	Nd-149	1,000
Neodymium-151	Nd-151	1,000

Promethium-141	Pm-141	1,000
Promethium-143	Pm-143	100
Promethium-144	Pm-144	10
Promethium-145	Pm-145	10
Promethium-146	Pm-146	1
Promethium-147	Pm-147	10
Promethium-148m	Pm-148m	10
Promethium-148	Pm-148	10
Promethium-149	Pm-149	100
Promethium-150	Pm-150	1,000
Promethium-151	Pm-151	100
Samarium-141m	Sm-141m	1,000
Samarium-141	Sm-141	1,000
Samarium-142	Sm-142	1,000
Samarium-145	Sm-145	100
Samarium-146	Sm-146	1
Samarium-147	Sm-147	100
Samarium-151	Sm-151	10
Samarium-153	Sm-153	100
Samarium-155	Sm-155	1,000
Samarium-156	Sm-156	1,000
Europium-145	Eu-145	100
Europium-146	Eu-146	100
Europium-147	Eu-147	100
Europium-148	Eu-148	10
Europium-149	Eu-149	100
Europium-150 (12.62h)	Eu-150	100

Europium-150 (34.2y)	Eu-150	1
Europium-152m	Eu-152m	100
Europium-152	Eu-152	1
Europium-154	Eu-154	1
Europium-155	Eu-155	10
Europium-156	Eu-156	100
Europium-157	Eu-157	100
Europium-158	Eu-158	1,000
Gadolinium-145	Gd-145	1,000
Gadolinium-146	Gd-146	10
Gadolinium-147	Gd-147	100
Gadolinium-148	Gd-148	0.001
Gadolinium-149	Gd-149	100
Gadolinium-151	Gd-151	10
Gadolinium-152	Gd-152	100
Gadolinium-153	Gd-153	10
Gadolinium-159	Gd-159	100
Terbium-147	Tb-147	1,000
Terbium-149	Tb-149	100
Terbium-150	Tb-150	1,000
Terbium-151	Tb-151	100
Terbium-153	Tb-153	1,000
Terbium-154	Tb-154	100
Terbium-155	Tb-155	1,000
Terbium-156m (5.0h)	Tb-156m	1,000
Terbium-156m (24.4h)	Tb-156m	1,000
Terbium-156	Tb-156	100

Terbium-157	Tb-157	10
Terbium-158	Tb-158	1
Terbium-160	Tb-160	10
Terbium-161	Tb-161	100
Dysprosium-155	Dy-155	1,000
Dysprosium-157	Dy-157	1,000
Dysprosium-159	Dy-159	100
Dysprosium-165	Dy-165	1,000
Dysprosium-166	Dy-166	100
Holmium-155	Ho-155	1,000
Holmium-157	Ho-157	1,000
Holmium-159	Ho-159	1,000
Holmium-161	Ho-161	1,000
Holmium-162m	Ho-162m	1,000
Holmium-162	Ho-162	1,000
Holmium-164m	Ho-164m	1,000
Holmium-164	Ho-164	1,000
Holmium-166m	Ho-166m	1
Holmium-166	Ho-166	100
Holmium-167	Ho-167	1,000
Erbium-161	Er-161	1,000
Erbium-165	Er-165	1,000
Erbium-169	Er-169	100
Erbium-171	Er-171	100
Erbium-172	Er-172	100
Thulium-162	Tm-162	1,000

Thulium-166	Tm-166	100
Thulium-167	Tm-167	100
Thulium-170	Tm-170	10
Thulium-171	Tm-171	10
Thulium-172	Tm-172	100
Thulium-173	Tm-173	100
Thulium-175	Tm-175	1,000
Ytterbium-162	Yb-162	1,000
Ytterbium-166	Yb-166	100
Ytterbium-167	Yb-167	1,000
Ytterbium-169	Yb-169	100
Ytterbium-175	Yb-175	100
Ytterbium-177	Yb-177	1,000
Ytterbium-178	Yb-178	1,000
Lutetium-169	Lu-169	100
Lutetium-170	Lu-170	100
Lutetium-171	Lu-171	100
Lutetium-172	Lu-172	100
Lutetium-173	Lu-173	10
Lutetium-174m	Lu-174m	10
Lutetium-174	Lu-174	10
Lutetium-176m	Lu-176m	1,000
Lutetium-176	Lu-176	100
Lutetium-177m	Lu-177m	10
Lutetium-177	Lu-177	100
Lutetium-178m	Lu-178m	1,000
Lutetium-178	Lu-178	1,000

Lutetium-179	Lu-179	1,000
Hafnium-170	Hf-170	100
Hafnium-172	Hf-172	1
Hafnium-173	Hf-173	1,000
Hafnium-175	Hf-175	100
Hafnium-177m	Hf-177m	1,000
Hafnium-178m	Hf-178m	0.1
Hafnium-179m	Hf-179m	10
Hafnium-180m	Hf-180m	1,000
Hafnium-181	Hf-181	10
Hafnium-182m	Hf-182m	1,000
Hafnium-182	Hf-182	0.1
Hafnium-183	Hf-183	1,000
Hafnium-184	Hf-184	100
Tantalum-172	Ta-172	1,000
Tantalum-173	Ta-173	1,000
Tantalum-174	Ta-174	1,000
Tantalum-175	Ta-175	1,000
Tantalum-176	Ta-176	100
Tantalum-177	Ta-177	1,000
Tantalum-178	Ta-178	1,000
Tantalum-179	Ta-179	100
Tantalum-180m	Ta-180m	1,000
Tantalum-180	Ta-180	100
Tantalum-182m	Ta-182m	1,000
Tantalum-182	Ta-182	10
Tantalum-183	Ta-183	100

Tantalum-184	Ta-184	100
Tantalum-185	Ta-185	1,000
Tantalum-186	Ta-186	1,000
Tungsten-176	W-176	1,000
Tungsten-177	W-177	1,000
Tungsten-178	W-178	1,000
Tungsten-179	W-179	1,000
Tungsten-181	W-181	1,000
Tungsten-185	W-185	100
Tungsten-187	W-187	100
Tungsten-188	W-188	10
Rhenium-177	Re-177	1,000
Rhenium-178	Re-178	1,000
Rhenium-181	Re-181	1,000
Rhenium-182 (12.7h)	Re-182	1,000
Rhenium-182 (64.0h)	Re-182	100
Rhenium-184m	Re-184m	10
Rhenium-184	Re-184	100
Rhenium-186m	Re-186m	10
Rhenium-186	Re-186	100
Rhenium-187	Re-187	1,000
Rhenium-188m	Re-188m	1,000
Rhenium-188	Re-188	100
Rhenium-189	Re-189	100
Osmium-180	Os-180	1,000
Osmium-181	Os-181	1,000

Osmium-182	Os-182	100
Osmium-185	Os-185	100
Osmium-189m	Os-189m	1,000
Osmium-191m	Os-191m	1,000
Osmium-191	Os-191	100
Osmium-193	Os-193	100
Osmium-194	Os-194	1
Iridium-182	Ir-182	1,000
Iridium-184	Ir-184	1,000
Iridium-185	Ir-185	1,000
Iridium-186	Ir-186	100
Iridium-187	Ir-187	1,000
Iridium-188	Ir-188	100
Iridium-189	Ir-189	100
Iridium-190m	Ir-190m	1,000
Iridium-190	Ir-190	100
Iridium-192 (73.8d)	Ir-192	1
Iridium-192m (1.4 min)	Ir-192m	10
Iridium-194m	Ir-194m	10
Iridium-194	Ir-194	100
Iridium-195m	Ir-195m	1,000
Iridium-195	Ir-195	1,000
Platinum-186	Pt-186	1,000
Platinum-188	Pt-188	100
Platinum-189	Pt-189	1,000
Platinum-191	Pt-191	100
Platinum-193m	Pt-193m	100

Platinum-193	Pt-193	1,000
Platinum-195m	Pt-195m	100
Platinum-197m	Pt-197m	1,000
Platinum-197	Pt-197	100
Platinum-199	Pt-199	1,000
Platinum-200	Pt-200	100
Gold-193	Au-193	1,000
Gold-194	Au-194	100
Gold-195	Au-195	10
Gold-198m	Au-198m	100
Gold-198	Au-198	100
Gold-199	Au-199	100
Gold-200m	Au-200m	100
Gold-200	Au-200	1,000
Gold-201	Au-201	1,000
Mercury-193m	Hg-193m	100
Mercury-193	Hg-193	1,000
Mercury-194	Hg-194	1
Mercury-195m	Hg-195m	100
Mercury-195	Hg-195	1,000
Mercury-197m	Hg-197m	100
Mercury-197	Hg-197	1,000
Mercury-199m	Hg-199m	1,000
Mercury-203	Hg-203	100
Thallium-194m	Tl-194m	1,000
Thallium-194	Tl-194	1,000

Thallium-195	Tl-195	1,000
Thallium-197	Tl-197	1,000
Thallium-198m	Tl-198m	1,000
Thallium-198	Tl-198	1,000
Thallium-199	Tl-199	1,000
Thallium-200	Tl-200	1,000
Thallium-201	Tl-201	1,000
Thallium-202	Tl-202	100
Thallium-204	Tl-204	100
Lead-195m	Pb-195m	1,000
Lead-198	Pb-198	1,000
Lead-199	Pb-199	1,000
Lead-200	Pb-200	100
Lead-201	Pb-201	1,000
Lead-202m	Pb-202m	1,000
Lead-202	Pb-202	10
Lead-203	Pb-203	1,000
Lead-205	Pb-205	100
Lead-209	Pb-209	1,000
Lead-210	Pb-210	0.01
Lead-211	Pb-211	100
Lead-212	Pb-212	1
Lead-214	Pb-214	100
Bismuth-200	Bi-200	1,000
Bismuth-201	Bi-201	1,000
Bismuth-202	Bi-202	1,000
Bismuth-203	Bi-203	100

Bismuth-205	Bi-205	100
Bismuth-206	Bi-206	100
Bismuth-207	Bi-207	10
Bismuth-210m	Bi-210m	0.1
Bismuth-210	Bi-210	1
Bismuth-212	Bi-212	10
Bismuth-213	Bi-213	10
Bismuth-214	Bi-214	100
Polonium-203	Po-203	1,000
Polonium-205	Po-205	1,000
Polonium-207	Po-207	1,000
Polonium-210	Po-210	0.1
Astatine-207	At-207	100
Astatine-211	At-211	10
Radon-220	Rn-220	1
Radon-222	Rn-222	1
Francium-222	Fr-222	100
Francium-223	Fr-223	100
Radium-223	Ra-223	0.1
Radium-224	Ra-224	0.1
Radium-225	Ra-225	0.1
Radium-226	Ra-226	0.1
Radium-227	Ra-227	1,000
Radium-228	Ra-228	0.1
Actinium-224	Ac-224	1

Actinium-225	Ac-225	0.01
Actinium-226	Ac-226	0.1
Actinium-227	Ac-227	0.001
Actinium-228	Ac-228	1
Thorium-226	Th-226	10
Thorium-227	Th-227	0.01
Thorium-228	Th-228	0.001
Thorium-229	Th-229	0.001
Thorium-230	Th-230	0.001
Thorium-231	Th-231	100
Thorium-232	Th-232	100
Thorium-234	Th-234	10
Thorium-natural		100
Protactinium-227	Pa-227	10
Protactinium-228	Pa-228	1
Protactinium-230	Pa-230	0.01
Protactinium-231	Pa-231	0.001
Protactinium-232	Pa-232	1
Protactinium-233	Pa-233	100
Protactinium-234	Pa-234	100
Uranium-230	U-230	0.01
Uranium-231	U-231	100
Uranium-232	U-232	0.001
Uranium-233	U-233	0.001
Uranium-234	U-234	0.001
Uranium-235	U-235	0.001

Uranium-236	U-236	0.001
Uranium-237	U-237	100
Uranium-238	U-238	100
Uranium-239	U-239	1,000
Uranium-240	U-240	100
Uranium-natural		100
Neptunium-232	Np-232	100
Neptunium-233	Np-233	1,000
Neptunium-234	Np-234	100
Neptunium-235	Np-235	100
Neptunium-236 ($1.15x10^5$y)	Np-236	0.001
Neptunium-236 (22.5h)	Np-236	1
Neptunium-237	Np-237	0.001
Neptunium-238	Np-238	10
Neptunium-239	Np-239	100
Neptunium-240	Np-240	1,000
Plutonium-234	Pu-234	10
Plutonium-235	Pu-235	1,000
Plutonium-236	Pu-236	0.001
Plutonium-237	Pu-237	100
Plutonium-238	Pu-238	0.001
Plutonium-239	Pu-239	0.001
Plutonium-240	Pu-240	0.001
Plutonium-241	Pu-241	0.01
Plutonium-242	Pu-242	0.001
Plutonium-243	Pu-243	1,000
Plutonium-244	Pu-244	0.001

Plutonium-245	Pu-245	100
Americium-237	Am-237	1,000
Americium-238	Am-238	100
Americium-239	Am-239	1,000
Americium-240	Am-240	100
Americium-241	Am-241	0.001
Americium-242m	Am-242m	0.001
Americium-242	Am-242	10
Americium-243	Am-243	0.001
Americium-244m	Am-244m	100
Americium-244	Am-244	10
Americium-245	Am-245	1,000
Americium-246m	Am-246m	1,000
Americium-246	Am-246	1,000
Curium-238	Cm-238	100
Curium-240	Cm-240	0.1
Curium-241	Cm-241	1
Curium-242	Cm-242	0.01
Curium-243	Cm-243	0.001
Curium-244	Cm-244	0.001
Curium-245	Cm-245	0.001
Curium-246	Cm-246	0.001
Curium-247	Cm-247	0.001
Curium-248	Cm-248	0.001
Curium-249	Cm-249	1,000
Berkelium-245	Bk-245	100

Berkelium-246	Bk-246	100
Berkelium-247	Bk-247	0.001
Berkelium-249	Bk-249	0.1
Berkelium-250	Bk-250	10
Californium-244	Cf-244	100
Californium-246	Cf-246	1
Californium-248	Cf-248	0.01
Californium-249	Cf-249	0.001
Californium-250	Cf-250	0.001
Californium-251	Cf-251	0.001
Californium-252	Cf-252	0.001
Californium-253	Cf-253	0.1
Californium-254	Cf-254	0.001
Any alpha emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition		0.001
Einsteinium-250	Es-250	100
Einsteinium-251	Es-251	100
Einsteinium-253	Es-253	0.1
Einsteinium-254m	Es-254m	1
Einsteinium-254	Es-254	0.01
Fermium-252	Fm-252	1
Fermium-253	Fm-253	1
Fermium-254	Fm-254	10
Fermium-255	Fm-255	1
Fermium-257	Fm-257	0.01
Mendelevium-257	Md-257	10

Mendelevium-258	Md-258	0.01
Any radionuclide other than alpha emitter radionuclides not listed above or mixtures of beta emitters of unknown composition		0.01

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*

Published Electronically: *November 7, 2018*

4731.2820 NATIONALLY TRACKED SOURCE THRESHOLDS.

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

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

Strontium-90	1,000	27,000	10	270
Thorium-228	20	540	0.2	5.4
Thorium-229	20	540	0.2	5.4
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81

Statutory Authority: *MS s 144.1202; 144.1203*

History: *33 SR 1440*

Published Electronically: *March 12, 2009*

4731.2950 LOW-LEVEL RADIOACTIVE WASTE; TRANSFER AND DISPOSAL.

Subpart 1. **Definitions.**

A. The terms used in this part have the meanings given in this subpart and part 4731.0100.

B. "Chemical description" means a description of the principal chemical characteristics of a low-level radioactive waste.

C. "Computer-readable medium" means that the regulatory agency's computer can transfer the information from the medium into its memory.

D. "Consignee" means the designated receiver of the shipment of low-level radioactive waste.

E. "Decontamination facility" means a facility, operating under a license issued by the commissioner, the NRC, or an agreement state, whose principal purpose is decontamination of equipment or materials to accomplish recycle, reuse, or other waste management objectives, and which, for purposes of this part, is not considered to be a consignee for low-level radioactive waste shipments.

F. "Disposal container" means a container principally used to confine low-level radioactive waste during disposal operations at a land disposal facility. For some shipments, the disposal container may be the transport package.

G. "EPA identification number" means the number received by a transporter following application to the administrator of the Environmental Protection Agency as required under Code of Federal Regulations, title 40, part 263.

H. "Generator" means a licensee, operating under a license issued by the commissioner, the NRC, or an agreement state, that:

(1) is a waste generator; or

(2) is the licensee to whom waste, such as waste generated as a result of decontamination or recycle activities, can be attributed within the context of the Low-Level Radioactive Waste Policy Amendments Act of 1985, Public Law 99-240.

I. "NRC Form 540," "NRC Form 540A," "NRC Form 541," "NRC Form 541A," "NRC Form 542," and "NRC Form 542A" are official NRC forms referenced in this part. Licensees need not use originals of the NRC forms as long as any substitute forms are equivalent to the original documentation in respect to content, clarity, size, and location of information. Upon agreement between the shipper and consignee, NRC Forms 541, 541A, 542, and 542A may be completed, transmitted, and stored in electronic media. The electronic media must have the capability for producing legible, accurate, and complete records in the format of the uniform manifest.

J. "Package" means the assembly of components necessary to ensure compliance with the packaging requirements of DOT regulations, together with its radioactive contents, as presented for transport.

K. "Physical description" means the items called for on NRC Form 541 to describe a low-level radioactive waste.

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

M. "Shipper" means the licensed waste generator, waste collector, or waste processor that offers low-level radioactive waste for transportation, typically consigning this type of waste to a licensed waste collector, waste processor, or land disposal facility operator.

N. "Shipping paper" means NRC Form 540 and, if required, NRC Form 540A, which includes the information required under Code of Federal Regulations, title 49, part 172.

O. "Uniform low-level radioactive waste manifest" or "uniform manifest" means the combination of NRC Forms 540, 541, and, if necessary, 542, and their respective continuation sheets as needed, or equivalent.

P. "Waste collector" means an entity, operating under a license issued by the commissioner, the NRC, or an agreement state, whose principal purpose is to collect and consolidate waste generated by others and to transfer the waste, without processing or repackaging the collected waste, to another licensed waste collector, licensed waste processor, or licensed land disposal facility.

Q. "Waste description" means the physical, chemical, and radiological description of a low-level radioactive waste as called for on NRC Form 541.

R. "Waste generator" means an entity, operating under a license issued by the commissioner, the NRC, or an agreement state, that:

(1) possesses any material or component that contains radioactivity or is radioactively contaminated for which the licensee foresees no further use; and

(2) transfers the material or component to a licensed land disposal facility or to a licensed waste collector or waste processor for handling or treatment prior to disposal.

A licensee performing processing or decontamination services may be a waste generator if the transfer of low-level radioactive waste from its facility is defined as residual waste.

S. "Waste processor" means an entity, operating under a license issued by the commissioner, the NRC, or an agreement state, whose principal purpose is to process, repackage, or otherwise treat low-level radioactive material or waste generated by others before eventual transfer of the waste to a licensed low-level radioactive waste land disposal facility.

T. "Waste type" means a waste within a disposal container having a unique physical description, such as a specific waste descriptor code or description or a waste sorbed on or solidified in a specifically defined media.

Subp. 2. **Manifest.**

A. A waste generator, waste collector, or waste processor that transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility must prepare a manifest reflecting information requested on applicable NRC Forms 540 (Uniform Low-Level Radioactive Waste Manifest (Shipping Paper)) and 541 (Uniform Low-Level Radioactive Waste Manifest (Container and Waste Description)) and, if necessary, on an applicable NRC Form 542 (Uniform Low-Level Radioactive Waste Manifest (Manifest Index and Regional Compact Tabulation)).

B. NRC Forms 540 and 540A must be completed and must physically accompany the pertinent low-level waste shipment.

C. Upon agreement between shipper and consignee, NRC Forms 541, 541A, 542, and 542A may be completed, transmitted, and stored in electronic media with the capability for producing legible, accurate, and complete records on the respective forms.

D. Licensees are not required by the commissioner, the NRC, or an agreement state to comply with the manifesting requirements of this subpart when they ship:

(1) low-level radioactive waste for processing and expect its return, such as for storage under their license, prior to disposal at a licensed land disposal facility;

(2) low-level radioactive waste that is being returned to the licensee that is the waste generator or generator; or

(3) radioactively contaminated material to a waste processor that becomes the processor's residual waste.

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

F. NRC Forms 540, 540A, 541, 541A, 542, and 542A, and the accompanying instructions, in hard copy, may be obtained from the Information and Records Management Branch, Office of the Chief Information Officer, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 415-7232. The forms are available online at http://www.nrc.gov/reading-rm/doc-collections/forms.

Subp. 3. **Other federal law.** This part includes information requirements of the DOT, as codified in Code of Federal Regulations, title 49, part 172. Information on hazardous, medical, or other waste, required to meet Environmental Protection Agency (EPA) regulations, as codified in Code of Federal Regulations, title 40, part 261 or elsewhere, is not addressed in this part and must be provided on the required EPA forms. However, the required EPA forms must accompany the uniform low-level radioactive waste manifest required by this part.

Subp. 4. **General information.** The shipper of the radioactive waste must provide the following information on the uniform manifest:

A. the name, facility address, and telephone number of the licensee shipping the waste;

B. an explicit declaration indicating whether the shipper is acting as a waste generator, waste collector, waste processor, or a combination of these identifiers for purposes of the manifested shipment; and

C. the name, address, and telephone number, or the name and EPA identification number for the carrier transporting the waste.

Subp. 5. **Shipment information.** The shipper of the radioactive waste must provide the following information regarding the waste shipment on the uniform manifest:

A. the date of the waste shipment;

B. the total number of packages or disposal containers;

C. the total disposal volume and disposal weight in the shipment;

D. the total radionuclide activity in the shipment;

E. the activity of each of the radionuclides H-3, C-14, Tc-99, and I-129 contained in the shipment; and

F. the total masses of U-233, U-235, and plutonium in special nuclear material and the total mass of uranium and thorium in source material.

Subp. 6. **Disposal container and waste information.** The shipper of the radioactive waste must provide the following information on the uniform manifest regarding the waste and each disposal container of waste in the shipment:

A. an alphabetic or numeric identification that uniquely identifies each disposal container in the shipment;

B. a physical description of the disposal container, including the manufacturer and model of any high integrity container;

C. the volume displaced by the disposal container;

D. the gross weight of the disposal container, including the waste;

E. for waste consigned to a disposal facility, the maximum radiation level at the surface of each disposal container;

F. a physical and chemical description of the waste;

G. the total weight percentage of chelating agent for any waste containing more than 0.1 percent chelating agent by weight, plus the identity of the principal chelating agent;

H. the approximate volume of waste within a container;

I. the sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name;

J. the identities and activities of individual radionuclides contained in each container, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material. For discrete waste types, such as activated materials, contaminated equipment, mechanical filters, sealed source or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides associated with or contained on these waste types within a disposal container must be reported; and

K. the total radioactivity within each container.

Subp. 7. **Uncontainerized waste information.** The shipper of the radioactive waste must provide the following information on the uniform manifest regarding a waste shipment delivered without a disposal container:

A. the approximate volume and weight of the waste;

B. a physical and chemical description of the waste;

C. the total weight percentage of chelating agent if the chelating agent exceeds 0.1 percent by weight, plus the identity of the principal chelating agent;

D. for waste consigned to a disposal facility, the classification of the waste according to Code of Federal Regulations, title 10, section 61.55. Waste not meeting the structural stability requirements of Code of Federal Regulations, title 10, section 61.56, paragraph (b), must be identified;

E. the identities and activities of individual radionuclides contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material; and

F. for wastes consigned to a disposal facility, the maximum radiation levels at the surface of the waste.

Subp. 8. **Multigenerator disposal container information.**

A. This subpart applies to disposal containers enclosing mixtures of waste originating from different generators. The origin of the low-level radioactive waste resulting from a waste processor's activities may be attributable to one or more generators, including waste generators. This subpart also applies to mixtures of wastes shipped in an uncontainerized form, for which portions of the mixture within the shipment originate from different generators.

B. For homogeneous mixtures of waste, such as incinerator ash, the shipper must provide the waste description applicable to the mixture and the volume of the waste attributed to each generator.

C. For heterogeneous mixtures of waste, such as the combined products from a large compactor, the shipper must identify each generator contributing waste to the disposal container and for discrete waste types, such as activated materials, contaminated equipment, mechanical filters, sealed source or devices, and wastes in solidification or stabilization media, the identities and activities of individual radionuclides contained on these waste types within the disposal container. For each generator, the shipper must provide the following:

(1) the volume of waste within the disposal container;

(2) a physical and chemical description of the waste, including the solidification agent, if any;

(3) the total weight percentage of chelating agents for any disposal container containing more than 0.1 percent chelating agent by weight, plus the identity of the principal chelating agent;

(4) the sorbing or solidification media, if any, and the identity of the solidification media vendor and brand name if the media is claimed to meet stability requirements under Code of Federal Regulations, title 10, section 61.56, paragraph (b); and

(5) radionuclide identities and activities contained in the waste, the masses of U-233, U-235, and plutonium in special nuclear material, and the masses of uranium and thorium in source material, if contained in the waste.

Subp. 9. **Certification.** An authorized representative of the waste generator, waste processor, or waste collector must certify by signing and dating the shipment manifest that the transported materials are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation according to the applicable regulations of the DOT and the NRC, the commissioner, or an agreement state. A waste collector, in signing the certification, is certifying that nothing has been done to the collected waste that would invalidate the waste generator's certification.

Subp. 10. **Control and tracking; transfers.** A licensee that transfers radioactive waste to a land disposal facility or a licensed waste collector must comply with this subpart. A licensee that transfers waste to a licensed waste processor for waste treatment or repackaging must comply with items D to I. A licensee must:

A. prepare all wastes so that the waste is classified according to Code of Federal Regulations, title 10, section 61.55, and meets the waste characteristics requirements under Code of Federal Regulations, title 10, section 61.56;

B. label each disposal container of waste, or transport package if potential radiation hazards preclude labeling of the individual disposal container, to identify whether it is Class A waste, Class B waste, Class C waste, or greater than Class C waste, according to Code of Federal Regulations, title 10, section 61.55;

C. conduct a quality assurance program to ensure compliance with Code of Federal Regulations, title 10, sections 61.55 and 61.56. The program must include management evaluation of audits;

D. prepare the uniform low-level radioactive waste manifest as required by this part;

E. forward a copy or electronically transfer the uniform low-level radioactive waste manifest to the intended consignee so that receipt of the manifest precedes the low-level radioactive waste shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee, or both;

F. include NRC Form 540, and Form 540A if required, with the shipment regardless of the option chosen in item E;

G. receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;

H. retain a copy of or electronically store the uniform low-level radioactive waste manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required under parts 4731.0525 to 4731.0840 and 4731.3000 to 4731.3175; and

I. for any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this part, conduct an investigation according to subpart 14.

Subp. 11. **Control and tracking; prepackaged waste.** A waste collector licensee that handles only prepackaged waste must:

A. acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of NRC Form 540;

B. prepare a new manifest to reflect consolidated shipments that meet the requirements of this part. The waste collector must ensure that, for each container of waste in the shipment, the manifest identifies the generator of that container of waste;

C. forward a copy or electronically transfer the uniform low-level radioactive waste manifest to the intended consignee so that receipt of the manifest precedes the low-level radioactive waste shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee, or both;

D. include NRC Form 540, and 540A if required, with the shipment regardless of the option chosen in item C;

E. receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;

F. retain a copy of or electronically store the uniform low-level radioactive waste manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required under parts 4731.0525 to 4731.0840 and 4731.3000 to 4731.3120;

G. for any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this part, conduct an investigation according to subpart 14; and

H. notify the shipper and the commissioner, the administrator of the nearest NRC regional office, or an agreement state licensing agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

Subp. 12. **Control and tracking; treatment or repackaging.** A licensed waste processor that treats or repackages waste must:

A. acknowledge receipt of the waste from the shipper within one week of receipt by returning a signed copy of NRC Form 540;

B. prepare a new manifest that meets the requirements of this part. Preparation of the new manifest reflects that the waste processor is responsible for meeting these requirements. For each container of waste in the shipment, the manifest must identify the waste generators, the preprocessed waste volume, and the other information as required under subpart 8;

C. prepare all wastes so that the waste is classified according to Code of Federal Regulations, title 10, section 61.55, and meets the waste characteristics requirements under Code of Federal Regulations, title 10, section 61.56;

D. label each package of waste to identify whether it is Class A waste, Class B waste, or Class C waste, according to Code of Federal Regulations, title 10, sections 61.55 and 61.57;

E. conduct a quality assurance program to ensure compliance with Code of Federal Regulations, title 10, sections 61.55 and 61.56. The program must include management evaluation of audits;

F. forward a copy or electronically transfer the uniform low-level radioactive waste manifest to the intended consignee so that receipt of the manifest precedes the low-level radioactive waste shipment or the manifest is delivered to the consignee with the waste at the time the waste is transferred to the consignee, or both;

G. include NRC Form 540, and Form 540A if required, with the shipment regardless of the option chosen in item F;

H. receive acknowledgment of the receipt of the shipment in the form of a signed copy of NRC Form 540;

I. retain a copy of or electronically store the uniform low-level radioactive waste manifest and documentation of acknowledgment of receipt as the record of transfer of licensed material as required under parts 4731.0525 to 4731.0840 and 4731.3000 to 4731.3120;

J. for any shipment or any part of a shipment for which acknowledgment of receipt has not been received within the times set forth in this part, conduct an investigation according to subpart 14; and

K. notify the shipper and the commissioner, the administrator of the nearest NRC regional office, or an agreement state licensing agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

Subp. 13. **Control and tracking; land disposal facility.** A land disposal facility operator must:

A. acknowledge receipt of the waste within one week of receipt by returning, as a minimum, a signed copy of NRC Form 540 to the shipper. The shipper to be notified is the licensee that last possessed the waste and transferred the waste to the operator. If any discrepancy exists between materials listed on the uniform low-level radioactive waste manifest and materials received, copies or electronic transfer of the affected forms must be returned indicating the discrepancy;

B. maintain copies of all completed manifests and electronically store the information required under Code of Federal Regulations, title 10, section 61.80, paragraph (l), until the commissioner or the NRC terminates the license; and

C. notify the shipper and the commissioner, the administrator of the nearest NRC regional office, or an agreement state licensing agency when any shipment, or part of a shipment, has not arrived within 60 days after receipt of an advance manifest, unless notified by the shipper that the shipment has been canceled.

Subp. 14. **Investigation.** A shipment or part of a shipment for which acknowledgment is not received within the times set forth in this part must:

A. be investigated by the shipper if the shipper has not received notification or receipt within 20 days after transfer; and

B. be traced and reported. The investigation must include tracing the shipment and filing a report with the commissioner, the administrator of the nearest NRC regional office, or an agreement state licensing agency. A licensee that conducts a trace investigation must file a written report with the commissioner within two weeks of completing the investigation.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

DOMESTIC LICENSING OF RADIOACTIVE MATERIALS

4731.3000 APPLICABILITY; DOMESTIC LICENSING OF RADIOACTIVE MATERIAL.

Parts 4731.3000 to 4731.3245 apply to all persons and govern domestic licensing of radioactive material. Parts 4731.3000 to 4731.3245 also give notice to all persons who knowingly provide to any licensee, applicant, certificate of registration holder, contractor, or subcontractor, components, equipment, materials, or other goods or services, that relate to a licensee's, applicant's, or certificate of registration holder's activities subject to parts 4731.3000 to 4731.3245, that they may be individually subject to the commissioner's enforcement action for violation of part 4731.0260.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3005 ACTIVITIES REQUIRING LICENSE.

Except for persons exempt under parts 4731.0300 to 4731.0370 and 4731.3010 to 4731.3245, no person shall manufacture, produce, transfer, receive, acquire, own, possess, or use radioactive material except as authorized in a specific or general license issued under this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3010 SPECIFIC EXEMPTIONS.

A. The commissioner may, upon application of any interested person or upon the commissioner's own initiative, grant exemptions from parts 4731.3200 to 4731.7280 as the commissioner determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest.

B. A licensee's activities are exempt from parts 4731.3000 to 4731.3245 to the extent that the licensee's activities are licensed under Code of Federal Regulations, title 10, part 72.

C. The United States Department of Energy is exempt from parts 4731.3000 to 4731.3245 to the extent that the licensee's activities are subject to the requirements of Code of Federal Regulations, title 10, parts 60 and 63.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3015 EXEMPTION; USE OF RADIOACTIVE MATERIAL UNDER CERTAIN FEDERAL CONTRACTS.

A. Except to the extent that United States Department of Energy facilities or activities of the types subject to licensing under United States Code, title 42, section 5842, the Energy Reorganization Act of 1974 are involved, a prime contractor of the United States Department of Energy is exempt from parts 4731.3000 to 4731.3245 to the extent that the contractor, under the prime contract with the United States Department of Energy, manufactures, produces, transfers, receives, acquires, owns, possesses, or uses radioactive material for:

(1) the performance of work for the United States Department of Energy at a United States government-owned or -controlled site, including the transportation of radioactive material to or from such site and the performance of contract services during temporary interruptions of such transportation;

(2) research in or development, manufacture, storage, testing, or transportation of atomic weapons or components thereof; or

(3) the use or operation of nuclear reactors or other nuclear devices in United States government-owned vehicles or vessels.

B. In addition to the exemptions under item A, and subject to the requirement for licensing of Department of Energy facilities and activities under the Energy Reorganization Act of 1974, a prime contractor or subcontractor of the Department of Energy or the NRC is exempt from parts 4731.3000 to 4731.3245 to the extent that:

(1) the prime contractor or subcontractor manufactures, produces, transfers, receives, acquires, owns, possesses, or uses radioactive material under the prime contract or subcontract; and

(2) the NRC and the commissioner determine that:

(a) the exemption is authorized by law; and

(b) under the terms of the contract or subcontract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3020 EXEMPTION; CARRIERS.

Common and contract carriers, freight forwarders, warehousers, and the United States Postal Service are exempt from parts 4731.3000 to 4731.8140 to the extent that they transport or store radioactive material in the regular course of the carriage for another or storage incident thereto.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3025 EXEMPTION; CERTAIN CONCENTRATIONS.

Subpart 1. **Exemption.** Except as provided in subparts 3 and 4, a person is exempt from parts 4731.3000 to 4731.7280 to the extent that the person receives, possesses, uses, transfers, owns, or acquires products or materials containing radioactive material in concentrations not in excess of those listed in part 4731.3140.

Subp. 2. **Import not authorized.** Parts 4731.3000 to 4731.3245 do not authorize the import of radioactive material or products containing radioactive materials.

Subp. 3. **Introduction by specific licensee.** A manufacturer, processor, or producer of a product or material in an agreement state is exempt from parts 4731.3000 to 4731.7280 to the extent that:

A. the manufacturer, processor, or producer transfers radioactive material contained in a product or material in concentrations not in excess of those specified in part 4731.3140; and

B. the radioactive material is introduced into the product or material by a licensee holding a specific license issued by the NRC expressly authorizing such introduction.

The exemption in this subpart does not apply to the transfer of radioactive material in any food, beverage, cosmetic, drug, or other commodity or product designed for ingestion or inhalation by, or application to, a human being.

Subp. 4. **Transfer limitations.** No person may introduce radioactive material into a product or material knowing or having reason to believe that it will be transferred to persons exempt under this part or equivalent regulations of the NRC or an agreement state, except according to a specific license issued under Code of Federal Regulations, title 10, section 32.11.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*
Published Electronically: *March 12, 2009*

4731.3030 EXEMPTION; CERTAIN ITEMS CONTAINING RADIOACTIVE MATERIAL.

Subpart 1. **Exempt products.** Except for persons who apply radioactive material to or incorporate radioactive material into the following products or persons who initially transfer for sale or distribution the following products containing radioactive material, a person is exempt from parts 4731.3000 to 4731.7280 to the extent that the person receives, possesses, uses, transfers, owns, or acquires the following products:

A. timepieces or hands or dials of timepieces that:

(1) contain not more than the following specified quantities of radioactive material:

(a) 25 millicuries of tritium per timepiece;

(b) five millicuries of tritium per hand;

(c) 15 millicuries of tritium per dial (bezels, when used, are considered part of the dial);

(d) 100 microcuries of promethium-147 per watch or 200 microcuries of promethium-147 per any other timepiece;

(e) 20 microcuries of promethium-147 per watch hand or 40 microcuries of promethium-147 per other timepiece hand;

(f) 60 microcuries of promethium-147 per watch dial or 120 microcuries of promethium-147 per any other timepiece dial (bezels, when used, are considered as part of the dial);

(g) one microcurie (0.037 MBq) of radium-226 per timepiece in intact timepieces manufactured prior to November 30, 2007; and

(2) do not exceed the following levels of radiation. The levels of radiation from hands and dials containing promethium-147 must not exceed, when measured through 50 milligrams per square centimeter of absorber:

(a) for wrist watches, 0.1 millirad per hour at ten centimeters from any surface;

(b) for pocket watches, 0.1 millirad per hour at one centimeter from any surface; or

(c) for any other timepiece, 0.2 millirad per hour at ten centimeters from any surface;

B. (1) static elimination devices which contain, as a sealed source or sources, by-product material consisting of a total of not more than 18.5 MBq (500 μCi) of polonium-210 per device;

(2) ion-generating tubes designed for ionization of air that contain, as a sealed source or sources, by-product material consisting of a total of not more than 18.5 MBq (500μCi) of polonium-210 per device or of a total of not more than 1.85 GBq (50 mCi) of hydrogen-3 (tritium) per device; and

(3) devices in subitems (1) and (2) authorized before December 31, 2014, for use under a general license that were manufactured, tested, and labeled by the manufacturer in accordance with the specifications contained in a specific license issued by the commissioner, the NRC, or an agreement state.

C. balances of precision containing not more than one millicurie of tritium per balance or not more than 0.5 millicurie of tritium per balance part manufactured before December 17, 2007;

D. marine compasses containing not more than 750 millicuries of tritium gas and other marine navigational instruments containing not more than 250 millicuries of tritium gas manufactured before December 17, 2007;

E. ionization chamber smoke detectors containing not more than one microcurie (μCi) of americium-241 per detector in the form of a foil and designed to protect life and property from fires;

F. electron tubes. For purposes of this item, "electron tubes" include spark gap tubes, power tubes, gas tubes including glow lamps, receiving tubes, microwave tubes, indicator tubes, pickup tubes, radiation detection tubes, and any other completely sealed tube that is designed to conduct or control electrical currents. The exemption under this item applies only if the levels of radiation from each electron tube containing radioactive material do not exceed one millirad per hour at one centimeter from any surface when measured through seven milligrams per square centimeter of absorber and if each tube does not contain more than one of the following specified quantities of radioactive materials:

(1) 150 millicuries of tritium per microwave receiver protector tube or ten millicuries of tritium per any other electron tube;

(2) one microcurie of cobalt-60;

(3) five microcuries of nickel-63;

(4) 30 microcuries of krypton-85;

(5) five microcuries of cesium-137; or

(6) 30 microcuries of promethium-147; or

G. ionizing radiation measuring instruments containing, for purposes of internal calibration or standardization, one or more sources of radioactive material. For purposes of this item, an instrument's source may contain either one type or different types of radionuclides and an individual exempt quantity may be composed of fractional parts of one or more of the exempt quantities in part 4731.3145, provided that the sum of the fractions does not exceed unity. For purposes of this item, 0.05 microcurie of americium-241 is an exempt quantity under part 4731.3145. The exemption under this item applies only if:

(1) each source contains no more than one exempt quantity under part 4731.3145; and

(2) each instrument contains no more than ten exempt quantities.

Subp. 2. **Specific license required.** A person who desires to apply radioactive material to or incorporate radioactive material into the products exempted under subpart 1 or who desires to initially transfer for sale or distribution such products containing radioactive material must apply for a specific license under Code of Federal Regulations, title 10, section 32.14, which license states that the product may be distributed by the licensee to persons exempt under subpart 1.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 33 SR 1440; 40 SR 145; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.3035 [Repealed, 33 SR 1440]

Published Electronically: *March 12, 2009*

4731.3040 EXEMPT QUANTITIES.

Subpart 1. **Exempt quantities.** Except as provided in subparts 3 to 5, a person is exempt from parts 4731.3000 to 4731.7280 to the extent that the person receives, possesses, uses, transfers, owns, or acquires radioactive material in individual quantities, each of which does not exceed the applicable quantity in part 4731.3145.

Subp. 2. **Receipt under prior license.** A person who possesses radioactive material received or acquired before September 25, 1971, under the general license then provided under Code of Federal Regulations, title 10, section 31.4, or similar general license of a state, is exempt from parts 4731.3000 to 4731.4360, and 4731.6000 to 4731.7280 to the extent that the person possesses, uses, transfers, or owns such radioactive material.

Subp. 3. **Limitation.** This part does not authorize, for purposes of commercial distribution, the production, packaging, repackaging, or transfer of radioactive material or the incorporation of radioactive material into products intended for commercial distribution.

Subp. 4. **Specific license required.** No person may, for purposes of commercial distribution, transfer radioactive material in the individual quantities under part 4731.3145, knowing or having reason to believe that such quantities of radioactive material will be transferred to persons exempt under this part or equivalent regulations of the NRC or an agreement state, except according to a license issued under Code of Federal Regulations, title 10, section 32.18, that states that the radioactive material may be transferred by the licensee to persons exempt under this part or equivalent regulations of the NRC or an agreement state.

Subp. 5. **Aggregation.** No person may, for purposes of producing an increased radiation level, combine quantities of radioactive material covered by this exemption so that the aggregate quantity exceeds the limits set forth in part 4731.3145, except for radioactive material combined within a device placed in use before May 3, 1999, or as otherwise permitted by this part.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.3045 EXEMPTION; SELF-LUMINOUS PRODUCTS CONTAINING TRITIUM, KRYPTON-85, OR PROMETHIUM-147.

Subpart 1. **Specific license exemption.** Except for persons who manufacture, process, produce, or initially transfer for sale or distribution self-luminous products containing tritium, krypton-85, or promethium-147, and except as provided in subpart 3, a person is exempt from parts 4731.2000 to 4731.2090 and 4731.3000 to 4731.7280 to the extent that the person receives, possesses, uses, transfers, owns, or acquires tritium, krypton-85, or promethium-147 in self-luminous products manufactured, processed, produced, or initially transferred according to a specific license issued

under Code of Federal Regulations, title 10, section 32.22, that authorizes the initial transfer of the product for use under this part.

Subp. 2. **Specific license required.** A person who desires to manufacture, process, produce, or initially transfer for sale or distribution self-luminous products containing tritium, krypton-85, or promethium-147 for use under subpart 1 must apply for a license according to Code of Federal Regulations, title 10, section 32.22, and for a certificate of registration in accordance with Code of Federal Regulations, title 10, section 32.210.

Subp. 3. **Limitation.** The exemption in subpart 1 does not apply to tritium, krypton-85, or promethium-147 used in products primarily for frivolous purposes or in toys or adornments.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3050 EXEMPTION; GAS AND AEROSOL DETECTORS CONTAINING RADIOACTIVE MATERIAL.

Subpart 1. **Specific license exemption.** Except for persons who manufacture, process, produce, or initially transfer for sale or distribution gas and aerosol detectors containing radioactive material, a person is exempt from parts 4731.1000 to 4731.2090 and 4731.3000 to 4731.7280 to the extent that the person receives, possesses, uses, transfers, owns, or acquires radioactive material in gas or aerosol detectors designed to protect health, safety, or property, and manufactured, processed, produced, or initially transferred according to a specific license issued under Code of Federal Regulations, title 10, section 32.26, that authorizes the initial transfer of the product for use under this part. This exemption also covers gas and aerosol detectors manufactured or distributed before November 30, 2007, in accordance with a specific license issued by a state under comparable provisions to Code of Federal Regulations, title 10, section 32.26, authorizing distribution to persons exempt from regulatory requirements.

Subp. 2. **Specific license required.** A person who desires to manufacture, process, or produce gas and aerosol detectors containing radioactive material or to initially transfer such products for use under subpart 1 must apply for a license under Code of Federal Regulations, title 10, section 32.26, and for a certificate of registration under Code of Federal Regulations, title 10, section 32.210.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 33 SR 1440; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3055 EXEMPTION; RADIOACTIVE DRUGS.

Subpart 1. **Exemption.** Except as provided in subparts 2 and 3, a person is exempt from parts 4731.3000 to 4731.3245 and 4731.4400 to 4731.4527, if the person receives, possesses, uses, transfers, owns, or acquires capsules containing one μCi (37 kBq) carbon-14 urea (allowing for

nominal variation that may occur during the manufacturing process) each, for in vivo diagnostic use for humans.

Subp. 2. **Research; license required.** A person who desires to use the capsules under subpart 1 for research involving human subjects must apply for and receive a specific license according to parts 4731.4400 to 4731.4527.

Subp. 3. **Specific license required.** A person who desires to manufacture, prepare, process, produce, package, repackage, or transfer for commercial distribution the capsules under subpart 1 must apply for and receive a specific license under Code of Federal Regulations, title 10, section 32.21.

Subp. 4. **Other law.** Nothing in this part relieves a person from complying with applicable United States Food and Drug Administration or other federal and state requirements governing receipt, administration, and use of drugs.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3056 EXEMPTION; CERTAIN INDUSTRIAL DEVICES.

Subpart 1. **Specific license exemption.** Except for persons who manufacture, process, produce, or initially transfer for sale or distribution industrial devices containing radioactive material 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 an ionized atmosphere, a person is exempt from parts 4731.1000 to 4731.2090 and 4731.3000 to 4731.7280 to the extent that the person receives, possesses, uses, transfers, owns, or acquires radioactive material in these certain detecting, measuring, gauging, or controlling devices and certain devices for producing an ionized atmosphere, and manufactured, processed, produced, or initially transferred according to a specific license issued under Code of Federal Regulations, title 10, section 32.30, that authorizes the initial transfer of the device for use under this part. This exemption does not cover sources not incorporated into a device, such as calibration and reference sources.

Subp. 2. **Specific license required.** A person who desires to manufacture, process, produce, or initially transfer for sale or distribution industrial devices containing radioactive material for use under subpart 1 must apply for a license under Code of Federal Regulations, title 10, section 32.30, and for a certificate of registration under Code of Federal Regulations, title 10, section 32.210.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*
Published Electronically: *August 27, 2015*

4731.3060 TYPES OF LICENSES.

A. Licenses for radioactive material are of two types: general and specific.

B. The commissioner issues a specific license to a named person who has filed an application for the license under parts 4731.3300 to 4731.7280.

C. A general license is provided by rule, grants authority to a person for certain activities involving radioactive material, and is effective without the filing of an application with the commissioner or the issuance of a licensing document to a particular person. However, registration with the commissioner may be required by the particular general license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3065 SPECIFIC LICENSES; APPLICATION.

Subpart 1. **General requirements.**

A. Applications for specific licenses must be filed on an application for radioactive material license form prescribed by the commissioner.

B. An application must be signed by the applicant or licensee or a person duly authorized to act for and on behalf of the applicant or licensee.

C. The commissioner may at any time after the filing of the original application, and before the expiration of the license, require further statements to enable the commissioner to determine whether the application should be granted or denied or whether a license should be modified or revoked.

D. An application must be accompanied by the fee prescribed under Minnesota Statutes, section 144.1205.

E. An application for a license to receive and possess radioactive material that the commissioner has determined will significantly affect the quality of the environment must be filed at least nine months prior to commencement of construction of the plant or facility in which the activity will be conducted and must be accompanied by any environmental report as required under Code of Federal Regulations, title 10, part 51, subpart A.

Subp. 2. **Sealed source requirements.**

A. Except as provided in items B, C, and D, an application for a specific license to use radioactive material in the form of a sealed source or in a device that contains the sealed source must:

(1) identify the source or device by manufacturer and model number as registered with the NRC under Code of Federal Regulations, title 10, section 32.210, with an agreement state, or for a source or a device containing radium-226 or accelerator-produced radioactive material with a state under provisions comparable to Code of Federal Regulations, title 10, section 32.210; or

(2) contain the information identified in Code of Federal Regulations, title 10, section 32.210 (c).

B. For sources or devices manufactured prior to October 23, 2012, that are not registered with the NRC under Code of Federal Regulations, title 10, section 32.210, or with an agreement state, and for which the applicant is unable to provide all categories of information specified in Code of Federal Regulations, title 10, section 32.210 (c), the applicant must provide:

(1) all available information identified in Code of Federal Regulations, title 10, section 32.210 (c) and this chapter concerning the source, and, if applicable, the device; and

(2) sufficient additional information to demonstrate that there is reasonable assurance that the radiation safety properties of the source or device are adequate to protect health and minimize danger to life and property. This information must include a description of the source or device, a description of radiation safety features, the intended use and associated operating experience, and the results of a recent leak test.

C. For sealed sources and devices allowed to be distributed without registration of safety information according to Code of Federal Regulations, title 10, section 32.210 (g)(1), the applicant may supply only the manufacturer, model number, and radionuclide and quantity.

D. If it is not feasible to identify each sealed source and device individually, the applicant may propose constraints on the number and type of sealed sources and devices to be used and the conditions under which they will be used, in lieu of identifying each sealed source and device.

Subp. 3. **Decommissioning requirements.** As provided under part 4731.3080, certain applications for specific licenses filed under parts 4731.3000 to 4731.3175 and 4731.3300 to 4731.4527 must contain a proposed decommissioning funding plan or a certification of financial assurance for decommissioning.

Subp. 4. **Additional requirements.**

A. An application to possess radioactive materials in unsealed form, on foils or plated sources, or sealed in glass in excess of the quantities in part 4731.3150 must contain:

(1) an evaluation showing that the maximum dose to a person off-site due to a release of radioactive material would not exceed one rem effective dose equivalent or five rems to the thyroid; or

(2) an emergency plan for responding to a release of radioactive material.

B. One or more of the following factors may be used to support an evaluation submitted under item A, subitem (1):

(1) the radioactive material is physically separated so that only a portion could be involved in an accident;

(2) all or part of the radioactive material is not subject to release during an accident because of the way it is stored or packaged;

(3) the release fraction in the respirable size range would be lower than the release fraction shown in part 4731.3150 due to the chemical or physical form of the material;

(4) the solubility of the radioactive material would reduce the dose received;

(5) facility design or engineered safety features in the facility would cause the release fraction to be lower than shown in part 4731.3150;

(6) operating restrictions or procedures would prevent a release fraction as large as that shown in part 4731.3150; or

(7) other factors appropriate for the specific facility.

Subp. 5. **Emergency plan.** An emergency plan submitted under subpart 4, item A, subitem (2), must include:

A. a brief description of the licensee's facility and area near the site;

B. identification of each type of radioactive materials accident for which protective actions may be needed;

C. a classification system for classifying accidents as alert or site area emergencies;

D. identification of the means of detecting each type of accident in a timely manner;

E. a brief description of the means and equipment for mitigating the consequences of each type of accident, including those provided to protect workers on-site, and a description of the program for maintaining the equipment;

F. a brief description of the methods and equipment to assess releases of radioactive materials;

G. a brief description of the responsibilities of licensee personnel should an accident occur, including identification of personnel responsible for promptly notifying off-site response organizations and the commissioner, and the responsibilities for developing, maintaining, and updating the plan;

H. a commitment to and a brief description of the means to promptly notify off-site response organizations and request off-site assistance, including medical assistance for the treatment of contaminated injured on-site workers when appropriate. A control point must be established. The notification and coordination must be planned so that unavailability of some personnel, parts of the facility, and some equipment does not prevent notification and coordination. The licensee must also commit to notifying the commissioner immediately after the licensee has notified the appropriate off-site response organizations and not later than one hour after the licensee declares an emergency. These reporting requirements do not supersede or release a licensee's responsibility to comply with the Emergency Planning and Community Right-to-Know Act of 1986, title III, Public Law 99-499, or other state or federal reporting requirements;

I. a brief description of the types of information on facility status, radioactive releases, and recommended protective actions, if necessary, to be given to off-site response organizations and to the commissioner;

J. a brief description of the frequency, performance objectives, and plans for the training that the licensee will provide workers on how to respond to an emergency, including any special instructions and orientation tours the licensee would offer to fire, police, medical, and other emergency personnel. The training must:

(1) familiarize personnel with site-specific emergency procedures;

(2) thoroughly prepare site personnel for their responsibilities in the event of an accident, using accident scenarios postulated as the most probable for the specific site; and

(3) use team training for accident scenarios postulated as the most probable for the specific site;

K. a brief description of the means of restoring the facility to a safe condition after an accident;

L. provisions for conducting quarterly communications checks with off-site response organizations and biennial on site exercises to test response to simulated emergencies. Quarterly communications checks with off-site response organizations must include checking and updating all necessary telephone numbers. The licensee must invite off-site response organizations to participate in the biennial exercises. Participation of off-site response organizations in biennial exercises, although recommended, is not required. Exercises must use accident scenarios postulated as most probable for the specific site and the scenarios must not be known to most exercise participants. The licensee must critique the exercises using individuals not having direct implementation responsibility for the plan. Critiques of exercises must evaluate the appropriateness of the plan, emergency procedures, facilities, equipment, training of personnel, and overall effectiveness of the response. Deficiencies found by the critiques must be corrected; and

M. a certification that the applicant has met its responsibilities under the Emergency Planning and Community Right-to-Know Act of 1986, title III, Public Law 99-499, if applicable to the applicant's activities at the proposed place of use of the radioactive material.

Subp. 6. **Comments.** A licensee must:

A. allow the off-site response organizations expected to respond in case of an accident 60 days to comment on the licensee's emergency plan before submitting it to the commissioner; and

B. provide any comments received within the 60 days to the commissioner along with the emergency plan.

Subp. 7. **Application to produce PET radioactive drugs.** An application from a medical facility, educational institution, or federal facility to produce positron emission tomography (PET) radioactive drugs for noncommercial transfer to licensees in its consortium authorized for medical use under NRC, or equivalent agreement state requirements must include:

A. a request for authorization for the production of PET radionuclides or evidence of an existing license issued by the NRC, or an agreement state with requirements for a PET radionuclide production facility within its consortium from which it receives PET radionuclides;

B. evidence that the applicant is qualified to produce radioactive drugs for medical use by meeting one of the criteria in part 4731.3395, subpart 1;

C. identification of individuals authorized to prepare the PET radioactive drugs if the applicant is a pharmacy, and documentation that each individual meets the requirements of an authorized nuclear pharmacist as specified in part 4731.3395, subpart 2; and

D. information identified in part 4731.3395, subpart 1, on the PET drugs to be noncommercially transferred to members of its consortium.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 33 SR 1440; 40 SR 145; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.3070 SPECIFIC LICENSES; APPROVAL.

Subpart 1. **Application.** The commissioner shall approve an application for a specific license if:

A. the application is for a purpose authorized under this chapter;

B. the applicant is qualified by training and experience to use the material for the purpose requested in such manner as to protect health and minimize danger to life and property;

C. the applicant's proposed equipment and facilities are adequate to protect health and minimize danger to life and property;

D. the applicant satisfies any applicable special requirements under this chapter; and

E. in the case of an application for a license to receive and possess radioactive material for the conduct of any activity that the commissioner determines will significantly affect the quality of the environment, before commencement of construction of the plant or facility in which the activity will be conducted, the commissioner, on the basis of information filed and evaluations made according to Code of Federal Regulations, title 10, part 51, subpart A, has concluded, after weighing the environmental, economic, technical, and other benefits against environmental costs and considering available alternatives, that the action called for is the issuance of the proposed license, with any appropriate conditions to protect environmental values. Commencement of construction prior to such conclusion is grounds for denial of a license to receive and possess radioactive material in such plant or facility.

Subp. 2. **License.** Upon a determination that an application meets the requirements of this chapter, the commissioner shall issue a specific license authorizing the possession and use of radioactive material.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3075 TERMS AND CONDITIONS OF LICENSES.

Subpart 1. **Applicable regulation.** A license issued under this chapter is subject to all rules and orders of the commissioner.

Subp. 2. **Transfer prohibited.**

A. No license issued or granted under this chapter nor any right under a license must be transferred, assigned, or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of a license to any person, unless the commissioner, after securing full information, finds that the transfer is in accordance with this chapter and gives consent in writing.

B. An application for transfer of license must include:

(1) the identity, technical, and financial qualifications of the proposed transferee; and

(2) financial assurance for decommissioning information required by part 4731.3080.

Subp. 3. **Scope of license.** A person licensed by the commissioner under this chapter must confine the licensee's possession and use of radioactive material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued under parts 4731.3000 to 4731.7280 carries with it the right to receive, acquire, own, and possess radioactive material. Preparation for shipment and transport of radioactive material must be according to parts 4731.0400 to 4731.0424.

Subp. 4. **Bankruptcy.**

A. A general licensee required to register under part 4731.3215, subpart 3a, and a specific licensee issued a license under this chapter must notify the commissioner, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any chapter of United States Code, title 11, by or against:

(1) the licensee;

(2) an entity, as defined under United States Code, title 11, section 101, paragraph (15), that controls the licensee or lists the license or licensee as property; or

(3) an affiliate of the licensee, as defined under United States Code, title 11, section 101, paragraph (2).

B. The bankruptcy notification must indicate the bankruptcy court in which the petition for bankruptcy was filed and the date of the filing of the petition.

Subp. 5. **Additional conditions.**

A. The commissioner may incorporate in any license, at the time of issuance or thereafter by appropriate rule or order, such additional conditions and requirements with respect to the licensee's receipt, possession, use, and transfer of radioactive material as the commissioner deems appropriate or necessary to protect health or to minimize danger to life or property.

B. The commissioner may require reports, record keeping, and inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of this chapter.

Subp. 6. **Emergency plan.** A licensee that is required to submit an emergency plan under part 4731.3065, subpart 4, item A, must follow the emergency plan approved by the commissioner. The licensee:

A. may change the plan without commissioner approval only if the changes do not decrease the effectiveness of the plan;

B. must furnish the change to the commissioner and to affected off-site response organizations within six months after the change is made; and

C. may not implement proposed changes that decrease, or potentially decrease, the effectiveness of the approved emergency plan without prior application to and prior approval by the commissioner.

Subp. 7. **Generator testing.** A licensee preparing technetium-99m radiopharmaceuticals from molybdenum-99 / technetium-99m generators or rubidium-82 from strontium-82/rubidium-82 generators must test the generator eluates for molybdenum-99 breakthrough or strontium-82 and strontium-85 contamination, respectively, according to part 4731.4435. The licensee must record the results of each test and retain each record for three years after the record is made. The licensee must report the results of any test that exceeds the permissible concentration listed in part 4731.4435, item A, at the time of generator elution, in accordance with part 4731.4528.

Subp. 8. **Security requirements for portable gauges.** A portable gauge licensee must use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal, whenever portable gauges are not under the control and constant surveillance of the licensee.

Subp. 9. **Authorization to produce PET.** Authorization under part 4731.3065, subpart 7, to produce positron emission tomography (PET) radioactive drugs for noncommercial transfer to medical use licensees in its consortium does not relieve the licensee from complying with applicable FDA requirements or other federal and state requirements governing radioactive drugs.

A. Each licensee authorized under part 4731.3065, subpart 7, to produce PET radioactive drugs for noncommercial transfer to medical use licensees in its consortium must:

(1) satisfy the labeling requirements in part 4731.3395, subpart 1, for each PET radioactive drug transport radiation shield and each syringe, vial, or other container used to hold a PET radioactive drug intended for noncommercial distribution to members of its consortium; and

(2) possess and use instrumentation to measure the radioactivity of the PET radioactive drugs intended for noncommercial distribution to members of its consortium and meet the procedural, radioactivity measurement, instrument test, instrument check, and instrument adjustment requirements in part 4731.3395, subpart 3.

B. A licensee that is a pharmacy authorized under part 4731.3065, subpart 7, to produce PET radioactive drugs for noncommercial transfer to medical use licensees in its consortium must require that any individual that prepares PET radioactive drugs must be:

(1) an authorized nuclear pharmacist that meets the requirements in part 4731.3395, subpart 2; or

(2) an individual under the supervision of an authorized nuclear pharmacist specified in part 4731.4407.

C. A pharmacy, authorized under part 4731.3065, subpart 7, to produce PET radioactive drugs for noncommercial transfer to medical use licensees in its consortium that allows an individual to work as an authorized nuclear pharmacist, must meet the requirements of part 4731.3395, subpart 2.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 40 SR 145; 44 SR 239; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.3080 FINANCIAL ASSURANCE AND RECORD KEEPING FOR DECOMMISSIONING.

Subpart 1. **Decommissioning funding plan required.**

A. An applicant for a specific license authorizing the possession and use of unsealed radioactive material of half-life greater than 120 days and in quantities exceeding 10^5 times the applicable quantities under part 4731.3160 must submit a decommissioning funding plan according to subpart 5. A decommissioning funding plan must also be submitted when a combination of isotopes is involved, if R divided by 10^5 is greater than one (unity rule), where R is the sum of the ratios of the quantity of each isotope to the applicable value under part 4731.3160.

B. A holder of or an applicant for a specific license authorizing possession and use of sealed sources or plated foils of half-life greater than 120 days and in quantities exceeding 10^{12} times the applicable quantities set forth in part 4731.3160 or, when a combination of isotopes is involved, if R, as defined in subpart 1, divided by 10^{12} is greater than 1, must submit a decommissioning funding plan as described in subpart 5.

Subp. 2. **Plan or financial assurance required.**

A. A holder of or an applicant for a specific license authorizing possession and use of radioactive material of half-life greater than 120 days and in quantities specified in subpart 4 must:

(1) submit a decommissioning funding plan as described in subpart 5; or

(2) submit a certification that financial assurance for decommissioning has been provided in the amount prescribed by subpart 4, using one of the methods described in subpart 6. The certification may state that the appropriate assurance will be obtained after the application has been approved and the license issued but before the receipt of licensed material.

B. If the applicant defers execution of the financial instrument until after the license has been issued, a signed original of the financial instrument obtained to satisfy the requirements of subpart 6 must be submitted to the commissioner before receipt of licensed material.

C. If the applicant does not defer execution of the financial instrument, the applicant must submit to the commissioner, as part of the certification, a signed original of the financial instrument obtained to satisfy the requirements of subpart 6.

Subp. 3. **Date-specific requirements.**

A. A holder of a specific license issued on or after July 27, 1990, which is of a type described in subpart 1 or 2, must provide financial assurance for decommissioning according to this subpart.

B. A holder of a specific license issued before July 27, 1990, and of a type described in subpart 1, must submit, on or before July 27, 1990, a decommissioning funding plan according to subpart 5 or a certification of financial assurance for decommissioning in an amount at least equal to $1,125,000 according to this part. If the licensee submits the certification of financial assurance rather than a decommissioning funding plan, the licensee must include a decommissioning funding plan in any application for license renewal.

C. A holder of a specific license issued before July 27, 1990, and of a type described in subpart 2, must submit, on or before July 27, 1990, a decommissioning funding plan as described in subpart 5 or a certification of financial assurance for decommissioning according to this part.

D. A licensee who has submitted an application before July 27, 1990, for renewal of a license according to part 4731.3090, must provide financial assurance for decommissioning according to subparts 1 and 2.

E. Waste collectors and waste processors, as defined under part 4731.2950, must provide financial assurance in an amount based on a decommissioning funding plan as described in subpart 5. The decommissioning funding plan must include the cost of disposal of the maximum amount (curies) of radioactive material permitted by license and the cost of disposal of the maximum quantity, by volume, of radioactive material that could be present at the licensee's facility at any time, in addition to the cost to remediate the licensee's site to meet the license termination criteria of parts 4731.2000 to 4731.2950. The decommissioning funding plan must be submitted by December 2, 2005.

Subp. 4. **Financial assurance; amounts.** The following amounts of financial assurance are required for decommissioning by quantity of material. Licensees required to submit the $113,000 or $225,000 amount must do so by June 2, 2005. Licensees having possession limits exceeding the upper bounds of this subpart must base financial assurance on a decommissioning funding plan:

Greater than 10^4 but less than or equal to 10^5 times the applicable quantities of part 4731.3160 in unsealed form.For a combination of isotopes, if R, as defined in subpart 1, divided by 10^4 is greater than 1 but R divided by 10^5 is less than or equal to 1.	$1,125,000

Greater than 10^3 but less than or equal to 10^4 times the applicable quantities of part 4731.3160 in unsealed form. For a combination of isotopes, if R, as defined in subpart 1, divided by 10^3 is greater than 1 but R divided by 10^4 is less than or equal to 1.	$225,000
Greater than 10^{10} times but less than or equal to 10^{12} times the applicable quantities of part 4731.3160 in sealed sources or plated foils. For a combination of isotopes, if R, as defined in subpart 1, divided by 10^{10} is greater than 1, but R divided by 10^{12} is less than or equal to 1.	$113,000

Subp. 5. **Funding plan requirements.**

A. Each decommissioning funding plan must be submitted for review and approval and must contain:

(1) a detailed cost estimate for decommissioning, in an amount reflecting:

(a) the cost of an independent contractor to perform all decommissioning activities;

(b) the cost of meeting the criteria in part 4731.2100, subpart 2, for unrestricted use, provided that, if the applicant or licensee can demonstrate the ability to meet the provisions of part 4731.2100, subpart 3, the cost estimate may be based on meeting the criteria in part 4731.2100, subpart 3;

(c) the volume of on-site subsurface material containing residual radioactivity that will require remediation to meet the criteria for license termination; and

(d) an adequate contingency factor;

(2) identification of and justification for using the key assumptions contained in the DCE;

(3) a description of the method of assuring funds for decommissioning under subpart 6, including the means for adjusting cost estimates and associated funding levels periodically over the life of the facility;

(4) a certification by the licensee that financial assurance for decommissioning has been provided in the amount of the cost estimate for decommissioning; and

(5) a signed original of the financial instrument obtained to satisfy the requirements of subpart 6, unless a previously submitted and accepted financial instrument continues to cover the cost estimate for decommissioning.

B. At the time of license renewal and at intervals not to exceed three years, the decommissioning funding plan must be resubmitted with adjustments as necessary to account for changes in costs and the extent of contamination. If the amount of financial assurance will be adjusted downward, this cannot be done until the updated decommissioning funding plan is approved.

The decommissioning funding plan must update the information submitted with the original or prior approved plan, and must specifically consider the effect of the following events on decommissioning costs:

(1) spills of radioactive material producing additional residual radioactivity in on-site subsurface material;

(2) waste inventory increasing above the amount previously estimated;

(3) waste disposal costs increasing above the amount previously estimated;

(4) facility modifications;

(5) changes in authorized possession limits;

(6) actual remediation costs that exceed the previous cost estimate;

(7) on-site disposal; and

(8) use of a settling pond.

Subp. 6. **Financial assurance requirements.**

A. Financial assurance for decommissioning must be provided by one or more of the methods described in items B to F.

B. Prepayment is the deposit prior to the start of operation into an account segregated from licensee assets and outside the licensee's administrative control of cash or liquid assets such that the amount of funds would be sufficient to pay decommissioning costs. Prepayment may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

C. A surety method, insurance, or other guarantee method guarantees that decommissioning costs will be paid. A surety method may be in the form of a surety bond, letter of credit, or line of credit. A parent company guarantee of funds for decommissioning costs based on a financial test may be used if the guarantee and test comply with part 4731.3155, but may not be used in combination with other financial methods to satisfy the requirements of this part. For commercial corporations that issue bonds, a guarantee of funds by the applicant or licensee for decommissioning costs based on a financial test may be used if the guarantee and test comply with part 4731.3165. For commercial corporations that do not issue bonds, a guarantee of funds by the applicant or licensee for decommissioning costs may be used if the guarantee and test comply with part 4731.3170. For nonprofit entities, such as colleges, universities, and nonprofit hospitals, a guarantee of funds by the applicant or licensee may be used if the guarantee and test comply with part 4731.3175. A guarantee by the applicant or licensee may not be used in combination with other financial methods used to satisfy this part or in any situation where the applicant or licensee has a parent company holding majority control of the voting stock of the company. Any surety method or insurance used to provide financial assurance for decommissioning must:

(1) be open-ended or, if written for a specified term, such as five years, must be renewed automatically unless 90 days or more before the renewal date, the issuer notifies the commissioner, the beneficiary, and the licensee of its intention not to renew;

(2) provide that the full face amount be paid to the beneficiary automatically before the expiration without proof of forfeiture if the licensee fails to provide a replacement acceptable to the commissioner within 30 days after receipt of notification of cancellation;

(3) be payable to a trust established for decommissioning costs. The trustee and trust must be acceptable to the commissioner. An acceptable trustee includes an appropriate state or federal government agency or an entity that has authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency; and

(4) remain in effect until the commissioner terminates the license.

D. An external sinking fund in which deposits are made at least annually, coupled with a surety method or insurance, the value of which may decrease by the amount being accumulated in the sinking fund, may be used as a method of financial assurance. The surety or insurance provisions must be as stated in item C. An external sinking fund:

(1) is a fund established and maintained by setting aside funds periodically in an account segregated from licensee assets and outside the licensee's administrative control in which the total amount of funds would be sufficient to pay decommissioning costs at the time termination of operation is expected; and

(2) may be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities.

E. In the case of federal, state, or local government licensees, a statement of intent containing a cost estimate for decommissioning or an amount according to subpart 4 and indicating that funds for decommissioning will be obtained when necessary may be used as a method of financial assurance.

F. When a governmental entity assumes custody and ownership of a site, an arrangement that is deemed acceptable by the governmental entity may be used as a method of financial assurance.

Subp. 7. **Record keeping.**

A. A person issued a license under parts 4731.3000 to 4731.7280 must keep records of information important to the decommissioning of the facility in an identified location until the site is released for unrestricted use.

B. Before licensed activities are transferred or assigned according to part 4731.3075, subpart 2, a licensee must transfer all records described in this subpart to the new licensee. The new licensee is responsible for maintaining the records until the license is terminated.

C. If records important to the decommissioning of a facility are kept for other purposes, reference to the records and their location may be used.

D. Information the commissioner considers important to decommissioning are:

(1) records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site, which:

(a) must include any known information on identification of involved nuclides, quantities, forms, and concentrations; and

(b) may be limited to instances when contamination remains after cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas, as in the case of possible seepage into porous materials such as concrete;

(2) as-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used or stored and of locations of possible inaccessible contamination, such as buried pipes, that may be subject to contamination. If required drawings are referenced, each relevant document need not be indexed individually. If drawings are not available, the licensee must substitute appropriate records of available information concerning these areas and locations;

(3) except for areas containing only sealed sources, if the sources have not leaked or if no contamination remains after a leak, or radioactive materials having only half-lives of less than 65 days, a list of the following, contained in a single document and updated every two years:

(a) all areas designated and formerly designated as restricted areas;

(b) all areas outside of restricted areas that require documentation under subitem (1);

(c) all areas outside of restricted areas where current and previous wastes have been buried as documented under part 4731.2560; and

(d) all areas outside of restricted areas that contain material such that, if the license expired, the licensee would be required to either decontaminate the area to meet the criteria for decommissioning under part 4731.2100 or apply for approval for disposal under part 4731.2410; and

(4) records of:

(a) the cost estimate performed for the decommissioning funding plan or of the amount certified for decommissioning; and

(b) the funding method used for assuring funds if either a funding plan or certification is used.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.3085 LICENSE EXPIRATION AND TERMINATION; DECOMMISSIONING.

Subpart 1. **Expiration.**

A. A specific license expires at the end of the day on the expiration date stated in the license, unless the licensee has filed an application for renewal under part 4731.3090 not less than 30 days before the expiration date stated in the existing license.

B. If an application for renewal has been filed at least 30 days before the expiration date stated in the existing license, the existing license expires at the end of the day on which the commissioner makes a final determination to deny the renewal application or, if the determination states an expiration date, the expiration date stated in the determination.

Subp. 2. **Revocation.** A specific license revoked by the commissioner expires at the end of the day on the date of the commissioner's final determination to revoke the license, on the expiration date stated in the determination, or as otherwise provided by a commissioner's order.

Subp. 3. **Termination notice.** A specific license continues in effect, beyond the expiration date if necessary, with respect to possession of radioactive material, until the commissioner notifies the licensee in writing that the license is terminated. During this time, the licensee must:

A. limit actions involving radioactive material to those related to decommissioning; and

B. continue to control entry to restricted areas until they are suitable for release according to this chapter.

Subp. 4. **Decommissioning.**

A. Within 60 days of any of the occurrences under item B, and consistent with the administrative directions under part 4731.0200, subpart 3, a licensee must provide notification to the commissioner in writing of such occurrence and:

(1) begin decommissioning the licensee's site or any separate building or outdoor area that contains residual radioactivity so that the building or outdoor area is suitable for release according to this chapter; or

(2) submit within 12 months of notification a decommissioning plan, if required under item E, and begin decommissioning upon approval of that plan.

B. Notice under item A is required when:

(1) the license has expired under subpart 1 or 2;

(2) the licensee has decided to permanently cease principal activities at the entire site or in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release according to this chapter;

(3) no principal activities have been conducted under the license for a period of 24 months; or

(4) no principal activities have been conducted for a period of 24 months in any separate building or outdoor area that contains residual radioactivity such that the building or outdoor area is unsuitable for release according to this chapter.

C. Coincident with the notification required under item A, the licensee must maintain in effect all decommissioning financial assurances established by the licensee under part 4731.3080 in conjunction with license issuance or renewal or as required under this part. The amount of the financial assurance must be increased, or may be decreased, as appropriate, to cover the detailed cost estimate for decommissioning established under item H, subitem (5). Following approval of the decommissioning plan, a licensee may reduce the amount of the financial assurance as decommissioning proceeds and radiological contamination is reduced at the site with the approval of the commissioner.

D. The commissioner may grant a request to extend the time periods established under item A if the commissioner determines that this relief is not detrimental to the public health and safety and is otherwise in the public interest. The request must be submitted no later than 30 days before notification under item A. The schedule for decommissioning in this subpart may not commence until the commissioner has made a determination on the request.

E. A decommissioning plan must be submitted if:

(1) required by a license condition; or

(2) the procedures and activities necessary to carry out decommissioning of the site or separate building or outdoor area have not been previously approved by the commissioner and the procedures could increase potential health and safety impacts to workers or the public, as in any of the following cases:

(a) procedures would involve techniques not applied routinely during cleanup and maintenance operations;

(b) workers would be entering areas not normally occupied where surface contamination and radiation levels are significantly higher than routinely encountered during operation;

(c) procedures could result in significantly greater airborne concentrations of radioactive materials than are present during operation; or

(d) procedures could result in significantly greater releases of radioactive material to the environment than those associated with operation.

F. The commissioner may approve an alternate schedule for submittal of a decommissioning plan required under this subpart if the commissioner determines that the alternative schedule is necessary to the effective conduct of decommissioning operations and presents no undue risk from the radiation to the public health and safety and is otherwise in the public interest.

G. Procedures such as those under item E, subitem (2), with potential health and safety impacts, may not be performed before approval of the decommissioning plan.

H. The proposed decommissioning plan for the site or separate building or outdoor area must include:

(1) a description of the conditions of the site or separate building or outdoor area sufficient to evaluate the acceptability of the plan;

(2) a description of planned decommissioning activities;

(3) a description of the methods used to ensure protection of workers and the environment against radiation hazards during decommissioning;

(4) a description of the planned final radiation survey;

(5) an updated detailed cost estimate for decommissioning, comparison of that estimate with present funds set aside for decommissioning, and a plan for ensuring the availability of adequate funds for completion of decommissioning; and

(6) for decommissioning plans calling for completion of decommissioning later than 24 months after plan approval, a justification for the delay based on the criteria in item K.

I. The commissioner shall approve a proposed decommissioning plan if the information in the plan demonstrates that the decommissioning will be completed as soon as practicable and that the health and safety of the workers and the public will be adequately protected.

J. Except as provided in item K, a licensee must:

(1) complete decommissioning of the site or separate building or outdoor area as soon as practicable but no later than 24 months following the initiation of decommissioning; and

(2) request license termination as soon as practicable but no later than 24 months following the initiation of decommissioning, when decommissioning involves the entire site.

K. The commissioner may approve a request for an alternative schedule for completion of decommissioning of the site or separate building or outdoor area, and license termination if appropriate, if the commissioner determines that the alternative is warranted by consideration of the following:

(1) whether it is technically feasible to complete decommissioning within the allotted 24-month period;

(2) whether sufficient waste disposal capacity is available to allow completion of decommissioning within the allotted 24-month period;

(3) whether a significant volume reduction in wastes requiring disposal will be achieved by allowing short-lived radionuclides to decay;

(4) whether a significant reduction in radiation exposure to workers can be achieved by allowing short-lived radionuclides to decay; and

(5) other site-specific factors that the commissioner may consider appropriate on a case-by-case basis, such as the regulatory requirements of other governmental agencies, lawsuits,

groundwater treatment activities, monitored natural groundwater restoration, actions that could result in more environmental harm than deferring clean up, and other factors beyond the control of the licensee.

L. As the final step in decommissioning, the licensee must:

(1) certify the disposition of all licensed material, including accumulated wastes, by submitting a completed NRC Form 314 or equivalent information; and

(2) conduct a radiation survey of the premises where the licensed activities were carried out and submit a report of the results of the survey, unless the licensee demonstrates in some other manner that the premises are suitable for release according to part 4731.2100. The licensee must, as appropriate:

(a) for gamma radiation, report levels of radiation in units of microroentgens (millisieverts) per hour at one meter from surfaces;

(b) for radioactivity, including alpha and beta radiation, report levels of radiation in units of disintegrations per minute or microcuries (megabecquerels) per 100 square centimeters removable and fixed for surfaces, microcuries (megabecquerels) per milliliter for water, and picocuries (becquerels) per gram for solids such as soils or concrete; and

(c) specify the survey instruments used and certify that each instrument is properly calibrated and tested.

M. Specific licenses, including expired licenses, shall be terminated by written notice to the licensee when the commissioner determines that:

(1) radioactive material has been properly disposed of;

(2) reasonable effort has been made to eliminate residual radioactive contamination, if present;

(3) a radiation survey has been performed that demonstrates, or other information submitted by the licensee is sufficient to demonstrate, that the premises are suitable for release according to part 4731.2100; and

(4) records required under part 4731.3115, subparts 3 and 5, have been received.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.3090 RENEWAL AND AMENDMENT OF LICENSES.

Subpart 1. **Renewal application.** Applications for renewal of a specific license must be filed on an application for radioactive material license form, as prescribed by the commissioner, according to part 4731.3065.

Subp. 2. **Extension; renewal pending.** If a licensee granted the extension described under part 4731.3085, subpart 1, item C, has a currently pending renewal application for the extended license, the application shall be considered withdrawn by the licensee and any renewal fees paid by the licensee for the application shall be refunded.

Subp. 3. **Amendment applications.** Applications for amendment of a license must be filed on an application for radioactive material license form, as prescribed by the commissioner, according to part 4731.3065 and must specify the respects in which the licensee desires the license to be amended and the grounds for the amendment.

Subp. 4. **Consideration criteria.** In considering an application by a licensee to renew or amend a license, the commissioner shall apply the applicable criteria under parts 4731.3070 and 4731.3300 to 4731.7280.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3105 TRANSFER OF RADIOACTIVE MATERIAL.

Subpart 1. **Authorization required.** No licensee shall transfer radioactive material except as authorized under this chapter.

Subp. 2. **Approved transfer.** Except as otherwise provided in a license and subject to subpart 3, a licensee may transfer radioactive material:

A. to the commissioner;

B. to the DOE or an agency in an agreement state that regulates radioactive material;

C. to any person exempt from the licensing requirements of parts 4731.3000 to 4731.3245, to the extent permitted under the exemption;

D. to a person in an agreement state subject to the jurisdiction of that state or the NRC who has been exempted from the licensing requirements of that state or the NRC, to the extent permitted under the exemption;

E. to a person authorized to receive radioactive material under terms of a specific license or a general license or their equivalents issued by the Atomic Energy Commission, the NRC, or an agreement state; or

F. as otherwise authorized by the commissioner in writing.

Subp. 3. **Verification for transfer.**

A. Before transferring radioactive material to a specific licensee of the NRC or an agreement state, or to a general licensee who is required to register with the NRC or an agreement state before receipt of the radioactive material, the licensee transferring the material must verify that the

transferee's license authorizes the receipt of the type, form, and quantity of radioactive material to be transferred.

B. Any of the following methods of verification are acceptable:

(1) the transferor may possess and read a current copy of the transferee's specific license or general license registration certificate;

(2) the transferor may possess a written certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of radioactive material to be transferred, specifying:

(a) the license or registration certificate number;

(b) the issuing agency; and

(c) the expiration date;

(3) for emergency shipments, the transferor may accept oral certification by the transferee that the transferee is authorized by license or registration certificate to receive the type, form, and quantity of radioactive material to be transferred, specifying:

(a) the license or registration certificate number;

(b) the issuing agency; and

(c) the expiration date.

The oral certification must be confirmed in writing within ten days; or

(4) the transferor may obtain other information compiled by a reporting service from official records of the NRC or the licensing agency of an agreement state regarding the identity of licensees or registrants and the scope and expiration dates of the licenses or registrations.

Subp. 4. **Confirmation.** The transferor may obtain and record confirmation from the NRC or the licensing agency of an agreement state that the transferee is licensed to receive the radioactive material:

A. when none of the methods of verification described in subpart 3 are readily available; or

B. when a transferor desires to verify that information received by one of the verification methods is correct or up-to-date.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3110 REPORTING REQUIREMENTS.

Subpart 1. **Immediate notification required.** A licensee must notify the commissioner as soon as possible but not later than four hours after the discovery of an event that prevents immediate protective actions necessary to avoid exposures to radiation or radioactive materials that could exceed regulatory limits or releases of licensed material that could exceed regulatory limits. Reportable events under this subpart include fires, explosions, toxic gas release, or similar hazards.

Subp. 2. **24-hour notification required.** A licensee must notify the commissioner within 24 hours after discovery of any of the following events involving licensed material:

A. an unplanned contamination event that:

(1) requires access to the contaminated area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the areas;

(2) involves a quantity of material greater than five times the lowest annual limit on intake specified in part 4731.2750 for the material; and

(3) restricts access to the area for a reason other than to allow isotopes with a half-life of less than 24 hours to decay prior to decontamination;

B. an event in which equipment is disabled or fails to function as designed when:

(1) the equipment is required by rule or license condition to prevent releases exceeding regulatory limits, to prevent exposure to radiation and radioactive materials exceeding regulatory limits, or to mitigate the consequences of an accident;

(2) the equipment is required to be available and operable when it is disabled or fails to function; and

(3) no redundant equipment is available and operable to perform the required safety function;

C. an event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body; or

D. an unplanned fire or explosion that damages any licensed material or any device, container, or equipment containing licensed materials when:

(1) the quantity of material involved is five times the lowest annual limit on intake specified in part 4731.2750 for the material; and

(2) the damage affects the integrity of the licensed material or its container.

Subp. 3. **Preparation and submission of reports.**

A. A licensee must make reports required under subparts 1 and 2 by telephone to the commissioner according to part 4731.0200, subpart 5. To the extent that the information is available at the time of notification, the information provided in the report must include:

(1) the caller's name and call-back telephone number;

(2) a description of the event, including date and time;

(3) the exact location of the event;

(4) the isotopes, quantities, and chemical and physical form of the licensed material involved; and

(5) any personnel radiation exposure data available.

B. A licensee who makes a report required under subpart 1 or 2 must submit a written follow-up report within 30 days of the initial report. Written reports prepared as required by other rules may be submitted to fulfill this requirement if the reports contain all of the necessary information and the appropriate distribution is made. The reports must be sent to the commissioner and include:

(1) a description of the event, including the probable cause of the event and the manufacturer and model number, if applicable, of any equipment that failed or malfunctioned;

(2) the exact location of the event;

(3) the isotopes, quantities, and chemical and physical form of the licensed material involved;

(4) the date and time of the event;

(5) corrective actions taken or planned and the results of any evaluations or assessments; and

(6) the extent of exposure of individuals to radiation or to radioactive materials, without identification of the individuals by name.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.3115 RECORDS.

Subpart 1. **Requirements.**

A. A person who receives radioactive material pursuant to a license issued under parts 4731.3000 to 4731.6270 must keep records showing the receipt, transfer, and disposal of the radioactive material according to this subpart and part 4731.0210.

B. A licensee must retain each record of receipt of radioactive material as long as the material is possessed and for three years following transfer or disposal of the material.

C. A licensee who transferred the material must retain each record of transfer for three years after each transfer unless a specific requirement in this chapter dictates otherwise.

D. A licensee who disposed of the material must retain each record of disposal of radioactive material until the commissioner terminates each license that authorizes the disposal of the material.

Subp. 2. **Retention.**

A. A licensee must retain each record that is required by this part or parts 4731.3200 to 4731.7280 or by license condition for the period specified by the appropriate rule or license condition.

B. If a retention period is not otherwise specified by rule or license condition, the record must be retained until the commissioner terminates the license that authorizes the activity that is subject to the record-keeping requirement.

C. If there is a conflict between this chapter, a license condition, or other written commissioner approval or authorization pertaining to the retention period for the same type of record, the retention period specified in this chapter applies unless the commissioner, under part 4731.3010, grants a specific exemption from the record retention requirements specified in this chapter.

D. Required records must be maintained according to part 4731.0210.

Subp. 3. **Transfer to commissioner.** Prior to license termination, a licensee authorized to possess radioactive material with a half-life greater than 120 days, in an unsealed form, must forward the following records to the commissioner:

A. records of disposal of licensed material made under parts 4731.2410 to 4731.2440, including burials authorized before January 28, 1981; and

B. records required under part 4731.2510, subpart 2, item D.

Subp. 4. **Transfer to new licensee.** If licensed activities are transferred or assigned under part 4731.3075, subpart 2, a licensee authorized to possess radioactive material, with a half-life greater than 120 days, in an unsealed form, must transfer the following records to the new licensee and the new licensee is responsible for maintaining the records until the license is terminated:

A. records of disposal of licensed material made under parts 4731.2410 to 4731.2440, including burials authorized before January 28, 1981; and

B. records required under part 4731.2510, subpart 2, item D.

Subp. 5. **Decommissioning records.** Prior to license termination, a licensee must forward the records required under part 4731.3080, subpart 7, to the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3120 INSPECTIONS AND TESTS.

Subpart 1. **Material and premises inspection.** A licensee must afford to the commissioner at all reasonable times opportunity to inspect radioactive material and the premises and facilities wherein radioactive material is used or stored.

Subp. 2. **Record inspection.** A licensee must make available to the commissioner for inspection, upon reasonable notice, records kept by the licensee as required under this chapter.

Subp. 3. **Testing.**

A. A licensee must perform, or permit the commissioner to perform, such tests as the commissioner deems appropriate or necessary for the administration of this chapter, including tests of:

(1) radioactive material;

(2) facilities wherein radioactive material is utilized or stored;

(3) radiation detection and monitoring instruments; and

(4) other equipment and devices used in connection with the utilization or storage of radioactive material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3130 MODIFICATION AND REVOCATION OF LICENSES.

A. The terms and conditions of a license issued under parts 4731.3000 to 4731.3245 are subject to amendment, revision, or modification by reason of rules and orders issued according to this chapter.

B. A license may be revoked, suspended, or modified, in whole or in part, for any material false statement in the application or any statement of fact required under Section 182 of the Act, or because of conditions revealed by such application or statement of fact or any report, record, or inspection or other means, which would warrant the commissioner to refuse to grant a license on an original application or for violation of or failure to observe any of the terms and provisions of any rule or order of the commissioner.

C. Except in cases of willfulness or those in which the public health, interest, or safety requires otherwise, no license must be modified, suspended, or revoked unless, prior to the institution of proceedings therefore, facts or conduct that may warrant such action are called to the attention of the licensee in writing and the licensee is accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3135 WITHHOLDING OR RECALL OF RADIOACTIVE MATERIAL.

The commissioner may cause the withholding or recall of radioactive material from a licensee who is not equipped to observe or fails to observe safety standards to protect health as may be established by the commissioner or who uses radioactive materials in violation of law or rule of the commissioner or in a manner other than as disclosed in the license application therefore or approved by the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3140 EXEMPT CONCENTRATIONS.

Subpart 1. **Parent isotope.** Many radioisotopes disintegrate into isotopes that are also radioactive. In expressing the concentrations in subpart 3, the activity stated is that of the parent isotope and takes into account the daughters.

Subp. 2. **Combination of isotopes.** For purposes of part 4731.3025, where a combination of isotopes is involved, the limit for the combination should be derived as follows: determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in subpart 3 for the specific isotope when not in combination. The sum of the ratios may not exceed one.

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

Subp. 3. **Exempt concentrations.**

Element (atomic number)	Isotope	Column I Gas concentration μCi/ml[1]	Column II Liquid and solid concentration μCi/ml[2]
Antimony (51)	Sb 122		3×10^{-4}

	Sb 124		2×10^{-4}
	Sb 125		1×10^{-3}
Argon (18)	A 37	1×10^{-3}	
	A 41	4×10^{-7}	
Arsenic (33)	As 73		5×10^{-3}
	As 74		5×10^{-4}
	As 76		2×10^{-4}
	As 77		8×10^{-4}
Barium (56)	Ba 131		2×10^{-3}
	Ba 140		3×10^{-4}
Beryllium (4)	Be 7		2×10^{-2}
Bismuth (83)	Bi 206		4×10^{-4}
Bromine (35)	Br 82	4×10^{-7}	3×10^{-3}
Cadmium (48)	Cd 109		2×10^{-3}
	Cd 115m		3×10^{-4}
	Cd 115		3×10^{-4}
Calcium (20)	Ca 45		9×10^{-5}
	Ca 47		5×10^{-4}
Carbon (6)	C 14	1×10^{-6}	8×10^{-3}
Cerium (58)	Ce 141		9×10^{-4}
	Ce 143		4×10^{-4}
	Ce 144		1×10^{-4}
Cesium (55)	Cs 131		2×10^{-2}
	Cs 134m		6×10^{-2}
	Cs 134		9×10^{-5}
Chlorine (17)	Cl 38	9×10^{-7}	4×10^{-3}
Chromium (24)	Cr 51		2×10^{-2}

Cobalt (27)	Co 57		5×10^{-3}
	Co 58		1×10^{-3}
	Co 60		5×10^{-4}
Copper (29)	Cu 64		3×10^{-3}
Dysprosium (66)	Dy 165		4×10^{-3}
	Dy 166		4×10^{-4}
Erbium (68)	Er 169		9×10^{-4}
	Er 171		1×10^{-3}
Europium (63)	Eu 152 (T/2=9.2 hrs)		6×10^{-4}
	Eu 155		2×10^{-3}
Fluorine (9)	F 18	2×10^{-6}	8×10^{-3}
Gadolinium (64)	Gd 153		2×10^{-3}
	Gd 159		8×10^{-4}
Gallium (31)	Ga 72		4×10^{-4}
Germanium (32)	Ge 71		2×10^{-2}
Gold (79)	Au 196		2×10^{-3}
	Au 198		5×10^{-4}
	Au 199		2×10^{-3}
Hafnium (72)	Hf 181		7×10^{-4}
Hydrogen (1)	H 3	5×10^{-6}	3×10^{-2}
Indium (49)	In 113m		1×10^{-2}
	In 114m		2×10^{-4}
Iodine (53)	I 126	3×10^{-9}	2×10^{-5}
	I 131	3×10^{-9}	2×10^{-5}
	I 132	8×10^{-8}	6×10^{-4}

	I 133	1×10^{-8}	7×10^{-5}
	I 134	2×10^{-7}	1×10^{-3}
Iridium (77)	Ir 190		2×10^{-3}
	Ir 192		4×10^{-4}
	Ir 194		3×10^{-4}
Iron (26)	Fe 55		8×10^{-3}
	Fe 59		6×10^{-4}
Krypton (36)	Kr 85m	1×10^{-6}	
	Kr 85	3×10^{-6}	
Lanthanum (57)	La 140		2×10^{-4}
Lead (82)	Pb 203		4×10^{-3}
Lutetium (71)	Lu 177		1×10^{-3}
Manganese (25)	Mn 52		3×10^{-4}
	Mn 54		1×10^{-3}
	Mn 56		1×10^{-3}
Mercury (80)	Hg 197m		2×10^{-3}
	Hg 197		3×10^{-3}
	Hg 203		2×10^{-4}
Molybdenum (42)	Mo 99		2×10^{-3}
Neodymium (60)	Nd 147		6×10^{-4}
	Nd 149		3×10^{-3}
Nickel (28)	Ni 65		1×10^{-3}
Niobium (Columbium) (41)	Nb 95		1×10^{-3}
	Nb 97		9×10^{-3}
Osmium (76)	Os 185		7×10^{-4}
	Os 191m		3×10^{-2}

	Os 191	2×10^{-3}
	Os 193	6×10^{-4}
Palladium (46)	Pd 103	3×10^{-3}
	Pd 109	9×10^{-4}
Phosphorus (15)	P 32	2×10^{-4}
Platinum (78)	Pt 191	1×10^{-3}
	Pt 193m	1×10^{-2}
	Pt 197m	1×10^{-2}
	Pt 197	1×10^{-3}
Potassium (19)	K 42	3×10^{-3}
Praseodymium (59)	Pr 142	3×10^{-4}
	Pr 143	5×10^{-4}
Promethium (61)	Pm 147	2×10^{-3}
	Pm 149	4×10^{-4}
Rhenium (75)	Re 183	6×10^{-3}
	Re 186	9×10^{-4}
	Re 188	6×10^{-4}
Rhodium (45)	Rh 103m	1×10^{-1}
	Rh 105	1×10^{-3}
Rubidium (37)	Rb 86	7×10^{-4}
Ruthenium (44)	Ru 97	4×10^{-4}
	Ru 103	8×10^{-4}
	Ru 105	1×10^{-3}
	Ru 106	1×10^{-4}
Samarium (62)	Sm 153	8×10^{-4}
Scandium (21)	Sc 46	4×10^{-4}

	Sc 47		9×10^{-4}
	Sc 48		3×10^{-4}
Selenium (34)	Se 75		3×10^{-3}
Silicon (14)	Si 31		9×10^{-3}
Silver (47)	Ag 105		1×10^{-3}
	Ag 110m		3×10^{-4}
	Ag 111		4×10^{-4}
Sodium (11)	Na 24		2×10^{-3}
Strontium (38)	Sr 85		1×10^{-3}
	Sr 89		1×10^{-4}
	Sr 91		7×10^{-4}
	Sr 92		7×10^{-4}
Sulfur (16)	S 35	9×10^{-8}	6×10^{-4}
Tantalum (73)	Ta 182		4×10^{-4}
Technetium (43)	Tc 96m		1×10^{-1}
	Tc 96		1×10^{-3}
Tellurium (52)	Te 125m		2×10^{-3}
	Te 125m		6×10^{-4}
	Te 127		3×10^{-3}
	Te 129m		3×10^{-4}
	Te 131m		6×10^{-4}
	Te 132		3×10^{-4}
Terbium (65)	Tb 160		4×10^{-4}
Thallium (81)	Tl 200		4×10^{-3}
	Tl 201		3×10^{-3}
	Tl 202		1×10^{-3}
	Tl 204		1×10^{-3}

Thulium (69)	Tm 170		5×10^{-4}
	Tm 171		5×10^{-3}
Tin (50)	Sn 113		9×10^{-4}
	Sn 125		2×10^{-4}
Tungsten (Wolfram) (74)	W 181		4×10^{-3}
	W 187		7×10^{-4}
Vanadium (23)	V 48		3×10^{-4}
Xenon (54)	Xe 131m	4×10^{-6}	
	Xe 133	3×10^{-6}	
	Xe 135	1×10^{-6}	
Ytterbium (70)	Yb 175		1×10^{-3}
Yttrium (39)	Y 90		2×10^{-4}
	Y 91m		3×10^{-2}
	Y 91		3×10^{-4}
	Y 92		6×10^{-4}
	Y 93		3×10^{-4}
Zinc (30)	Zn 65		1×10^{-3}
	Zn 69m		7×10^{-4}
	Zn 69		2×10^{-2}
Zirconium (40)	Zr 95		6×10^{-4}
	Zr 97		2×10^{-4}
Beta- or gamma-emitting radioactive material not listed above with half-life less than three years		1×10^{-10}	1×10^{-6}

[1]Values are given only for those materials normally used as gases.

[2]μCi/gm for solids.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

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4731.3145 EXEMPT QUANTITIES.

Radioactive Material	Microcuries
Antimony 122 (Sb 122)	100
Antimony 124 (Sb 124)	10
Antimony 125 (Sb 125)	10
Arsenic 73 (As 73)	100
Arsenic 74 (As 74)	10
Arsenic 76 (As 76)	10
Arsenic 77 (As 77)	100
Barium 131 (Ba 131)	10
Barium 133 (Ba 133)	10
Barium 140 (Ba 140)	10
Bismuth 210 (Bi 210)	1
Bromine 82 (Br 82)	10
Cadmium 109 (Cd 109)	10
Cadmium 115m (Cd 115m)	10
Cadmium 115 (Cd 115)	100
Calcium 45 (Ca 45)	10
Calcium 47 (Ca 47)	10
Carbon 14 (C 14)	100
Cerium 141 (Ce 141)	100
Cerium 143 (Ce 143)	100
Cerium 144 (Ce 144)	1

Cesium 129 (Cs 129)	100
Cesium 131 (Cs 131)	1,000
Cesium 134m (Cs 134m)	100
Cesium 134 (Cs 134)	1
Cesium 135 (Cs 135)	10
Cesium 136 (Cs 136)	10
Cesium 137 (Cs 137)	10
Chlorine 36 (Cl 36)	10
Chlorine 38 (Cl 38)	10
Chromium 51 (Cr 51)	1,000
Cobalt 57 (Co 57)	100
Cobalt 58m (Co 58m)	10
Cobalt 58 (Co 58)	10
Cobalt 60 (Co 60)	1
Copper 64 (Cu 64)	100
Dysprosium 165 (Dy 165)	10
Dysprosium 166 (Dy 166)	100
Erbium 169 (Er 169)	100
Erbium 171 (Er 171)	100
Europium 152 9.2 h (Eu 152 9.2 h)	100
Europium 152 13 yr (Eu 152 13 yr)	1
Europium 154 (Eu 154)	1
Europium 155 (Eu 155)	10
Fluorine 18 (F 18)	1,000
Gadolinium 153 (Gd 153)	10
Gadolinium 159 (Gd 159)	100

Gallium 67 (Ga 67)	100
Gallium 72 (Ga 72)	10
Germanium 68 (Ge 68)	10
Germanium 71 (Ge 71)	100
Gold 195 (Au 195)	10
Gold 198 (Au 198)	100
Gold 199 (Au 199)	100
Hafnium 181 (Hf 181)	10
Holmium 166 (Ho 166)	100
Hydrogen 3 (H 3)	1,000
Indium 111 (In 111)	100
Indium 113m (In 113m)	100
Indium 114m (In 114m)	10
Indium 115m (In 115m)	100
Indium 115 (In 115)	10
Iodine 123 (I 123)	100
Iodine 125 (I 125)	1
Iodine 126 (I 126)	1
Iodine 129 (I 129)	0.1
Iodine 131 (I 131)	1
Iodine 132 (I 132)	10
Iodine 133 (I 133)	1
Iodine 134 (I 134)	10
Iodine 135 (I 135)	10
Iridium 192 (Ir 192)	10
Iridium 194 (Ir 194)	100
Iron 52 (Fe 52)	10

Iron 55 (Fe 55)	100
Iron 59 (Fe 59)	10
Krypton 85 (Kr 85)	100
Krypton 87 (Kr 87)	10
Lanthanum 140 (La 140)	10
Lutetium 177 (Lu 177)	100
Manganese 52 (Mn 52)	10
Manganese 54 (Mn 54)	10
Manganese 56 (Mn 56)	10
Mercury 197m (Hg 197m)	100
Mercury 197 (Hg 197)	100
Mercury 203 (Hg 203)	10
Molybdenum 99 (Mo 99)	100
Neodymium 147 (Nd 147)	100
Neodymium 149 (Nd 149)	100
Nickel 59 (Ni 59)	100
Nickel 63 (Ni 63)	10
Nickel 65 (Ni 65)	100
Niobium 93m (Nb 93m)	10
Niobium 95 (Nb 95)	10
Niobium 97 (Nb 97)	10
Osmium 185 (Os 185)	10
Osmium 191m (Os 191m)	100
Osmium 191 (Os 191)	100
Osmium 193 (Os 193)	100

Palladium 103 (Pd 103)	100
Palladium 109 (Pd 109)	100
Phosphorus 32 (P 32)	10
Platinum 191 (Pt 191)	100
Platinum 193m (Pt 193m)	100
Platinum 193 (Pt 193)	100
Platinum 197m (Pt 197m)	100
Platinum 197 (Pt 197)	100
Polonium 210 (Po 210)	0.1
Potassium 42 (K 42)	10
Potassium 43 (K 43)	10
Praseodymium 142 (Pr 142)	100
Praseodymium 143 (Pr 143)	100
Promethium 147 (Pm 147)	10
Promethium 149 (Pm 149)	10
Rhenium 186 (Re 186)	100
Rhenium 188 (Re 188)	100
Rhodium 103m (Rh 103m)	100
Rhodium 105 (Rh 105)	100
Rubidium 81 (Rb 81)	10
Rubidium 86 (Rb 86)	10
Rubidium 87 (Rb 87)	10
Ruthenium 97 (Ru 97)	100
Ruthenium 103 (Ru 103)	10
Ruthenium 105 (Ru 105)	10
Ruthenium 106 (Ru 106)	1
Samarium 151 (Sm 151)	10

Samarium 153 (Sm 153)	100
Scandium 46 (Sc 46)	10
Scandium 47 (Sc 47)	100
Scandium 48 (Sc 48)	10
Selenium 75 (Se 75)	10
Silicon 31 (Si 31)	100
Silver 105 (Ag 105)	10
Silver 110m (Ag 110m)	1
Silver 111 (Ag 111)	100
Sodium 22 (Na 22)	10
Sodium 24 (Na 24)	10
Strontium 85 (Sr 85)	10
Strontium 89 (Sr 89)	1
Strontium 90 (Sr 90)	0.1
Strontium 91 (Sr 91)	10
Strontium 92 (Sr 92)	10
Sulfur 35 (S 35)	100
Tantalum 182 (Ta 182)	10
Technetium 96 (Tc 96)	10
Technetium 97m (Tc 97m)	100
Technetium 97 (Tc 97)	100
Technetium 99m (Tc 99m)	100
Technetium 99 (Tc 99)	10
Tellurium 125m (Te 125m)	10
Tellurium 127m (Te 127m)	10
Tellurium 127 (Te 127)	100
Tellurium 129m (Te 129m)	10

Tellurium 129 (Te 129)	100
Tellurium 131m (Te 131m)	10
Tellurium 132 (Te 132)	10
Terbium 160 (Tb 160)	10
Thallium 200 (Tl 200)	100
Thallium 201 (Tl 201)	100
Thallium 202 (Tl 202)	100
Thallium 204 (Tl 204)	10
Thulium 170 (Tm 170)	10
Thulium 171 (Tm 171)	10
Tin 113 (Sn 113)	10
Tin 125 (Sn 125)	10
Tungsten 181 (W 181)	10
Tungsten 185 (W 185)	10
Tungsten 187 (W 187)	100
Vanadium 48 (V 48)	10
Xenon 131m (Xe 131m)	1,000
Xenon 133 (Xe 133)	100
Xenon 135 (Xe 135)	100
Ytterbium 175 (Yb 175)	100
Yttrium 87 (Y 87)	10
Yttrium 88 (Y 88)	10
Yttrium 90 (Y 90)	10
Yttrium 91 (Y 91)	10
Yttrium 92 (Y 92)	100
Yttrium 93 (Y 93)	100

Zinc 65 (Zn 65)	10
Zinc 69m (Zn 69m)	100
Zinc 69 (Zn 69)	1,000
Zirconium 93 (Zr 93)	10
Zirconium 95 (Zr 95)	10
Zirconium 97 (Zr 97)	10
Any radioactive material not listed above other than alpha-emitting radioactive materials	0.1

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 33 SR 1440; 40 SR 145*

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4731.3150 RADIOACTIVE MATERIALS; EMERGENCY PLAN QUANTITIES.

This part specifies quantities of radioactive materials requiring consideration of the need for an emergency plan for responding to a release.

Radioactive material[1]	Release fraction	Quantity (curies)
Actinium-228	0.001	4,000
Americium-241	0.001	2
Americium-242	0.001	2
Americium-243	0.001	2
Antimony-124	0.01	4,000
Antimony-126	0.01	6,000
Barium-133	0.01	10,000
Barium-140	0.01	30,000
Bismuth-207	0.01	5,000
Bismuth-210	0.01	600

Cadmium-109	0.01	1,000
Cadmium-113	0.01	80
Calcium-45	0.01	20,000
Californium-252	0.001	9 (20 mg)
Carbon-14 (noncarbon dioxide)	0.01	50,000
Cerium-141	0.01	10,000
Cerium-144	0.01	300
Cesium-134	0.01	2,000
Cesium-137	0.01	3,000
Chlorine-36	0.5	100
Chromium-51	0.01	300,000
Cobalt-60	0.001	5,000
Copper-64	0.01	200,000
Curium-242	0.001	60
Curium-243	0.001	3
Curium-244	0.001	4
Curium-245	0.001	2
Europium-152	0.01	500
Europium-154	0.01	400
Europium-155	0.01	3,000
Germanium-68	0.01	2,000
Gadolinium-153	0.01	5,000
Gold-198	0.01	30,000
Hafnium-172	0.01	400
Hafnium-181	0.01	7,000
Holmium-166m	0.01	100

Hydrogen-3	0.5	20,000
Iodine-125	0.5	1
Iodine-131	0.5	10
Indium-114m	0.01	1,000
Iridium-192	0.001	40,000
Iron-55	0.01	40,000
Iron-59	0.01	7,000
Krypton-85	1.0	6,000,000
Lead-210	0.01	8
Manganese-56	0.01	60,000
Mercury-203	0.01	10,000
Molybdenum-99	0.01	30,000
Neptunium-237	0.001	2
Nickel-63	0.01	20,000
Niobium-94	0.01	300
Phosphorus-32	0.5	100
Phosphorus-33	0.5	1,000
Polonium-210	0.01	10
Potassium-42	0.01	9,000
Promethium-145	0.01	4,000
Promethium-147	0.01	4,000
Radium-226	0.001	100
Ruthenium-106	0.01	200
Samarium-151	0.01	4,000
Scandium-46	0.01	3,000

Selenium-75	0.01	10,000
Silver-110m	0.01	1,000
Sodium-22	0.01	9,000
Sodium-24	0.01	10,000
Strontium-89	0.01	3,000
Strontium-90	0.01	90
Sulfur-35	0.5	900
Technetium-99	0.01	10,000
Technetium-99m	0.01	400,000
Tellurium-127m	0.01	5,000
Tellurium-129m	0.01	5,000
Terbium-160	0.01	4,000
Thulium-170	0.01	4,000
Tin-113	0.01	10,000
Tin-123	0.01	3,000
Tin-126	0.01	1,000
Titanium-44	0.01	100
Vanadium-48	0.01	7,000
Xenon-133	1.0	900,000
Yttrium-91	0.01	2,000
Zinc-65	0.01	5,000
Zirconium-93	0.01	400
Zirconium-95	0.01	5,000
Any other beta-gamma emitter	0.01	10,000
Mixed fission products	0.01	1,000

Mixed corrosion products	0.01	10,000
Contaminated equipment, beta-gamma	0.001	10,000
Irradiated material, any form other than solid noncombustible	0.01	1,000
Irradiated material, solid noncombustible	0.001	10,000
Mixed radioactive waste, beta-gamma	0.01	1,000
Packaged mixed waste, beta-gamma[2]	0.001	10,000
Any other alpha emitter	0.001	2
Contaminated equipment, alpha	0.0001	20
Packaged waste, alpha[2]	0.0001	20
Combinations of radioactive materials listed above[1]		

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

[2] Waste packaged in Type B containers does not require an emergency plan.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.3155 ASSURING DECOMMISSIONING FUNDS; PARENT COMPANY GUARANTEES.

Subpart 1. **General requirement.** An applicant or licensee may provide reasonable assurance of the availability of funds for decommissioning based on obtaining a parent company guarantee that funds will be available for decommissioning costs and on a demonstration that the parent company passes the financial test under subpart 2. This part establishes criteria for passing the financial test and for obtaining the parent company guarantee.

Subp. 2. **Financial test requirements.**

A. To pass the financial test, a parent company must meet the criteria of item B or C.

B. The parent company must have:

(1) two of the following three ratios:

(a) a ratio of total liabilities to net worth less than 2.0;

(b) a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and

(c) a ratio of current assets to current liabilities greater than 1.5;

(2) net working capital and tangible net worth each at least six times the current decommissioning cost estimates for the total of all facilities or parts thereof, or prescribed amount if a certification is used, or, for a power reactor licensee, at least six times the amount of decommissioning funds being assured by a parent company guarantee for the total of all reactor units or parts thereof. Tangible net worth must be calculated to exclude the net book value of the nuclear units;

(3) tangible net worth of at least $10,000,000; and

(4) assets located in the United States amounting to at least 90 percent of the total assets or at least six times the current decommissioning cost estimates for the total of all facilities or parts thereof, or prescribed amount if a certification is used, or, for a power reactor licensee, at least six times the amount of decommissioning funds being assured by a parent company guarantee for the total of all reactor units or parts thereof.

C. The parent company must have:

(1) a current rating for its most recent bond issuance of AAA, AA, A, or BBB as issued by Standard and Poor's or Aaa, Aa, A, or Baa as issued by Moody's;

(2) tangible net worth at least six times the current decommissioning cost estimates for the total of all facilities or parts thereof, or prescribed amount if a certification is used, or, for a power reactor licensee, at least six times the amount of decommissioning funds being assured by a parent company guarantee for the total of all reactor units or parts thereof. Tangible net worth must be calculated to exclude the net book value of the nuclear units;

(3) tangible net worth of at least $10,000,000; and

(4) assets located in the United States amounting to at least 90 percent of the total assets or at least six times the current decommissioning cost estimates for the total of all facilities or parts thereof, or prescribed amount if a certification is used, or, for a power reactor licensee, at least six times the amount of decommissioning funds being assured by a parent company guarantee for the total of all reactor units or parts thereof.

Subp. 3. **Audit.** A parent company's independent certified public accountant must compare the data used by the parent company in the financial test, which must be derived from the independently audited, year-end financial statements for the latest fiscal year, with the amounts in such financial statements. In connection with that procedure, the licensee must inform the NRC within 90 days of any matters coming to the auditor's attention that cause the auditor to believe that the data in the financial test should be adjusted and that the company no longer passes the test.

Subp. 4. **Continued compliance.**

A. After the initial financial test, a parent company must repeat the passage of the test within 90 days after the close of each succeeding fiscal year.

B. If a parent company no longer meets the requirements of subpart 2, the licensee must send notice to the commissioner of intent to establish alternate financial assurance according to this chapter. The notice must be sent by certified mail within 90 days after the end of the fiscal year for which the year-end financial data show that the parent company no longer meets the financial test requirements. The licensee must provide alternate financial assurance within 120 days after the end of such fiscal year.

Subp. 5. **Terms of guarantee.** The terms of a parent company guarantee that an applicant or licensee obtains must provide that:

A. the parent company guarantee remains in force unless the guarantor sends notice of cancellation by certified mail to the licensee and the commissioner. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by both the licensee and the commissioner, as evidenced by the return receipts;

B. if the licensee fails to provide alternate financial assurance according to this chapter within 90 days after receipt by the licensee and commissioner of a notice of cancellation of the parent company guarantee from the guarantor, the guarantor must provide alternative financial assurance in the name of the licensee;

C. the parent company guarantee and financial test provisions remain in effect until the commissioner terminates the license; and

D. if a trust is established for decommissioning costs, the trustee and trust must be acceptable to the commissioner. An acceptable trustee includes an appropriate state or federal government agency or an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

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4731.3160 QUANTITIES OF LICENSED MATERIAL REQUIRING LABELING FOR DECOMMISSIONING.

Subpart 1. **Table.** The following quantities of licensed material require labeling for decommissioning:

Materials	Microcuries
Americium-241	0.01
Antimony-122	100
Antimony-124	10
Antimony-125	10
Arsenic-73	100
Arsenic-74	10
Arsenic-76	10
Arsenic-77	100
Barium-131	10
Barium-133	10
Barium-140	10
Bismuth-210	1
Bromine-82	10
Cadmium-109	10
Cadmium-115m	10
Cadmium-115	100
Calcium-45	10
Calcium-47	10
Carbon-14	100
Cerium-141	100
Cerium-143	100
Cerium-144	1

Cesium-131	1,000
Cesium-134m	100
Cesium-134	1
Cesium-135	10
Cesium-136	10
Cesium-137	10
Chlorine-36	10
Chlorine-38	10
Chromium-51	1,000
Cobalt-58m	10
Cobalt-58	10
Cobalt-60	1
Copper-64	100
Dysprosium-165	10
Dysprosium-166	100
Erbium-169	100
Erbium-171	100
Europium-152 9.2h	100
Europium-152 13 yr	1
Europium-154	1
Europium-155	10
Fluorine-18	1,000
Gadolinium-153	10
Gadolinium-159	100
Gallium-72	10
Germanium-71	100

Gold-198	100
Gold-199	100
Hafnium-181	10
Holmium-166	100
Hydrogen-3	1,000
Indium-113m	100
Indium-114m	10
Indium-115m	100
Indium-115	10
Iodine-125	1
Iodine-126	1
Iodine-129	0.1
Iodine-131	1
Iodine-132	10
Iodine-133	1
Iodine-134	10
Iodine-135	10
Iridium-192	10
Iridium-194	100
Iron-55	100
Iron-59	10
Krypton-85	100
Krypton-87	10
Lanthanum-140	10
Lutetium-177	100
Manganese-52	10

Manganese-54	10
Manganese-56	10
Mercury-197m	100
Mercury-197	100
Mercury-203	10
Molybdenum-99	100
Neodymium-147	100
Neodymium-149	100
Nickel-59	100
Nickel-63	10
Nickel-65	100
Niobium-93m	10
Niobium-95	10
Niobium-97	10
Osmium-185	10
Osmium-191m	100
Osmium-191	100
Osmium-193	100
Palladium-103	100
Palladium-109	100
Phosphorus-32	10
Platinum-191	100
Platinum-193m	100
Platinum-193	100
Platinum-197m	100
Platinum-197	100

Plutonium-239	0.01
Polonium-210	0.1
Potassium-42	10
Praseodymium-142	100
Praseodymium-143	100
Promethium-147	10
Promethium-149	10
Radium-226	0.01
Rhenium-186	100
Rhenium-188	100
Rhodium-103m	100
Rhodium-105	100
Rubidium-86	10
Rubidium-87	10
Ruthenium-97	100
Ruthenium-103	10
Ruthenium-105	10
Ruthenium-106	1
Samarium-151	10
Samarium-153	100
Scandium-46	10
Scandium-47	100
Scandium-48	10
Selenium-75	10
Silicon-31	100
Silver-105	10
Silver-110m	1

Silver-111	100
Sodium-24	10
Strontium-85	10
Strontium-89	1
Strontium-90	0.1
Strontium-91	10
Strontium-92	10
Sulfur-35	100
Tantalum-182	10
Technetium-96	10
Technetium-97m	100
Technetium-97	100
Technetium-99m	100
Technetium-99	10
Tellurium-125m	10
Tellurium-127m	10
Tellurium-127	100
Tellurium-129m	10
Tellurium-129	100
Tellurium-131m	10
Tellurium-132	10
Terbium-160	10
Thallium-200	100
Thallium-201	100
Thallium-202	100
Thallium-204	10
Thorium (natural)[1]	100

Thulium-170	10
Thulium-171	10
Tin-113	10
Tin-125	10
Tungsten-181	10
Tungsten-185	10
Tungsten-187	100
Uranium (natural)[2]	100
Uranium-233	0.01
Uranium-234 -- Uranium-235	0.01
Vanadium-48	10
Xenon-131m	1,000
Xenon-133	100
Xenon-135	100
Ytterbium-175	100
Yttrium-90	10
Yttrium-91	10
Yttrium-92	100
Yttrium-93	100
Zinc-65	10
Zinc-69m	100
Zinc-69	1,000
Zirconium-93	10
Zirconium-95	10
Zirconium-97	10

Any alpha-emitting radionuclide not listed above or mixtures of alpha emitters of unknown composition	0.01
Any radionuclide other than alpha-emitting radionuclides not listed above or mixtures of beta emitters of unknown composition	0.1

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

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

Subp. 2. **Combination of isotopes.** For purposes of parts 4731.3000 to 4731.3245, where a combination of isotopes in known amounts is involved, the limit for the combination should be derived as follows: determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination must not exceed one.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

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4731.3165 ASSURING DECOMMISSIONING FUNDS; SELF-GUARANTEES; BOND RATING.

Subpart 1. **General requirement.** This part applies to an applicant or licensee that has a rated bond issuance and wishes to self-guarantee. An applicant or licensee may provide reasonable assurance of the availability of funds for decommissioning based on furnishing its own guarantee that funds will be available for decommissioning costs and on a demonstration that the company passes the financial test under subpart 2. This part establishes criteria for passing the financial test for the self-guarantee and establishes the terms for a self-guarantee.

Subp. 2. **Financial test requirements.** To pass the financial test, a company must have:

A. tangible net worth at least ten times the total current decommissioning cost estimate for the total of all facilities or parts thereof, or the current amount required if certification is used, or, for a power reactor licensee, at least ten times the amount of decommissioning funds being assured by a self-guarantee, for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor for the total of all reactor units or parts thereof. Tangible net worth must be calculated to exclude the net book value of the nuclear units;

B. assets located in the United States amounting to at least 90 percent of total assets or at least ten times the total current decommissioning cost estimate for the total of all facilities or parts thereof, or the current amount required if certification is used, or, for a power reactor licensee, at least ten times the amount of decommissioning funds being assured by a self-guarantee, for all

decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor for the total of all reactor units or parts thereof;

C. a current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard and Poor's or Aaa, Aa, or A as issued by Moody's; and

D. at least one class of equity securities registered under the Securities Exchange Act of 1934, United States Code, title 15, sections 78a to 78mm.

Subp. 3. **Audit.** A company's independent certified public accountant must compare the data used by the company in the financial test, which must be derived from the independently audited, year-end financial statements for the latest fiscal year, with the amounts in such financial statements. In connection with that procedure, the licensee must inform the commissioner within 90 days of any matters coming to the attention of the auditor that cause the auditor to believe that the data in the financial test should be adjusted and that the company no longer passes the test.

Subp. 4. **Continued compliance.**

A. After the initial financial test, a company must repeat passage of the test within 90 days after the close of each succeeding fiscal year.

B. If a licensee no longer meets the requirements of subpart 2, the licensee must send immediate notice to the commissioner of its intent to establish alternate financial assurance according to this chapter within 120 days of the notice.

Subp. 5. **Terms of guarantee.** The terms of a self-guarantee that an applicant or licensee furnishes must provide that:

A. the guarantee remains in force unless the licensee sends notice of cancellation by certified mail to the commissioner. Cancellation may not occur, however, during the 120 days beginning on the date of receipt of the notice of cancellation by the commissioner, as evidenced by the return receipt;

B. the licensee must provide alternative financial assurance according to this chapter within 90 days following receipt by the commissioner of a notice of cancellation of the guarantee;

C. the guarantee and financial test provisions remain in effect until the commissioner terminates the license or until another financial assurance method acceptable to the commissioner is put in effect by the licensee;

D. the licensee must promptly forward to the commissioner and the licensee's independent auditor all reports covering the latest fiscal year filed by the licensee with the Securities and Exchange Commission according to section 13 of the Securities Exchange Act of 1934, United States Code, title 15, section 78m;

E. if, at any time, the licensee's most recent bond issuance ceases to be rated in any category of A or above by either Standard and Poor's or Moody's, the licensee must provide notice in writing of such fact to the commissioner within 20 days after publication of the change by the rating service.

If the licensee's most recent bond issuance ceases to be rated in any category of A or above by both Standard and Poor's and Moody's, the licensee no longer meets the requirements of subpart 2; and

F. the applicant or licensee must provide to the commissioner a written guarantee (a written commitment by a corporate officer) that states that the licensee shall fund and carry out the required decommissioning activities or, upon issuance of an order by the commissioner, the licensee shall set up and fund a trust in the amount of the current cost estimates for decommissioning.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3170 ASSURING DECOMMISSIONING FUNDS; SELF-GUARANTEE; NO OUTSTANDING RATED BONDS.

Subpart 1. **General requirement.** This part applies to an applicant or licensee that has no outstanding rated bonds and wishes to self-guarantee. An applicant or licensee may provide reasonable assurance of the availability of funds for decommissioning based on furnishing its own guarantee that funds will be available for decommissioning costs and on a demonstration that the company passes the financial test under subpart 2. This part establishes criteria for passing the financial test for the self-guarantee and establishes the terms for a self-guarantee.

Subp. 2. **Financial test requirement.** To pass the financial test, a company must have:

A. tangible net worth greater than $10,000,000, or at least ten times the total current decommissioning cost estimate, or the current amount required if certification is used, whichever is greater, for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor;

B. assets located in the United States amounting to at least 90 percent of total assets or at least ten times the total current decommissioning cost estimate, or the current amount required if certification is used, for all decommissioning activities for which the company is responsible as a self-guaranteeing licensee and as a parent-guarantor; and

C. a ratio of cash flow divided by total liabilities greater than 0.15 and a ratio of total liabilities divided by net worth less than 1.5.

Subp. 3. **Audit.** A company's independent certified public accountant must compare the data used by the company in the financial test, which must be derived from the independently audited year-end financial statements, based on United States generally accepted accounting practices, for the latest fiscal year, with the amounts in such financial statements. In connection with that procedure, the licensee must inform the commissioner within 90 days of any matters that may cause the auditor to believe that the data in the financial test should be adjusted and that the company no longer passes the test.

Subp. 4. **Continued compliance.**

A. After the initial financial test, a company must repeat passage of the test within 90 days after the close of each succeeding fiscal year.

B. If a licensee no longer meets the requirements of subpart 2, the licensee must send notice to the commissioner of intent to establish alternative financial assurance according to this chapter. The notice must be sent by certified mail, return receipt requested, within 90 days after the end of the fiscal year for which the year-end financial data show that the licensee no longer meets the financial test requirements. The licensee must provide alternative financial assurance within 120 days after the end of the fiscal year.

Subp. 5. **Terms of guarantee.** The terms of a self-guarantee that an applicant or licensee furnishes must provide that:

A. the guarantee remains in force unless the licensee sends notice of cancellation by certified mail, return receipt requested, to the commissioner. Cancellation may not occur until an alternative financial assurance mechanism is in place;

B. the licensee must provide alternative financial assurance according to this chapter within 90 days following receipt by the commissioner of a notice of cancellation of the guarantee;

C. the guarantee and financial test provisions remain in effect until the commissioner terminates the license or until another financial assurance method acceptable to the commissioner is put in effect by the licensee; and

D. the applicant or licensee must provide to the commissioner a written guarantee (a written commitment by a corporate officer) that states that the licensee shall fund and carry out the required decommissioning activities or, upon issuance of an order by the commissioner, the licensee shall set up and fund a trust in the amount of the current cost estimates for decommissioning.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3175 ASSURING DECOMMISSIONING FUNDS; NONPROFIT ENTITIES.

Subpart 1. **General requirement.** This part applies to an applicant or licensee that is a nonprofit entity, such as a college, university, or nonprofit hospital, and wishes to self-guarantee. An applicant or licensee may provide reasonable assurance of the availability of funds for decommissioning based on furnishing its own guarantee that funds will be available for decommissioning costs and on a demonstration that the applicant or licensee passes the financial test under subpart 2. This part establishes criteria for passing the financial test for the self-guarantee and establishes the terms for a self-guarantee.

Subp. 2. **Financial test requirements.**

A. To pass the financial test, a college or university must:

(1) for applicants or licensees that issue bonds, have a current rating for its most recent uninsured, uncollateralized, and unencumbered bond issuance of AAA, AA, or A as issued by Standard and Poor's or Aaa, Aa, or A as issued by Moody's; or

(2) for applicants or licensees that do not issue bonds, have an unrestricted endowment consisting of assets located in the United States of at least $50,000,000, or at least 30 times the total current decommissioning cost estimate, or the current amount required if certification is used, whichever is greater, for all decommissioning activities for which the college or university is responsible as a self-guaranteeing licensee.

B. To pass the financial test, a hospital must:

(1) for applicants or licensees that issue bonds, have a current rating for its most recent uninsured, uncollateralized, and unencumbered bond issuance of AAA, AA, or A as issued by Standard and Poor's or Aaa, Aa, or A as issued by Moody's; or

(2) for applicants or licensees that do not issue bonds, meet all the following tests:

(a) total revenues less total expenditures, divided by total revenues, must be equal to or greater than 0.04;

(b) long-term debt divided by net fixed assets must be less than or equal to 0.67;

(c) current assets and depreciation fund, divided by current liabilities, must be greater than or equal to 2.55; and

(d) operating revenues must be at least 100 times the total current decommissioning cost estimate, or the current amount required if certification is used, for all decommissioning activities for which the hospital is responsible as a self-guaranteeing licensee.

Subp. 3. **Audit.** A licensee's independent certified public accountant must compare the data used by the licensee in the financial test, which must be derived from the independently audited, year-end financial statements, based on United States generally accepted accounting practices, for the latest fiscal year, with the amounts in such financial statements. In connection with that procedure, the licensee must inform the commissioner within 90 days of any matters coming to the attention of the auditor that cause the auditor to believe that the data in the financial test should be adjusted and that the licensee no longer passes the test.

Subp. 4. **Continued compliance.**

A. After the initial financial test, a licensee must repeat passage of the test within 90 days after the close of each succeeding fiscal year.

B. If a licensee no longer meets the requirements of subpart 2, the licensee must send notice to the commissioner of its intent to establish alternative financial assurance according to this chapter. The notice must be sent by certified mail, return receipt requested, within 90 days after the end of the fiscal year for which the year-end financial data show that the licensee no longer meets the financial test requirements. The licensee must provide alternate financial assurance within 120 days after the end of the fiscal year.

Subp. 5. **Terms of guarantee.** The terms of a self-guarantee that an applicant or licensee furnishes must provide that:

A. the guarantee remains in force unless the licensee sends notice of cancellation by certified mail or return receipt requested to the commissioner. Cancellation may not occur unless an alternative financial assurance mechanism is in place;

B. the licensee must provide alternative financial assurance according to this chapter within 90 days following receipt by the commissioner of a notice of cancellation of the guarantee;

C. the guarantee and financial test provisions remain in effect until the commissioner terminates the license or until another financial assurance method acceptable to the commissioner is put in effect by the licensee;

D. the applicant or licensee must provide to the commissioner a written guarantee (a written commitment by a corporate officer or officer of the institution) that states that the licensee shall fund and carry out the required decommissioning activities or, upon issuance of an order by the commissioner, the licensee shall set up and fund a trust in the amount of the current cost estimates for decommissioning; and

E. if, at any time, the licensee's most recent bond issuance ceases to be rated in any category of A or above by either Standard and Poor's or Moody's, the licensee must provide notice in writing of the fact to the commissioner within 20 days after publication of the change by the rating service.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3200 GENERAL DOMESTIC LICENSES FOR RADIOACTIVE MATERIAL.

A. Parts 4731.3200 to 4731.3245 establish general licenses for the possession and use of radioactive material and a general license for ownership of radioactive material. Specific provisions of this chapter are applicable to general licenses established under parts 4731.3200 to 4731.3245, as provided under item B and as provided in the particular general license.

B. A general license issued under parts 4731.3200 to 4731.3245 is subject to parts 4731.1000 to 4731.1090, 4731.2000 to 4731.2950, and 4731.3000 to 4731.3175 and Code of Federal Regulations, title 10, part 21, unless indicated otherwise in the specific provision of the general license. Attention is directed particularly to the provisions of parts 4731.2000 to 4731.2950 concerning labeling of containers.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3210 [Repealed, 40 SR 145]
Published Electronically: *August 27, 2015*

4731.3215 GENERAL LICENSE; DETECTING, MEASURING, GAUGING, CONTROLLING, AND OTHER DEVICES.

Subpart 1. **License issued.** Commercial and industrial firms; research, educational, and medical institutions; individuals in the conduct of their business; and state or local government agencies are issued a general license to acquire, receive, possess, use, or transfer, according to this part, radioactive material contained in devices designed and manufactured for:

A. detecting, measuring, gauging, or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition; or

B. producing light or an ionized atmosphere.

Subp. 2. **Applicability.**

A. The general license under subpart 1 applies only to radioactive material contained in devices that have been manufactured or initially transferred and labeled according to:

(1) a specific license issued under part 4731.3330;

(2) an equivalent specific license issued by the NRC or an agreement state; or

(3) an equivalent specific license issued by a state with provisions comparable to part 4731.3330.

B. The devices must have been received from one of the specific licensees described in item A or through a transfer made under subpart 3, item M.

Subp. 3. **Requirements.** A person who acquires, receives, possesses, uses, or transfers radioactive material in a device according to the general license issued under subpart 1 must:

A. ensure that all labels that are affixed to the device at the time of receipt and that bear a statement that removal of the label is prohibited are maintained on the device and must comply with all instructions and precautions provided by the labels;

B. ensure that the device is tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than six-month intervals or at such other intervals as are specified in the label, except:

(1) devices containing only krypton need not be tested for leakage of radioactive material;

(2) devices containing only tritium or not more than 100 microcuries of other beta- or gamma-emitting material or ten microcuries of alpha-emitting material need not be tested for any purpose; and

(3) devices held in storage in the original shipping container prior to initial installation need not be tested for any purpose;

C. ensure that the tests under item B and other testing, installation, servicing, and removal from installation involving the radioactive material, its shielding, or its containment are performed:

(1) according to the instructions provided by the labels; or

(2) by a person holding a specific license issued under parts 4731.3000 to 4731.3175 or 4731.3300 to 4731.3400 or issued by the NRC or an agreement state to perform such activities;

D. maintain records showing compliance with items B and C. The records must include:

(1) the results of the tests;

(2) the dates the tests were performed; and

(3) the names of persons performing the tests, installation, servicing, and removal from installation of radioactive material and its shielding or containment;

E. retain the records under item D as follows:

(1) each record of a test for leakage or radioactive material required by item B must be retained for three years after the next required leak test is performed or until the sealed source is transferred or disposed of;

(2) each record of a test of the on-off mechanism and indicator required by item B must be retained for three years after the next required test of the on-off mechanism and indicator is performed or until the sealed source is transferred or disposed of; and

(3) each record showing compliance with item C must be retained for three years from the date of the recorded event or until the device is transferred or disposed of;

F. immediately suspend operation of the device if there is a failure of or damage to or any indication of a possible failure of or damage to the shielding of the radioactive material or the on-off mechanism or indicator or upon the detection of 0.005 microcurie (185 Bq) or more removable radioactive material until the device has been repaired by the manufacturer or other person holding a specific license issued under parts 4731.3000 to 4731.3175 or 4731.3300 to 4731.3400 or issued by the NRC or an agreement state to repair the device. The device and any radioactive material from the device may only be disposed of by transfer to a person authorized by a specific license to receive the radioactive material contained in the device or as otherwise approved by the commissioner;

G. within 30 days, furnish to the commissioner a report containing a brief description of any event under item F and the remedial actions taken and, in the case of detection of 0.005 microcurie or more of removable radioactive material or failure of or damage to a source likely to result in contamination of the premises or environs, a plan for ensuring that the premises and environs are acceptable for unrestricted use. Under these circumstances, the criteria under part 4731.2100, subpart 2, may be applicable, as determined by the commissioner on a case-by-case basis;

H. not abandon the device containing radioactive material;

I. not export the device containing radioactive material, except according to Code of Federal Regulations, title 10, part 110;

J. transfer or dispose of the device containing radioactive material only:

(1) by export as provided in item I;

(2) by transfer to another general licensee as authorized under item M;

(3) to a person authorized to receive the device by a specific license issued under parts 4731.3000 to 4731.3175 or 4731.3300 to 4731.3400 or under equivalent regulations of the NRC or an agreement state that authorizes waste collection; or

(4) as otherwise approved under item L;

K. within 30 days of a transfer under item J, report to the commissioner:

(1) the identification of the device by manufacturer's or initial transferor's name, model number, and serial number;

(2) the name, address, and license number of the person receiving the device. No license number is required if the device is exported; and

(3) the date of the transfer;

L. obtain written approval from the commissioner before transferring the device to another specific licensee not specifically identified in item J; however, a holder of a specific license may transfer a device for possession and use under its own specific license without prior approval, if the holder:

(1) verifies that the specific license authorizes the possession and use, or applies for and obtains an amendment to the license authorizing the possession and use;

(2) removes, alters, covers, or clearly and unambiguously augments the existing label, otherwise required by subpart 3, item A, so that the device is labeled in compliance with part 4731.2330; however, the manufacturer, model number, and serial number must be retained;

(3) obtains the manufacturer's or initial transferor's information concerning maintenance that would be applicable under the specific license, such as leak testing procedures; and

(4) reports the transfer under item K;

M. transfer the device to another general licensee only if:

(1) the device remains in use at a particular location, in which case the transferor must give the transferee a copy of this part and parts 4731.2600, 4731.2610, 4731.3115, and 4731.3200 and any safety documents identified in the label of the device. Within 30 days of the transfer, the transferor must report to the commissioner:

(a) the manufacturer's or initial transferor's name;

(b) the model number and the serial number of the device transferred;

(c) the transferee's name and mailing address for the location of use; and

(d) the name, title, and telephone number of the responsible individual identified by the transferee under item P to have knowledge of and authority to take actions to ensure compliance with the appropriate rules and requirements; or

(2) the device is held in storage by an intermediate person in the original shipping container at its intended location of use prior to initial use by a general licensee;

N. comply with parts 4731.2600 and 4731.2610 for reporting radiation incidents, theft, and loss of licensed material, but is exempt from the remainder of parts 4731.1000 to 4731.1090 and 4731.2000 to 4731.2950 and Code of Federal Regulations, title 10, part 21;

O. respond to written requests from the commissioner to provide information relating to the general license within 30 calendar days of the date of the request, or other time specified in the request. If the general licensee cannot provide the requested information within the allotted time, the general licensee must, within the same time period, request a longer period to supply the information by submitting a letter to the commissioner and provide written justification as to why it cannot comply;

P. appoint an individual responsible for having knowledge of the appropriate rules and requirements and the authority for taking required actions to comply with appropriate rules and requirements. The general licensee, through the appointed individual, must ensure the day-to-day compliance with appropriate rules and requirements. The appointment does not relieve the general licensee of any of the general licensee's responsibility in this regard;

Q. report changes to the mailing address for the location of use, including change in name of the general licensee, to the commissioner within 30 days of the effective date of the change. For a portable device, a report of address change is required only for a change in the device's primary place of storage; and

R. not hold devices that are not in use for more than two years. If a device with shutters is not being used, the shutters must be locked in the closed position. The testing required under item B need not be performed during the period of storage only. When a device is put back into service or transferred to another person, and has not been tested within the required test interval, the device must be tested for leakage before use or transfer and the shutters must be tested before use. Devices kept in standby for future use are excluded from the two-year time limit if the general licensee performs quarterly physical inventories of these devices while they are in standby.

Subp. 3a. **Registration of generally licensed devices.**

A. A person to whom subpart 3 applies shall register generally licensed devices according to items B and C. These devices contain:

(1) at least ten millicuries (370 MBq) of cesium-137;

(2) at least 0.1 millicurie (3.7 MBq) of strontium-90;

(3) at least one millicurie (37 MBq) of cobalt-60;

(4) at least 0.1 millicurie (3.7 MBq) of radium-226; or

(5) at least one millicurie (37 MBq) of americium-241 or any other transuranic (any other element with an atomic number greater than uranium-92) based on the activity indicated on the label.

B. If in possession of a device meeting the criteria of item A, a person to whom subpart 3 applies must register the device annually with the commissioner and pay the fee required under Minnesota Statutes, section 144.1205.

(1) Registration must be done by verifying, correcting, or adding to the information provided in a request for registration received from the commissioner. Registration information must be submitted to the commissioner within 30 days of the date of the request for registration or as otherwise indicated in the request.

(2) A general licensee holding devices meeting the criteria of item A is subject to the bankruptcy notification requirement under part 4731.3075, subpart 4. Each address for a location of use under item C, subitem (4), represents a separate general license and requires a separate registration and fee.

(3) Persons generally licensed by the NRC or an agreement state with respect to devices meeting the criteria in item A are not subject to registration under this item if the devices are used in areas subject to the commissioner's jurisdiction for a period of less than 180 days in any calendar year. The commissioner shall not request registration information from such licensees.

C. In registering devices under item B, a person to whom subpart 3 applies must furnish the following information and any other information specifically requested by the commissioner:

(1) name and mailing address of the general licensee;

(2) the following information about each device:

(a) the manufacturer or initial transferor;

(b) the model number;

(c) the serial number; and

(d) the radioisotope and activity, as indicated on the label;

(3) name, title, and telephone number of the responsible person designated as a representative of the general licensee under subpart 3, item P;

(4) address or location at which each device is used or stored. For portable devices, the address of the primary place of storage must be furnished;

(5) certification by the responsible representative of the general licensee that the information concerning the device has been verified through a physical inventory and checking of label information; and

(6) certification by the responsible representative of the general licensee that the responsible representative is aware of the requirements of the general license.

Subp. 4. **Limitation.** The general license issued under subpart 1 does not authorize the manufacture or import of devices containing radioactive material.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3220 GENERAL LICENSE; INSTALLATION OF GENERALLY LICENSED DEVICES.

A person who holds a specific license issued by the NRC or an agreement state authorizing the holder to manufacture, install, or service a device described under part 4731.3215 is issued a general license to install and service such device in areas subject to the commissioner's authority, if:

A. the device has been manufactured, labeled, installed, and serviced according to applicable provisions of the specific license issued to the person by the commissioner, the NRC, or an agreement state; and

B. the specific license holder ensures that any labels required to be affixed to the device under rules of the commissioner, the NRC, or the agreement state that licensed manufacture of the device bear a statement that removal of the label is prohibited.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3225 GENERAL LICENSE; LUMINOUS SAFETY DEVICES FOR AIRCRAFT.

Subpart 1. **License issued.** A general license is issued to own, receive, acquire, possess, and use tritium or promethium-147 contained in luminous safety devices for use in aircraft, provided that:

A. each device contains not more than ten curies (370 GBq) of tritium or 300 millicuries (11.1 GBq) of promethium-147; and

B. each device:

(1) has been manufactured, assembled, or initially transferred according to a license issued by the commissioner under part 4731.3345; or

(2) has been manufactured or assembled according to a specific license issued by the commissioner, the NRC, or an agreement state that authorizes the manufacture or assembly of the device for distribution to persons generally licensed by the commissioner, the NRC, or an agreement state.

Subp. 2. **Exemption.** Persons who own, receive, acquire, possess, or use luminous safety devices under the general license issued in subpart 1 are exempt from parts 4731.1000 to 4731.1090

and 4731.2000 to 4731.2950 and Code of Federal Regulations, title 10, part 21, except that they must comply with parts 4731.2600 and 4731.2610.

Subp. 3. **Limitation.** The general license under this part does not authorize:

A. the manufacture, assembly, repair, export, or import of luminous safety devices containing tritium or promethium-147; or

B. the ownership, receipt, acquisition, possession, or use of promethium-147 contained in instrument dials.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3230 GENERAL LICENSE; AMERICIUM-241 AND RADIUM-226 CALIBRATION OR REFERENCE SOURCES.

Subpart 1. **License issued; americium-241.** A general license is issued to persons listed in this part to own, receive, acquire, possess, use, and transfer, according to the provisions of subparts 4 and 5, americium-241 or radium-226 in the form of calibration or reference sources:

A. a person who holds a specific license issued by the commissioner that authorizes the person to receive, possess, use, and transfer radioactive material; and

B. a government agency that holds a specific license issued by the NRC that authorizes the person to receive, possess, use, and transfer radioactive material.

Subp. 2. [Repealed, 33 SR 1440]

Subp. 3. [Repealed, 33 SR 1440]

Subp. 4. **Calibration or reference source requirements.** The general licenses in subpart 1 apply only to calibration or reference sources that have been manufactured or initially transferred according to a specific license issued to the manufacturer under part 4731.3365 or by the NRC or an agreement state that authorizes manufacture of the sources for distribution to persons generally licensed by an agreement state.

Subp. 5. **Additional requirements.**

A. The general licenses issued under this part are subject to parts 4731.0260; 4731.1000 to 4731.2950; 4731.3025, subpart 4; 4731.3075, subparts 1, 2, 3, 5, and 6; and 4731.3110 to 4731.3135 and Code of Federal Regulations, title 10, part 21.

B. Persons who own, receive, acquire, possess, use, or transfer one or more calibration or reference sources under the general licenses:

(1) must not possess at any one time, at any one location of storage or use, more than five microcuries (0.185 kilobecquerels) of americium-241 or radium-226 in the sources;

(2) must not receive, possess, use, or transfer the source unless the source or storage container bears a label that includes the following statement or a substantially similar statement that contains the information called for:

"The receipt, possession, use, and transfer of this source, Model....., Serial No. ....., are subject to a general license and the regulations of the Nuclear Regulatory Commission or of a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority. Do not remove this label.

CAUTION - RADIOACTIVE MATERIAL - THIS SOURCE CONTAINS AMERICIUM-241 [or RADIUM-226, as appropriate]. DO NOT TOUCH RADIOACTIVE PORTION OF THIS SOURCE.

(Name of manufacturer or initial transferor)";

(3) must not transfer, abandon, or dispose of the source except by transfer to a person authorized by a license from the commissioner, the NRC, or an agreement state to receive the source;

(4) must store the source, except when the source is being used, in a closed container adequately designed and constructed to contain americium-241 or radium-226 that might otherwise escape during storage; and

(5) must not use the source for any purpose other than the calibration of radiation detectors or the standardization of other sources.

C. Sources generally licensed under this part before January 19, 1975, may bear labels authorized by the regulations in effect on January 1, 1975. Sources containing radium-226 generally licensed under this part and manufactured before November 30, 2007, must be labeled according to the applicable state regulations at the time of manufacture or import.

Subp. 6. **Limitation.** The general licenses under this part do not authorize the manufacture, export, or import of calibration or reference sources containing americium-241 or radium-226.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.3235 GENERAL LICENSE; OWNING RADIOACTIVE MATERIAL.

A general license is issued to own radioactive material without regard to quantity. Notwithstanding any other provision of this chapter, a general licensee under this part is not authorized to manufacture, produce, transfer, receive, possess, use, import, or export radioactive material, except as authorized in a specific license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3240 GENERAL LICENSE; STRONTIUM-90 ICE DETECTION DEVICES.

Subpart 1. **License issued.** A general license is issued to own, receive, acquire, possess, use, and transfer strontium-90 contained in ice detection devices, provided that:

A. each device contains not more than 50 microcuries (1.85 MBq) of strontium-90; and

B. each device has been manufactured or initially transferred according to a license issued under part 4731.3380 or according to a specific license issued to the manufacturer by the commissioner, the NRC, or an agreement state that authorizes manufacture of the ice detection devices for distribution to persons generally licensed by the commissioner, the NRC, or an agreement state.

Subp. 2. **Requirements.** Persons who own, receive, acquire, possess, use, or transfer strontium-90 contained in ice detection devices under the general license issued under subpart 1:

A. must, upon occurrence of visually observable damage to the device, such as a bend, crack, or discoloration from overheating:

(1) discontinue use of the device until it has been inspected, tested for leakage, and repaired by a person holding a specific license issued under parts 4731.3000 to 4731.3175 or 4731.3300 to 4731.3400 or by the NRC or an agreement state to manufacture or service the device; or

(2) dispose of the device according to part 4731.2400;

B. must ensure that all labels affixed to the device at the time of receipt, and which bear a statement that prohibits removal of the labels, are maintained thereon; and

C. are exempt from parts 4731.1000 to 4731.2950 and Code of Federal Regulations, title 10, part 21, except that the persons must comply with parts 4731.2400, 4731.2600, and 4731.2610.

Subp. 3. **Limitation.** The general license issued under subpart 1 does not authorize the manufacture, assembly, disassembly, repair, or import of strontium-90 in ice detection devices.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.3245 GENERAL LICENSE; IN VITRO CLINICAL OR LABORATORY TESTING USE.

Subpart 1. **License issued.** A physician, veterinarian in the practice of veterinary medicine, clinical laboratory, or hospital is issued a general license to receive, acquire, possess, transfer, or use, according to this part, the following radioactive materials in prepackaged units for use in in vitro clinical or laboratory tests not involving internal or external administration of radioactive material, or the radiation therefrom, to human beings or animals:

A. iodine-125, in units not exceeding ten microcuries (0.37 MBq) each;

B. iodine-131, in units not exceeding ten microcuries (0.37 MBq) each;

C. carbon-14, in units not exceeding ten microcuries (0.37 MBq) each;

D. hydrogen-3 (tritium), in units not exceeding 50 microcuries (1.85 MBq) each;

E. iron-59, in units not exceeding 20 microcuries (0.74 MBq) each;

F. selenium-75, in units not exceeding ten microcuries (0.37 MBq) each;

G. mock iodine-125 reference or calibration sources, in units not exceeding 0.05 microcurie (1.85 kBq) of iodine-129 and 0.005 microcurie (0.185 kBq) of americium-241 each; and

H. cobalt-57, in units not exceeding ten microcuries (0.37 MBq) each.

Subp. 2. **License requirements.** A person must not receive, acquire, possess, use, or transfer radioactive material under the general license issued under subpart 1 unless the person:

A. has filed a registration certificate in vitro testing with radioactive material under general license form, as prescribed by the commissioner, with the commissioner and received from the commissioner a validated copy of the form with a registration number assigned; or

B. has a license that authorizes the medical use of radioactive material issued under parts 4731.4400 to 4731.4527.

Subp. 3. **Additional requirements.** A person who receives, acquires, possesses, or uses radioactive material under the general license issued under subpart 1 must:

A. not possess at any one time, at any one location of storage or use, a total amount of iodine-125, iodine-131, selenium-75, iron-59, or cobalt-57 in excess of 200 microcuries (7.4 MBq);

B. store the radioactive material, until used, in the original shipping container or in a container providing equivalent radiation protection;

C. use the radioactive material only for the uses authorized under subpart 1;

D. not transfer the radioactive material, except by transfer to a person who is authorized to receive it under a license issued by the commissioner, the NRC, or an agreement state, nor transfer the radioactive material in any manner other than in the unopened, labeled shipping container as received from the supplier; and

E. dispose of the mock iodine-125 reference or calibration sources described in subpart 1, item G, as required under part 4731.2400.

Subp. 4. **Limitation.** A general licensee under this part must not receive, acquire, possess, or use radioactive material:

A. except as prepackaged units that are labeled according to:

(1) a specific license issued under part 4731.3390; or

(2) a specific license issued by the NRC or an agreement state that authorizes the manufacture and distribution of iodine-125, iodine-131, carbon-14, hydrogen-3 (tritium), selenium-75, iron-59, mock iodine-125, or cobalt-57 to persons generally licensed by the NRC or an agreement state; and

B. unless the following statement, or a substantially similar statement that contains the information called for, appears on a label affixed to each prepackaged unit or appears in a leaflet or brochure that accompanies the package:

"This radioactive material may be received, acquired, possessed, and used only by physicians, veterinarians in the practice of veterinary medicine, clinical laboratories, or hospitals and only for in vitro clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to the rules of and a general license issued by the Nuclear Regulatory Commission or a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority.

(Name of manufacturer)"

Subp. 5. **Changes in registration.** A registrant possessing or using radioactive material under the general license issued under subpart 1 must report in writing to the commissioner any changes in the information provided in the form under subpart 2, item A. The report must be furnished within 30 days after the effective date of the change.

Subp. 6. **Exemptions.** A person using radioactive material under the general license issued under subpart 1 is exempt from parts 4731.1000 to 4731.2950 and Code of Federal Regulations, title 10, part 21, with respect to radioactive material covered by the general license, except that persons using mock iodine-125 under subpart 1, item G, must comply with parts 4731.2400, 4731.2600, and 4731.2610.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.3250 GENERAL LICENSE; CERTAIN ITEMS AND SELF-LUMINOUS PRODUCTS CONTAINING RADIUM-226.

Subpart 1. **General license.** A general license is hereby issued to any person to acquire, receive, possess, use, or transfer, according to the provisions of subparts 2 to 4, radium-226 contained in the following products manufactured prior to November 30, 2007.

A. Antiquities originally intended for use by the general public. For the purposes of this item, "antiquities" means products originally intended for use by the general public and distributed in the late 19th and early 20th centuries, such as radium emanator jars, revigators, radium water jars, radon generators, refrigerator cards, radium bath salts, and healing pads.

B. Intact timepieces containing greater than one microcurie (0.037 MBq), nonintact timepieces, and timepiece hands and dials no longer installed in timepieces.

C. Luminous items installed in air, marine, or land vehicles.

D. All other luminous products, provided that no more than 100 items are used or stored at the same location at any one time.

E. Small radium sources containing no more than one microcurie (0.037 MBq) of radium-226. For the purposes of this item, "small radium sources" means discrete survey instrument check sources, sources contained in radiation measuring instruments, sources used in educational demonstrations, such as cloud chambers and spinthariscopes, electron tubes, lightning rods, ionization sources, static eliminators, or as designated by the NRC.

Subp. 2. **Exempt provisions.** Persons who acquire, receive, possess, use, or transfer byproduct material under the general license issued in subpart 1 are exempt from the provisions of parts 4731.1000 to 4731.2950, 4731.3110 and 4731.3115, and Code of Federal Regulations, title 10, part 21, to the extent that the receipt, possession, use, or transfer of byproduct material is within the terms of the general license; provided, that this exemption is not deemed to apply to any person specifically licensed under this chapter.

Subp. 3. **General requirements.** Any person who acquires, receives, possesses, uses, or transfers byproduct material according to the general license in subpart 1:

A. must notify the commissioner if there is any indication that damage to the product may result in a loss of the radioactive material. A report containing a brief description of the event, and the remedial action taken, must be furnished within 30 days to the Radioactive Materials Unit, Minnesota Department of Health, 625 Robert Street N., P.O. Box 64975, St. Paul, MN 55164-0975;

B. must not abandon products containing radium-226. The product, and any radioactive material from the product, may only be disposed of according to part 4731.2460 or by transfer to a person authorized by a specific license to receive the radium-226 in the product or as otherwise approved by the NRC;

C. must not export products containing radium-226 except according to Code of Federal Regulations, title 10, part 110;

D. must dispose of products containing radium-226:

(1) at a disposal facility authorized to dispose of radioactive material according to any federal or state solid or hazardous waste law, including the Solid Waste Disposal Act, as authorized under the Energy Policy Act of 2005;

(2) by transfer to a person authorized to receive radium-226 under a specific license issued by the NRC or an agreement state; or

(3) as otherwise approved by the commissioner; and

E. must respond to written requests from the commissioner to provide information relating to the general license within 30 calendar days of the date of the request, or other time specified in the request. If the general licensee cannot provide the requested information within the allotted time, the licensee must, within that same time period, request a longer period to supply the information by providing the commissioner a written justification for the request.

Subp. 4. **Limitation.** The general license in subpart 1 does not authorize the manufacture, assembly, disassembly, repair, or import of products containing radium-226, except that timepieces may be disassembled and repaired.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *33 SR 1440; 40 SR 145*

Published Electronically: *August 27, 2015*

SPECIFIC DOMESTIC LICENSING OF RADIOACTIVE MATERIAL

4731.3300 SPECIFIC DOMESTIC LICENSES TO MANUFACTURE OR TRANSFER CERTAIN ITEMS CONTAINING RADIOACTIVE MATERIAL.

Subpart 1. **Scope.** Parts 4731.3300 to 4731.3400 provide for:

A. issuance of specific licenses to persons who manufacture or initially transfer items containing radioactive material for sale or distribution to persons exempted from the licensing requirements of parts 4731.3000 to 4731.3175 or persons generally licensed under parts 4731.3200 to 4731.3245 or 4731.4400 to 4731.4527 and rules governing holders of such licenses;

B. issuance of specific licenses to persons who introduce radioactive material into a product or material owned by or in the possession of the licensee or another and rules governing holders of such licenses; and

C. issuance of certificates of registration (governing radiation safety information about a product) to manufacturers or initial transferors of sealed source or devices containing sealed sources that are to be used by persons specifically licensed under parts 4731.3000 to 4731.3175 or equivalent regulations of the NRC or an agreement state.

Subp. 2. **Applicability.** Parts 4731.3300 to 4731.3400 are in addition to, and not in substitution for, other requirements of this chapter. In particular, the provisions of parts 4731.3000 to 4731.3175 apply to applications, licenses, and certificates of registration subject to parts 4731.3300 to 4731.3400.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.3305 [Repealed, 33 SR 1440]

Published Electronically: *March 12, 2009*

4731.3315 PROHIBITION OF INTRODUCTION.

No person may introduce radioactive material in a product or material knowing or having reason to believe that it will be transferred to a person that is exempt under part 4731.3025 or equivalent regulations of the NRC or an agreement state, except according to a specific license issued under Code of Federal Regulations, title 10, section 32.11.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*
Published Electronically: *March 12, 2009*

4731.3320 [Repealed, 33 SR 1440]
Published Electronically: *March 12, 2009*

4731.3325 ORGAN DOSES.

This part specifies dose limits for exposure to radioactive materials in self-luminous products containing tritium or promethium-147 and certain other devices containing radioactive material according to part 4731.3225.

Part of Body	Column I (rem)	Column II (rem)	Column III (rem)	Column IV (rem)
Whole body; head and trunk; active blood-forming organs; gonads; or lens of eyes	0.001	0.01	0.5	15
Hands and forearms; feet and ankles; localized areas of skin averaged over areas no larger than one square centimeter	0.015	0.15	7.5	200
Other organs	0.003	0.03	1.5	50

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3330 SPECIFIC LICENSE; CERTAIN DEVICES CONTAINING RADIOACTIVE MATERIALS; MANUFACTURE OR INITIAL TRANSFER.

Subpart 1. **Approval criteria.** An application for a specific license to manufacture or initially transfer devices containing radioactive material to a person generally licensed under part 4731.3215 or equivalent regulations of the NRC or an agreement state shall be approved if:

A. the applicant satisfies the general requirements of part 4731.3070;

B. the applicant submits sufficient information relating to the design, manufacture, prototype testing, quality control, labels, proposed uses, installation, servicing, leak testing, operating and safety instructions, and potential hazards of the device to provide reasonable assurance that:

(1) the device can be safely operated by persons not having training in radiological protection;

(2) under ordinary conditions of handling, storage, and use of the device, the radioactive material contained in the device will not be released or inadvertently removed from the device and it is unlikely that any person will receive in one year a dose in excess of ten percent of the annual limits under part 4731.2020, subpart 1; and

(3) under accident conditions, such as fire and explosion, associated with handling, storage, and use of the device, it is unlikely that any person would receive an external radiation dose or dose commitment in excess of the dose to the appropriate organ as specified in part 4731.3325, Column IV;

C. each device bears a durable, legible, clearly visible label or labels approved by the commissioner, which contain in a clearly identified and separate statement:

(1) instructions and precautions necessary to ensure safe installation, operation, and servicing of the device. Documents such as operating and service manuals may be identified in the label and used to provide this information;

(2) the requirement, or lack of requirement, for leak testing or for testing any on-off mechanism and indicator, including the maximum time interval for the testing, and the identification of radioactive material by isotope, quantity of radioactivity, and date of determination of the quantity; and

(3) the information called for in the following statement, in the same or substantially similar form:

"The receipt, possession, use, and transfer of this device, Model ....., Serial No. ....., are subject to a general license or the equivalent and the regulations of the Minnesota commissioner of health, the Nuclear Regulatory Commission, or a state that has entered into an agreement with the Nuclear Regulatory Commission for the exercise of regulatory authority. This label must be maintained on the device in a legible condition. Removal of this label is prohibited.

CAUTION - RADIOACTIVE MATERIAL

(Name of manufacturer or initial transferor)"

The model, serial number, and name of the manufacturer or initial transferor may be omitted from the label if the information is elsewhere specified in labeling affixed to the device;

D. each device having a separable source housing that provides the primary shielding for the source also bears, on the source housing, a durable label containing the device model number and serial number, the isotope and quantity, the words "Caution-Radioactive Material," the radiation symbol described in part 4731.2300, and the name of the manufacturer or initial distributor;

E. each device meeting the criteria of part 4731.3215, subpart 3a, bears a permanent embossed, etched, stamped, or engraved label affixed to the source housing if separable, or the device if the source housing is not separable, that includes the words "Caution-Radioactive Material" and, if practicable, the radiation symbol described in part 4731.2300; and

F. the device has been registered in the Sealed Source and Device Registry.

Subp. 2. **Additional requirements; alternate testing intervals.** In the event the applicant desires that the device be required to be tested at intervals longer than six months, for proper operation of the on-off mechanism and indicator, if any, or for leakage of radioactive material, or for both:

A. the applicant must include in the application sufficient information to demonstrate that the longer interval is justified:

(1) by performance characteristics of the device or similar devices; and

(2) by design features that have a significant bearing on the probability or consequences of leakage of radioactive material from the device or failure of the on-off mechanism and indicator; and

B. the commissioner, in determining the acceptable interval for the test for leakage of radioactive material, shall consider information that includes, but is not limited to:

(1) primary containment (source capsule);

(2) protection of primary containment;

(3) method of sealing containment;

(4) containment construction materials;

(5) form of contained radioactive material;

(6) maximum temperature withstood during prototype tests;

(7) maximum pressure withstood during prototype tests;

(8) maximum quantity of contained radioactive material;

(9) radiotoxicity of contained radioactive material; and

(10) operating experience with identical devices or similarly designed and constructed devices.

Subp. 3. **Additional requirements; general licensee authority.** If the applicant desires that a general licensee under part 4731.3215 or under equivalent regulations of the NRC or an agreement state be authorized to install the device, collect the sample to be analyzed by a specific licensee for leakage of radioactive material, service the device, test the on-off mechanism and indicator, or remove the device from installation, the applicant must:

A. include in the application written instructions to be followed by the general licensee, the estimated calendar quarter doses associated with such activity, and the bases for these estimates; and

B. submit information to demonstrate that performance of the activity by an individual untrained in radiological protection, in addition to other handling, storage, and use of devices under the general license, is unlikely to cause the individual to receive a dose in excess of ten percent of the annual limits under part 4731.2020, subpart 1.

Subp. 4. **Transfer for use under general license; requirements.** If a device containing radioactive material is to be transferred for use under a general license issued under part 4731.3215, a person that is licensed under this part must provide the information specified in this subpart to each person to whom a device is to be transferred. The information must be provided before the device may be transferred. In case of a transfer through an intermediate person, the information must also be provided to the intended user before the initial transfer to the intermediate person. The required information includes:

A. a copy of the general license issued under part 4731.3215. If part 4731.3215, subpart 3, items B to D, or 3a, do not apply to the particular device, those items may be omitted;

B. a copy of parts 4731.2600, 4731.2610, 4731.3115, and 4731.3200, item B;

C. a list of the services that can only be performed by a specific licensee;

D. information on acceptable disposal options, including estimated costs of disposal; and

E. an indication that the commissioner's policy is to issue high civil penalties for improper disposal.

Subp. 5. **Transfer for use under equivalent regulations; requirements.** If radioactive material is to be transferred in a device for use under an equivalent general license of the NRC or an agreement state, a person that is licensed under this part must provide the information specified in this subpart to each person to whom a device is to be transferred. The information must be provided before the device may be transferred. In the case of a transfer through an intermediate person, the information must also be provided to the intended user before initial transfer to the intermediate person. The required information includes:

A. a copy of the NRC or agreement state regulations equivalent to parts 4731.2600; 4731.2610; 4731.3115; 4731.3205; and 4731.3215, or a copy of parts 4731.2600; 4731.2610; 4731.3115; 4731.3205; and 4731.3215. If a copy of the commissioner's rules is provided to a prospective general licensee in lieu of the NRC or agreement state regulations, the copy must be accompanied by a note explaining that use of the device is regulated by the NRC or agreement state. If certain subparts, items, or subitems do not apply to the particular device, those subparts, items, and subitems may be omitted;

B. a list of the services that can only be performed by a specific licensee;

C. information on acceptable disposal options, including estimated costs of disposal; and

D. the name or title, address, and telephone number of the contact at the NRC or agreement state regulatory agency from which additional information may be obtained.

Subp. 6. **Alternative methods.** A licensee may propose an alternative method of informing customers, other than that specified under subparts 4 and 5, for approval by the commissioner.

Subp. 7. **Labeling requirements.** A device that is transferred after February 19, 2002, must meet the labeling requirements in subpart 1, items D and E.

Subp. 8. **Records upon bankruptcy.** If a notification of bankruptcy is made under part 4731.3075, subpart 4, or the license is to be terminated, a person licensed under this part must provide, upon request, to the commissioner, the NRC, and any appropriate agreement state, records of final disposition required under subpart 11.

Subp. 9. **Report; transfer for use under general license.** A person licensed under this part to initially transfer devices to generally licensed persons must report all transfers of devices to persons for use under the general license in part 4731.3215 and all receipts of devices from persons licensed under part 4731.3215 to the commissioner. The report must be submitted on a quarterly basis on a transfers of industrial devices report form prescribed by the commissioner or in a clear and legible report containing all the data required by the form. The report must:

A. include:

(1) the identity of each general licensee by name and mailing address for the location of use. If there is no mailing address for the location of use, an alternate address for the general licensee must be submitted along with information on the actual location of use;

(2) the name, title, and telephone number of the person identified by the general licensee as having knowledge of and authority to take required actions to ensure compliance with the appropriate rules and requirements;

(3) the date of transfer;

(4) the type, model number, and serial number of the device transferred; and

(5) the quantity and type of radioactive material in the device;

B. if one or more intermediate persons will temporarily possess the device at the intended place of use before its possession by the user, include the same information for both the intended user and the intermediate person and clearly designate the intermediate person;

C. for devices received from a person generally licensed under part 4731.3215, include the identity of the general licensee by name and address, the type, model number, and serial number of the device received, the date of receipt, and, in the case of devices not initially transferred by the reporting licensee, the name of the manufacturer or initial transferor;

D. if the licensee makes changes to a device possessed by a person generally licensed under part 4731.3215, such that the label must be changed to update the required information, identify the general licensee, the device, and the changes to information on the device label;

E. cover each calendar quarter, be filed within 30 days of the end of the calendar quarter, and clearly indicate the period covered by the report;

F. clearly identify the specific licensee submitting the report and include the license number of the specific licensee; and

G. if no transfers have been made to or from persons generally licensed under part 4731.3215 during the reporting period, so indicate.

Subp. 10. **Report; transfer for use under equivalent regulations.** A person licensed under this part to initially transfer devices to generally licensed persons must report all transfers of devices to persons for use under a general license issued by the NRC or an agreement state under regulations that are equivalent to part 4731.3215, and all receipts of devices from general licensees in the NRC's or agreement state's jurisdiction to the NRC or the responsible agreement state agency. The report must be submitted on a transfers of industrial devices report form prescribed by the NRC or in a clear and legible report containing all of the data required by the form. The report must:

A. include:

(1) the identity of each general licensee by name and mailing address for the location of use. If there is no mailing address for the location of use, an alternate address for the general licensee must be submitted along with information on the actual location of use;

(2) the name, title, and telephone number of the person identified by the general licensee as having knowledge of and authority to take required actions to ensure compliance with the appropriate rules and requirements;

(3) the date of transfer;

(4) the type, model number, and serial number of the device transferred; and

(5) the quantity and type of radioactive material contained in the device;

B. if one or more intermediate persons will temporarily possess the device at the intended place of use before its possession by the user, include the same information for both the intended user and each intermediate person and clearly designate the intermediate person;

C. for devices received from a general licensee, include the identity of the general licensee by name and address; the type, model number, and serial number of the device received; the date of receipt; and in the case of devices not initially transferred by the reporting licensee, the name of the manufacturer or initial transferor;

D. if the licensee makes changes to a device possessed by a general licensee, such that the label must be changed to update required information, identify the general licensee, the device, and the changes to information on the device label;

E. cover each calendar quarter, be filed within 30 days of the end of the calendar quarter, and clearly indicate the period covered by the report;

F. clearly identify the specific licensee submitting the report and include the license number of the specific licensee; and

G. upon request of the NRC or responsible agreement state agency, include a statement that no transfers have been made to or from a general licensee during the reporting period, if applicable.

Subp. 11. **Record retention.** A person licensed under this part to initially transfer devices to generally licensed persons must maintain all information concerning transfers and receipts of devices that supports the reports required under subparts 9 and 10. The records must be maintained for three years following the date of the recorded event.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 40 SR 145; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.3345 SPECIFIC LICENSE; LUMINOUS SAFETY DEVICES; MANUFACTURE, ASSEMBLE, REPAIR, OR INITIALLY TRANSFER.

Subpart 1. **Approval criteria.** An application for a specific license to manufacture, assemble, repair, or initially transfer luminous safety devices containing tritium or promethium-147 for use in aircraft, for distribution to persons generally licensed under part 4731.3225, shall be approved if:

A. the applicant satisfies the general requirements of part 4731.3070;

B. the applicant submits sufficient information regarding each device pertinent to evaluation of the potential radiation exposure, including:

(1) chemical and physical form and maximum quantity of tritium or promethium-147 in each device;

(2) details of construction and design;

(3) details of the method of binding or containing the tritium or promethium-147;

(4) procedures for and results of prototype testing to demonstrate that the tritium or promethium-147 will not be released to the environment under the most severe conditions likely to be encountered in normal use;

(5) quality assurance procedures to be followed that are sufficient to ensure compliance with subpart 4; and

(6) any additional information, including experimental studies and tests, required by the commissioner to facilitate a determination of the safety of the device;

C. each device will contain no more than ten curies of tritium or 300 millicuries of promethium-147. The levels of radiation from each device containing promethium-147 will not

exceed 0.5 millirad per hour at ten centimeters from any surface when measured through 50 milligrams per square centimeter of absorber;

D. the commissioner determines that:

(1) the method of incorporation and binding of the tritium or promethium-147 in the device is such that the tritium or promethium-147 will not be released under the most severe conditions that are likely to be encountered in normal use and handling of the device;

(2) the tritium or promethium-147 is incorporated or enclosed so as to preclude direct physical contact by any person with it;

(3) the device is so designed that it cannot easily be disassembled; and

(4) prototypes of the device have been subjected to and have satisfactorily passed the tests under item E;

E. the applicant must subject at least five prototypes of the device to tests as follows:

(1) the devices are subjected to tests that adequately take into account the individual, aggregate, and cumulative effects of environmental conditions expected in service that could adversely affect the effective containment of tritium or promethium-147, such as temperature, moisture, absolute pressure, water immersion, vibration, shock, and weathering;

(2) the devices are inspected for evidence of physical damage and for loss of tritium or promethium-147, after each stage of testing, using methods of inspection adequate for determining compliance with the criteria in subitem (3); and

(3) device designs are rejected for which the following has been detected for any unit:

(a) a leak resulting in a loss of 0.1 percent or more of the original amount of tritium or promethium-147 from the device;

(b) surface contamination of tritium or promethium-147 on the device of more than 2,200 disintegrations per minute per 100 square centimeters of surface area; or

(c) any other evidence of physical damage; and

F. the device has been registered in the Sealed Source and Device Registry.

Subp. 2. **Labeling requirements.** A person licensed under this part to manufacture, assemble, or initially transfer devices containing tritium or promethium-147 for distribution to persons generally licensed under part 4731.3225 must, except as provided in subpart 3, affix to each device a label containing:

A. the radiation symbol prescribed by part 4731.2300;

B. such other information as may be required by the commissioner, including disposal instructions when appropriate; and

C. the following or a substantially similar statement that contains all of the information called for:

"The receipt, possession, use, and transfer of this device, Model ..., Serial No. ..., containing ... (identity and quantity of radioactive material) are subject to a general license or the equivalent and the regulations of the Minnesota commissioner of health, the Nuclear Regulatory Commission, or a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority. Do not remove this label.

CAUTION -- RADIOACTIVE MATERIAL

(Name of manufacturer, assembler, or initial transferor)"

The model, serial number, and name of manufacturer, assembler, or initial transferor may be omitted from the label if they are elsewhere specified in the labeling affixed to the device.

Subp. 3. **Alternative labeling.** If the commissioner determines that it is not feasible to affix a label to the device containing all the information required under subpart 2, the commissioner may waive those requirements and require in lieu thereof that:

A. a label be affixed to the device identifying:

(1) the manufacturer, assembler, or initial transferor; and

(2) the type of radioactive material; and

B. a leaflet bearing the following information be enclosed in or accompany the container in which the device is shipped:

(1) the name of the manufacturer, assembler, or initial transferor;

(2) the type and quantity of radioactive material;

(3) the model number;

(4) a statement that the receipt, possession, use, and transfer of the device are subject to a general license or the equivalent and the rules of the commissioner, the NRC, or an agreement state; and

(5) such other information as may be required by the commissioner, including disposal instructions when appropriate.

Subp. 4. **Quality assurance; transfer prohibition.**

A. A person licensed under this part must visually inspect each device and must reject any that has an observable physical defect that could adversely affect containment of the tritium or promethium-147.

B. A person licensed under this part must:

(1) maintain quality assurance systems in the manufacture of the luminous safety device in a manner sufficient to provide reasonable assurance that the safety-related components of the distributed devices are capable of performing their intended functions; and

(2) subject inspection lots to acceptance sampling procedures, by procedures specified in item C and in the license issued under this part, to provide at least 95 percent confidence that the Lot Tolerance Percent Defective of 5.0 percent will not be exceeded.

C. The licensee must subject each inspection lot to:

(1) tests that adequately take into account the individual, aggregate, and cumulative effects of environmental conditions expected in service that could adversely affect the effective containment of tritium or promethium-147, such as absolute pressure and water immersion; and

(2) inspection for evidence of physical damage, containment failure, or for loss of tritium or promethium-147 after each stage of testing, using methods of inspection adequate for applying the following criteria for defective:

(a) a leak resulting in a loss of 0.1 percent or more of the original amount of tritium or promethium-147 from the device;

(b) levels of radiation in excess of 0.5 millirad (5 microgray) per hour at ten centimeters from any surface when measured through 50 milligrams per square centimeter of absorber, if the device contains promethium-147; and

(c) any other criteria specified in the license issued under this part.

D. No person licensed under this part shall transfer to persons generally licensed under part 4731.3225 or under an equivalent general license of the NRC or an agreement state:

(1) any luminous safety device that has been tested and found defective under a condition of a license issued under this part, unless the defective luminous safety device has been repaired or reworked, retested, and determined by an independent inspector to meet the applicable acceptance criteria; or

(2) any luminous safety device contained within any lot that has been sampled and rejected as a result of the procedures in item B, subitem (2), unless:

(a) a procedure for defining sub-lot size, independence, and additional testing procedures is contained in the license issued under this part; and

(b) each individual sub-lot is sampled, tested, and accepted in accordance with items B, subitem (2), and D, subitem (2), unit (a), and any other criteria that may be required as a condition of the license issued under this part.

Subp. 5. **Transfer reports.**

A. A person licensed under this part must file an annual report with the commissioner that covers the year ending June 30 and is filed within 30 days thereafter. If no transfers have been made

to persons generally licensed under part 4731.3225 during the reporting period, the report must so indicate. The report must:

(1) state the total quantity of tritium or promethium-147 transferred to persons generally licensed under part 4731.3225;

(2) identify each general licensee by name;

(3) state the kinds and numbers of luminous devices transferred; and

(4) specify the quantity of tritium or promethium-147 in each kind of device.

B. A person licensed under this part must report annually all transfers of devices to persons for use under a general license in the NRC's or an agreement state's regulations that are equivalent to part 4731.3225 to the NRC or responsible agreement state agency. If no transfers have been made to the NRC or a particular agreement state during the reporting period, this information must be reported to the NRC or responsible agreement state agency upon request of the agency. The report must:

(1) state the total quantity of tritium of promethium-147 transferred;

(2) identify each general licensee by name;

(3) state the kinds and numbers of luminous devices transferred; and

(4) specify the quantity of tritium or promethium-147 in each kind of device.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3365 SPECIFIC LICENSE; CALIBRATION OR REFERENCE SOURCES; MANUFACTURE OR INITIAL TRANSFER.

Subpart 1. **Approval criteria.** An application for a specific license to manufacture or initially transfer calibration and reference sources containing americium-241 or radium-226 for distribution to persons generally licensed under part 4731.3230 shall be approved if:

A. the applicant satisfies the general requirements of part 4731.3070;

B. the applicant submits sufficient information regarding each type of calibration or reference source pertinent to evaluation of the potential radiation exposure, including:

(1) chemical and physical form and maximum quantity of americium-241 or radium-226 in the source;

(2) details of construction and design;

(3) details of the method of incorporation and binding of the americium-241 or radium-226 in the source;

(4) procedures for and results of prototype testing of sources that are designed to contain more than 0.005 microcurie (185 Bq) of americium-241 or radium-226, to demonstrate that the americium-241 or radium-226, respectively, contained in each source will not be released or be removed from the source under normal conditions of use;

(5) details of quality control procedures to be followed in manufacture of the source;

(6) a description of labeling to be affixed to the source or the storage container for the source; and

(7) any additional information, including experimental studies and tests, required by the commissioner to facilitate a determination of the safety of the source;

C. each source will contain no more than five microcuries (185 kBq) of americium-241 or radium-226;

D. the commissioner determines, with respect to any type of source containing more than 0.005 microcurie (185 Bq) of americium-241 or radium-226, that:

(1) the method of incorporation and binding of the americium-241 or radium-226 in the source is such that the americium-241 or radium-226 will not be released or be removed from the source under normal conditions of use and handling of the source; and

(2) the source has been subjected to and has satisfactorily passed appropriate tests required by item E; and

E. the applicant subjects at least five prototypes of each source that is designed to contain more than 0.005 microcurie (0.185 kilobecquerel) of americium-241 or radium-226 to tests as follows:

(1) the initial quantity of radioactive material deposited on each source is measured by direct counting of the source;

(2) the sources are subjected to tests that adequately take into account the individual, aggregate, and cumulative effects of environmental conditions expected in service that could adversely affect the effective containment or binding of americium-241 or radium-226, such as physical handling, moisture, and water immersion;

(3) the sources are inspected for evidence of physical damage and for loss of americium-241 or radium-226, after each stage of testing, using methods of inspection adequate for determining compliance with the criteria in subitem (4); and

(4) source designs are rejected for which the following has been detected for any unit: removal of more than 0.005 microcurie (0.185 kilobecquerel) of americium-241 or radium-226 from the source or any other evidence of physical damage.

Subp. 2. **Labeling requirements.** A person licensed under this part must affix to each source or storage container for the source a label that:

A. contains sufficient information relative to safe use and storage of the source; and

B. includes the following statement or a substantially similar statement that contains the information called for:

"The receipt, possession, use, and transfer of this source, Model ..., Serial No. ..., are subject to a general license and the regulations of the Minnesota commissioner of health, the Nuclear Regulatory Commission, or a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority. Do not remove this label.

CAUTION -- RADIOACTIVE MATERIAL -- THIS SOURCE CONTAINS

AMERICIUM-241 [or RADIUM-226, as appropriate]. DO NOT TOUCH

RADIOACTIVE PORTION OF THIS SOURCE.

(Name of manufacturer or initial transferor)"

Sources licensed under Code of Federal Regulations, title 10, before January 19, 1975, may bear labels authorized by the regulations in effect on January 1, 1975.

Subp. 3. **Leak testing.**

A. A person licensed under this part must perform a dry wipe test upon each source containing more than 0.1 microcurie (3.7 kBq) of americium-241 or radium-226 before transferring the source to a general licensee under part 4731.3230 or equivalent regulations of the NRC or an agreement state.

B. The test must be performed by wiping the entire radioactive surface of the source with a filter paper with the application of moderate finger pressure.

C. The radioactivity on the paper must be measured by using methods capable of detecting 0.005 microcurie (0.185 kBq) of americium-241 or radium-226.

D. If a source has been shown to be leaking or losing more than 0.005 microcurie (0.185kBq) of americium-241 or radium-226 by the methods described in this subpart, the source must be rejected and must not be transferred to a general licensee under part 4731.3230, or equivalent regulations of the NRC or an agreement state.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 33 SR 1440; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3380 SPECIFIC LICENSE; ICE DETECTION DEVICES; MANUFACTURE OR INITIAL TRANSFER.

Subpart 1. **Approval criteria.** An application for a specific license to manufacture or initially transfer ice detection devices containing strontium-90 for distribution to persons generally licensed under part 4731.3240 shall be approved if:

A. the applicant satisfies the general requirements of part 4731.3070;

B. the applicant submits sufficient information regarding each type of device pertinent to evaluation of the potential radiation exposure, including:

(1) chemical and physical form and maximum quantity of strontium-90 in the device;

(2) details of construction and design of the source of radiation and its shielding;

(3) radiation profile of a prototype device;

(4) procedures for and results of prototype testing of devices to demonstrate that the strontium-90 contained in each device will not be released or be removed from the device under the most severe conditions likely to be encountered in normal handling and use;

(5) details of quality control procedures to be followed in manufacture of the device;

(6) description of labeling to be affixed to the device;

(7) instructions for handling and installation of the device; and

(8) any additional information, including experimental studies and tests, required by the commissioner to facilitate a determination of the safety of the device;

C. each device will contain no more than 50 microcuries of strontium-90 in an insoluble form;

D. each device will bear durable, legible labeling that includes:

(1) the radiation caution symbol prescribed by part 4731.2300;

(2) a statement that the device contains strontium-90 and the quantity thereof;

(3) instructions for disposal;

(4) a statement that the device may be possessed pursuant to a general license;

(5) a statement that the manufacturer or civil authorities should be notified if the device is found;

(6) a statement that removal of the labeling is prohibited; and

(7) a statement that disassembly and repair of the device may be performed only by a person holding a specific license to manufacture or service such devices; and

E. the commissioner determines that:

(1) the method of incorporation and binding of the strontium-90 in the device is such that the strontium-90 will not be released from the device under the most severe conditions that are likely to be encountered in normal use and handling of the device;

(2) the strontium-90 is incorporated or enclosed so as to preclude direct physical contact by any individual with it and is shielded so that no individual will receive a radiation exposure to

a major portion of the individual's body in excess of 0.5 rem in a year under ordinary circumstances of use;

(3) the device is so designed that it cannot be easily disassembled;

(4) prototypes of the device have been subjected to and have satisfactorily passed the tests under item F; and

(5) quality control procedures have been established to satisfy the requirements of subpart 2;

F. the applicant subjects at least five prototypes of the device to tests as follows:

(1) the devices are subjected to tests that adequately take into account the individual, aggregate, and cumulative effects of environmental conditions expected in service that could adversely affect the effective containment of strontium-90, such as temperature, moisture, absolute pressure, water immersion, vibration, shock, and weathering;

(2) the devices are inspected for evidence of physical damage and for loss of strontium-90 after each stage of testing, using methods of inspection adequate for determining compliance with the criteria in subitem (3); and

(3) device designs are rejected for which the following has been detected for any unit:

(a) a leak resulting in a loss of 0.1 percent or more of the original amount of strontium-90 from the device;

(b) surface contamination of strontium-90 on the device of more than 2,200 disintegrations per minute per 100 square centimeters of surface area; or

(c) any other evidence of physical damage; and

G. the device has been registered in the Sealed Source and Device Registry.

Subp. 2. **Quality assurance; transfer prohibition.**

A. A person licensed under this part must visually inspect each device and must reject any that has an observable physical defect that could affect containment of the strontium-90.

B. A person licensed under this part must test each device for possible loss of strontium-90 or for contamination by wiping with filter paper an area of at least 100 square centimeters on the outside surface of the device or wiping the entire surface area if it is less than 100 square centimeters. Detection on the filter paper of more than 2,200 disintegrations per minute of radioactive material per 100 square centimeters of surface wiped must be cause for rejection of the tested device.

C. A person licensed under this part must:

(1) maintain quality assurance systems in the manufacture of the ice detection device containing strontium-90 in a manner sufficient to provide reasonable assurance that the safety-related components of the distributed devices are capable of performing their intended functions; and

(2) subject inspection lots to acceptance sampling procedures, by procedures specified in item D and in the license issued under this part, to provide at least 95 percent confidence that the Lot Tolerance Percent Defective of 5.0 percent will not be exceeded.

D. Each person licensed under this part must subject each inspection lot to:

(1) tests that adequately take into account the individual, aggregate, and cumulative effects of environmental conditions expected in service that could possibly affect the effective containment of strontium-90, such as absolute pressure and water immersion; and

(2) inspection for evidence of physical damage, containment failure, or for loss of strontium-90 after each stage of testing, using methods of inspection adequate to determine compliance with the following criteria for defective: a leak resulting in a loss of 0.1 percent or more of the original amount of strontium-90 from the device and any other criteria specified in the license issued under this part.

E. No person licensed under this part shall transfer to persons generally licensed under part 4731.3240, or under an equivalent general license of the NRC or an agreement state:

(1) any ice detection device containing strontium-90 tested and found defective under the criteria specified in a license issued under this part, unless the defective ice detection device has been repaired or reworked, retested, and determined by an independent inspector to meet the applicable acceptance criteria; or

(2) any ice detection device containing strontium-90 contained within any lot that has been sampled and rejected as a result of the procedures in item C, subitem (2), unless:

(a) a procedure for defining sub-lot size, independence, and additional testing procedures is contained in the license issued under this part; and

(b) each individual sub-lot is sampled, tested, and accepted in accordance with unit (a) and item C, subitem (2), and any other criteria as may be required as a condition of the license issued under this part.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.3390 SPECIFIC LICENSE; MATERIAL FOR IN VITRO CLINICAL OR LABORATORY TESTING; MANUFACTURE AND DISTRIBUTION.

An application for a specific license to manufacture or distribute radioactive material for use under the general license under part 4731.3245 shall be approved if:

A. the applicant satisfies the general requirements of part 4731.3070;

B. the radioactive material is prepared for distribution in prepackaged units of:

(1) iodine-125 in units not exceeding ten microcuries (370 kBq) each;

(2) iodine-131 in units not exceeding ten microcuries (370 kBq) each;

(3) carbon-14 in units not exceeding ten microcuries (370 kBq) each;

(4) hydrogen-3 (tritium) in units not exceeding 50 microcuries (1.85 MBq) each;

(5) iron-59 in units not exceeding 20 microcuries (740 kBq) each;

(6) selenium-75 in units not exceeding ten microcuries (370 kBq) each;

(7) mock iodine-125 in units not exceeding 0.05 microcurie (1.85 kBq) of iodine-129 and 0.005 microcurie (185 Bq) of americium-241 each; and

(8) cobalt-57 in units not exceeding ten microcuries (370 kBq) each;

C. each prepackaged unit bears a durable, clearly visible label that:

(1) identifies the radioactive contents as to chemical form and radionuclide; and

(2) indicates that the amount of radioactivity does not exceed:

(a) ten microcuries (370 kBq) of iodine-125, iodine-131, carbon-14, or selenium-75;

(b) 50 microcuries (1.85 MBq) of hydrogen-3 (tritium);

(c) 20 microcuries (740 kBq) of iron-59;

(d) mock iodine-125 in units not exceeding 0.05 microcuries (1.85 kBq) of iodine-129 and 0.005 microcurie (185 Bq) of americium-241 each; or

(e) cobalt-57 in units not exceeding ten microcuries (370 kBq); and

(3) displays the radiation caution symbol described in part 4731.2300, and the words "Caution, Radioactive Material" and "Not for Internal or External Use in Humans or Animals";

D. the following statement, or a substantially similar statement that contains all the information called for, appears on a label affixed to each prepackaged unit or appears in a leaflet or brochure that accompanies the package:

"The radioactive material may be received, acquired, possessed, and used only by physicians, veterinarians in the practice of veterinary medicine, clinical laboratories, or hospitals and only for in vitro clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to the regulations and a general license of the Minnesota commissioner of health, the Nuclear Regulatory Commission, or a state with which the Nuclear Regulatory Commission has entered into an agreement for the exercise of regulatory authority.

(Name of manufacturer)"; and

E. the label affixed to the unit, or the leaflet or brochure that accompanies the package, contains adequate information as to the precautions to be observed in handling and storing the radioactive material. In the case of a mock iodine-125 reference or calibration source, the information

accompanying the source must also contain directions to the licensee regarding the waste disposal requirements under part 4731.2400.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.3395 SPECIFIC LICENSE; RADIOACTIVE DRUGS FOR MEDICAL USE; MANUFACTURE, PREPARATION, OR TRANSFER.

Subpart 1. **Approval criteria.** An application for a specific license to manufacture, prepare, or transfer for commercial distribution radioactive drugs containing radioactive material for use by persons authorized according to parts 4731.4400 to 4731.4527 shall be approved if the applicant:

A. satisfies the general requirements specified in part 4731.3070;

B. submits evidence that the applicant is at least one of the following:

(1) registered or licensed with the United States Food and Drug Administration as the owner or operator of a drug establishment that engages in the manufacture, preparation, propagation, compounding, or processing of a drug under Code of Federal Regulations, title 21, section 207.17(a);

(2) registered or licensed with a state agency as a drug manufacturer;

(3) licensed as a pharmacy by a state board of pharmacy;

(4) operating as a nuclear pharmacy within a federal medical institution; or

(5) a positron emission tomography (PET) drug production facility registered with a state agency;

C. submits the following information regarding the radionuclide:

(1) the chemical and physical form;

(2) the maximum activity per vial, syringe, generator, or other container of the radioactive drug; and

(3) the shielding provided by the packaging to show it is appropriate for safe handling and storage of the radioactive drugs by medical use licensees; and

D. commits to the following labeling requirements:

(1) a label must be affixed to each transport radiation shield, whether it is constructed of lead, glass, plastic, or other material, of a radioactive drug to be transferred for commercial distribution and include the radiation symbol, the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL," the name of the radioactive drug or its abbreviation, and the quantity of radioactivity at a specific date and time. For a radioactive drug with a half-life greater than 100 days, the time may be omitted; and

(2) a label must be affixed to each syringe, vial, or other container used to hold a radioactive drug to be transferred for commercial distribution. The label must include the radiation symbol, the words "CAUTION, RADIOACTIVE MATERIAL" or "DANGER, RADIOACTIVE MATERIAL," and an identifier that ensures that the syringe, vial, or other container can be correlated with the information on the transport radiation shield label.

Subp. 2. **Pharmacy licensees.**

A. A licensee described in subpart 1, item B, subitem (3) or (4) may:

(1) prepare radioactive drugs for medical use, provided that the radioactive drug is prepared by either an authorized nuclear pharmacist, as specified in subitem (2) or item C, or an individual under the supervision of an authorized nuclear pharmacist, as specified in part 4731.4407; and

(2) allow a pharmacist to work as an authorized nuclear pharmacist if:

(a) the individual qualifies as an authorized nuclear pharmacist;

(b) the individual meets the requirements under parts 4731.4413 and 4731.4415 and the licensee has received an approved license amendment identifying the individual as an authorized nuclear pharmacist; or

(c) the individual is designated as an authorized nuclear pharmacist according to item C.

B. The actions authorized in item A are permitted notwithstanding more restrictive language in license conditions.

C. A licensee described in subpart 1, item B, subitem (3) or (4), may designate a pharmacist as an authorized nuclear pharmacist if the individual was a nuclear pharmacist preparing only radioactive drugs containing accelerator-produced radioactive material, and the individual practiced at a pharmacy at a government agency or federally recognized Indian Tribe before November 30, 2007, or at all other pharmacies before August 8, 2009, or an earlier date as noticed by the NRC.

D. No later than 30 days after the date that a licensee described in subpart 1, item B, subitem (3) or (4), allows an individual to work as an authorized nuclear pharmacist under item A, subitem (2), unit (a) or (c), the licensee must provide to the commissioner a copy of:

(1) the individual's certification by a specialty board whose certification process has been recognized as specified in part 4731.4413, subpart 1; or

(2) the NRC or agreement state license, or the permit issued by an NRC master materials licensee, or the permit issued by a licensee of broad scope, or the authorization from a commercial nuclear pharmacy authorized to issue its own authorized nuclear pharmacist; or

(3) documentation that only accelerator-produced radioactive materials were used in the practice of nuclear pharmacy at a government agency or federally recognized Indian Tribe

before November 30, 2007, or at all other pharmacies before August 8, 2009, or an earlier date as noticed by the NRC; and

(4) a copy of the individual's state pharmacy licensure or registration.

Subp. 3. **Measuring radioactivity.** A licensee under this part must:

A. possess and use instrumentation to measure the radioactivity of radioactive drugs;

B. have procedures for use of the instrumentation;

C. measure, by direct measurement or a combination of measurements and calculations, the amount of radioactivity in dosages of alpha-, beta-, or photon-emitting radioactive drugs prior to transfer for commercial distribution;

D. perform tests before initial use, periodically, and following repair on each instrument for accuracy, linearity, and geometry dependence, as appropriate for the use of the instrument, and make adjustments when necessary; and

E. check each instrument for constancy and proper operation at the beginning of each day of use.

Subp. 3a. **Labeling requirements.** A licensee must satisfy the labeling requirements of subpart 1, item D.

Subp. 4. **Other law.** Nothing in this part relieves a licensee from complying with applicable United States Food and Drug Administration, other federal, or state requirements governing radioactive drugs.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 44 SR 239; 46 SR 791; 49 SR 1193*

Published Electronically: *May 28, 2025*

4731.3400 SPECIFIC LICENSE; SOURCES OR DEVICES FOR MEDICAL USE; MANUFACTURE AND DISTRIBUTION.

Subpart 1. **Approval criteria.** An application for a specific license to manufacture and distribute sources and devices containing radioactive material to persons licensed according to parts 4731.4400 to 4731.4527 for use as a calibration, transmission, or reference source or for the uses listed under parts 4731.4404, 4731.4450, 4731.4460, and 4731.4463 shall be approved if:

A. the applicant satisfies the general requirements of part 4731.3070;

B. the applicant submits sufficient information regarding each type of source or device pertinent to an evaluation of its radiation safety, including:

(1) the radioactive material contained, its chemical and physical form, and amount;

(2) details of design and construction of the source or device;

(3) procedures for, and results of, prototype tests to demonstrate that the source or device will maintain its integrity under stresses likely to be encountered in normal use and accidents;

(4) for devices containing radioactive material, the radiation profile of a prototype device;

(5) details of quality control procedures to ensure that production sources and devices meet the standards of the design and prototype tests;

(6) procedures and standards for calibrating sources and devices;

(7) legend and methods for labeling sources and devices as to their radioactive content; and

(8) instructions for handling and storing the source or device from the radiation safety standpoint. These instructions must be:

(a) included on a durable label attached to the source or device;

(b) attached to a permanent storage container for the source of device; or

(c) summarized on the label, for instructions that are too lengthy for the label, and printed in detail on a brochure that is referenced on the label;

C. the label affixed to the source or device, or to the permanent storage container for the source or device, contains:

(1) information on the radionuclide;

(2) the quantity;

(3) the date of assay; and

(4) a statement that the commissioner has approved distribution of the (name of source or device) to persons licensed to use radioactive material identified under parts 4731.4423, 4731.4450, 4731.4460, and 4731.4463, as appropriate, and to persons who hold equivalent licenses issued by the NRC or an agreement state; and

D. the source or device has been registered in the Sealed Source and Device Registry.

Subp. 2. **Alternative testing intervals.**

A. In the event the applicant desires that the source or device be required to be tested for leakage of radioactive material at intervals longer than six months, the applicant must include in the application sufficient information to demonstrate that the longer interval is justified by:

(1) performance characteristics of the source or device or similar sources or devices; and

(2) design features that have a significant bearing on the probability or consequences of leakage of radioactive material from the source.

B. In determining the acceptable interval for testing leakage of radioactive material, the commissioner shall consider information that includes, but is not limited to:

(1) primary containment (source capsule);

(2) protection of primary containment;

(3) method of sealing containment;

(4) containment construction materials;

(5) form of contained radioactive materials;

(6) maximum temperature withstood during prototype tests;

(7) maximum pressure withstood during prototype tests;

(8) maximum quantity of contained radioactive material;

(9) radiotoxicity of contained radioactive material; and

(10) operating experience with identical sources or devices or similarly designed and constructed sources or devices.

Subp. 3. **Application pending.** If an application was filed according to subpart 1 on or before October 15, 1974, for a license to manufacture and distribute a source or device that was distributed commercially on or before August 16, 1974, the applicant may continue the distribution until the commissioner issues the license or notifies the applicant otherwise.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 40 SR 145*
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4731.3405 [Repealer, 40 SR 145]
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4731.3410 [Repealed, 40 SR 145]
Published Electronically: *August 27, 2015*

4731.3415 [Repealed, 40 SR 145]
Published Electronically: *August 27, 2015*

4731.3420 [Repealed, 40 SR 145]
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4731.3450 SERIALIZATION OF NATIONALLY TRACKED SOURCES.

Each licensee who manufactures a nationally tracked source after February 6, 2007, shall assign a unique serial number to each nationally tracked source. Serial numbers must be composed only of alphanumeric characters.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *33 SR 1440*

Published Electronically: *March 12, 2009*

4731.3500 SPECIFIC DOMESTIC LICENSES OF BROAD SCOPE FOR RADIOACTIVE MATERIAL.

Subpart 1. **Applicability.** Parts 4731.3500 to 4731.3580 contain requirements for the issuance of specific licenses of broad scope for radioactive material and for holders of such licenses. Parts 4731.3500 to 4731.3580 are in addition to and not in substitution for other requirements of this chapter. In particular, parts 4731.3000 to 4731.3175 apply to applications and licenses subject to parts 4731.3500 to 4731.3580.

Subp. 2. **Types of broad scope licenses.** The different types of broad scope licenses are as follows:

A. "Type A specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use, and transfer of any chemical or physical form of the radioactive material specified in the license, but not exceeding quantities specified in the license, for purposes authorized by the commissioner. The quantities specified are usually in the multicurie range;

B. "Type B specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use, and transfer of any chemical or physical form of radioactive material specified in part 4731.3580 for purposes authorized by the commissioner. The possession limit for a Type B specific license of broad scope:

(1) if only one radionuclide is possessed thereunder, is the quantity specified for that radionuclide in part 4731.3580, Column I; and

(2) if two or more radionuclides are possessed thereunder, is determined as follows:

(a) for each radionuclide, determine the ratio of the quantity possessed to the applicable quantity specified in part 4731.3580, Column I, for that radionuclide; and

(b) the sum of the ratios for all radionuclides possessed under the license must not exceed unity; and

C. "Type C specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use, and transfer of any chemical or physical form of radioactive material specified in part 4731.3580 for purposes authorized by the commissioner. The possession limit for a Type C specific license of broad scope:

(1) if only one radionuclide is possessed thereunder, is the quantity specified for that radionuclide in part 4731.3580, Column II; and

(2) if two or more radionuclides are possessed thereunder, is determined for each as follows:

(a) for each radionuclide, determine the ratio of the quantity possessed to the applicable quantity specified in part 4731.3580, Column II, for that radionuclide; and

(b) the sum of ratios for all radionuclides possessed under the license must not exceed unity.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3520 SPECIFIC LICENSE OF BROAD SCOPE; APPLICATION.

A person must file an application for a specific license of broad scope on an application for radioactive material license form according to part 4731.3065.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.3530 TYPE A SPECIFIC LICENSE OF BROAD SCOPE.

An application for a Type A specific license of broad scope shall be approved if the applicant:

A. satisfies the general requirements under part 4731.3070;

B. has engaged in an appropriate number of activities involving the use of radioactive material; and

C. has established administrative controls and provisions relating to organization and management, procedures, record keeping, material control and accounting, and management review that are necessary to ensure safe operations, including:

(1) the establishment of a radiation safety committee composed of such persons as a radiation safety officer, a representative of management, and other persons trained and experienced in the safe use of radioactive materials;

(2) the appointment of a radiation safety officer who is qualified by training and experience in radiation protection and who is available for advice and assistance on radiological safety matters; and

(3) the establishment of appropriate administrative procedures to ensure:

(a) control of procurement and use of radioactive material;

(b) completion of safety evaluations of proposed uses of radioactive material that take into consideration such matters as the adequacy of facilities and equipment, the training and experience of the user, and the operating or handling procedures; and

(c) review, approval, and recording by the radiation safety committee of safety evaluations of proposed uses prepared according to unit (b) before use of the radioactive material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3540 TYPE B SPECIFIC LICENSE OF BROAD SCOPE.

An application for a Type B specific license of broad scope shall be approved if the applicant:

A. satisfies the general requirements under part 4731.3070; and

B. has established administrative controls and provisions relating to organization and management, procedures, record keeping, material control and accounting, and management review that are necessary to ensure safe operations, including:

(1) the appointment of a radiation safety officer who is qualified by training and experience in radiation protection and who is available for advice and assistance on radiological safety matters; and

(2) the establishment of appropriate administrative procedures to ensure:

(a) control of procurement and use of radioactive material;

(b) completion of safety evaluations of proposed uses of radioactive material that take into consideration such matters as the adequacy of facilities and equipment, the training and experience of the user, and the operating or handling procedures; and

(c) review, approval, and recording by the radiation safety officer of safety evaluations of proposed uses prepared according to unit (b) before use of the radioactive material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3550 TYPE C SPECIFIC LICENSE OF BROAD SCOPE.

An application for a Type C specific license of broad scope shall be approved if the applicant:

A. satisfies the general requirements under part 4731.3070;

B. submits a statement that radioactive material will be used only by, or under the direct supervision of, individuals who have received:

(1) a college degree at the bachelor level, or equivalent training and experience, in the physical or biological sciences or in engineering; and

(2) at least 40 hours of training and experience in the safe handling of radioactive material and in the characteristics of ionizing radiation, units of radiation dose and quantities,

radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of radioactive material to be used; and

C. has established administrative controls and provisions relating to procurement of radioactive material, procedures, record keeping, material control and accounting, and management review necessary to ensure safe operation.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3560 APPLICATION FOR OTHER SPECIFIC LICENSES.

An application filed under parts 4731.3000 to 4731.3175 for a specific license other than one of broad scope shall be considered by the commissioner as an application for a specific license of broad scope under parts 4731.3500 to 4731.3580 if the applicable requirements of parts 4731.3500 to 4731.3580 are satisfied.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.3570 SPECIFIC LICENSES OF BROAD SCOPE; CONDITIONS.

A. Unless specifically authorized in this chapter, persons licensed under parts 4731.3500 to 4731.3580 must not:

(1) conduct tracer studies in the environment involving direct release of radioactive material;

(2) receive, acquire, own, possess, use, transfer, or import devices containing 100,000 curies or more of radioactive material in sealed sources used for irradiation of materials;

(3) conduct activities for which a specific license issued by the commissioner under parts 4731.3300 to 4731.4527, is required; or

(4) add or cause the addition of radioactive material to any food, beverage, cosmetic, drug, or other product designed for ingestion or inhalation by, or application to, a human being.

B. Each Type A specific license of broad scope issued under parts 4731.3500 to 4731.3580 is subject to the condition that radioactive material possessed under the license may only be used by, or under the direct supervision of, individuals approved by the licensee's radiation safety committee.

C. Each Type B specific license of broad scope issued under parts 4731.3500 to 4731.3580 is subject to the condition that radioactive material possessed under the license may only be used by, or under the direct supervision of, individuals approved by the licensee's radiation safety officer.

D. Each Type C specific license of broad scope issued under parts 4371.3500 to 4731.3580 is subject to the condition that radioactive material possessed under the license may only be used by, or under the direct supervision of, individuals who satisfy the requirements of part 4731.3550.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.3580 LIMITS FOR BROAD SCOPE LICENSES.

The following limits apply to specific licenses of broad scope issued under parts 4731.3500 to 4731.3580:

Radioactive Material	Column I curies	Column II curies
Antimony-122	1	0.01
Antimony-124	1	0.01
Antimony-125	1	0.01
Arsenic-73	10	0.1
Arsenic-74	1	0.01
Arsenic-76	1	0.01
Arsenic-77	10	0.1
Barium-131	10	0.1
Barium-140	1	0.01
Beryllium-7	10	0.1
Bismuth-210	0.1	0.001
Bromine-82	10	0.1
Cadmium-109	1	0.01
Cadmium-115m	1	0.01
Cadmium-115	10	0.1
Calcium-45	1	0.01
Calcium-47	10	0.1

Carbon-14	100	1
Cerium-141	10	0.1
Cerium-143	10	0.1
Cerium-144	0.1	0.001
Cesium-131	100	1
Cesium-134m	100	1
Cesium-134	0.1	0.001
Cesium-135	1	0.01
Cesium-136	10	0.1
Cesium-137	0.1	0.001
Chlorine-36	1	0.01
Chlorine-38	100	1
Chromium-51	100	1
Cobalt-57	10	0.1
Cobalt-58m	100	1
Cobalt-58	1	0.01
Cobalt-60	0.1	0.001
Copper-64	10	0.1
Dysprosium-165	100	1
Dysprosium-166	10	0.1
Erbium-169	10	0.1
Erbium-171	10	0.1
Europium-152 9.2 h	10	0.1
Europium-152 13 y	0.1	0.001
Europium-154	0.1	0.001
Europium-155	1	0.01

Fluorine-18	100	1
Gadolinium-153	1	0.01
Gadolinium-159	10	0.1
Gallium-72	10	0.1
Germanium-71	100	1
Gold-198	10	0.1
Gold-199	10	0.1
Hafnium-181	1	0.01
Holmium-166	10	0.1
Hydrogen-3	100	1
Indium-113m	100	1
Indium-114m	1	0.01
Indium-115m	100	1
Indium-115	1	0.01
Iodine-125	0.1	0.001
Iodine-126	0.1	0.001
Iodine-129	0.1	0.01
Iodine-131	0.1	0.001
Iodine-132	10	0.1
Iodine-133	1	0.01
Iodine-134	10	0.1
Iodine-135	1	0.01
Iridium-192	1	0.01
Iridium-194	10	0.1
Iron-55	10	0.1
Iron-59	1	0.01

Krypton-85	100	1
Krypton-87	10	0.1
Lanthanum-140	1	0.01
Lutetium-177	10	0.1
Manganese-52	1	0.01
Manganese-54	1	0.01
Manganese-56	10	0.1
Mercury-197m	10	0.1
Mercury-197	10	0.1
Mercury-203	1	0.01
Molybdenum-99	10	0.1
Neodymium-147	10	0.1
Neodymium-149	10	0.1
Nickel-59	10	0.1
Nickel-63	1	0.01
Nickel-65	10	0.1
Niobium-93m	1	0.01
Niobium-95	1	0.01
Niobium-97	100	1
Osmium-185	1	0.01
Osmium-191m	100	1
Osmium-191	10	0.1
Osmium-193	10	0.1
Palladium-103	10	0.1
Palladium-109	10	0.1
Phosphorus-32	1	0.01

Platinum-191	10	0.1
Platinum-193m	100	1
Platinum-193	10	0.1
Platinum-197m	100	1
Platinum-197	10	0.1
Polonium-210	0.01	0.0001
Potassium-42	1	0.01
Praseodymium-142	10	0.1
Praseodymium-143	10	0.1
Promethium-147	1	0.01
Promethium-149	10	0.1
Radium-226	0.01	0.0001
Rhenium-186	10	0.1
Rhenium-188	10	0.1
Rhodium-103m	1,000	10
Rhodium-105	10	0.1
Rubidium-86	1	0.01
Rubidium-87	1	0.01
Ruthenium-97	100	1
Ruthenium-103	1	0.01
Ruthenium-105	10	0.1
Ruthenium-106	0.1	0.001
Samarium-151	1	0.01
Samarium-153	10	0.1
Scandium-46	1	0.01
Scandium-47	10	0.1
Scandium-48	1	0.01

Selenium-75	1	0.01
Silicon-31	10	0.1
Silver-105	1	0.01
Silver-110m	0.1	0.001
Silver-111	10	0.1
Sodium-22	0.1	0.001
Sodium-24	1	0.01
Strontium-85m	1,000	10
Strontium-85	1	0.01
Strontium-89	1	0.01
Strontium-90	0.01	0.0001
Strontium-91	10	0.1
Strontium-92	10	0.1
Sulfur-35	10	0.1
Tantalum-182	1	0.01
Technetium-96	10	0.1
Technetium-97m	10	0.1
Technetium-97	10	0.1
Technetium-99m	100	1
Technetium-99	1	0.01
Tellurium-125m	1	0.01
Tellurium-127m	1	0.01
Tellurium-127	10	0.1
Tellurium-129m	1	0.01
Tellurium-129	100	1
Tellurium-131m	10	0.1
Tellurium-132	1	0.01

Terbium-160	1	0.01
Thallium-200	10	0.1
Thallium-201	10	0.1
Thallium-202	10	0.1
Thallium-204	1	0.01
Thulium-170	1	0.01
Thulium-171	1	0.01
Tin-113	1	0.01
Tin-125	1	0.01
Tungsten-181	1	0.01
Tungsten-185	1	0.01
Tungsten-187	10	0.1
Vanadium-48	1	0.01
Xenon-131m	1,000	10
Xenon-133	100	1
Xenon-135	100	1
Ytterbium-175	10	0.1
Yttrium-90	1	0.01
Yttrium-91	1	0.01
Yttrium-92	10	0.1
Yttrium-93	1	0.01
Zinc-65	1	0.01
Zinc-69m	10	0.1
Zinc-69	100	1
Zirconium-93	1	0.01
Zirconium-95	1	0.01

Zirconium-97	1	0.01
Any radioactive material other than alpha-emitting byproduct material not listed above	0.1	0.001

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*
Published Electronically: *March 12, 2009*

INDUSTRIAL RADIOGRAPHY

4731.4000 LICENSES FOR INDUSTRIAL RADIOGRAPHY AND RADIATION SAFETY REQUIREMENTS FOR INDUSTRIAL RADIOGRAPHIC OPERATIONS.

Parts 4731.4000 to 4731.4360 prescribe licensing requirements for the use of sealed sources containing radioactive material and radiation safety requirements for persons using these sealed sources in industrial radiography. The requirements of parts 4731.4000 to 4731.4360 are in addition to, and not in substitution for, other requirements of this chapter. In particular, parts 4731.0300 to 4731.0424 and 4731.1000 to 4731.3175 apply to applications and licenses subject to parts 4731.4000 to 4731.4360. Parts 4731.4000 to 4731.4360 do not apply to medical uses of radioactive material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4010 SPECIFIC LICENSE; APPLICATION.

A person must file an application for a specific license for use of sealed sources in industrial radiography on the application for radioactive material license form according to part 4731.3070.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.4020 SPECIFIC LICENSE; INDUSTRIAL RADIOGRAPHY.

An application for a specific license for the use of licensed material in industrial radiography shall be approved if the applicant:

A. satisfies the general requirements under part 4731.3070, as appropriate, and any special requirements contained in parts 4731.4000 to 4731.4360;

B. submits a program for training radiographers and radiographers' assistants that meets the requirements of part 4731.4140;

C. submits procedures for verifying and documenting the certification status of radiographers and for ensuring that the certification of individuals acting as radiographers remains valid;

D. submits written operating and emergency procedures according to part 4731.4150;

E. submits a description of a program for inspections of the job performance of each radiographer and radiographer's assistant at intervals not to exceed six months according to part 4731.4140, subpart 4;

F. submits a description of the applicant's overall organizational structure as it applies to the radiation safety responsibilities in industrial radiography, including specified delegation of authority and responsibility;

G. identifies and lists the qualifications of the individual designated as the radiation safety officer under part 4731.4130 and potential designees responsible for ensuring that the licensee's radiation safety program is implemented according to approved procedures;

H. if the applicant intends to perform leak testing of sealed sources or exposure devices containing depleted uranium shielding, describes the procedures for performing leak testing and the qualifications of the person authorized to do the leak testing. If the applicant intends to analyze its own wipe samples, the application must include a description of the procedures to be followed. The description must include:

(1) the instruments to be used;

(2) the methods of performing the analysis; and

(3) the pertinent experience of the person who will analyze the wipe samples;

I. if the applicant intends to perform in-house calibrations of survey instruments, describes methods to be used and the relevant experience of the person who will perform the calibrations. All calibrations must be performed according to part 4731.4060; and

J. identifies and describes the location of all field stations and permanent radiographic installations and the locations where all records required by this chapter will be maintained.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4030 PERFORMANCE REQUIREMENTS; INDUSTRIAL RADIOGRAPHY EQUIPMENT.

Subpart 1. **ANSI standard.**

A. This subpart applies to equipment used in industrial radiographic operations.

B. A radiographic exposure device, source assembly, or sealed source and all associated equipment must meet the requirements specified in American National Standard N432, "Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography," American National Standards Institute (ANSI) (1981). The ANSI standard is incorporated by reference, is not subject to frequent change, and is available through the MnLink system. This publication may be purchased from the American National Standards Institute, Inc., 25 West 43rd Street, New York, NY 10036; telephone: (212) 642-4900.

C. Engineering analysis may be submitted by an applicant or licensee to demonstrate the applicability of previously performed testing on similar individual radiography equipment components. Upon review, the commissioner may find the engineering analysis an acceptable alternative to actual testing of the component according to the ANSI standard.

Subp. 2. **Additional requirements.**

A. In addition to the requirements under subpart 1, the requirements in this subpart apply to radiographic exposure devices, source changers, source assemblies, and sealed sources.

B. A licensee must ensure that a radiographic exposure device has attached to it a durable, legible, clearly visible label bearing:

(1) the chemical symbol and mass number of the radionuclide in the device;

(2) the activity and the date on which the activity was last measured;

(3) the model or product code and serial number of the sealed source;

(4) the manufacturer of the sealed source; and

(5) the licensee's name, address, and telephone number.

C. Radiographic exposure devices intended for use as Type B transport containers must meet the applicable requirements under parts 4731.0400 to 4731.0424.

D. Modification of radiographic exposure devices, source changers, source assemblies, and associated equipment is prohibited, unless the design of a replacement component, including source holder, source assembly, controls, or guide tubes, would not compromise the design safety features of the system.

Subp. 3. **Removable sources and source changers; requirements.**

A. In addition to the requirements in subparts 1 and 2, the requirements in this subpart apply to radiographic exposure devices, source assemblies, and associated equipment that allow the source to be moved out of the device for radiographic operations or to source changers.

B. The coupling between the source assembly and the control cable must be designed so that the source assembly will not become disconnected if cranked outside the guide tube. The coupling must be such that it cannot be unintentionally disconnected under normal and reasonably foreseeable abnormal conditions.

C. The device must automatically secure the source assembly when it is cranked back into the fully shielded position within the device. This securing system may only be released by means of a deliberate operation on the exposure device.

D. The outlet fittings, lock box, and drive cable fittings on each radiographic exposure device must be equipped with safety plugs or covers that must be installed during storage and transportation to protect the source assembly from water, mud, sand, or other foreign matter.

E. A sealed source or source assembly must have attached to it or engraved on it a durable, legible, visible label with the words: "DANGEROUS--RADIOACTIVE" and the label may not interfere with the safe operation of the exposure device or associated equipment.

F. The guide tube must be:

(1) able to withstand a crushing test that closely approximates the crushing forces that are likely to be encountered during use; and

(2) able to withstand a kinking resistance test that closely approximates the kinking forces that are likely to be encountered during use.

G. Guide tubes must be used when moving the source out of the device.

H. An exposure head or similar device that is designed to prevent the source assembly from passing out of the end of the guide tube must be attached to the outermost end of the guide tube during industrial radiography operations.

I. The guide tube exposure head connection must be able to withstand the tensile test for control units specified in ANSI N432, incorporated by reference under subpart 1, item B.

J. Source changers must provide a system that ensures the source will not be accidentally withdrawn from the changer when connecting or disconnecting the drive cable to or from a source assembly.

Subp. 4. **Exception.** Notwithstanding subpart 1, item B, equipment used in industrial radiographic operations need not comply with section 8.9.2(c) of the endurance test in ANSI N432 if the prototype equipment has been tested using a torque value representative of the torque that an individual using the radiography equipment can realistically exert on the lever or crankshaft of the drive mechanism.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.4040 LIMITS ON EXTERNAL RADIATION LEVELS.

The maximum exposure rate limits for storage containers and source changers are 200 millirems (2 mSv) per hour at any exterior surface, and ten millirems (0.1 mSv) per hour at one meter from any exterior surface with the sealed source in the shielded position.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4050 LOCKING OF RADIOGRAPHIC EXPOSURE DEVICES, STORAGE CONTAINERS, AND SOURCE CHANGERS.

Subpart 1. **Radiographic exposure devices.**

A. A radiographic exposure device must have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position.

B. The exposure device and its container must be kept locked, and if a keyed lock, with the key removed at all times, when not under the direct surveillance of a radiographer or a radiographer's assistant, except at permanent radiographic installations according to part 4731.4190.

C. During radiographic operations, the sealed source assembly must be secured in the shielded position each time the source is returned to that position.

Subp. 2. **Storage containers and source changers.** A sealed source storage container and source changer must:

A. have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position; and

B. be kept locked, and if a keyed lock, with the key removed at all times, when containing sealed sources, except when under the direct surveillance of a radiographer or a radiographer's assistant.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4060 RADIATION SURVEY INSTRUMENTS.

Subpart 1. **Required instruments.** A licensee must keep sufficient calibrated and operable radiation survey instruments at each location where radioactive material is present to make the radiation surveys required under parts 4731.2000 to 4731.2950 and 4731.4000 to 4731.4360. Instrumentation required under this part must be capable of measuring a range from two millirems (0.02 mSv) per hour through one rem (0.01 Sv) per hour.

Subp. 2. **Calibration.** A licensee must have each radiation survey instrument required under subpart 1 calibrated:

A. at intervals not to exceed six months and after instrument servicing, except for battery changes;

B. for linear scale instruments, at two points located approximately one-third and two-thirds of full-scale on each scale; for logarithmic scale instruments, at midrange of each decade and at two points of at least one decade; and for digital instruments, at three points between two and 1,000 millirems (0.02 and 10 mSv) per hour; and

C. so that an accuracy within plus or minus 20 percent of the calibration source can be demonstrated at each point checked.

Subp. 3. **Record keeping.** A licensee must maintain records of the instrument calibrations that are required under this part and must retain each record for three years after it is made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4070 LEAK TESTING, REPLACEMENT, AND OTHER MODIFICATIONS OF SEALED SOURCES.

Subpart 1. **Authorized personnel.**

A. The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing of any sealed source must be performed by persons authorized to do so by the NRC or an agreement state.

B. The opening, repair, or modification of any sealed source must be performed by persons specifically authorized to do so by the NRC or an agreement state.

Subp. 2. **Leak testing requirements.**

A. A licensee who uses a sealed source must have the source tested for leakage at intervals not to exceed six months.

B. Leak testing of a sealed source must be performed using a method approved by the NRC or an agreement state.

C. A wipe sample must be taken from the nearest accessible point to the sealed source where contamination might accumulate. The wipe sample must be analyzed for radioactive contamination. The analysis must be capable of detecting the presence of 0.005 microcurie (185 Bq) of radioactive material on the test sample. The analysis must be performed by a person specifically authorized by the NRC or an agreement state to perform the analysis.

D. A licensee must maintain records of the leak tests according to part 4731.4240.

E. Unless a sealed source is accompanied by a certificate from the transferor that shows that it has been leak tested within six months before the transfer, the sealed source may not be used by the licensee until tested for leakage. Sealed sources that are in storage and not in use do not require leak testing, but must be tested before use or transfer to another person if the interval of storage exceeds six months.

Subp. 3. **Leaking source.**

A. A test conducted under subpart 2 that reveals the presence of 0.005 microcurie (185 Bq) or more of removable radioactive material must be considered evidence that the sealed source is leaking.

B. The licensee must immediately withdraw the equipment involved from use and must have it decontaminated and repaired or disposed of according to this chapter.

C. A report must be filed with the commissioner, within five days and must include:

(1) the model number and serial number, if assigned, of the leaking source;

(2) the identity of the radionuclide and its estimated activity;

(3) the results of the test;

(4) the date of the test; and

(5) the action taken.

Subp. 4. **Depleted uranium testing.**

A. An exposure device using depleted uranium shielding and an S-tube configuration must be tested for depleted uranium contamination at intervals not to exceed 12 months. The analysis must be capable of detecting the presence of 0.005 microcuries (185 Bq) of radioactive material on the test sample and must be performed by a person specifically authorized by the NRC or an agreement state to perform the analysis.

B. If testing under item A reveals the presence of 0.005 microcuries (185 Bq) or more of removable depleted uranium contamination, the exposure device must be removed from use until an evaluation of the wear on the S-tube has been made.

C. If the evaluation under item B reveals that the S-tube is worn through, the device may not be used again.

D. Depleted uranium shielded devices do not have to be tested for depleted uranium contamination while in storage and not in use.

E. Before using or transferring a depleted uranium shielded device, the device must be tested for depleted uranium contamination if the interval of storage exceeded 12 months.

F. A record of the depleted uranium leak test must be made according to part 4731.4240.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 36 SR 74*

Published Electronically: *August 15, 2011*

4731.4080 QUARTERLY INVENTORY.

Subpart 1. **Inventory required.** A licensee must conduct a quarterly physical inventory to account for all sealed sources and for devices containing depleted uranium received and possessed under a license issued under parts 4731.4000 to 4731.4360.

Subp. 2. **Record keeping.** A licensee must maintain records of the quarterly inventory according to part 4731.4250.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4090 EQUIPMENT INSPECTION AND MAINTENANCE.

Subpart 1. **Daily checks required.** A licensee must perform visual and operability checks on survey meters, radiographic exposure devices and associated equipment, transport and storage containers, and source changers before use on each day the equipment is to be used to ensure that the equipment is in good working condition, that the sources are adequately shielded, and that required labeling is present. Survey instrument operability must be performed using check sources or other appropriate means. If equipment problems are found, the equipment must be removed from service until repaired.

Subp. 2. **Written procedures.** A licensee must have written procedures for:

A. inspection and routine maintenance, at intervals not to exceed three months or before the first use thereafter to ensure the proper functioning of components important to safety, of the following. If equipment problems are found, the equipment must be removed from service until repaired:

(1) radiographic exposure devices;

(2) source changers;

(3) associated equipment;

(4) transport and storage containers; and

(5) survey instruments;

B. ensuring that replacement components meet design specifications;

C. inspection and maintenance necessary to maintain the Type B packaging used to transport radioactive materials. The inspection and maintenance program must include procedures to ensure that Type B packages are shipped and maintained according to the certificate of compliance or other approval; and

D. maintaining records of equipment problems and of any maintenance performed under subpart 1 according to part 4731.4270.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4100 PERMANENT RADIOGRAPHIC INSTALLATIONS; ENTRANCE CONTROLS.

Subpart 1. **Required entrance controls.** An entrance that is used for personnel access to the high radiation area in a permanent radiographic installation must have:

A. an entrance control of the type described in part 4731.2220, subpart 1, item A, subitem (1), that reduces the radiation level upon entry into the area; or

B. conspicuous visible and audible warning signals to warn of the presence of radiation. The visible signal must be actuated by radiation whenever the source is exposed. The audible signal must be actuated when an attempt is made to enter the installation while the source is exposed.

Subp. 2. **Testing.**

A. The alarm system under subpart 1 must be tested for proper operation with a radiation source each day before the installation is used for radiographic operations. The test must include a check of both the visible and audible signals. Entrance control devices that reduce the radiation level upon entry as provided under subpart 1, item A, must be tested monthly.

B. If an entrance control device or an alarm is operating improperly, it must be immediately labeled as defective and repaired within seven calendar days. The facility may continue to be used during the seven-day period if the licensee implements the continuous surveillance requirements under part 4731.4190 and uses an alarming ratemeter.

C. A licensee must maintain records of alarm system and entrance control device tests required under this part and retain each record for three years after it is made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4110 LABELING; PACKAGING; SECURITY.

Subpart 1. **Required label.** A licensee may not use a source changer or a container to store licensed material unless the source changer or the storage container has securely attached to it a durable, legible, and clearly visible label bearing the standard radiation symbol under part 4731.2300, having a minimum diameter of 25 millimeters, and the wording: "CAUTION (or DANGER) - RADIOACTIVE MATERIAL. NOTIFY CIVIL AUTHORITIES (or name of company)."

Subp. 2. **Required packaging.** A licensee may not transport licensed material unless the material is packaged, and the package is labeled, marked, and accompanied with appropriate shipping papers, according to parts 4731.0400 to 4731.0424.

Subp. 3. **Required security.** Locked radiographic exposure devices and storage containers must be physically secured to prevent tampering or removal by unauthorized personnel. A licensee must store licensed material in a manner that minimizes danger from explosion or fire.

Subp. 4. **Required transport security.** A licensee must lock and physically secure the transport package containing licensed material in the transporting vehicle to prevent accidental loss, tampering, or unauthorized removal of the licensed material from the vehicle.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*
Published Electronically: *September 13, 2019*

4731.4120 INDUSTRIAL RADIOGRAPHIC OPERATIONS.

Subpart 1. **Qualified personnel present.** When radiography is performed at a location other than a permanent radiographic installation, the radiographer must be accompanied by at least one other qualified radiographer or an individual who has at a minimum met the requirements of part 4731.4140, subpart 2. The additional qualified individual must observe the operations and be capable of providing immediate assistance to prevent unauthorized entry. Radiography may not be performed if only one qualified individual is present.

Subp. 2. **Permanent installation; requirement.** All radiographic operations conducted at locations of use authorized on the license must be conducted in a permanent radiographic installation, unless specifically authorized by the commissioner.

Subp. 3. **Offshore water operations.** A licensee may conduct lay-barge, offshore platform, or underwater radiography only if procedures have been approved by the commissioner, the NRC, or an agreement state.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4130 RADIATION SAFETY OFFICER.

Subpart 1. **Generally.** A licensee's radiation safety officer must ensure that radiation safety activities are performed according to approved procedures and regulatory requirements in the daily operation of the licensee's program.

Subp. 2. **Minimum qualifications.** At a minimum, a radiation safety officer for industrial radiography must complete:

A. training and testing according to part 4731.4140, subpart 1;

B. 2,000 hours of hands-on experience as a qualified radiographer in industrial radiographic operations; and

C. formal training in the establishment and maintenance of a radiation protection program.

Subp. 3. **Alternate qualifications.** The commissioner shall consider alternatives to subpart 2 when the radiation safety officer has appropriate training or experience in the field of ionizing radiation and has adequate formal training with respect to the establishment and maintenance of a radiation safety protection program.

Subp. 4. **Duties.** Duties of the radiation safety officer include, but are not limited to:

A. establishing and overseeing all operating, emergency, and ALARA procedures as required under parts 4731.2000 to 4731.2950, and reviewing them regularly to ensure that the procedures in use conform to parts 4731.2000 to 4731.2950, to other rules, and to the license conditions;

B. overseeing and approving all phases of the training program for radiographic personnel, ensuring that appropriate and effective radiation protection practices are taught;

C. ensuring that required radiation surveys and leak tests are performed and documented according to this chapter, including any corrective measures when levels of radiation exceed established limits;

D. ensuring that personnel monitoring devices are calibrated and used properly by occupationally exposed personnel, that records are kept of the monitoring results, and that timely notifications are made as required under part 4731.2620; and

E. ensuring that operations are conducted safely and assuming control for instituting corrective actions, including stopping operations when necessary.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4140 RADIOGRAPHER TRAINING.

Subpart 1. **Requirements; radiographer.** A licensee may not permit an individual to act as a radiographer until the individual:

A. receives training according to subpart 6;

B. completes a minimum of two months of on-the-job training;

C. is certified through a radiographer certification program by a certifying entity according to part 4731.4360;

D. receives copies of and instruction in parts 4731.0200, 4731.0280, and 4731.0290; the applicable DOT regulations under parts 4731.0400 to 4731.0424; the applicable portions of parts 4731.1000 to 4731.2950; parts 4731.4000 to 4731.4360; the license under which the radiographer will perform industrial radiography; and the licensee's operating and emergency procedures;

E. demonstrates understanding of the licensee's license and operating and emergency procedures by successfully completing a written or oral examination covering the material;

F. receives training in the use of the licensee's radiographic exposure devices and sealed sources, in the daily inspection of devices and associated equipment, and in the use of radiation survey instruments; and

G. demonstrates understanding of the use of the radiographic exposure devices, sources, survey instruments, and associated equipment under item F by successfully completing a practical examination covering the material.

Subp. 2. **Requirements; radiographer's assistant.** A licensee may not permit an individual to act as a radiographer's assistant until the individual:

A. receives copies of and instruction in parts 4731.0200, 4731.0280, and 4731.0290; the applicable DOT regulations under parts 4731.0400 to 4731.0424; the applicable portions of parts 4731.1000 to 4731.2950; parts 4731.4000 to 4731.4360; the license under which the radiographer's assistant will perform industrial radiography; and the licensee's operating and emergency procedures;

B. develops competence to use, under the personal supervision of a radiographer, the radiographic exposure devices, sealed sources, associated equipment, and radiation survey instruments that the assistant will use; and

C. demonstrates understanding of the instructions provided under item A by successfully completing a written test on the subjects covered and demonstrates competence in the use of hardware described under item B by successfully completing a practical examination on the use of the hardware.

Subp. 3. **Refresher training.** A licensee must provide annual refresher safety training for each radiographer and radiographer's assistant at intervals not to exceed 12 months.

Subp. 4. **Job performance review.**

A. Except as provided in item C, the radiation safety officer or designee must conduct an inspection program of the job performance of each radiographer and radiographer's assistant to ensure that this chapter, the license requirements, and the licensee's operating and emergency procedures are followed. The inspection program must:

(1) include observation of the performance of each radiographer and radiographer's assistant during an actual industrial radiographic operation, at intervals not to exceed six months; and

(2) provide that, if a radiographer or a radiographer's assistant has not participated in an industrial radiographic operation for more than six months since the last inspection, the radiographer must redemonstrate knowledge of the training requirements of subpart 1, item F, and the radiographer's assistant must redemonstrate knowledge of the training requirements of subpart 2, item B, by a practical examination before the individuals can next participate in a radiographic operation.

B. The commissioner may consider alternatives to item A in situations where an individual serves as both radiographer and radiation safety officer.

C. In those operations where a single individual serves as both radiographer and radiation safety officer, and performs all radiography operations, an inspection program is not required.

Subp. 5. **Record keeping.** A licensee must maintain records of training under this part, including certification documents, written and practical examinations, refresher safety training, and inspections of job performance, according to part 4731.4290.

Subp. 6. **Required subjects.** A radiographer must receive training in:

A. the fundamentals of radiation safety, including:

(1) characteristics of gamma radiation;

(2) units of radiation dose and quantity of radioactivity;

(3) hazards of exposure to radiation;

(4) levels of radiation from licensed material; and

(5) methods of controlling radiation dose (time, distance, and shielding);

B. radiation detection instruments, including:

(1) use, operation, calibration, and limitations of radiation survey instruments;

(2) survey techniques; and

(3) use of personnel monitoring equipment;

C. equipment to be used, including:

(1) operation and control of radiographic exposure equipment, remote handling equipment, and storage containers, including pictures or models of source assemblies (pigtails);

(2) storage, control, and disposal of licensed material; and

(3) inspection and maintenance of equipment;

D. the requirements of pertinent portions of this chapter; and

E. case histories of accidents in radiography.

Subp. 7. **Certification records.** Records of radiographer certification maintained according to part 4731.4290, subpart 1, must provide appropriate affirmation of the certification requirements specified in subpart 1, item C.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.4150 OPERATING AND EMERGENCY PROCEDURES.

Subpart 1. **Required procedures.** A licensee must establish operating and emergency procedures that include, as a minimum, instructions in:

A. appropriate handling and use of licensed sealed sources and radiographic exposure devices so that no person is likely to be exposed to radiation doses in excess of the limits established under parts 4731.2000 to 4731.2950;

B. methods and occasions for conducting radiation surveys;

C. methods for controlling access to radiographic areas;

D. methods and occasions for locking and securing radiographic exposure devices, transport and storage containers, and sealed sources;

E. personnel monitoring and the use of personnel monitoring equipment;

F. transporting sealed sources to field locations, including packing of radiographic exposure devices and storage containers in the vehicles, placarding of vehicles when needed, and control of the sealed sources during transportation;

G. inspection, maintenance, and operability checks of radiographic exposure devices, survey instruments, transport containers, and storage containers;

H. steps that must be taken immediately by radiography personnel in the event a pocket dosimeter is found to be off-scale or an alarm ratemeter alarms unexpectedly;

I. procedures for identifying and reporting defects and noncompliance, as required under Code of Federal Regulations, title 10, part 21;

J. procedures for notifying proper persons in the event of an accident;

K. minimizing exposure of persons in the event of an accident;

L. source recovery procedures, if the licensee will perform source recovery; and

M. maintaining records.

Subp. 2. **Record keeping.** A licensee must maintain a copy of current operating and emergency procedures until the commissioner terminates the license. Superseded material must be retained for three years after the change is made. The licensee must maintain copies of current operating and emergency procedures according to part 4731.4330.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4160 SUPERVISION OF RADIOGRAPHER'S ASSISTANTS.

When a radiographer's assistant uses radiographic exposure devices, associated equipment, or sealed sources or conducts radiation surveys required under part 4731.4180, subpart 1, item B, to determine that the sealed source has returned to the shielded position after an exposure, the assistant must be under the personal supervision of a radiographer. The personal supervision must include:

A. the radiographer's physical presence at the site where the sealed sources are being used;

B. the availability of the radiographer to give immediate assistance if required; and

C. the radiographer's direct observation of the assistant's performance of the operations referred to in this part.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4170 PERSONNEL MONITORING.

Subpart 1. **Monitoring requirements.**

A. A licensee may not permit an individual to act as a radiographer or a radiographer's assistant unless, at all times during radiographic operations, each individual wears, on the trunk of the body, a combination of direct reading dosimeter, an operating alarm ratemeter, and a personnel dosimeter.

B. At permanent radiography installations where other appropriate alarm or warning devices are in routine use, wearing an alarm ratemeter is not required.

C. Pocket dosimeters must have a range from zero to 200 millirems (2 mSv) and must be recharged at the start of each shift. Electronic personal dosimeters may only be used in place of ion-chamber pocket dosimeters.

D. Each personnel dosimeter must be assigned to and worn by only one individual.

E. Film badges must be replaced at periods not to exceed one month and other personnel dosimeters that require replacement must be replaced at periods not to exceed three months. All personnel dosimeters must be evaluated at periods not to exceed three months or promptly after replacement, whichever is more frequent.

Subp. 2. **Direct reading dosimeters.** Direct reading dosimeters, such as pocket dosimeters or electronic personal dosimeters, must be read and the exposures recorded at the beginning and end of each shift and records must be maintained according to part 4731.4310.

Subp. 3. **Pocket dosimeters.** Pocket dosimeters, or electronic personal dosimeters, must be checked at periods not to exceed 12 months for correct response to radiation and records must be maintained according to part 4731.4310. Acceptable dosimeters must read within plus or minus 20 percent of the true radiation exposure.

Subp. 4. **High readings.** If an individual's pocket chamber is found to be off-scale, or if the individual's electronic personal dosimeter reads greater than 200 millirems (2 mSv), and the possibility of radiation exposure cannot be ruled out as the cause, the individual's personnel dosimeter that requires processing must be sent for processing and evaluation within 24 hours. For personnel dosimeters that do not require processing, evaluation of the dosimeter must be started within 24 hours. The individual may not resume work associated with licensed material use until a determination of the individual's radiation exposure has been made. The determination must be made by the radiation safety officer or the radiation safety officer's designee. The results of the determination must be included in the records maintained according to part 4731.4310.

Subp. 5. **Lost or damaged dosimeters.** If the personnel dosimeter that is required under subpart 1 is lost or damaged, the worker must cease work immediately until a replacement personnel dosimeter meeting the requirements of subpart 1 is provided and the exposure is calculated for the time period from issuance to loss or damage of the personnel dosimeter. The results of the calculated exposure and the time period for which the personnel dosimeter was lost or damaged must be included in the records maintained according to part 4731.4310.

Subp. 6. **Report retention.** Dosimetry results must be retained according to part 4731.4310.

Subp. 7. **Ratemeter requirements.** An alarm ratemeter must:

A. be checked to ensure that the alarm functions properly (sounds) before use at the start of each shift;

B. be set to give an alarm signal at a preset dose rate of 500 millirems per hour (5 mSv/hr), with an accuracy of plus or minus 20 percent of the true radiation dose rate;

C. require special means to change the preset alarm function; and

D. be calibrated at periods not to exceed 12 months for correct response to radiation. A licensee must maintain records of alarm ratemeter calibrations according to part 4731.4310.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4180 RADIATION SURVEYS.

Subpart 1. **Survey requirements.** A licensee must:

A. conduct radiation surveys with a calibrated and operable radiation survey instrument that meets the requirements under part 4731.4060;

B. using a survey instrument meeting the requirements of item A, conduct a survey of the radiographic exposure device and the guide tube after each exposure when approaching the device or the guide tube. The survey must determine that the sealed source has returned to its shielded position before exchanging films, repositioning the exposure head, or dismantling equipment;

C. conduct a survey of the radiographic exposure device with a calibrated radiation survey instrument any time the source is exchanged and whenever a radiographic exposure device is placed in a storage area to ensure that the sealed source is in its shielded position; and

D. maintain records according to subpart 2.

Subp. 2. **Record keeping.** A licensee must maintain a record of each exposure device survey conducted before the device is placed in storage under subpart 1, item C, if that survey is the last one performed in the workday. Each record must be maintained for three years after it is made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4190 SURVEILLANCE.

During a radiographic operation, the radiographer, or the other individual present as required under part 4731.4120, must maintain continuous direct visual surveillance of the operation to protect against unauthorized entry into a high radiation area except at permanent radiographic installations where all entryways are locked and the requirements under part 4731.4100 are met.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4200 POSTING.

All areas in which industrial radiography is being performed must be conspicuously posted according to part 4731.2310. Exceptions under part 4731.2320 do not apply to industrial radiographic operations.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4210 RECORDS; SPECIFIC LICENSE FOR INDUSTRIAL RADIOGRAPHY.

A licensee must maintain a copy of its license, license conditions, documents incorporated by reference, and amendments to each of these items until superseded by new documents approved by the commissioner, or until the commissioner terminates the license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4220 RECORDS; RECEIPT AND TRANSFER OF SEALED SOURCES.

Subpart 1. **Receipt and transfer records.** A licensee must maintain records showing the receipts and transfers of sealed sources and devices using depleted uranium for shielding and retain each record for three years after it is made.

Subp. 2. **Record requirements.** Records under subpart 1 must include:

A. the date;

B. the name of the individual making the record;

C. the radionuclide and number of curies (becquerels) or mass for depleted uranium; and

D. the manufacturer, model, and serial number of each sealed source or device, as appropriate.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4240 RECORDS; LEAK TESTING.

A licensee must maintain records of leak test results for sealed sources and for devices containing depleted uranium. The results must be stated in units of microcuries (becquerels). The licensee must retain each record for three years after it is made or until the source in storage is removed.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4250 RECORDS; QUARTERLY INVENTORY.

Subpart 1. **Quarterly inventory records.** A licensee must maintain records of the quarterly inventory of sealed sources and of devices containing depleted uranium as required under part 4731.4080 and retain each record for three years after it is made.

Subp. 2. **Record requirements.** Records required under subpart 1 must include:

A. the date of the inventory;

B. the name of the individual conducting the inventory;

C. the radionuclide;

D. the number of curies (becquerels) or mass for depleted uranium in each device;

E. the location of sealed source or devices; and

F. the manufacturer, model, and serial number of each sealed source or device, as appropriate.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4260 UTILIZATION LOGS.

Subpart 1. **Logs required.** A licensee must maintain utilization logs showing for each sealed source:

A. a description, including the make, model, and serial number, of the radiographic exposure device or transport or storage container in which the sealed source is located;

B. the identity and signature of the radiographer to whom assigned; and

C. the plant or site where used and dates of use, including the dates removed and returned to storage.

Subp. 2. **Retention.** A licensee must retain the logs required under subpart 1 for three years after the log is made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4270 RECORDS; INSPECTION AND MAINTENANCE.

Subpart 1. **Inspection and maintenance records.** A licensee must maintain records specified under part 4731.4090 of equipment problems found in daily checks and quarterly inspections of radiographic exposure devices, transport and storage containers, associated equipment, source changers, and survey instruments and retain each record for three years after it is made.

Subp. 2. **Record requirements.** The records under subpart 1 must include:

A. the date of check or inspection;

B. the name of inspector;

C. equipment involved;

D. any problems found; and

E. what repair or maintenance, if any, was done.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4290 RECORDS; TRAINING AND CERTIFICATION.

Subpart 1. **Training and certification records.** A licensee must maintain records of training and certification of each radiographer and each radiographer's assistant for three years and must include:

A. radiographer certification documents and verification of certification status;

B. copies of written tests;

C. dates of oral and practical examinations; and

D. names of individuals conducting and receiving the oral and practical examinations.

Subp. 2. **Refresher training and inspection records.** A licensee must maintain records of annual refresher safety training and semiannual inspections of job performance for each radiographer and each radiographer's assistant. The records must list the topics discussed during the refresher safety training, the dates the annual refresher safety training was conducted, and names of the instructors and attendees. For inspections of job performance, the records must include a list showing the items checked and any noncompliances observed by the radiation safety officer.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4310 RECORDS; PERSONNEL MONITORING.

According to part 4731.4170, a licensee must maintain records of:

A. direct reading dosimeter readings and yearly operability checks according to part 4731.4170, subparts 2 and 3, for three years after the record is made;

B. alarming ratemeter calibrations for three years after the record is made;

C. personnel dosimeter results until the commissioner terminates the license; and

D. estimates of exposures as a result of off-scale personal direct reading dosimeters or lost or damaged personnel dosimeters until the commissioner terminates the license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4330 LOCATION OF DOCUMENTS AND RECORDS.

Subpart 1. **Records in one location.** A licensee must maintain copies of all records required under this chapter at the location identified under part 4731.4020, item J.

Subp. 2. **Records at each location.** A licensee must maintain copies of the following documents and records, sufficient to demonstrate compliance, at each applicable field station and each temporary job site:

A. the license authorizing the use of licensed material;

B. a copy of parts 4731.1000 to 4731.2950 and 4731.4000 to 4731.4360;

C. utilization records for each radiographic exposure device dispatched from that location as required under part 4731.4260;

D. records of equipment problems identified in daily checks of equipment as required under part 4731.4270, subpart 1;

E. records of alarm system and entrance control checks required under part 4731.4100, if applicable;

F. records of direct reading dosimeters such as pocket dosimeter or electronic personal dosimeters readings as required under part 4731.4310;

G. operating and emergency procedures required under part 4731.4150;

H. evidence of the latest calibration of the radiation survey instruments in use at the site, as required under part 4731.4060;

I. evidence of the latest calibrations of alarm ratemeters and operability checks of pocket dosimeters or electronic personal dosimeters as required under part 4731.4310;

J. the latest survey records required under part 4731.4180;

K. the shipping papers for the transportation of radioactive materials required under part 4731.0402; and

L. when operating under reciprocity according to part 4731.0355, a copy of the NRC or agreement state license authorizing the use of licensed materials.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4350 NOTIFICATIONS.

Subpart 1. **Immediate notification required.** A licensee must notify the commissioner as soon as possible but not later than four hours after the discovery of any event that prevents immediate protective actions necessary to avoid exposures to radiation or radioactive materials that could exceed regulatory limits or releases of licensed material that could exceed regulatory limits. Reportable events under this subpart include fires, explosions, toxic gas release, or similar hazards.

Subp. 2. **24-hour notification required.** A licensee must notify the commissioner within 24 hours after discovery of any of the following events involving licensed material:

A. the occurrence of any of the following incidents involving radiographic equipment:

(1) unintentional disconnection of the source assembly from the control cable;

(2) inability to retract the source assembly to its fully shielded position and secure it in the fully shielded position; or

(3) failure of any component, critical to safe operation of the device, to properly perform its intended function;

B. an event in which equipment is disabled or fails to function as designed when:

(1) the equipment is required by rule or license condition to prevent releases exceeding regulatory limits, to prevent exposure to radiation and radioactive materials exceeding regulatory limits, or to mitigate the consequences of an accident;

(2) the equipment is required to be available and operable when it is disabled or fails to function; and

(3) no redundant equipment is available and operable to perform the required safety function;

C. an unplanned contamination event that:

(1) requires access to the contaminated area, by workers or the public, to be restricted for more than 24 hours by imposing additional radiological controls or by prohibiting entry into the areas;

(2) involves a quantity of material greater than five times the lowest annual limit on intake specified in part 4731.2750 for the material; and

(3) restricts access to the area for a reason other than to allow isotopes with a half-life of less than 24 hours to decay prior to decontamination;

D. an event that requires unplanned medical treatment at a medical facility of an individual with spreadable radioactive contamination on the individual's clothing or body; or

E. an unplanned fire or explosion that damages any licensed material or any device, container, or equipment containing licensed materials when:

(1) the quantity of material involved is five times the lowest annual limit on intake specified in part 4731.2750; and

(2) the damage affects the integrity of the licensed material or its container.

Subp. 3. **Preparation and submission of notifications.** A licensee must make notifications required under subparts 1 and 2 by telephone to the commissioner according to part 4731.0200, subpart 5. To the extent the information is available at the time of notification, the information provided must include:

A. the caller's name and call-back telephone number;

B. a description of the event, including date and time;

C. the exact location of the event;

D. the isotopes, quantities, and chemical and physical form of the licensed material involved; and

E. any personnel radiation exposure data available.

Subp. 4. **Reports required.** A licensee who makes a notification required under subpart 1 or 2 must submit a written follow-up report within 30 days of the notification. Written reports prepared as required by other rules may be submitted to fulfill this requirement if the reports contain all of the necessary information and the appropriate distribution is made. The reports must be sent to the commissioner and include:

A. a description of the incident;

B. the cause of each incident, if known;

C. the name of the manufacturer and model number of equipment involved in the incident;

D. the place, date, and time of the incident;

E. the actions taken to establish normal operations;

F. the corrective actions taken or planned to prevent recurrence;

G. the qualifications of personnel involved in the incident;

H. the isotopes, quantities, and chemical and physical form of the licensed material involved;

I. the results of any evaluations or assessments; and

J. the extent of exposure of individuals to radiation or to radioactive materials, without identification of the individuals by name.

Subp. 5. **Reporting unlisted use.** A licensee conducting radiographic operations or storing radioactive material at any location not listed on the license for a period in excess of 180 days in a calendar year must notify the commissioner prior to exceeding the 180 days.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 36 SR 74; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.4360 RADIOGRAPHER CERTIFICATION.

Subpart 1. **Requirements for an independent certifying organization.** An independent certifying organization must:

A. be an organization such as a society or association whose members participate in, or have an interest in, the fields of industrial radiography;

B. make its membership available to the general public nationwide that is not restricted because of race, color, creed, religion, national origin, sex, disability, sexual orientation, or age;

C. have a certification program open to nonmembers as well as members;

D. be an incorporated, nationally recognized organization that is involved in setting national standards of practice within its fields of expertise;

E. have an adequate staff, a viable system for financing its operations, and a policy and decision-making review board;

F. have a set of written organizational bylaws and policies that provide adequate assurance of lack of conflict of interest and a system for monitoring and enforcing those bylaws and policies;

G. have a committee, whose members can carry out their responsibilities impartially, to review and approve the certification guidelines and procedures and to advise the organization's staff in implementing the certification program;

H. have a committee, whose members can carry out their responsibilities impartially, to review complaints against certified individuals and to determine appropriate sanctions;

I. have written procedures describing all aspects of its certification program and maintain records of the current status of each individual's certification and the administration of its certification program;

J. have procedures to ensure that certified individuals are provided due process with respect to the administration of its certification program, including the process of becoming certified and any sanctions imposed against certified individuals;

K. have procedures for proctoring examinations, including qualifications for proctors. The procedures must ensure that the individuals proctoring each examination are not employed by the same company or corporation, or a wholly-owned subsidiary of such company or corporation, as any of the examinees;

L. exchange information about certified individuals with the commissioner, other independent certifying organizations, the NRC, and agreement states and allow periodic review of its certification program and related records; and

M. provide a description to the commissioner of its procedures for choosing examination sites and for providing an appropriate examination environment.

Subp. 2. **Requirements for certification programs.** All certification programs must:

A. require applicants for certification to:

(1) receive training in the topics under part 4731.4140, subpart 6, or equivalent NRC or agreement state regulations; and

(2) satisfactorily complete a written examination covering these topics;

B. require applicants for certification to provide documentation that demonstrates that the applicant has:

(1) received training in the topics under part 4731.4140, subpart 6, or equivalent NRC or agreement state regulations;

(2) satisfactorily completed a minimum period of on-the-job training; and

(3) received verification by an NRC or agreement state licensee that the applicant has demonstrated the capability of independently working as a radiographer;

C. include procedures to ensure that all examination questions are protected from disclosure;

D. include procedures for denying an application and revoking, suspending, and reinstating certification;

E. provide a certification period of not less than three years nor more than five years;

F. include procedures for renewing certifications and, if the procedures allow renewals without examination, require evidence of recent full-time employment and annual refresher training; and

G. provide a timely response to inquiries, by telephone or letter, from members of the public about an individual's certification status.

Subp. 3. **Requirements for written examinations.** All examinations must:

A. be designed to test an individual's knowledge and understanding of the topics under part 4731.4140, subpart 6, or equivalent NRC or agreement state requirements;

B. be written in a multiple-choice format; and

C. have test items drawn from a question bank containing psychometrically valid questions based on the material under part 4731.4140, subpart 6.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

MEDICAL USE OF RADIOACTIVE MATERIAL

4731.4400 APPLICABILITY FOR THE USE OF RADIOACTIVE MATERIALS IN THE HEALING ARTS.

Parts 4731.4400 to 4731.4527 apply to the medical use of radioactive material and provide for issuing specific licenses authorizing the medical use of radioactive material. Parts 4731.4400 to 4731.4527 provide for the radiation safety of workers, the general public, patients, and human research subjects. Parts 4731.4400 to 4731.4527 are in addition to, and not in substitution for, other

requirements in this chapter. All requirements of this chapter apply to applicants and licensees subject to parts 4731.4400 to 4731.4527 unless specifically exempted.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4401 PROTECTION OF HUMAN RESEARCH SUBJECTS.

A. A licensee may conduct research involving human research subjects only if the licensee uses radioactive materials specified in the license and for the uses authorized in the license.

B. If the research is conducted, funded, supported, or regulated by a federal agency that has implemented Code of Federal Regulations, title 45, part 46, subpart A, the federal policy for the protection of human subjects, the licensee must, before conducting research:

(1) obtain review and approval of the research from an institutional review board according to Code of Federal Regulations, title 45, section 46.111; and

(2) obtain informed consent from the human research subject according to Code of Federal Regulations, title 45, section 46.116.

C. If the research will not be conducted, funded, supported, or regulated by a federal agency that has implemented the federal policy, the licensee must, before conducting research, apply for and receive a specific amendment to its medical use license. The amendment request must include a written commitment that the licensee will, before conducting research:

(1) obtain review and approval of the research from an institutional review board according to Code of Federal Regulations, title 45, section 46.111; and

(2) obtain informed consent from the human research subject according to Code of Federal Regulations, title 45, section 46.116.

D. Nothing in this part relieves licensees from complying with other parts of this chapter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4402 IMPLEMENTATION.

Subpart 1. **License exemption.** If a license condition exempted a licensee from a provision of Code of Federal Regulations, title 10, part 35, on October 24, 2002, then the license condition continues to exempt the licensee from the requirements in the corresponding provision of parts 4731.4400 to 4731.4527.

Subp. 2. **Superseding law.** When a requirement in parts 4731.4400 to 4731.4527 differs from a requirement in an existing license condition, the requirement in parts 4731.4400 to 4731.4527 governs.

Subp. 3. **Continued compliance.** A licensee must continue to comply with any license condition that requires the licensee to implement procedures required under parts 4731.4466 and 4731.4472 to 4731.4474 until there is a license amendment or renewal that modifies the license condition.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4403 SPECIFIC LICENSE; MEDICAL USE OF RADIOACTIVE MATERIALS.

Subpart 1. **Specific license required.**

A. Except as provided in item B, a person may manufacture, produce, acquire, receive, possess, prepare, use, or transfer radioactive material for medical use only under a specific license issued by the NRC or an agreement state.

B. A specific license is not needed for an individual who:

(1) receives, possesses, uses, or transfers radioactive material according to this chapter under the supervision of an authorized user as provided under part 4731.4407, unless prohibited by a license condition; or

(2) prepares unsealed radioactive material for medical use according to this chapter under the supervision of an authorized nuclear pharmacist or authorized user as provided under part 4731.4407, unless prohibited by a license condition.

Subp. 2. **Application for license, amendment, or renewal.**

A. An application for a specific license under subpart 1 must be signed by the applicant's or licensee's management.

B. An application for a license for medical use of radioactive materials as described in parts 4731.4404, 4731.4432, 4731.4434, 4731.4440, 4731.4450, 4731.4460, and 4731.4463 must include:

(1) an original application for radioactive material license form prescribed by the commissioner that includes the facility diagram, equipment, and training and experience qualifications of the radiation safety officer, associate radiation safety officers, authorized users, authorized medical physicists, ophthalmic physicists, and authorized nuclear pharmacists; and

(2) the procedures required under parts 4731.4466 and 4731.4472 to 4731.4474, as applicable.

C. A request for a license amendment or renewal must include:

(1) an original copy of the form prescribed by the commissioner under item B or a letter requesting the amendment or renewal containing all the information in the form prescribed by the commissioner under item B; and

(2) the procedures required under parts 4731.4466 and 4731.4472 to 4731.4474, as applicable.

D. In addition to the requirements under items B and C, an application for a license or amendment for medical use of radioactive material under part 4731.4404 must include:

(1) information regarding any radiation safety aspects of the medical use of the material that is not addressed in, or differs from, parts 4731.4400 to 4731.4427 and 4731.4500 to 4731.4528;

(2) identification of and commitment to follow the applicable radiation safety program requirements in parts 4731.4432 to 4731.4479 that are appropriate for the specific medical use;

(3) any additional specific information on:

(a) radiation safety precautions and instructions;

(b) methodology for measurement of dosages or doses to be administered to patients or human research subjects; and

(c) calibration, maintenance, and repair of instruments and equipment necessary for radiation safety; and

(4) any other information requested by the commissioner for review of the application.

E. An applicant that satisfies the requirements under part 4731.3530 may apply for a Type A specific license of broad scope.

Subp. 3. **License amendments.** A licensee must apply for and receive a license amendment:

A. before the licensee receives, prepares, or uses radioactive material for a type of use that is permitted under this chapter, but not authorized under the licensee's current license issued under parts 4731.4400 to 4731.4527;

B. before the licensee permits anyone to work as an authorized user, authorized nuclear pharmacist, authorized medical physicist, or ophthalmic physicist under the license, except that the licensee may permit an individual to work as an authorized user, authorized nuclear pharmacist, authorized medical physicist, or ophthalmic physicist for 60 days before being authorized on a license if the individual is an authorized user, authorized nuclear pharmacist, authorized medical physicist, or ophthalmic physicist for the same type of use:

(1) on a license issued by the commissioner, the NRC, or an agreement state or on an equivalent permit or license recognized by the commissioner, the NRC, or an agreement state that authorizes the use of radioactive material in medical use or in the practice of nuclear pharmacy;

(2) on a permit issued by the commissioner, the NRC, or an agreement state specific licensee of broad scope that is authorized to permit the use of radioactive material in medical use or in the practice of nuclear pharmacy;

(3) on a permit issued by an NRC master material licensee that is authorized to permit the use of radioactive material in medical use or in the practice of nuclear pharmacy; or

(4) by a commercial nuclear pharmacy that has been authorized to identify authorized nuclear pharmacists;

C. before the licensee changes radiation safety officers, except as provided under part 4731.4405, subpart 1, item C;

D. before the licensee permits anyone to work as an associate radiation safety officer, or before the radiation safety officer assigns duties and tasks to an associate radiation safety officer that differ from those for which the individual is authorized on the license;

E. before the licensee receives radioactive material in excess of the amount or in a form different than authorized in the license or before the licensee receives a radionuclide that is different than the radionuclide authorized in the license;

F. before the licensee adds or changes the areas of use identified in the application or in the license, except for areas of use where radioactive material is used only according to part 4731.4432 or 4731.4434;

G. before the licensee changes an address identified in the application or on the license;

H. before the licensee revises procedures required under parts 4731.4466 and 4731.4472 to 4731.4474, as applicable, when the revision reduces radiation safety; and

I. before the licensee receives a sealed source from a different manufacturer or of a different model number than authorized by its license unless the sealed source is used for manual brachytherapy, is listed in the Sealed Source and Device Registry, and is in a quantity and for an isotope authorized by the license. If a licensee obtains a sealed source in accordance with this item, the licensee must submit an amendment request to add the sealed source to the licensee's radioactive materials license within 30 days after receiving the source.

Subp. 4. **Notifications of changes.**

A. A licensee must notify the commissioner by letter no later than 30 days after:

(1) an authorized user, authorized nuclear pharmacist, radiation safety officer, associate radiation officer, authorized medical physicist, or ophthalmic physicist has a name change;

(2) the licensee's mailing address changes;

(3) the licensee's name changes, but the name change does not constitute a transfer of control of the license as described under part 4731.3075, subpart 2;

(4) the licensee has added to or changed the areas of use identified in the application or license where radioactive material is used according to part 4731.4432 or 4731.4434;

(5) the licensee permits an individual qualified to be a radiation safety officer under parts 4731.4411 and 4731.4415, to function as a temporary radiation safety officer and to perform the functions of a radiation safety officer as described under part 4731.4405, subpart 1, item C; or

(6) the licensee permits an individual to work under the provisions of subpart 3, item B, as an authorized user, authorized medical physicist, ophthalmic physicist, or authorized nuclear pharmacist prior to being added to the license. The notification must include a copy of the commissioner, the NRC, or an agreement state license, the permit issued by an NRC master material licensee, the permit issued by the commissioner, the NRC, or an agreement state licensee of broad scope, or the permit issued by an NRC master material license broad scope permittee.

B. A licensee must mail required documents to the address under part 4731.0200, subpart 4.

Subp. 5. **Exemptions; broad scope license.** A licensee possessing a Type A specific license of broad scope for medical use, issued under parts 4731.3500 to 4731.3580, is exempt from:

A. subpart 2, item D, regarding the need to file an amendment to the license for medical use of radioactive materials under part 4731.4404;

B. subpart 3, item B;

C. subpart 3, item F, regarding additions to or changes in the areas of use at the addresses identified in the application or license;

D. subpart 4, item A, subitem (1), for an authorized user, authorized nuclear pharmacist, authorized medical physicist, or ophthalmic physicist;

E. subpart 4, item A, subitem (4), regarding additions to or changes in the areas of use identified in the application or license where radioactive material is used under part 4731.4432 or 4731.4434; and

F. part 4731.4410, item A.

Subp. 6. **License issuance.**

A. The commissioner shall issue a license for the medical use of radioactive material if:

(1) the applicant complies with subpart 2;

(2) the applicant pays any applicable fee as provided under Minnesota Statutes, section 144.1205;

(3) the commissioner finds the applicant equipped and committed to observe the safety standards established by the commissioner in this chapter for the protection of the public health and safety; and

(4) the applicant meets the requirements of parts 4731.3000 to 4731.3175.

B. The commissioner shall issue a license for mobile medical services if the applicant:

(1) meets the requirements under item A; and

(2) ensures that individuals or human research subjects to whom unsealed radioactive material or radiation from implants containing radioactive material will be administered are released following treatment according to part 4731.4427.

Subp. 7. **Specific exemptions.** The commissioner may, upon application of any interested person or upon the commissioner's own initiative, grant exemptions from parts 4731.4400 to 4731.4527 that the commissioner determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 33 SR 1440; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4404 OTHER MEDICAL USES.

A licensee may use radioactive material or a radiation source approved for medical use that is not specifically addressed in parts 4731.4432 to 4731.4479 if the applicant or licensee:

A. submits the information required under part 4731.4403, subpart 2, items B to D; and

B. receives written approval from the commissioner in a license or license amendment and uses the material according to rules and specific conditions the commissioner considers necessary for the medical use of the material.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4405 RADIATION PROTECTION PROGRAM.

Subpart 1. **Authority and responsibilities.**

A. In addition to the radiation protection program requirements under part 4731.2010, a licensee's management must approve in writing:

(1) requests for license application, renewal, or amendment before submission to the commissioner;

(2) any individual before allowing that individual to work as an authorized user, authorized nuclear pharmacist, or authorized medical physicist; and

(3) radiation protection program changes that do not require a license amendment and are permitted under subpart 2.

B. A licensee's management must appoint a radiation safety officer, who agrees, in writing, to be responsible for implementing the radiation protection program. The licensee, through the radiation safety officer, must ensure that radiation safety activities are being performed according to licensee-approved procedures and this chapter. A licensee's management may appoint, in writing, one or more associate radiation safety officers to support the radiation safety officer. The radiation safety officer, with written agreement of the licensee's management, must assign the specific duties and tasks to each associate radiation safety officer. These duties and tasks are restricted to the types of use for which the associate radiation safety officer is listed on a license. The radiation safety officer may delegate duties and tasks to the associate radiation safety officer but shall not delegate the authority or responsibilities for implementing the radiation protection program.

C. For up to 60 days each year, a licensee may permit an individual qualified to be a radiation safety officer under parts 4731.4411 and 4731.4415 to function as a temporary radiation safety officer and to perform the functions of a radiation safety officer, as provided in item G, if the licensee takes the actions required by items B, E, G, and H, and notifies the commissioner according to part 4731.4403, subpart 4, item A.

D. A licensee may simultaneously appoint more than one temporary radiation safety officer according to item C if needed to ensure that the licensee has a temporary radiation safety officer that satisfies the requirements to be a radiation safety officer for each of the different types of uses of radioactive material permitted by the license.

E. A licensee must establish in writing the authority, duties, and responsibilities of the radiation safety officer.

F. Licensees that are authorized for two or more different types of uses of radioactive materials under parts 4731.4440 to 4731.4459 and 4731.4463 to 4731.4479, or two or more types of units under parts 4731.4463 to 4731.4479 must establish a radiation safety committee to oversee all uses of radioactive material permitted by the license. The committee must include an authorized user of each type of use permitted by the 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. The committee may include other members the licensee considers appropriate.

G. A licensee must provide the radiation safety officer sufficient authority, organizational freedom, time resources, and management prerogative to:

(1) identify radiation safety problems;

(2) initiate, recommend, or provide corrective actions;

(3) stop unsafe operations; and

(4) verify implementation of corrective actions.

H. A licensee must retain a record of actions taken under items A, B, and E, according to part 4731.4500, subpart 1.

Subp. 2. **Program changes.**

A. A licensee may revise its radiation protection program without commissioner approval if:

(1) the revision does not require a license amendment under part 4731.4403, subpart 3;

(2) the revision is in compliance with this chapter and the license;

(3) the revision has been reviewed and approved by the radiation safety officer and licensee management; and

(4) the affected individuals are instructed on the revised program before the changes are implemented.

B. A licensee must retain a record of each change according to part 4731.4500, subpart 2.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4407 SUPERVISED INDIVIDUALS.

A. A licensee that permits the receipt, possession, use, or transfer of radioactive material by an individual under the supervision of an authorized user, as allowed under part 4731.4403, subpart 1, item B, subitem (1), must:

(1) in addition to the requirements under part 4731.1020, instruct the supervised individual in the licensee's written radiation protection procedures and written directive procedures, the requirements of this chapter, and license conditions with respect to the use of radioactive material; and

(2) require the supervised individual to follow:

(a) the instructions of the supervising authorized user for medical uses of radioactive material;

(b) the written radiation protection procedures established by the licensee;

(c) the written directive procedures;

(d) the requirements of this chapter; and

(e) the license conditions with respect to the medical use of radioactive material.

B. A licensee that permits the preparation of radioactive material for medical use by an individual under the supervision of an authorized nuclear pharmacist or physician who is an authorized user, as allowed under part 4731.4403, subpart 1, item B, subitem (2), must:

(1) in addition to the requirements under part 4731.1020, instruct the supervised individual in the preparation of radioactive material for medical use, as appropriate to the individual's involvement with radioactive material; and

(2) require the supervised individual to follow:

(a) the instructions of the supervising authorized user or authorized nuclear pharmacist regarding the preparation of radioactive material for medical use;

(b) the written radiation protection procedures established by the licensee;

(c) the requirements of this chapter; and

(d) the license conditions.

C. A licensee that permits supervised activities under item A or B is responsible for the acts and omissions of the supervised individual.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4408 WRITTEN DIRECTIVES.

Subpart 1. **Written directive required.**

A. A written directive must be dated and signed by an authorized user before administration of:

(1) I-131 sodium iodide greater than 30 microcuries (1.11 MBq);

(2) any therapeutic dosage of unsealed radioactive material; or

(3) any therapeutic dose of radiation from radioactive material.

B. If, because of the emergent nature of a patient's condition, a delay to provide a written directive would jeopardize the patient's health, an oral directive is acceptable. The information contained in the oral directive must be documented as soon as possible in writing in the patient's record. A written directive must be prepared within 48 hours of the oral directive.

Subp. 2. **Content requirements.** The written directive under subpart 1 must contain the patient or human research subject's name and:

A. for an administration of quantities greater than 30 microcuries (1.11 MBq) of sodium iodide I-131, the dosage;

B. for an administration of a therapeutic dosage of an unsealed radioactive material other than sodium iodide I-131, the radioactive drug, dosage, and route of administration;

C. for gamma stereotactic radiosurgery, the total dose, treatment site, and values for the target coordinate settings per treatment for each anatomically distinct treatment site;

D. for teletherapy, the total dose, dose per fraction, number of fractions, and treatment site;

E. for high dose-rate remote afterloading brachytherapy, the radionuclide, treatment site, dose per fraction, number of fractions, and total dose;

F. for permanent implant brachytherapy:

(1) before implantation: the treatment site, radionuclide, and total source strength; and

(2) after implantation but before the patient leaves the post-treatment recovery area: the treatment site, number of sources implanted, total source strength implanted, and date; or

G. for all other brachytherapy, including low, medium, and pulsed dose-rate remote afterloaders:

(1) before implantation: the treatment site, radionuclide, and dose; and

(2) after implantation but before completion of the procedure: the radionuclide, treatment site, number of sources, total source strength and exposure time or the total dose, and date.

Subp. 3. **Revisions.**

A. A written revision to an existing written directive may be made if the revision is dated and signed by an authorized user before the administration of the dosage of unsealed radioactive material, the brachytherapy dose, the gamma stereotactic radiosurgery dose, the teletherapy dose, or the next fractional dose.

B. If, because of a patient's condition, a delay to provide a written revision to an existing written directive would jeopardize the patient's health, an oral revision to an existing written directive is acceptable. The oral revision must be documented as soon as possible in the patient's record. A revised written directive must be signed by the authorized user within 48 hours of the oral revision.

Subp. 4. **Retention.** A licensee must retain a copy of the written directive according to part 4731.4501, subpart 1.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4409 PROCEDURES FOR ADMINISTRATIONS REQUIRING WRITTEN DIRECTIVE.

A. For any administration requiring a written directive, a licensee must develop, implement, and maintain written procedures to provide high confidence that:

(1) the patient's or human research subject's identity is verified before each administration; and

(2) each administration is in accordance with the written directive.

B. At a minimum, the procedures required by item A must address the following that are applicable to the licensee's use of radioactive material:

(1) verifying the identity of the patient or human research subject;

(2) verifying that the administration is in accordance with the treatment plan, if applicable, and the written directive;

(3) checking both manual and computer-generated dose calculations;

(4) verifying that any computer-generated dose calculations are correctly transferred into the consoles of therapeutic medical units authorized under part 4731.4404 or 4731.4463;

(5) determining if a medical event, as defined in part 4731.4525, has occurred; and

(6) determining, for permanent implant brachytherapy, within 60 calendar days from the date the implant was performed, the total source strength administered outside of the treatment site compared to the total source strength documented in the post-implantation portion of the written directive, unless a written justification of patient unavailability is documented.

C. A licensee must retain a copy of the procedures required under item A according to part 4731.4501, subpart 2.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440; 46 SR 791*

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4731.4410 SUPPLIERS OF MEDICAL USE SEALED SOURCES OR DEVICES.

For medical use, a licensee may use only:

A. sealed sources or devices manufactured, labeled, packaged, and distributed according to a license issued under parts 4731.3000 to 4731.3175 and 4731.3400 or equivalent requirements of the NRC or an agreement state;

B. sealed sources or devices noncommercially transferred from a licensee licensed under parts 4731.4400 to 4731.4527 or equivalent requirements of the NRC or an agreement state; or

C. teletherapy sources manufactured and distributed according to a license issued under parts 4731.3000 to 4731.3175 or equivalent requirements of the NRC or an agreement state.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*

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4731.4411 RADIATION SAFETY OFFICER AND ASSOCIATE RADIATION SAFETY OFFICER TRAINING.

Subpart 1. **Training and education requirements.** Except as provided under part 4731.4414, a licensee must require an individual fulfilling the responsibilities of a radiation safety officer or an individual assigned duties and tasks as an associate radiation safety officer as provided under part 4731.4405, subpart 1, to be an individual who:

A. (1) is certified by a specialty board whose certification process has been recognized by the NRC or an agreement state. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page; and

(2) has training in the radiation safety, regulatory issues, and emergency procedures for the types of use for which a licensee seeks approval. This training requirement may be satisfied by completing training that is supervised by a radiation safety officer, associate radiation safety officer, authorized medical physicist, authorized nuclear pharmacist, or authorized user, as appropriate, who is authorized for the types of use for which the licensee is seeking approval;

B. (1) has completed a structured educational program consisting of both:

(a) 200 hours of classroom and laboratory training in the following areas:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity;

iv. radiation biology; and

v. radiation dosimetry;

(b) one year of full-time radiation safety experience under the supervision of an individual identified as the radiation safety officer on an NRC or agreement state license or permit issued by an NRC master material licensee that authorizes similar types of uses of radioactive material. An associate radiation safety officer may provide supervision for those areas for which the associate radiation safety officer is authorized on an NRC or agreement state license or permit issued by an NRC master material licensee. The full-time radiation safety experience must involve:

i. shipping, receiving, and performing related radiation surveys;

ii. using and performing checks for proper operation of instruments used to determine the activity of dosages, survey meters, and instruments used to measure radionuclides;

iii. securing and controlling radioactive material;

iv. using administrative controls to avoid mistakes in the administration of radioactive material;

v. using procedures to prevent or minimize radioactive contamination and using proper decontamination procedures;

vi. using emergency procedures to control radioactive material; and

vii. disposing of radioactive material;

(2) has obtained written attestation, signed by a preceptor radiation safety officer or associate radiation safety officer who has experience with the radiation safety aspects of similar types of use of radioactive material for which the individual is seeking approval as a radiation safety officer or an associate radiation safety officer. The written attestation must state that the individual has satisfactorily completed the requirements in this item and is able to independently fulfill the radiation safety-related duties as a radiation safety officer or as an associate radiation safety officer for a medical use licensee; and

(3) has training in the radiation safety, regulatory issues, and emergency procedures for the types of use for which a licensee seeks approval. This training requirement may be satisfied by completing training that is supervised by a radiation safety officer, associate radiation safety officer, authorized medical physicist, authorized nuclear pharmacist, or authorized user, as appropriate, who is authorized for the types of use for which the licensee is seeking approval;

C. (1) is a medical physicist who has been certified by a specialty board whose certification process has been recognized by the NRC or an agreement state under part 4731.4412, has experience in radiation safety for similar types of use of radioactive material for which the licensee is seeking approval of the individual as radiation safety officer or associate radiation safety officer; and

(2) has training in the radiation safety, regulatory issues, and emergency procedures for the types of use for which a licensee seeks approval. This training requirement may be satisfied by completing training that is supervised by a radiation safety officer, associate radiation safety officer, authorized medical physicist, authorized nuclear pharmacist, or authorized user, as appropriate, who is authorized for the types of use for which the licensee is seeking approval;

D. (1) is an authorized user, authorized medical physicist, or authorized nuclear pharmacist identified on an NRC or agreement state license, a permit issued by an NRC master material licensee, a permit issued by an NRC or agreement state licensee of broad scope, or a permit issued by an NRC master material license broad scope permittee, and has experience with the radiation safety aspects of similar types of use of radioactive material for which the individual has radiation safety officer responsibilities; and

(2) has training in the radiation safety, regulatory issues, and emergency procedures for the types of use for which a licensee seeks approval. This training requirement may be satisfied by completing training that is supervised by a radiation safety officer, associate radiation safety officer, authorized medical physicist, authorized nuclear pharmacist, or authorized user, as appropriate, who is authorized for the types of use for which the licensee is seeking approval; or

E. has experience with the radiation safety aspects of the types of use for which the individual is seeking simultaneous approval both as the radiation safety officer and the authorized user on the same new medical use license, and has training in the radiation safety, regulatory issues, and emergency procedures for the types of use for which a licensee seeks approval. This training requirement may be satisfied by completing training that is supervised by a radiation safety officer,

associate radiation safety officer, authorized medical physicist, authorized nuclear pharmacist, or authorized user, as appropriate, who is authorized for the types of use for which the licensee is seeking approval.

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. (1) hold a bachelor's or graduate degree from an accredited college or university in physical science or engineering or biological science with a minimum of 20 college credits in physical science;

(2) have five or more years of professional experience in health physics, including at least three years in applied health physics. Graduate training may be substituted for no more than two years of the required experience; and

(3) pass an examination administered by diplomates of the specialty board, which evaluates knowledge and competence in radiation physics and instrumentation, radiation protection, mathematics pertaining to the use and measurement of radioactivity, radiation biology, and radiation dosimetry; or

B. (1) hold a master's or doctor's degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university;

(2) have two years of full-time practical training or supervised experience in medical physics:

(a) under the supervision of a medical physicist who is certified in medical physics by a specialty board recognized by the NRC or an agreement state; or

(b) in clinical nuclear medicine facilities providing diagnostic or therapeutic services under the direction of physicians who meet the requirements for authorized users in part 4731.4414, 4731.4436, or 4731.4443; and

(3) pass an examination, administered by diplomates of the specialty board, that assesses knowledge and competence in clinical diagnostic radiological or nuclear medicine physics and in radiation safety.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4412 AUTHORIZED MEDICAL PHYSICIST TRAINING.

Subpart 1. **Training and education requirements.** Except as provided in part 4731.4414, a licensee must require an authorized medical physicist to be an individual who:

A. (1) is certified by a specialty board whose certification process has been recognized by the NRC or an agreement state. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page; and

(2) has training for the types of use for which authorization is sought that includes hands-on device operation, safety procedures, clinical use, and the operation of a treatment planning system. This training requirement may be satisfied by satisfactorily completing either a training program provided by the vendor or by training supervised by an authorized medical physicist authorized for the types of use for which the individual is seeking authorization; or

B. (1) holds a master's or doctor's degree in physics, medical physics, other physical science, engineering, or applied mathematics from an accredited college or university, and:

(a) has completed one year of full-time training in medical physics; and

(b) has completed an additional year of full-time work experience under the supervision of an individual who meets the requirements for an authorized medical physicist for the types of use for which the individual is seeking authorization. This training and work experience must be conducted in clinical radiation facilities that provide high-energy, external beam therapy (photons and electrons with energies greater than or equal to 1,000,000 electron volts) and brachytherapy services and must include:

i. performing sealed source leak tests and inventories;

ii. performing decay corrections;

iii. performing full calibration and periodic spot checks of external beam treatment units, stereotactic radiosurgery units, and remote afterloading units as applicable; and

iv. conducting radiation surveys around external beam treatment units, stereotactic radiosurgery units, and remote afterloading units as applicable;

(2) has obtained written attestation that the individual has satisfactorily completed the requirements in this item and is able to independently fulfill the radiation safety-related duties as an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status. The written attestation must be signed by a preceptor authorized medical physicist who meets the requirements in this part, part 4731.4414, or equivalent NRC or agreement state requirements for an authorized medical physicist for each type of therapeutic medical unit for which the individual is requesting authorized medical physicist status; and

(3) has training for the types of use for which authorization is sought that includes hands-on device operation, safety procedures, clinical use, and the operation of a treatment planning system. This training requirement may be satisfied by satisfactorily completing either a training program provided by the vendor or by training supervised by an authorized medical physicist authorized for the types of use for which the individual is seeking authorization.

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. hold a master's or doctor's degree in physics, medical physics, or other physical science, engineering, or applied mathematics from an accredited college or university; and

B. have two years of full-time practical training or supervised experience in medical physics:

(1) under the supervision of a medical physicist who is certified in medical physics by a specialty board recognized by the NRC or an agreement state; or

(2) in clinical radiation facilities providing high-energy, external beam therapy (photons and electrons with energies greater than or equal to 1,000,000 electron volts) and brachytherapy services under the direction of physicians who meet the requirements in part 4731.4414, 4731.4458, or 4731.4479; and

C. pass an examination, administered by diplomates of the specialty board, that assesses knowledge and competence in clinical radiation therapy, radiation safety, calibration, quality assurance, and treatment planning for external beam therapy, brachytherapy, and stereotactic radiosurgery.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4413 AUTHORIZED NUCLEAR PHARMACIST TRAINING.

Subpart 1. **Training and education requirements.** Except as provided in part 4731.4414, a licensee must require an authorized nuclear pharmacist to be a pharmacist who:

A. is certified by a specialty board whose certification process has been recognized by the NRC or an agreement state. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page; or

B. (1) has completed 700 hours in a structured educational program consisting of both:

(a) 200 hours of classroom and laboratory training in the following areas:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity;

iv. chemistry of radioactive material for medical use; and

v. radiation biology; and

(b) supervised practical experience in a nuclear pharmacy involving:

i. shipping, receiving, and performing related radiation surveys;

ii. using and performing checks for proper operation of instruments used to determine the activity of dosages, survey meters, and, if appropriate, instruments used to measure alpha- or beta-emitting radionuclides;

iii. calculating, assaying, and safely preparing dosages for patients or human research subjects;

iv. using administrative controls to avoid medical events in the administration of radioactive material; and

v. using procedures to prevent or minimize radioactive contamination and using proper decontamination procedures; and

(2) has obtained written attestation signed by a preceptor authorized nuclear pharmacist, that the individual has satisfactorily completed the requirements in this item and is able to independently fulfill the radiation safety-related duties as an authorized nuclear pharmacist.

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. have graduated from a pharmacy program accredited by the Accreditation Council for Pharmacy Education (ACPE), previously named the American Council on Pharmaceutical Education, or have passed the Foreign Pharmacy Graduate Examination Committee (FPGEC) examination;

B. hold a current, active license to practice pharmacy;

C. provide evidence of having acquired at least 4,000 hours of training or experience in nuclear pharmacy practice. Academic training may be substituted for no more than 2,000 hours of the required training and experience; and

D. pass an examination in nuclear pharmacy, administered by diplomates of the specialty board, that assesses knowledge and competency in procurement, compounding, quality assurance, dispensing, distribution, health and safety, radiation safety, provision of information and consultation, monitoring patient outcomes, research, and development.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 46 SR 791; 49 SR 1193*

Published Electronically: *May 28, 2025*

4731.4414 TRAINING; EXPERIENCED RADIATION SAFETY OFFICER, TELETHERAPY OR MEDICAL PHYSICIST, AUTHORIZED USER, AND NUCLEAR PHARMACIST.

A. An individual identified as a radiation safety officer, a teletherapy or medical physicist, or a nuclear pharmacist on a license issued by the NRC or an agreement state; a permit issued by an NRC or agreement state broad scope licensee; a master material license permit; or a permit issued by a master material license permittee of broad scope on or before January 14, 2019, need not comply with the training requirements under part 4731.4411, 4731.4412, or 4731.4413, respectively, except a radiation safety officer or authorized medical physicist identified in this item must meet the training requirements in part 4731.4411, subpart 1, item A, subitem (2), or 4731.4412, subpart 1, item A, subitem (2), as appropriate, for any material or uses for which they were not authorized prior to this date.

B. An individual certified by the American Board of Health Physics in Comprehensive Health Physics; American Board of Radiology; American Board of Nuclear Medicine; American Board of Science in Nuclear Medicine; Board of Pharmaceutical Specialties in Nuclear Pharmacy; American Board of Medical Physics in radiation oncology physics; Royal College of Physicians and Surgeons of Canada in nuclear medicine; American Osteopathic Board of Radiology; or American Osteopathic Board of Nuclear Medicine on or before October 24, 2005, need not comply with the training requirements of part 4731.4411 to be identified as a radiation safety officer or as an associate radiation safety officer on a commission or an agreement state license or commission master material license permit for those materials and uses that these individuals performed on or before October 24, 2005.

C. An individual certified by the American Board of Radiology in therapeutic radiological physics, roentgen ray and gamma ray physics, x-ray and radium physics, or radiological physics, or certified by the American Board of Medical Physics in radiation oncology physics on or before October 24, 2005, need not comply with the training requirements for an authorized medical physicist in part 4731.4412 for those materials and uses that these individuals performed on or before October 24, 2005.

D. Physicians, dentists, or podiatrists identified as authorized users for the medical use of radioactive material on a license issued by the NRC or an agreement state; a permit issued by an NRC master material licensee; a permit issued by an NRC or agreement state broad scope licensee; or a permit issued by an NRC master material license broad scope permittee on or before January 14, 2019, who perform only those medical uses for which they were authorized on that date, need not comply with the training requirements of parts 4731.4432 to 4731.4479.

E. Physicians, dentists, or podiatrists not identified as authorized users for the medical use of radioactive material on a license issued by the NRC or an agreement state, a permit issued by an NRC master material licensee, a permit issued by an NRC or agreement state broad scope licensee, or a permit issued in accordance with an NRC master material broad scope license on or before October 24, 2005, need not comply with the training requirements of parts 4731.4432 to 4731.4479 for those materials and uses that these individuals performed on or before October 24, 2005, as follows:

(1) for uses authorized under part 4731.4432 or 4731.4434, or oral administration of sodium iodide I-131 requiring a written directive for imaging and localization purposes, a physician who was certified on or before October 24, 2005, in nuclear medicine by the American Board of Nuclear Medicine, diagnostic radiology by the American Board of Radiology, diagnostic radiology or radiology by the American Osteopathic Board of Radiology, nuclear medicine by the Royal College of Physicians and Surgeons of Canada, or the American Osteopathic Board of Nuclear Medicine in nuclear medicine;

(2) for uses authorized under part 4731.4440, a physician who was certified on or before October 24, 2005, by the American Board of Nuclear Medicine; the American Board of Radiology in radiology, therapeutic radiology, or radiation oncology; nuclear medicine by the Royal College of Physicians and Surgeons of Canada; or the American Osteopathic Board of Radiology after 1984;

(3) for uses authorized under part 4731.4450 or 4731.4463, a physician who was certified on or before October 24, 2005, in radiology, therapeutic radiology, or radiation oncology by the American Board of Radiology; radiation oncology by the American Osteopathic Board of Radiology; radiology, with specialization in radiotherapy, as a British "Fellow of the Faculty of Radiology" or "Fellow of the Royal College of Radiology"; or therapeutic radiology by the Canadian Royal College of Physicians and Surgeons; and

(4) for uses authorized under part 4731.4460, a physician who was certified on or before October 24, 2005, in radiology, diagnostic radiology, therapeutic radiology, or radiation oncology by the American Board of Radiology; nuclear medicine by the American Board of Nuclear Medicine; diagnostic radiology or radiology by the American Osteopathic Board of Radiology; or nuclear medicine by the Royal College of Physicians and Surgeons of Canada.

F. Individuals who need not comply with training requirements described in this part may serve as preceptors for, and supervisors of, applicants seeking authorization on licenses issued under this chapter for the same uses for which these individuals are authorized.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791; 49 SR 1193*
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4731.4415 RECENTNESS OF TRAINING.

The training and experience specified under parts 4731.4405 to 4731.4414 and 4731.4432 to 4731.4479 must have been obtained within the seven years preceding the date of application or the individual must have had related continuing education and experience since the required training and experience was completed.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4420 MEASURING ACTIVITY OF UNSEALED RADIOACTIVE MATERIAL; INSTRUMENTS REQUIRED.

A. For direct measurements performed according to part 4731.4422, a licensee must possess and use instrumentation to measure the activity of unsealed radioactive material before it is administered to a patient or human research subject.

B. A licensee must check and test the instrumentation required under item A according to nationally recognized standards or the manufacturer's instructions and at the following intervals as applicable:

(1) check each instrument for constancy at the beginning of each day of use;

(2) test each instrument for linearity upon installation and at intervals not to exceed three months thereafter;

(3) test each instrument for accuracy upon installation and at intervals not to exceed 12 months thereafter; and

(4) test each instrument for geometry dependence upon installation.

C. A licensee must also perform the required checks and tests in this part following adjustment or repair of the instrument.

D. The licensee must keep a record of geometry dependence for the duration of the use of the instrument and must retain a record of all other instrument checks and tests for three years. The records must include:

(1) the model and serial number of the instrument;

(2) the date of the check or test;

(3) the results of the check or test; and

(4) the name of the individual performing the check or test.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.4421 CALIBRATION OF SURVEY INSTRUMENTS.

A. A licensee must calibrate the survey instruments used to show compliance with parts 4731.2000 to 4731.2950 and 4731.4400 to 4731.4527 before first use, intervals not to exceed 12 months, and following a repair that affects the calibration. A licensee must:

(1) calibrate all scales with readings up to 1,000 millirems (10 mSv) per hour with a radiation source;

(2) calibrate two separate readings on each scale or decade that will be used to show compliance; and

(3) conspicuously note on the instrument the date of calibration.

B. A licensee may not use survey instruments if the difference between the indicated exposure rate and the calculated exposure rate is more than 20 percent.

C. A licensee must retain a record of each survey instrument calibration according to part 4731.4502, subpart 2.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.4422 DETERMINATION OF DOSAGES; UNSEALED RADIOACTIVE MATERIAL.

A. A licensee must determine and record the activity of each dosage before medical use.

B. For a unit dosage, the determination under item A must be made by:

(1) direct measurement of radioactivity; or

(2) a decay correction, based on the activity or activity concentration determined by:

(a) a manufacturer or preparer licensed under part 4731.3395 or equivalent requirements of the NRC or an agreement state;

(b) an NRC or agreement state licensee for use in research according to the radioactive drug research committee-approved protocol or an investigational new drug protocol accepted by the Food and Drug Administration; or

(c) a PET radioactive drug producer licensed according to part 4731.3065, subpart 7, or equivalent requirements of the NRC or an agreement state.

C. For other than unit dosages, the determination under item A must be made by:

(1) direct measurement of radioactivity;

(2) a combination of measurement of radioactivity and mathematical calculations;

(3) a combination of volumetric measurements and mathematical calculations, based on the measurement made by a manufacturer or preparer licensed under part 4731.3395 or equivalent requirements of the NRC or an agreement state; or

(4) a PET radioactive drug producer licensed according to part 4731.3065, subpart 7, or equivalent requirements of the NRC or an agreement state.

D. Unless otherwise directed by the authorized user, a licensee may not use a dosage if the dosage does not fall within the prescribed dosage range or if the dosage differs from the prescribed dosage by more than 20 percent.

E. A licensee must retain a record of the dosage determination required under this part according to part 4731.4503.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.4423 AUTHORIZATION FOR CHECK, CALIBRATION, TRANSMISSION, AND REFERENCE USE.

Subpart 1. **Check, calibration, transmission, and reference use.** A person authorized under part 4731.4403, subpart 1, for medical use of radioactive material may receive, possess, and use the following radioactive material for check, calibration, transmission, and reference use:

A. sealed sources that do not exceed 30 millicuries (1.11 GBq) each and that are manufactured and distributed by a person licensed under part 4731.3400 or equivalent requirements of the NRC or an agreement state;

B. sealed sources that do not exceed 30 millicuries (1.11 GBq) each and that are redistributed by a licensee authorized to redistribute the sealed sources manufactured and distributed by a person licensed under part 4731.3400, providing the redistributed sealed sources are in the original packaging and shielding and are accompanied by the manufacturer's approved instructions;

C. any radioactive material with a half-life not longer than 120 days in individual amounts not to exceed 15 millicuries (0.56 GBq);

D. any radioactive material with a half-life longer than 120 days in individual amounts not to exceed the smaller of 200 microcuries (7.4 MBq) or 1,000 times the quantities in part 4731.3160; and

E. technetium-99m in amounts as needed.

Subp. 2. **Restriction of use.** Radioactive material in sealed sources authorized by this part must not be:

A. used for medical use as defined in part 4731.0100 except in accordance with the requirements in part 4731.4460; or

B. combined (i.e., bundled or aggregated) to create an activity greater than the maximum activity of any single sealed source authorized under this part.

Subp. 3. **Listing on license.** A licensee using calibration, transmission, and reference sources in accordance with subpart 1 or 2 need not list these sources on a specific medical use license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4424 POSSESSION OF SEALED SOURCES AND BRACHYTHERAPY SOURCES; REQUIREMENTS.

A. A licensee in possession of any sealed source or brachytherapy source must follow the radiation safety and handling instructions supplied by the manufacturer.

B. A licensee in possession of a sealed source must:

(1) test the source for leakage before its first use unless the licensee has a certificate from the supplier indicating that the source was tested within six months before transfer to the licensee; and

(2) test the source for leakage at intervals not to exceed six months or at other intervals approved by the NRC or an agreement state in the sealed source and device registry.

C. To satisfy the leak test requirements under item B, a licensee must measure the sample so that the leak test can detect the presence of 0.005 microcurie (185 Bq) of radioactive material on the sample.

D. A licensee must retain leak test records according to part 4731.4504, subpart 1.

E. If the leak test reveals the presence of 0.005 microcurie (185 Bq) or more of removable contamination, the licensee must:

(1) immediately withdraw the sealed source from use and store, dispose, or cause it to be repaired according to parts 4731.2000 to 4731.2950 and 4731.3000 to 4731.3175; and

(2) file a report within five days of the leak test according to part 4731.4527.

F. A licensee need not perform a leak test on:

(1) sources containing only radioactive material with a half-life of less than 30 days;

(2) sources containing only radioactive material as a gas;

(3) sources containing 100 microcuries (3.7 MBq) or less of beta- or gamma-emitting material or ten microcuries (0.37 MBq) or less of alpha-emitting material;

(4) seeds of iridium-192 encased in nylon ribbon; or

(5) sources stored and not being used. The licensee must, however, test each source under this subitem for leakage before any use or transfer, unless it has been leak-tested within six months before the date of use or transfer.

G. A licensee in possession of sealed sources or brachytherapy sources, except for gamma stereotactic radiosurgery sources, must conduct a semiannual physical inventory of all such sources in the licensee's possession. The licensee must retain each inventory record according to part 4731.4504, subpart 2.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4425 LABELING VIALS AND SYRINGES.

Each syringe and vial that contains unsealed radioactive material must be labeled to identify the radioactive drug. Each syringe shield and vial shield must also be labeled unless the label on the syringe or vial is visible when shielded.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4426 SURVEYS OF AMBIENT RADIATION EXPOSURE RATE.

A. In addition to the surveys required under parts 4731.2000 to 4731.2950, a licensee must survey with a radiation detection survey instrument at the end of each day of use all areas where unsealed radioactive materials requiring a written directive were prepared for use or administered.

B. A licensee need not perform the surveys required under item A in an area where patients or human research subjects are confined when they cannot be released under part 4731.4427.

C. A licensee must retain a record of each survey according to part 4731.4505.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4427 RELEASE OF INDIVIDUALS CONTAINING UNSEALED RADIOACTIVE MATERIAL OR IMPLANTS.

A. A licensee may authorize release from licensee control of an individual who has been administered unsealed radioactive material or implants containing radioactive material if the total effective dose equivalent to any other individual from exposure to the released individual is not likely to exceed 0.5 rem (5 mSv).

B. A licensee must provide the released individual, or the individual's parent or guardian, with instructions, including written instructions, on actions recommended to maintain doses to other individuals as low as is reasonably achievable if the total effective dose equivalent to any other individual is likely to exceed 0.1 rem (1 mSv). If the total effective dose equivalent to a nursing infant or child could exceed 0.1 rem (1 mSv), assuming there were no interruption of breast-feeding, the instructions must also include guidance on the interruption or discontinuation of breast-feeding and information on the potential consequences, if any, of failure to follow the guidance.

C. A licensee must maintain a record of the basis for authorizing the release of the individual according to part 4731.4506, subpart 1.

D. A licensee must maintain a record of instructions provided to a breast-feeding woman according to part 4731.4506, subpart 2.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831*

Published Electronically: *March 12, 2009*

4731.4428 MOBILE MEDICAL SERVICE.

A. A licensee providing mobile medical service must:

(1) obtain a letter signed by the management of each client for which services are rendered that permits the use of radioactive material at the client's address and clearly delineates the authority and responsibility of the licensee and the client;

(2) check instruments used to measure the activity of unsealed radioactive material for proper function before medical use at each client's address or on each day of use, whichever is more frequent. At a minimum, the check for proper function required by this subitem must include a constancy check;

(3) check survey instruments for proper operation with a dedicated check source before use at each client's address; and

(4) before leaving a client's address, survey all areas of use to ensure compliance with parts 4731.2000 to 4731.2950.

B. A mobile medical service may not have radioactive material delivered from the manufacturer or the distributor to the client unless the client has a license allowing possession of the radioactive material. Radioactive material delivered to the client must be received and handled in conformance with the client's license.

C. A licensee providing mobile medical services must retain the letter required under item A, subitem (1), and the record of each survey required under item A, subitem (4), according to part 4731.4507.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4429 DECAY-IN-STORAGE.

A licensee may hold radioactive material with a physical half-life of less than or equal to 120 days for decay-in-storage before disposal without regard to its radioactivity, if the licensee adheres to the requirements of part 4731.2405.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*
Published Electronically: *March 12, 2009*

4731.4430 CONTROL OF AEROSOLS AND GASES.

Subpart 1. **Collection system.** A licensee who administers radioactive aerosols or gases must do so with a system that will keep airborne concentrations within the limits prescribed by parts 4731.2020 and 4731.2090.

Subp. 2. **System vented or system collection.** The system must either be directly vented to the atmosphere through an air exhaust or provide for collection and decay or disposal of the aerosol or gas in a shielded container.

Subp. 3. **Negative pressure required.** A licensee must only administer radioactive gases in rooms that are at negative pressure compared to surrounding rooms.

Subp. 4. **Calculation of time needed after a release.** Before receiving, using, or storing a radioactive gas, the licensee must calculate the amount of time needed after a release to reduce the concentration in the area of use to the occupational limit listed in part 4731.2750. The calculation must be based on the highest activity of gas handled in a single container and the measured available air exhaust rate.

Subp. 5. **Posting time needed after a release.** A licensee must post the time needed after a release to reduce the concentration to the occupational limit calculated for the area of use and require that, in case of a gas spill, individuals evacuate the room until the posted time has elapsed.

Subp. 6. **Monthly check on collection system.** A licensee must check the operation of collection systems monthly and measure the ventilation rates in areas of use at intervals not to exceed six months.

Subp. 7. **Records retention.** Records of these checks and measurements must be maintained for three years.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *36 SR 74*

Published Electronically: *August 15, 2011*

4731.4432 UNSEALED RADIOACTIVE MATERIAL; UPTAKE, DILUTION, AND EXCRETION STUDIES; WRITTEN DIRECTIVE NOT REQUIRED.

Except for quantities that require a written directive under part 4731.4408 or 4731.4409, a licensee may use any unsealed radioactive material prepared for medical use for uptake, dilution, or excretion studies that is:

A. obtained from a manufacturer or preparer licensed under part 4731.3395 or equivalent requirements of the NRC or an agreement state or a PET radioactive drug producer licensed according to part 4731.3065, subpart 7, or equivalent requirements of the NRC or an agreement state;

B. excluding production of PET radionuclides, prepared by:

(1) an authorized nuclear pharmacist;

(2) a physician who is an authorized user and who meets the requirements of part 4731.4436 or parts 4731.4436, subpart 1, item C, subitem (1), unit (b), subunit vii, and 4731.4443; or

(3) an individual under the supervision, according to part 4731.4407, of the authorized nuclear pharmacist in subitem (1) or the physician who is an authorized user in subitem (2);

C. obtained from and prepared for a commissioner, NRC, or agreement state licensee for use in research according to a radioactive drug research committee-approved protocol or an investigational new drug protocol accepted by the Food and Drug Administration; or

D. prepared by the licensee for use in research according to a radioactive drug research committee-approved application or an investigational new drug protocol accepted by the Food and Drug Administration.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.4433 UPTAKE, DILUTION, AND EXCRETION STUDIES; TRAINING.

Subpart 1. **Training and education requirements.** Except as provided under part 4731.4414, a licensee must require the authorized user of unsealed radioactive material for the uses authorized under part 4731.4432 to be a physician who:

A. is certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page;

B. is an authorized user under part 4731.4436 or 4731.4443 or under equivalent requirements of the NRC or an agreement state; or

C. has:

(1) completed 60 hours of training and experience, including a minimum of eight hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material for uptake, dilution, and excretion studies. The training and experience must include:

(a) classroom and laboratory training in the following areas:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity;

iv. chemistry of radioactive material for medical use; and

v. radiation biology; and

(b) work experience, under the supervision of an authorized user who meets the requirements in this part, part 4731.4414, 4731.4436, or 4731.4443, or equivalent requirements of the NRC or an agreement state, involving:

i. ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

ii. performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

iii. calculating, measuring, and safely preparing patient or human research subject dosages;

iv. using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

v. using procedures to safely contain spilled radioactive material and using proper decontamination procedures; and

vi. administering dosages of radioactive drugs to patients or human research subjects; and

(2) obtained written attestation that the individual has satisfactorily completed the requirements in this item and is able to independently fulfill the radiation safety-related duties as an authorized user for the medical uses authorized under part 4731.4432. The attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements in part 4731.4414, 4731.4433, 4731.4436, or 4731.4443, or equivalent requirements of the NRC or an agreement state; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements in part 4731.4414, 4731.4433, 4731.4436, or 4731.4443, or equivalent requirements of the NRC or an agreement state, and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this item.

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. complete 60 hours of training and experience in basic radionuclide handling techniques and radiation safety applicable to the medical use of unsealed radioactive material for uptake, dilution, and excretion studies that include the topics listed in subpart 1, item C, subitem (1), units (a) and (b); and

B. pass an examination, administered by diplomates of the specialty board, that assesses knowledge and competence in radiation safety, radionuclide handling, and quality control.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4434 UNSEALED RADIOACTIVE MATERIAL; IMAGING AND LOCALIZATION STUDIES; WRITTEN DIRECTIVE NOT REQUIRED.

Except for quantities that require a written directive under part 4731.4408, a licensee may use any unsealed radioactive material prepared for medical use for imaging and localization studies that is:

A. obtained from a manufacturer or preparer licensed under part 4731.3395 or equivalent requirements of the NRC or an agreement state or a PET radioactive drug producer licensed according to part 4731.3065, subpart 7, or equivalent requirements of the NRC or an agreement state;

B. excluding production of PET radionuclides, prepared by:

(1) an authorized nuclear pharmacist;

(2) a physician who is an authorized user and meets the requirements specified in part 4731.4436; or parts 4731.4436, subpart 1, item C, subitem (1), unit (b), subunit vii, and 4731.4443; or

(3) an individual under the supervision, according to part 4731.4407, of the authorized nuclear pharmacist in subitem (1) or the physician who is an authorized user in subitem (2);

C. obtained from and prepared by an NRC or agreement state licensee for use in research according to a radioactive drug research committee-approved protocol or an investigational new drug protocol accepted by the Food and Drug Administration; or

D. prepared by the licensee for use in research according to a radioactive drug research committee-approved application or an investigational new drug protocol accepted by the Food and Drug Administration.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 33 SR 1440*

Published Electronically: *March 12, 2009*

4731.4435 PERMISSIBLE MOLYBDENUM-99, STRONTIUM-82, AND STRONTIUM-85 CONCENTRATION.

A. A licensee may not administer to humans a radiopharmaceutical that contains:

(1) more than 0.15 microcurie of molybdenum-99 per millicurie of technetium-99m (0.15 kilobecquerel of molybdenum-99 per megabecquerel of technetium-99m);

(2) more than 0.02 microcuries of strontium-82 per millicurie of rubidium-82 chloride injection (0.02 kBq of strontium-82 per MBq of rubidium-82 chloride); or

(3) more than 0.2 microcuries of strontium-85 per millicurie of rubidium-82 chloride injection (0.2 kBq of strontium-85 per MBq of rubidium-82).

B. A licensee that uses molybdenum-99/technetium-99m generators for preparing a technetium-99m radiopharmaceutical must measure the molybdenum-99 concentration in each eluate from a generator to demonstrate compliance with item A.

C. A licensee that uses a strontium-82/rubidium-82 generator for preparing a rubidium-82 radiopharmaceutical must, before the first patient use of the day, measure the concentration of strontium-82 and strontium-85 radionuclides to demonstrate compliance with item A.

D. If a licensee is required to measure the molybdenum-99 concentration or strontium-82 and strontium-85 concentrations, the licensee must retain a record of each measurement according to part 4731.4509.

E. The licensee must report any measurement that exceeds the limits in item A at the time of generator elution, in accordance with part 4731.4528.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4436 IMAGING AND LOCALIZATION STUDIES; TRAINING.

Subpart 1. **Training and education requirements.** Except as provided under part 4731.4414, a licensee must require an authorized user of unsealed radioactive material for the uses authorized under part 4731.4434 to be a physician who:

A. is certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state. The names of board certification that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page;

B. is an authorized user under part 4731.4443 and meets the requirements in item C, subitem (1), unit (b), subunit vii, or equivalent requirements of the NRC or an agreement state; or

C. has:

(1) completed 700 hours of training and experience, including a minimum of 80 hours of classroom and laboratory training, in basic radionuclide handling techniques applicable to the medical use of unsealed radioactive material for imaging and localization studies. The training and experience must include, at a minimum:

(a) classroom and laboratory training in the following areas:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity;

iv. chemistry of radioactive material for medical use; and

v. radiation biology; and

(b) work experience, under the supervision of an authorized user who meets the requirements in this part, part 4731.4414, or in subunit vii and part 4731.4443, or equivalent requirements of the NRC or an agreement state. An authorized nuclear pharmacist who meets the requirements in part 4731.4413 or 4731.4414 may provide the supervised work experience for subunit vii. Work experience must involve:

i. ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

ii. performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

iii. calculating, measuring, and safely preparing patient or human research subject dosages;

iv. using administrative controls to prevent a medical event involving the use of unsealed radioactive material;

v. using procedures to safely contain spilled radioactive material and using proper decontamination procedures;

vi. administering dosages of radioactive drugs to patients or human research subjects; and

vii. eluting generator systems, appropriate for preparation of radioactive drugs for imaging and localization studies, measuring and testing the eluate for radionuclidic purity, and processing the eluate with reagent kits to prepare labeled radioactive drugs; and

(2) obtained written attestation that the individual physician has satisfactorily completed the requirements in this item and is able to independently fulfill the radiation safety-related duties as an authorized user for the medical uses authorized under parts 4731.4432 and 4731.4434. The attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements in this part, part 4731.4414, or in subitem (1), unit (b), subunit vii, and part 4731.4443, or equivalent requirements of the NRC or an agreement state; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements in this part, part 4731.4414, or in subitem (1), unit (b), subunit vii, and part 4731.4443, or equivalent requirements of the NRC or an agreement state, and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in this item.

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. complete 700 hours of training and experience in basic radionuclide handling techniques and radiation safety applicable to the medical use of unsealed radioactive material for imaging and localization studies that include the topics listed in subpart 1, item C, subitem (1), units (a) and (b); and

B. pass an examination administered by diplomates of the specialty board, which assesses knowledge and competence in radiation safety, radionuclide handling, and quality control.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

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4731.4440 UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE REQUIRED.

A licensee may use any unsealed radioactive material identified in part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi, prepared for medical use and for which a written directive is required that is:

A. obtained from a manufacturer or preparer licensed under part 4731.3395 or equivalent requirements of the NRC or an agreement state or a PET radioactive drug producer licensed according to part 4731.3065, subpart 7, or equivalent requirements of the NRC or an agreement state;

B. excluding production of PET radionuclides, prepared by an authorized nuclear pharmacist, a physician who is an authorized user and meets the requirements under part 4731.4436 or 4731.4443, or an individual under the supervision of either, as specified under part 4731.4407;

C. obtained from and prepared by a commissioner, NRC, or agreement state licensee for use in research according to an investigational new drug protocol accepted by the Food and Drug Administration; or

D. prepared by the licensee for use in research according to an investigational new drug protocol accepted by the Food and Drug Administration.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440; 46 SR 791*

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4731.4441 SAFETY INSTRUCTIONS.

A. In addition to the requirements of part 4731.1020, a licensee must provide radiation safety instruction, initially and at least annually, to personnel caring for patients or human research subjects who cannot be released under part 4731.4427. To satisfy this requirement, the instruction must be commensurate with the duties of the personnel and include:

(1) patient or human research subject control;

(2) visitor control, including:

(a) routine visitation of hospitalized individuals according to part 4731.2090, subpart 1, item A; and

(b) visitation authorized under part 4731.2090, subpart 3;

(3) contamination control;

(4) waste control; and

(5) notification of the radiation safety officer or the officer's designee and the authorized user if the patient or human research subject has a medical emergency or dies.

B. A licensee must retain a record of individuals receiving instruction according to part 4731.4510.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4442 SAFETY PRECAUTIONS.

A. For each patient or human research subject who cannot be released under part 4731.4427, a licensee must:

(1) quarter the patient or the human research subject in:

(a) a private room with a private sanitary facility; or

(b) a room, with a private sanitary facility, with another individual who also has received therapy with unsealed radioactive material and who also cannot be released under part 4731.4427;

(2) visibly post the patient's or the human research subject's room with a "Radioactive Materials" sign;

(3) note on the door or in the patient's or human research subject's chart where and how long visitors may stay in the patient's or human research subject's room; and

(4) either:

(a) monitor material and items removed from the patient's or human research subject's room to determine that their radioactivity cannot be distinguished from the natural background radiation level with a radiation detection survey instrument set on its most sensitive scale and with no interposed shielding; or

(b) handle the material and items as radioactive waste.

B. A licensee must notify the radiation safety officer or the officer's designee and the authorized user as soon as possible if the patient or human research subject has a medical emergency or dies.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4443 UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE REQUIRED; TRAINING.

Subpart 1. **Training and education requirements.** Except as provided under part 4731.4414, a licensee must require an authorized user of unsealed radioactive material for the uses authorized under part 4731.4440 to be a physician who:

A. is certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state, and meets the requirements in item B, subitem (1), unit (b), subunit vi. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page; or

B. has:

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

(a) classroom and laboratory training in:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity;

iv. chemistry of radioactive material for medical use; and

v. radiation biology; and

(b) work experience, under the supervision of an authorized user who meets the requirements in this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state. A supervising authorized user who meets the requirements in this item must also have experience in administering dosages in the same dosage category or categories under subunit vi as the individual requesting authorized user status. The work experience must involve:

i. ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

ii. performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

iii. calculating, measuring, and safely preparing patient or human research subject dosages;

iv. using administrative controls to prevent a medical event involving the use of radioactive material;

v. using procedures to safely contain spilled radioactive material and using proper decontamination procedures; and

vi. administering dosages of radioactive drugs to patients or human research subjects from the three categories in this subunit. Radioactive drugs containing radionuclides in categories not included in this subunit are regulated under part 4731.4404. This work experience must involve a minimum of three cases in each of the following categories for which the individual is requesting authorized user status: oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for which a written directive is required; oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) (experience with at least three cases also satisfies the requirement of oral administration of less than or equal to 33 millicuries of I-131); parenteral administration of any radioactive drug that contains a radionuclide that is primarily used for its electron emission, beta radiation characteristics, alpha radiation characteristics, or a photon energy of less than 150 kilo electron volts for which a written directive is required; and

(2) obtained written attestation that the individual has satisfactorily completed the requirements in this item and is able to independently fulfill the radiation safety-related duties as an authorized user for the medical uses authorized under part 4731.4440 for which the individual is requesting authorized user status. The attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state and has experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state; has experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status; and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subitem (1).

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. successfully complete residency training in a radiation therapy or nuclear medicine training program or a program in a related medical specialty. These residency training programs must include 700 hours of training and experience as described in subpart 1, item B, subitem (1), units (a) and (b), subunits i to v. Eligible training programs must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association; and

B. pass an examination, administered by diplomates of the specialty board, that tests knowledge and competence in radiation safety, radionuclide handling, quality assurance, and clinical use of unsealed radioactive material for which a written directive is required.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*
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4731.4444 ORAL ADMINISTRATION OF SODIUM IODIDE I-131; QUANTITIES LESS THAN OR EQUAL TO 33 MILLICURIES (1.22 GBq); WRITTEN DIRECTIVE REQUIRED; TRAINING.

Except as provided under part 4731.4414, a licensee must require an authorized user for the oral administration of sodium iodide (I-131) requiring a written directive in quantities less than or equal to 33 millicuries (1.22 GBq) to be a physician who:

A. is certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state and includes all of the requirements of item C, subitems (1) and (2). The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page;

B. is an authorized user under part 4731.4443, for oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for which a written directive is required or oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) under part 4731.4443 or 4731.4445, or under equivalent requirements of the NRC or an agreement state; or

C. has:

(1) successfully completed 80 hours of classroom and laboratory training, applicable to the medical use of sodium iodide (I-131) for procedures requiring a written directive. The training must include:

(a) radiation physics and instrumentation;

(b) radiation protection;

(c) mathematics pertaining to the use and measurement of radioactivity;

(d) chemistry of radioactive material for medical use; and

(e) radiation biology;

(2) work experience under the supervision of an authorized user who meets the requirements of this part, part 4731.4414, 4731.4443, or 4731.4445, or equivalent requirements of the NRC or an agreement state. A supervising authorized user who meets the requirements in part 4731.4443, subpart 1, item B, must also have experience in oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for which a written directive is required or oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) as specified in part 4731.4443. The work experience must involve:

(a) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(b) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for the proper operation of survey meters;

(c) calculating, measuring, and safely preparing patient or human research subject dosages;

(d) using administrative controls to prevent a medical event involving the use of radioactive materials;

(e) using procedures to safely contain spilled radioactive material and using proper decontamination procedures; and

(f) administering dosages to patients or human research subjects that include at least three cases involving the oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide I-131; and

(3) obtained written attestation that the individual has satisfactorily completed the requirements of this item and is able to independently fulfill the radiation safety-related duties as an authorized user for oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide I-131 for medical uses authorized under part 4731.4440. The written attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements of this part, part 4731.4414, 4731.4443, or 4731.4445, or equivalent requirements of the NRC or an agreement state and has experience in oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for which a written directive is required or oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) as specified in part 4731.4443; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements of this part, part 4731.4414, 4731.4443, or 4731.4445, or equivalent requirements of the NRC or an agreement state; has experience in oral administration of less than or equal to 33 millicuries (1.22 GBq) of sodium iodide (I-131) for which a written directive is required or oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide (I-131) as specified in part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi; and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical

Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subitems (1) and (2).

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

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4731.4445 ORAL ADMINISTRATION OF SODIUM IODIDE; QUANTITIES GREATER THAN 33 MILLICURIES (1.22 GBq); WRITTEN DIRECTIVE REQUIRED; TRAINING.

Except as provided under part 4731.4414, a licensee must require an authorized user for the oral administration of sodium iodide (I-131) requiring a written directive in quantities greater than 33 millicuries (1.22 GBq) to be a physician who:

A. is certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state and includes all the requirements in item C, subitems (1) and (2). The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page;

B. is an authorized user for the oral administration of I-131 in quantities greater than 33 millicuries under part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi; or equivalent requirements of the NRC or an agreement state; or

C. has:

(1) successfully completed 80 hours of classroom and laboratory training, applicable to the medical use of I-131 for procedures requiring a written directive. The training must include:

(a) radiation physics and instrumentation;

(b) radiation protection;

(c) mathematics pertaining to the use and measurement of radioactivity;

(d) chemistry of radioactive materials for medical use; and

(e) radiation biology;

(2) work experience under the supervision of an authorized user who meets the requirements of this part, part 4731.4414 or 4731.4443, or equivalent requirements of the NRC or an agreement state. A supervising authorized user who meets the requirements in part 4731.4443, subpart 1, item B, must also have experience in the oral administration of I-131 in quantities greater than 33 millicuries under part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi. The work experience must involve:

(a) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(b) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(c) calculating, measuring, and safely preparing patient or human research subject dosages;

(d) using administrative controls to prevent a medical event involving the use of radioactive material;

(e) using procedures to safely contain spilled radioactive material and using proper decontamination procedures; and

(f) administering dosages to patients or human research subjects, including at least three cases involving the oral administration of greater than 33 millicuries (1.22 GBq) of I-131; and

(3) obtained written attestation that the individual has satisfactorily completed the requirements of this item and is able to independently fulfill the radiation-related duties as an authorized user for oral administration of greater than 33 millicuries (1.22 GBq) of sodium iodide I-131 for medical uses authorized under part 4731.4440. The written attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements in this part, part 4731.4414 or 4731.4443, or equivalent requirements of the NRC or an agreement state, and has experience in the oral administration of I-131 in quantities greater than 33 millicuries (1.22 GBq) as specified in part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements in this part, part 4731.4414 or 4731.4443, or equivalent requirements of the NRC or an agreement state; has experience in the oral administration of I-131 in quantities greater than 33 millicuries (1.22 GBq) as specified in part 4731.4443, subpart 1, item B, subitem (1), unit (b), subunit vi; and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subitems (1) and (2).

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

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4731.4446 PARENTERAL ADMINISTRATION OF UNSEALED RADIOACTIVE MATERIAL; WRITTEN DIRECTIVE REQUIRED; TRAINING.

A. Except as provided in part 4731.4414, the licensee must require an authorized user for the parenteral administration requiring a written directive to be a physician who is:

(1) an authorized user under part 4731.4443 for the parenteral administration of any radioactive drug that contains a radionuclide that is primarily used for its electron emission, beta radiation characteristics, alpha radiation characteristics, or a photon-energy of less than 150 kilo electron volts for which a written directive is required, or equivalent requirements of the NRC or an agreement state;

(2) an authorized user under part 4731.4458 or 4731.4479 or equivalent requirements of the NRC or an agreement state and meets the requirements in item B; or

(3) certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state under part 4731.4458 or 4731.4479 and meets the requirements in item B.

B. The physician under item A, subitems (2) and (3), must have:

(1) successfully completed 80 hours of classroom and laboratory training, applicable to parenteral administrations of any radioactive drug that contains a radionuclide that is primarily used for its electron emission, beta radiation characteristics, alpha radiation characteristics, or a photon-energy of less than 150 kilo electron volts for which a written directive is required. The training must include:

(a) radiation physics and instrumentation;

(b) radiation protection;

(c) mathematics pertaining to the use and measurement of radioactivity;

(d) chemistry of radioactive material for medical use; and

(e) radiation biology;

(2) work experience, under the supervision of an authorized user who meets the requirements in this part, part 4731.4414 or 4731.4443, or equivalent requirements of the NRC or agreement state, in the parenteral administration of any radioactive drug that contains a radionuclide that is primarily used for its electron emission, beta radiation characteristics, alpha radiation characteristics, or a photon-energy of less than 150 kilo electron volts for which a written directive is required. A supervising authorized user who meets the requirements in this part or part 4731.4443, or equivalent requirements of the NRC or agreement state, must have experience in administering dosages in the same category or categories as the individual requesting authorized user status. The work experience must involve:

(a) ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

(b) performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

(c) calculating, measuring, and safely preparing patient or human research subject dosages;

(d) using administrative controls to prevent a medical event involving the use of unsealed radioactive materials;

(e) using procedures to contain spilled radioactive materials safely and using proper decontamination procedures; and

(f) administering dosages to patients or human research subjects, that include at least three cases involving the parenteral administration, for which a written directive is required, of any radioactive drug that contains a radionuclide that is primarily used for its electron emission, beta radiation characteristics, alpha radiation characteristics, or a photon-energy of less than 150 kilo electron volts; and

(3) obtained written attestation that the individual has satisfactorily completed the requirements in this item and item A, subitem (2) or (3), and is able to independently fulfill the radiation safety-related duties as an authorized user for the parenteral administration of unsealed radioactive material requiring a written directive. The written attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements in this part, part 4731.4414, or 4731.4443, or equivalent requirements of the NRC or agreement state. A preceptor authorized user who meets the requirements in this part or part 4731.4443, or equivalent requirements of the NRC or agreement state, must have experience in administering dosages in the same category or categories as the individual requesting authorized user status; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements in this part, part 4731.4414 or 4731.4443, or equivalent requirements of the NRC or agreement state; has experience in administering dosages in the same dosage category or categories as the individual requesting authorized user status; and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subitems (1) and (2).

Statutory Authority: *MS s 144.1202; 144.1203*

History: *32 SR 831; 36 SR 74; 46 SR 791*

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4731.4450 USE OF BRACHYTHERAPY SOURCES.

A licensee must use only brachytherapy sources:

A. as approved in the sealed source and device registry for manual brachytherapy medical use. The manual brachytherapy sources may be used for manual brachytherapy uses that are not explicitly listed in the sealed source and device registry, but must be used in accordance with the radiation safety conditions and limitations described in the sealed source and device registry; or

B. in research to deliver therapeutic doses for medical use, according to an active investigational device exemption application accepted by the Food and Drug Administration, provided the requirements of part 4731.4410, item A, are met.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4451 SURVEYS AFTER SOURCE IMPLANT AND REMOVAL.

A. Immediately after implanting sources in a patient or human research subject, a licensee must make a survey to locate and account for all sources that have not been implanted.

B. Immediately after removing the last temporary implant source from a patient or human research subject, a licensee must make a survey of the patient or human research subject with a radiation detection survey instrument to confirm that all sources have been removed.

C. A licensee must retain a record of the surveys required under this part according to part 4731.4511.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4452 BRACHYTHERAPY SOURCES ACCOUNTABILITY.

A. A licensee must maintain accountability at all times for all brachytherapy sources in storage or use.

B. As soon as possible after removing sources from a patient or human research subject, a licensee must return brachytherapy sources to a secure storage area.

C. A licensee must maintain a record of the brachytherapy source accountability according to part 4731.4512.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4453 BRACHYTHERAPY; SAFETY INSTRUCTIONS.

A. In addition to the requirements of part 4731.1020, a licensee must provide radiation safety instruction, initially and at least annually, to personnel caring for patients or human research subjects who are receiving brachytherapy and cannot be released under part 4731.4427. To satisfy this requirement, the instruction must be commensurate with the duties of the personnel and include:

(1) the size and appearance of the brachytherapy source;

(2) safe handling and shielding instructions;

(3) patient or human research subject control;

(4) visitor control, including:

(a) routine visitation of hospitalized individuals according to part 4731.2090, subpart 1, item A; and

(b) visitation authorized under part 4731.2090, subpart 3; and

(5) notification of the radiation safety officer or the officer's designee and an authorized user if the patient or human research subject has a medical emergency or dies.

B. A licensee must retain a record of individuals receiving instruction according to part 4731.4510.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4454 BRACHYTHERAPY; SAFETY PRECAUTIONS.

A. For each patient or human research subject who is receiving brachytherapy and cannot be released under part 4731.4427, a licensee must:

(1) not quarter the patient or human research subject in the same room as an individual who is not receiving brachytherapy;

(2) visibly post the patient's or human research subject's room with a "Radioactive Materials" sign; and

(3) note on the door or in the patient's or human research subject's chart where and how long visitors may stay in the patient's or human research subject's room.

B. A licensee must have applicable emergency response equipment available near each treatment room to respond to a source:

(1) dislodged from the patient; or

(2) lodged within the patient following removal of the source applicators.

C. A licensee must notify the radiation safety officer or the officer's designee and an authorized user as soon as possible if the patient or human research subject has a medical emergency or dies.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4455 BRACHYTHERAPY; CALIBRATION MEASUREMENTS.

A. Before the first medical use of a brachytherapy source, a licensee must have:

(1) determined the source output or activity using a dosimetry system that meets the requirements of part 4731.4468, subpart 1;

(2) determined source positioning accuracy within applicators; and

(3) used published protocols currently accepted by nationally recognized bodies to meet the requirements of this item.

B. A licensee may use measurements provided by the source manufacturer or by a calibration laboratory accredited by the American Association of Physicists in Medicine that are made according to item A.

C. A licensee must mathematically correct the outputs or activities determined under item A for physical decay at intervals consistent with one percent physical decay.

D. A licensee must retain a record of each calibration according to part 4731.4513.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4456 DECAY OF STRONTIUM-90 SOURCES FOR OPHTHALMIC TREATMENTS.

A. Licensees who use strontium-90 for ophthalmic treatments must ensure that certain activities as specified in item B are performed by either:

(1) an authorized medical physicist; or

(2) an individual who:

(a) is identified as an ophthalmic physicist on a:

i. specific medical use license issued by the commissioner, the NRC, or an agreement state;

ii. permit issued by the commissioner, the NRC, or an agreement state broad scope medical use licensee;

iii. medical use permit issued by an NRC master material licensee; or

iv. permit issued by an NRC master material licensee broad scope medical use permittee; and

(b) holds a master's or doctorate degree in physics, medical physics, other physical sciences, engineering, or applied mathematics from an accredited college or university; and

(c) has successfully completed one year of full-time training in medical physics and an additional year of full-time work experience under the supervision of a medical physicist; and

(d) has documented training in:

i. the creation, modification, and completion of written directives;

ii. procedures for administrations requiring a written directive; and

iii. performing the calibration measurements of brachytherapy sources as detailed in part 4731.4455.

B. The individuals who are identified in item A must:

(1) calculate the activity of each strontium-90 source that is used to determine the treatment times for ophthalmic treatments. The decay must be based on the activity determined under part 4731.4455; and

(2) assist the licensee in developing, implementing, and maintaining written procedures to provide high confidence that the administration is in accordance with the written directive. These procedures must include the frequencies that the individual meeting the requirements in item A will observe treatments, review the treatment methodology, calculate treatment time for the prescribed dose, and review records to verify that the administrations were in accordance with the written directives.

C. A licensee must maintain a record of the activity of each strontium-90 source according to part 4731.4514.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4457 THERAPY-RELATED COMPUTER SYSTEMS.

A licensee must perform acceptance testing on the treatment planning system of therapy-related computer systems according to published protocols accepted by nationally recognized bodies. At a minimum, the acceptance testing must include, as applicable, verification of:

A. the source-specific input parameters required by the dose calculation algorithm;

B. the accuracy of dose, dwell time, and treatment time calculations at representative points;

C. the accuracy of isodose plots and graphic displays; and

D. the accuracy of the software used to determine sealed source positions from radiographic images.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4458 MANUAL BRACHYTHERAPY TRAINING.

Subpart 1. **Training and education requirements.** Except as provided under part 4731.4414, a licensee must require an authorized user of a manual brachytherapy source for the uses authorized under part 4731.4450 to be a physician who:

A. is certified by a medical specialty board whose certification has been recognized by the NRC or an agreement state. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page; or

B. has:

(1) completed a structured educational program in basic radionuclide handling techniques applicable to the use of manual brachytherapy sources that includes:

(a) 200 hours of classroom and laboratory training in:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity; and

iv. radiation biology; and

(b) 500 hours of work experience, under the supervision of an authorized user who meets the requirements in this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state at a medical institution authorized to use radioactive materials under part 4731.4450, involving:

i. ordering, receiving, and unpacking radioactive materials safely and performing the related radiation surveys;

ii. checking survey meters for proper operation;

iii. preparing, implanting, and removing brachytherapy sources;

iv. maintaining running inventories of material on hand;

v. using administrative controls to prevent a medical event involving the use of radioactive material; and

vi. using emergency procedures to control radioactive material;

(2) completed three years of supervised clinical experience in radiation oncology, under an authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state, as part of a formal training program approved by the Residency Review Committee for Radiation Oncology of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association. This experience may be obtained concurrently with the supervised work experience required under subitem (1), unit (b); and

(3) obtained written attestation that the individual has satisfactorily completed the requirements of this item and is able to independently fulfill the radiation safety-related duties as an authorized user of manual brachytherapy sources for the medical uses authorized under part 4731.4450. The attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state, and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subitems (1) and (2).

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. successfully complete a minimum of three years of residency training in a radiation oncology program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association; and

B. pass an examination, administered by diplomates of the specialty board, that tests knowledge and competence in radiation safety, radionuclide handling, treatment planning, quality assurance, and clinical use of manual brachytherapy.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4459 OPHTHALMIC USE OF STRONTIUM-90; TRAINING.

Except as provided under part 4731.4414, a licensee must require an authorized user of strontium-90 for ophthalmic radiotherapy to be a physician who:

A. is an authorized user under part 4731.4458 or equivalent requirements of the NRC or an agreement state; or

B. has:

(1) completed 24 hours of classroom and laboratory training applicable to the medical use of strontium-90 for ophthalmic radiotherapy. The training must include:

(a) radiation physics and instrumentation;

(b) radiation protection;

(c) mathematics pertaining to the use and measurement of radioactivity; and

(d) radiation biology;

(2) had supervised clinical training in ophthalmic radiotherapy under the supervision of an authorized user at a medical institution, clinic, or private practice that includes the use of strontium-90 for the ophthalmic treatment of five individuals. The supervised clinical training must involve:

(a) examination of each individual to be treated;

(b) calculation of the dose to be administered;

(c) administration of the dose; and

(d) follow up and review of each individual's case history; and

(3) obtained written attestation, signed by a preceptor authorized user who meets the requirements of this part, part 4731.4414, or 4731.4458, or equivalent requirements of the NRC or an agreement state, that the individual has satisfactorily completed the requirements in subitems (1) and (2) and is able to independently fulfill the radiation safety-related duties as an authorized user of strontium-90 for ophthalmic use.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4460 USE OF SEALED SOURCES AND MEDICAL DEVICES FOR DIAGNOSIS.

A. A licensee must use only sealed sources that are not in medical devices for diagnostic medical uses if the sealed sources are approved in the sealed source and device registry for diagnostic medicine. The sealed sources may be used for diagnostic medical uses that are not explicitly listed in the sealed source and device registry but must be used in accordance with the radiation safety conditions and limitations described in the sealed source and device registry.

B. A licensee must only use medical devices containing sealed sources for diagnostic medical uses if both the sealed sources and medical devices are approved in the sealed source and device registry for diagnostic medical uses. The diagnostic medical devices may be used for

diagnostic medical uses that are not explicitly listed in the sealed source and device registry but must be used in accordance with the radiation safety conditions and limitations described in the sealed source and device registry.

C. Sealed sources and devices for diagnostic medical uses may be used in research in accordance with an active Investigational Device Exemption (IDE) application accepted by the U.S. Food and Drug Administration provided the requirements of part 4731.4410, item A, are met.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
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4731.4461 USE OF SEALED SOURCES FOR DIAGNOSIS; TRAINING.

Except as provided under part 4731.4414, a licensee must require an authorized user of a diagnostic sealed source or a device authorized under part 4731.4460 to be a physician, dentist, or podiatrist who:

A. is certified by a specialty board whose certification process includes all of the requirements of items C and D and whose certification has been recognized by the NRC or an agreement state. The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page;

B. is an authorized user for uses listed in part 4731.4434 or equivalent requirements of the NRC or an agreement state;

C. has completed eight hours of classroom and laboratory training in basic radionuclide handling techniques specifically applicable to the use of the device. The training must include:

(1) radiation physics and instrumentation;

(2) radiation protection;

(3) mathematics pertaining to the use and measurement of radioactivity; and

(4) radiation biology; and

D. has completed training in the use of the device for the uses requested.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4463 USE OF A SEALED SOURCE; REMOTE AFTERLOADER UNIT, TELETHERAPY UNIT, OR GAMMA STEREOTACTIC RADIOSURGERY UNIT.

A. A licensee must only use sealed sources:

(1) approved and as provided for in the sealed source and device registry in photon-emitting remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units to deliver therapeutic doses for medical uses; or

(2) in research involving photon-emitting remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units according to an active investigational device exemption application accepted by the Food and Drug Administration, provided the requirements of part 4731.4410, item A, are met.

B. A licensee must use photon-emitting remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units:

(1) approved in the sealed source and device registry to deliver a therapeutic dose for medical use. These devices may be used for therapeutic medical treatments that are not explicitly provided for in the sealed source and device registry, but must be used in accordance with radiation safety conditions and limitations described in the sealed source and device registry; or

(2) in research according to an active investigational device exemption application accepted by the FDA provided the requirements of part 4731.4410, item A, are met.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
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4731.4464 TREATMENT WITH REMOTE AFTERLOADER UNIT; SURVEYS.

A. Before releasing a patient or human research subject who has been treated with a remote afterloader unit from licensee control, a licensee must survey the patient or human research subject and the remote afterloader unit with a portable radiation detection survey instrument to confirm that the source has been removed from the patient or human research subject and returned to the safe shielded position.

B. A licensee must retain a record of the required surveys according to part 4731.4511.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4465 INSTALLATION, MAINTENANCE, ADJUSTMENT, AND REPAIR REQUIREMENTS.

A. Only a person specifically licensed by the commissioner, the NRC, or an agreement state shall install, maintain, adjust, or repair a remote afterloader unit, teletherapy unit, or gamma stereotactic radiosurgery unit that involves work on the source shielding, the source driving unit, or other electronic or mechanical component that could expose the source, reduce the shielding around the source, or compromise the radiation safety of the unit or the source.

B. Except for low dose-rate remote afterloader units, only a person specifically licensed by the commissioner, the NRC, or an agreement state shall install, replace, relocate, or remove a sealed source or source contained in other remote afterloader units, teletherapy units, or gamma stereotactic radiosurgery units.

C. For a low dose-rate remote afterloader unit, only a person specifically licensed by the commissioner, the NRC, or an agreement state or an authorized medical physicist shall install, replace, relocate, or remove a sealed source contained in the unit.

D. A licensee must retain a record of the installation, maintenance, adjustment, and repair of remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units according to part 4731.4515.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4466 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA STEREOTACTIC RADIOSURGERY UNITS; SAFETY PROCEDURES AND INSTRUCTIONS.

A. This part applies to remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units.

B. A licensee must:

(1) secure the unit, the console, the console keys, and the treatment room when not in use or unattended;

(2) permit only individuals approved by the authorized user, radiation safety officer, or authorized medical physicist to be present in the treatment room during treatment with the source;

(3) prevent dual operation of more than one radiation-producing device in a treatment room, if applicable; and

(4) develop, implement, and maintain written procedures for responding to an abnormal situation when the operator is unable to place the source in the shielded position or remove the patient or human research subject from the radiation field with controls from outside the treatment room. These procedures must include:

(a) instructions for responding to equipment failures and the names of the individuals responsible for implementing corrective actions;

(b) the process for restricting access to and posting the treatment area to minimize the risk of inadvertent exposure; and

(c) the names and telephone numbers of the authorized user, authorized medical physicist, and radiation safety officer to be contacted if the unit or console operates abnormally.

C. A copy of the procedures required under item B, subitem (4), must be physically located at the unit console.

D. A licensee must post instructions at the unit console to inform the operator of:

(1) the location of the procedures required under item B, subitem (4); and

(2) the names and telephone numbers of the authorized user, authorized medical physicist, and radiation safety officer to be contacted if the unit or console operates abnormally.

E. A licensee must:

(1) prior to the first use for patient treatment of a new unit or an existing unit with a manufacturer upgrade that affects the operation and safety of the unit, ensure that vendor operational and safety training is provided to all individuals who will operate the unit. The vendor operational and safety training must be provided by the device manufacturer or by an individual certified by the device manufacturer to provide the operational and safety training; and

(2) provide operational and safety instructions, initially and at least annually, to all individuals who operate the unit, as appropriate to the individual's assigned duties. The instructions must include instruction in:

(a) the procedures identified under item B, subitem (4); and

(b) the operating procedures of the unit.

F. A licensee must ensure that operators, authorized medical physicists, and authorized users participate in drills of the emergency procedures, initially and at least annually.

G. A licensee must retain a record of individuals receiving instruction required under item E according to part 4731.4510.

H. A licensee must retain a copy of the procedures required under item B, subitem (4), and item E, subitem (2), unit (b), according to part 4731.4516.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
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4731.4467 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA STEREOTACTIC RADIOSURGERY UNITS; SAFETY PRECAUTIONS.

A. This part applies to remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units.

B. A licensee must control access to the treatment room by a door at each entrance.

C. A licensee must equip each entrance to the treatment room with an electrical interlock system that:

(1) prevents the operator from initiating the treatment cycle unless each treatment room entrance door is closed;

(2) causes the source to be shielded when an entrance door is opened; and

(3) prevents the source from being exposed following an interlock interruption until all treatment room entrance doors are closed and the source on-off control is reset at the console.

D. A licensee must require any individual entering the treatment room to ensure, through the use of appropriate radiation monitors, that radiation levels have returned to ambient levels.

E. Except for low-dose remote afterloader units, a licensee must construct or equip each treatment room with viewing and intercom systems to permit continuous observation of the patient or human research subject from the treatment console during irradiation.

F. For licensed activities where sources are placed within the patient's or human research subject's body, a licensee must only conduct treatments that allow for expeditious removal of a decoupled or jammed source.

G. A licensee must:

(1) for medium dose-rate and pulsed dose-rate remote afterloader units, require:

(a) an authorized medical physicist and either an authorized user or a physician, under the supervision of an authorized user, who has been trained in the operation and emergency response for the unit, to be physically present during the initiation of all patient treatments involving the unit; and

(b) an authorized medical physicist and either an authorized user or an individual, under the supervision of an authorized user, who has been trained to remove the source applicator in the event of an emergency involving the unit, to be immediately available during continuation of all patient treatments involving the unit;

(2) for high dose-rate remote afterloader units, require:

(a) an authorized user and an authorized medical physicist to be physically present during the initiation of all patient treatments involving the unit; and

(b) an authorized medical physicist and either an authorized user or a physician, under the supervision of an authorized user, who has been trained in the operation and emergency response for the unit, to be physically present during continuation of all patient treatments involving the unit;

(3) for gamma stereotactic radiosurgery units, require an authorized user and an authorized medical physicist to be physically present throughout all patient treatments involving the unit; and

(4) notify the radiation safety officer or the officer's designee and an authorized user as soon as possible if the patient or human research subject has a medical emergency or dies.

H. A licensee must have applicable emergency response equipment available near each treatment room to respond to a source:

(1) remaining in the unshielded position; or

(2) lodged within the patient following completion of the treatment.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.4468 DOSIMETRY EQUIPMENT.

Subpart 1. **Required equipment.** Except for low dose-rate remote afterloader sources where the source output or activity is determined by the manufacturer, a licensee must have a calibrated dosimetry system available for use. To satisfy this requirement:

A. the system must have been calibrated by a calibration laboratory accredited by the American Association of Physicists in Medicine (AAPM) or by using a source or system traceable to the National Institute of Standards and Technology (NIST) and published protocols accepted by nationally recognized bodies:

(1) within the previous two years; and

(2) after any servicing that may have affected system calibration; or

B. the system must have been calibrated within the previous four years. Eighteen to 30 months after that calibration:

(1) the system must have been intercompared with another dosimetry system that was calibrated within the past 24 months by NIST or by a calibration laboratory accredited by the AAPM; and

(2) the results of the intercomparison must have indicated that the calibration factor of the licensee's system had not changed by more than two percent. The licensee may not use the intercomparison result to change the calibration factor. When intercomparing dosimetry systems to be used for calibrating sealed sources for therapeutic units, the licensee must use a comparable unit with a beam attenuator or collimators, as applicable, and sources of the same radionuclide as the source used at the licensee's facility.

Subp. 2. **Spot check measurements.** A licensee must have a dosimetry system available for spot check output measurements, if applicable. To satisfy this requirement, the system may be compared with a system that has been calibrated according to subpart 1. The comparison must have been performed within the previous year and after each servicing that may have affected system calibration. The spot check system may be the same system used to meet the requirement under subpart 1.

Subp. 3. **Record retention.** A licensee must retain a record of each calibration, intercomparison, and comparison according to part 4731.4517.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4469 TELETHERAPY UNITS; FULL CALIBRATION.

Subpart 1. **Calibration required.** A licensee authorized to use a teletherapy unit for medical use must perform full calibration measurements on each teletherapy unit:

A. before the first medical use of the unit;

B. before medical use under the following conditions:

(1) whenever spot check measurements indicate that the output differs by more than five percent from the output obtained at the last full calibration corrected mathematically for radioactive decay;

(2) following replacement of the source or following reinstallation of the teletherapy unit in a new location; and

(3) following any repair of the teletherapy unit that includes removal of the source or major repair of the components associated with the source exposure assembly; and

C. at intervals not exceeding one year.

Subp. 2. **Required determinations.** To satisfy subpart 1, full calibration measurements must include determination of:

A. the output within plus or minus three percent for the range of field sizes and for the distance or range of distances used for medical use;

B. the coincidence of the radiation field and the field indicated by the light beam localizing device;

C. the uniformity of the radiation field and its dependence on the orientation of the useful beam;

D. timer accuracy and linearity over the range of use;

E. on-off error; and

F. the accuracy of all distance-measuring and localization devices in medical use.

Subp. 3. **Required system.** A licensee must use the dosimetry system described in part 4731.4468, subpart 1, to measure the output for one set of exposure conditions. The remaining radiation measurements required under subpart 2 may be made using a dosimetry system that indicates relative dose rates.

Subp. 4. **Required protocols.** A licensee must make full calibration measurements required under subpart 1 according to published protocols accepted by nationally recognized bodies.

Subp. 5. **Required corrections.** A licensee must mathematically correct the outputs determined in subpart 2, item A, for physical decay for intervals not exceeding one month for cobalt-60, six months for cesium-137, or at intervals consistent with one percent decay for all other nuclides.

Subp. 6. **Authorized medical physicist.** Full calibration measurements required under subpart 1 and physical decay corrections required under subpart 5 must be performed by the authorized medical physicist.

Subp. 7. **Record retention.** A licensee must retain a record of each calibration according to part 4731.4518.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4470 REMOTE AFTERLOADER UNITS; FULL CALIBRATION.

Subpart 1. **Calibration required.** A licensee authorized to use a remote afterloader unit for medical use must perform full calibration measurements on each unit:

A. before the first medical use of the unit;

B. before medical use under the following conditions:

(1) following replacement of the source or following reinstallation of the unit in a new location outside the facility; and

(2) following any repair of the unit that includes removal of the source or major repair of the components associated with the source exposure assembly;

C. at intervals not exceeding one quarter for high dose-rate, medium dose-rate, and pulsed dose-rate remote afterloader units with sources whose half-life exceeds 75 days; and

D. at intervals not exceeding one year for low dose-rate remote afterloader units.

Subp. 2. **Required determinations.** To satisfy subpart 1, full calibration measurements must include, as applicable, determination of:

A. the output within plus or minus five percent;

B. source positioning accuracy to within plus or minus one millimeter;

C. source retraction with backup battery upon power failure;

D. length of the source transfer tubes;

E. timer accuracy and linearity over the typical range of use;

F. length of the applicators; and

G. function of the source transfer tubes, applicators, and transfer tube-applicator interfaces.

Subp. 3. **Required system.** A licensee must use the dosimetry system described in part 4731.4468, subpart 1, to measure the output.

Subp. 4. **Required protocols.** A licensee must make full calibration measurements required under subpart 1 according to published protocols accepted by nationally recognized bodies.

Subp. 5. **Autoradiograph required.** In addition to the requirements for full calibrations for low dose-rate remote afterloader units under subpart 2, a licensee must perform an autoradiograph of the source to verify inventory and source arrangement at intervals not exceeding one quarter.

Subp. 6. **Measurements by manufacturer.** For low dose-rate remote afterloader units, a licensee may use measurements provided by the source manufacturer that are made according to subparts 1 to 5.

Subp. 7. **Required corrections.** A licensee must mathematically correct the outputs determined in subpart 2, item A, for physical decay at intervals consistent with one percent physical decay.

Subp. 8. **Authorized medical physicist.** Full calibration measurements required under subpart 1 and physical decay corrections required under subpart 7 must be performed by the authorized medical physicist.

Subp. 9. **Record retention.** A licensee must retain a record of each calibration according to part 4731.4518.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4471 GAMMA STEREOTACTIC RADIOSURGERY UNITS; FULL CALIBRATION.

Subpart 1. **Calibration required.** A licensee authorized to use a gamma stereotactic radiosurgery unit for medical use must perform full calibration measurements on each unit:

A. before the first medical use of the unit;

B. before medical use under the following conditions:

(1) whenever spot check measurements indicate that the output differs by more than five percent from the output obtained at the last full calibration corrected mathematically for radioactive decay;

(2) following replacement of the sources or following reinstallations of the gamma stereotactic radiosurgery unit in a new location; and

(3) following any repair of the gamma stereotactic radiosurgery unit that includes removal of the sources or major repair of the components associated with the source assembly; and

C. at intervals not exceeding one year, except that relative helmet factors need only be determined before the first medical use of a helmet and following any damage to a helmet.

Subp. 2. **Required determinations.** To satisfy subpart 1, full calibration measurements must include determination of:

A. the output within plus or minus three percent;

B. relative helmet factors;

C. isocenter coincidence;

D. timer accuracy and linearity over the range of use;

E. on-off error;

F. trunnion centricity;

G. treatment table retraction mechanism, using backup battery power or hydraulic backups with the unit off;

H. helmet microswitches;

I. emergency timing circuits; and

J. stereotactic frames and localization devices (trunnions).

Subp. 3. **Required system.** A licensee must use the dosimetry system described in part 4731.4468, subpart 1, to measure the output for one set of exposure conditions. The remaining radiation measurements required under subpart 2 may be made using a dosimetry system that indicates relative dose rates.

Subp. 4. **Required protocols.** A licensee must make full calibration measurements required under subpart 1 according to published protocols accepted by nationally recognized bodies.

Subp. 5. **Required corrections.** A licensee must mathematically correct the outputs determined under subpart 2, item A, at intervals not exceeding one month for cobalt-60 and at intervals consistent with one percent physical decay for all other radionuclides.

Subp. 6. **Authorized medical physicist.** Full calibration measurements required under subpart 1 and physical decay corrections required under subpart 5 must be performed by the authorized medical physicist.

Subp. 7. **Record retention.** A licensee must retain a record of each calibration according to part 4731.4518.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4472 TELETHERAPY UNITS; PERIODIC SPOT CHECKS.

Subpart 1. **Output spot checks required.** A licensee authorized to use teletherapy units for medical use must perform output spot checks on each teletherapy unit once in each calendar month that include determination of:

A. timer accuracy and timer linearity over the range of use;

B. on-off error;

C. the coincidence of the radiation field and the field indicated by the light beam localizing device;

D. the accuracy of all distance-measuring and localization devices used for medical use;

E. the output for one typical set of operating conditions measured with the dosimetry system described in part 4731.4468, subpart 2; and

F. the difference between the measurement made in item E and the anticipated output, expressed as a percentage of the anticipated output, that is, the value obtained at last full calibration corrected mathematically for physical decay.

Subp. 2. **Written procedures.** A licensee must perform measurements required under subpart 1 according to written procedures established by the authorized medical physicist. The authorized medical physicist need not actually perform the spot check measurements.

Subp. 3. **Review.** A licensee must have the authorized medical physicist review the results of each spot check within 15 days. The authorized medical physicist must notify the licensee as soon as possible in writing of the results of each spot check.

Subp. 4. **Safety spot checks required.** A licensee authorized to use a teletherapy unit for medical use must perform safety spot checks of each teletherapy facility once in each calendar month and after each source installation to ensure proper operation of:

A. electrical interlocks at each teletherapy room entrance;

B. electrical or mechanical stops installed to limit use of the primary beam of radiation, including restriction of source housing angulation or elevation, carriage or stand travel, and operation of the beam on-off mechanism;

C. source exposure indicator lights on the teletherapy unit, on the control console, and in the facility;

D. viewing and intercom systems;

E. treatment room doors from inside and outside the treatment room; and

F. electrically assisted treatment room doors with the teletherapy unit electrical power turned off.

Subp. 5. **Malfunctions.** If the results of the checks required under subpart 4 indicate the malfunction of any system, a licensee must lock the control console in the off position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

Subp. 6. **Record retention.** A licensee must retain a record of each spot check required under subparts 1 and 4 and a copy of the procedures required under subpart 2 according to part 4731.4519.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4473 REMOTE AFTERLOADER UNITS; PERIODIC SPOT CHECKS.

Subpart 1. **Spot check required.** A licensee authorized to use remote afterloader units for medical use must perform spot checks of each remote afterloader facility and on each unit:

A. before the first use of a high dose-rate, medium dose-rate, or pulsed dose-rate remote afterloader unit on a given day;

B. before each patient treatment with a low dose-rate remote afterloader unit; and

C. after each source installation.

Subp. 2. **Written procedures.** A licensee must perform the measurements required under subpart 1 according to written procedures established by the authorized medical physicist. The authorized medical physicist need not actually perform the spot check measurement.

Subp. 3. **Review.** A licensee must have the authorized medical physicist review the results of each spot check within 15 days. The authorized medical physicist must notify the licensee as soon as possible in writing of the results of the spot check.

Subp. 4. **Minimum requirements.** To satisfy subpart 1, spot checks must, at a minimum, ensure proper operation of:

A. electrical interlocks at each remote afterloader unit room entrance;

B. source exposure indicator lights on the remote afterloader unit, on the control console, and in the facility;

C. viewing and intercom systems in each high dose-rate, medium dose-rate, and pulsed dose-rate remote afterloader facility;

D. emergency response equipment;

E. radiation monitors used to indicate the source position;

F. timer accuracy;

G. date and time in the unit's computer; and

H. decayed source activity in the unit's computer.

Subp. 5. **Malfunctions.** If the results of the checks required under subpart 4 indicate the malfunction of any system, a licensee must lock the control console in the off position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

Subp. 6. **Record retention.** A licensee must retain a record of each check required under subpart 4 and a copy of the procedures required under subpart 2 according to part 4731.4520.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4474 GAMMA STEREOTACTIC RADIOSURGERY UNITS; PERIODIC SPOT CHECKS.

Subpart 1. **Spot checks required.** A licensee authorized to use gamma stereotactic radiosurgery units for medical use must perform spot checks of each gamma stereotactic radiosurgery facility and on each unit:

A. monthly;

B. before the first use of the unit on a given day; and

C. after each source installation.

Subp. 2. **Written procedures; review.** A licensee must:

A. perform the spot checks required under subpart 1 according to written procedures established by the authorized medical physicist. The authorized medical physicist need not actually perform the spot check measurements; and

B. have the authorized medical physicist review the results of each spot check within 15 days. The authorized medical physicist must notify the licensee as soon as possible in writing of the results of each spot check.

Subp. 3. **Monthly requirements.** To satisfy subpart 1, item A, monthly spot checks must, at a minimum:

A. ensure proper operation of:

(1) the treatment table retraction mechanism, using backup battery power or hydraulic backups with the unit off;

(2) helmet microswitches;

(3) emergency timing circuits; and

(4) stereotactic frames and localizing devices (trunnions); and

B. determine:

(1) the output for one typical set of operating conditions measured with the dosimetry system described under part 4731.4468, subpart 2;

(2) the difference between the measurement made in subitem (1) and the anticipated output, expressed as a percentage of the anticipated output, that is, the value obtained at last full calibration corrected mathematically for physical decay;

(3) source output against computer calculation;

(4) timer accuracy and linearity over the range of use;

(5) on-off error; and

(6) trunnion centricity.

Subp. 4. **Other requirements.** To satisfy subpart 1, items B and C, spot checks must ensure proper operation of:

A. electrical interlocks at each gamma stereotactic radiosurgery room entrance;

B. source exposure indicator lights on the gamma stereotactic radiosurgery unit, on the control console, and in the facility;

C. viewing and intercom systems;

D. timer termination;

E. radiation monitors used to indicate room exposures; and

F. emergency off buttons.

Subp. 5. **Repair.** A licensee must arrange for repair of any system identified under subpart 3 that is not operating properly as soon as possible.

Subp. 6. **Malfunctions.** If the results of the checks required under subpart 4 indicate the malfunction of any system, a licensee must lock the control console in the off position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

Subp. 7. **Record retention.** A licensee must retain a record of each check required under subparts 3 and 4 and a copy of the procedures required under subpart 2 according to part 4731.4521.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4475 MOBILE REMOTE AFTERLOADER UNITS; ADDITIONAL REQUIREMENTS.

Subpart 1. **General requirements.** A licensee providing mobile remote afterloader service must:

A. check survey instruments before medical use at each address of use or on each day of use, whichever is more frequent; and

B. account for all sources before departure from a client's address of use.

Subp. 2. **Check requirements.** In addition to the periodic spot checks required under part 4731.4473, a licensee authorized to use mobile afterloaders for medical use must perform checks on each remote afterloader unit before use at each address of use. At a minimum, checks must be made to verify the operation of:

A. electrical interlocks on treatment area access points;

B. source exposure indicator lights on the remote afterloader unit, on the control console, and in the facility;

C. viewing and intercom systems;

D. applicators, source transfer tubes, and transfer tube-applicator interfaces;

E. radiation monitors used to indicate room exposures;

F. source positioning (accuracy); and

G. radiation monitors used to indicate whether the source has returned to a safe shielded position.

Subp. 3. **Simulated treatment cycle.** In addition to the requirements for checks under subpart 2, a licensee must ensure proper overall operation of the remote afterloader unit by conducting a simulated cycle of treatment before use at each address of use.

Subp. 4. **Malfunctions.** If the results of the checks required under subpart 2 indicate the malfunction of any system, a licensee must lock the control console in the off position and not use the unit except as may be necessary to repair, replace, or check the malfunctioning system.

Subp. 5. **Record retention.** A licensee must retain a record of each check required under subpart 2 according to part 4731.4522.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4476 RADIATION SURVEYS.

Subpart 1. **Surveys required.** In addition to the survey requirement under part 4731.2200, a licensee must make surveys to ensure that the maximum radiation levels and average radiation levels from the surface of the main source safe with the source in the shielded position do not exceed the levels stated in the sealed source and device registry.

Subp. 2. **When required.** A licensee must make the survey required under subpart 1 upon installation of a new source and following repairs to the source shielding, the source driving unit, or other electronic or mechanical component that could:

A. expose the source;

B. reduce the shielding around the source; or

C. compromise the radiation safety of the unit or the source.

Subp. 3. **Record retention.** A licensee must retain a record of the radiation surveys required under subpart 1 according to part 4731.4523.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4477 TELETHERAPY AND GAMMA STEREOTACTIC RADIOSURGERY UNITS; FULL-INSPECTION SERVICING.

Subpart 1. **Inspection and servicing required.** A licensee must have each teletherapy unit and gamma stereotactic radiosurgery unit fully inspected and serviced during source replacement to ensure proper functioning of the source exposure mechanism and other safety components. The interval between each full-inspection servicing must not exceed five years for each teletherapy unit, and must not exceed seven years for each gamma stereotactic radiosurgery unit.

Subp. 2. **Qualified inspectors.** The inspection and servicing must be performed by persons specifically licensed to do so by the commissioner, the NRC, or an agreement state.

Subp. 3. **Record retention.** A licensee must keep a record of the inspection and servicing according to part 4731.4524.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4478 TELETHERAPY AND GAMMA STEREOTACTIC COMPUTER SYSTEMS.

A licensee must perform acceptance testing on the treatment planning system of teletherapy and gamma stereotactic computer systems according to published protocols accepted by nationally recognized bodies. At a minimum, the acceptance testing must include, as applicable, verification of:

A. the source-specific input parameters required by the dose calculation algorithm;

B. the accuracy of dose, dwell time, and treatment time calculations at representative points;

C. the accuracy of isodose plots and graphic displays;

D. the accuracy of the software used to determine sealed source positions from radiographic images; and

E. the accuracy of electronic transfer of the treatment delivery parameters to the treatment delivery unit from the treatment planning system.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4479 REMOTE AFTERLOADER UNITS, TELETHERAPY UNITS, AND GAMMA STEREOTACTIC RADIOSURGERY UNITS; TRAINING.

Subpart 1. **Training and education requirements.** Except as provided under part 4731.4414, a licensee must require an authorized user of a sealed source for a use authorized under part 4731.4463 to be a physician who:

A. is certified by a medical specialty board whose certification process has been recognized by the NRC or an agreement state, and meets the requirements in item B, subitem (4). The names of board certifications that have been recognized by the NRC or an agreement state are posted on the NRC's Medical Use Licensee Toolkit web page; or

B. has:

(1) completed a structured educational program in basic radionuclide techniques applicable to the use of a sealed source in a therapeutic medical unit that includes:

(a) 200 hours of classroom and laboratory training in the following areas:

i. radiation physics and instrumentation;

ii. radiation protection;

iii. mathematics pertaining to the use and measurement of radioactivity; and

iv. radiation biology; and

(b) 500 hours of work experience, under the supervision of an authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state, at a medical institution that is authorized to use radioactive material in part 4731.4463, involving:

i. reviewing full calibration measurements and periodic spot checks;

ii. preparing treatment plans and calculating treatment doses and times;

iii. using administrative controls to prevent a medical event involving the use of radioactive materials;

iv. implementing emergency procedures to be followed in the event of an abnormal operation of the medical unit or console;

v. checking and using survey meters; and

vi. selecting the proper dose and how it is to be administered;

(2) completed three years of supervised clinical experience in radiation therapy, under an authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state, as part of a formal training program approved by the Residency Review Committee for Radiation Oncology of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association. The experience may be obtained concurrently with the supervised work experience required under subitem (1), unit (b);

(3) obtained written attestation that the individual has satisfactorily completed the requirements in subitems (1), (2), and (4), and is able to independently fulfill the radiation safety-related duties as an authorized user of each type of therapeutic medical unit for which the individual is requesting authorized user status. The written attestation must be obtained from either:

(a) a preceptor authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state for each type of therapeutic medical unit for which the individual is requesting authorized user status; or

(b) a residency program director who affirms in writing that the attestation represents the consensus of the residency program faculty where at least one faculty member is an authorized user who meets the requirements of this part, part 4731.4414, or equivalent requirements of the NRC or an agreement state, for the type(s) of therapeutic medical unit for which the individual is requesting authorized user status, and concurs with the attestation provided by the residency program director. The residency training program must be approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education or the Royal College of Physicians and Surgeons of Canada or the Council on Postdoctoral Training of the American Osteopathic Association and must include training and experience specified in subitems (1) and (2); and

(4) received training in device operation, safety procedures, and clinical use for the types of use for which authorization is sought. This training requirement may be satisfied by satisfactory completion of a training program provided by the vendor for new users or by receiving training supervised by an authorized user or authorized medical physicist, as appropriate, who is authorized for the types of use for which the individual is seeking authorization.

Subp. 2. **Certification requirements.** A specialty board under subpart 1, item A, shall require all candidates for certification to:

A. successfully complete a minimum of three years of residency training in a radiation therapy program approved by the Residency Review Committee of the Accreditation Council for Graduate Medical Education, the Royal College of Physicians and Surgeons of Canada, or the Council on Postdoctoral Training of the American Osteopathic Association; and

B. pass an examination, administered by diplomates of the specialty board, that tests knowledge and competence in radiation safety, radionuclide handling, treatment planning, quality assurance, and clinical use of stereotactic radiosurgery, remote afterloaders, and external beam therapy.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4500 RADIATION PROTECTION PROGRAM RECORDS.

Subpart 1. **Records of authority and responsibilities; radiation protection programs.** A licensee must retain:

A. a record of actions taken by the licensee's management according to part 4731.4405, subpart 1, item A, for five years. The record must include a summary of the actions taken and a signature of licensee management;

B. a copy of the authorities, duties, and responsibilities of the radiation safety officer, as required under part 4731.4405, subpart 1, item E, and a signed copy of the radiation safety officer's agreement to be responsible for implementing the radiation safety program, as required under part 4731.4405, subpart 1, item B, for the duration of the license. The records must include the signature of the radiation safety officer and licensee management; and

C. for each associate radiation safety officer appointed under part 4731.4405, subpart 1, item B, the licensee shall retain, for five years after the associate radiation safety officer is removed from the license, a copy of the written document appointing the associate radiation safety officer signed by the licensee's management.

Subp. 2. **Protection program changes.** A licensee must retain a record of each radiation protection program change made under part 4731.4405, subpart 2, for five years. The record must include a copy of the old and new procedures, the effective date of the change, and the signature of the licensee's management that reviewed and approved the change.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4501 WRITTEN DIRECTIVE RECORDS.

Subpart 1. **Written directive.** A licensee must retain a copy of each written directive required under part 4731.4408 for three years.

Subp. 2. **Administration procedures.** A licensee must retain a copy of the procedures required under part 4731.4409, item A, for the duration of the license.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4502 INSTRUMENT CALIBRATION RECORDS.

Subpart 1. **Activity measurement instruments.** A licensee must maintain a record of instrument calibrations required under part 4731.4420 for three years. The record must include:

A. the model and serial numbers of the instrument;

B. the date of the calibration;

C. the results of the calibration; and

D. the name of the individual who performed the calibration.

Subp. 2. **Survey instruments.** A licensee must maintain a record of radiation survey instrument calibrations required under part 4731.4421 for three years. The record must include:

A. the model and serial number of the instrument;

B. the date of the calibration;

C. the results of the calibration; and

D. the name of the individual who performed the calibration.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4503 DOSAGE RECORDS.

A licensee must maintain a record of dosage determinations required under part 4731.4422 for three years. The record must contain:

A. the identity of the radiopharmaceutical;

B. the patient's or human research subject's name or identification number, if one has been assigned;

C. the prescribed dosage, the determined dosage, or a notation that the total activity is less than 30 microcuries (1.1 MBq);

D. the date and time of the dosage determination; and

E. the name of the individual who determined the dosage.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4504 LEAK TEST AND INVENTORY RECORDS.

Subpart 1. **Leak tests.** A licensee must retain records of leak tests required under part 4731.4424, item B, for three years. The records must contain:

A. the model number and serial number, if one has been assigned, of each source tested;

B. the identity of each source radionuclide and its estimated activity;

C. the results of the test;

D. the date of the test; and

E. the name of the individual who performed the test.

Subp. 2. **Inventories.** A licensee must retain records of the semiannual physical inventory of sealed sources and brachytherapy sources required under part 4731.4424, item G, for three years. The inventory records must contain:

A. the model number and serial number, if one has been assigned, of each source;

B. the identity of each source radionuclide and its nominal activity;

C. the location of each source; and

D. the name of the individual who performed the inventory.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *September 25, 2017*

4731.4505 SURVEY RECORDS; AMBIENT RADIATION EXPOSURE.

A licensee must retain a record of each survey required under part 4731.4426 for three years. The record must include:

A. the date of the survey;

B. the results of the survey;

C. the instrument used to make the survey; and

D. the name of the individual who performed the survey.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4506 RELEASE RECORDS; INDIVIDUALS CONTAINING RADIOACTIVE MATERIAL OR IMPLANTS.

Subpart 1. **Release basis.** A licensee must retain a record of the basis for authorizing the release of an individual according to part 4731.4427, if the total effective dose equivalent is calculated by:

A. using the retained activity rather than the activity administered;

B. using an occupancy factor less than 0.25 at one meter;

C. using the biological or effective half-life; or

D. considering the shielding by tissue.

Subp. 2. **Instructions to mothers.** A licensee must retain a record that the instructions required under part 4731.4427, item B, were provided to a breast-feeding woman if the radiation dose to the infant or child from continued breast-feeding could result in a total effective dose equivalent exceeding 0.5 rem (5 mSv).

Subp. 3. **Retention period.** The records required under this part must be retained for three years after the date of release of the individual.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4507 MOBILE MEDICAL SERVICE RECORDS.

A. A licensee must retain a copy of each letter that permits the use of radioactive material at a client's address of use, according to part 4731.4428, item A, subitem (1). Each letter must clearly delineate the authority and responsibility of the licensee and the client and must be retained for three years after the last provision of service.

B. A licensee must retain the record of each survey required under part 4731.4428, item A, subitem (4), for three years. The record must include:

(1) the date of the survey;

(2) the results of the survey;

(3) the instrument used to make the survey; and

(4) the name of the individual who performed the survey.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4508 [Repealed, 33 SR 1440]
Published Electronically: *March 12, 2009*

4731.4509 MOLYBDENUM-99, STRONTIUM-82, AND STRONTIUM-85 CONCENTRATION RECORDS.

A licensee must maintain a record of the molybdenum-99 concentration or strontium-82 and strontium-85 concentration tests required under part 4731.4435, item B, for three years. The record must include:

A. for each measured elution of technetium-99m:

(1) the ratio of the measures expressed as microcuries of molybdenum per millicurie of technetium-99m, (or kilobecquerel of molybdenum-99 per megabecquerel of technetium-99m);

(2) the time and date of the measurement; and

(3) the name of the individual who made the measurement; and

B. for each measured elution of rubidium-82:

(1) the ratio of the measures expressed as microcuries of strontium-82 per millicurie of rubidium-82 (or kBq of strontium-82 per MBq or rubidium-82), and microcuries of strontium-85 per millicurie of rubidium-82 (or kBq of strontium-85 per MBq or rubidium-82);

(2) the time and date of the measurement; and

(3) the name of the individual who made the measurement.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 33 SR 1440*

Published Electronically: *April 12, 2024*

4731.4510 SAFETY INSTRUCTION RECORDS.

A licensee must maintain a record of safety instructions required under parts 4731.4441 and 4731.4453 and the operational and safety instructions required by part 4731.4466 for three years. The record must include:

A. a list of the topics covered;

B. the date of the instruction;

C. the names of the attendees; and

D. the names of the individuals who provided the instruction.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4511 SURVEY RECORDS; SOURCE IMPLANT AND REMOVAL.

A licensee must maintain a record of the surveys required under parts 4731.4451 and 4731.4464 for three years. The record must include:

A. the date and results of the survey;

B. the survey instrument used; and

C. the name of the individual who made the survey.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4512 BRACHYTHERAPY SOURCE ACCOUNTABILITY RECORDS.

A licensee must maintain a record of brachytherapy source accountability required under part 4731.4452 for three years as follows:

A. for temporary implants, the record must include:

(1) the number and activity of sources removed from storage;

(2) the time and date they were removed from storage;

(3) the name of the individual who removed them from storage; and

(4) the location of use;

B. for sources being returned to storage, the record must include:

(1) the number and activity of sources returned to storage;

(2) the time and date they were returned to storage; and

(3) the name of the individual who returned them to storage;

C. for permanent implants, the record must include:

(1) the number and activity of sources removed from storage;

(2) the date they were removed from storage;

(3) the name of the individual who removed them from storage; and

(4) the number and activity of sources permanently implanted in the patient or human research subject; and

D. for sources that were not implanted, the record must include:

(1) the number and activity of sources not implanted;

(2) the date they were returned to storage; and

(3) the name of the individual who returned them to storage.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4513 BRACHYTHERAPY SOURCE CALIBRATION RECORDS.

A licensee must maintain a record of the calibrations of brachytherapy sources required under part 4731.4455 for three years after the last use of the source. The records must include:

A. the date of the calibration;

B. the manufacturer's name, the model number and serial number for the source, and instruments used to calibrate the source;

C. the source output or activity;

D. the source positioning accuracy within the applicators; and

E. the signature of the authorized medical physicist.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4514 STRONTIUM-90 DECAY RECORDS.

A licensee must maintain a record of the activity of a strontium-90 source required under part 4731.4456 for the life of the source. The record must include:

A. the date and initial activity of the source as determined under part 4731.4455; and

B. for each decay calculation, the date and the source activity as determined under part 4731.4456.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4515 INSTALLATION, MAINTENANCE, ADJUSTMENT, AND REPAIR RECORDS.

A licensee must retain a record of the installation, maintenance, adjustment, and repair of remote afterloader units, teletherapy units, and gamma stereotactic radiosurgery units as required under part 4731.4465 for three years. For each installation, maintenance, adjustment, and repair, the record must include:

A. the date;

B. a description of the service; and

C. the name of the individual who performed the work.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4516 SAFETY PROCEDURES RECORDS.

A licensee must retain a copy of the procedures required under part 4731.4466, items B, subitem (4), and E, subitem (2), until the licensee no longer possesses the remote afterloader unit, teletherapy unit, or gamma stereotactic radiosurgery unit.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4517 DOSIMETRY EQUIPMENT RECORDS.

A licensee must retain a record of the calibrations, intercomparisons, and comparisons of dosimetry equipment required under part 4731.4468 for the duration of the license. For each calibration, intercomparison, or comparison, the record must include:

A. the date;

B. the manufacturer's name, model number, and serial number for the instrument that was calibrated, intercompared, or compared;

C. the correction factor that was determined from the calibration or comparison or the apparent correction factor that was determined from an intercomparison; and

D. the name of the individual who performed the calibration, intercomparison, or comparison.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4518 CALIBRATION RECORDS; TELETHERAPY, REMOTE AFTERLOADER, AND GAMMA STEREOTACTIC RADIOSURGERY UNITS.

A licensee must maintain a record of the teletherapy unit, remote afterloader unit, and gamma stereotactic radiosurgery unit full calibrations required under parts 4731.4469 to 4731.4471 for three years. The record must include:

A. the date of the calibration;

B. the unit manufacturer's name;

C. the model number and serial number of the teletherapy, remote afterloader, and gamma stereotactic radiosurgery unit;

D. the model number, serial number, and identity of the source;

E. the model number, serial number, and identity of the source instruments used to calibrate the units;

F. the results and an assessment of the full calibrations;

G. the results of the autoradiograph required for low dose-rate remote afterloader units; and

H. the signature of the authorized medical physicist who performed the full calibration.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4519 SPOT CHECK RECORDS; TELETHERAPY UNITS.

A. A licensee must retain a record of each periodic spot check for teletherapy units required under part 4731.4472 for three years. The record must include:

(1) the date of the spot check;

(2) the unit manufacturer's name;

(3) the model number and serial number for the teletherapy unit;

(4) the model number, serial number, and identity of the source;

(5) instruments used to measure the output of the teletherapy unit;

(6) an assessment of time linearity and constancy;

(7) the calculated on-off error;

(8) a determination of the coincidence of the radiation field and the field indicated by the light beam localizing device;

(9) the determined accuracy of each distance measuring and localization device;

(10) the difference between the anticipated output and the measured output;

(11) notations indicating the operability of each entrance door electrical interlock, electrical or mechanical stop, source exposure indicator light, and viewing and intercom system and doors;

(12) the name of the individual who performed the periodic spot check; and

(13) the signature of the authorized medical physicist who reviewed the record of the spot check.

B. A licensee must retain a copy of the procedures required under part 4731.4472, subpart 2, until the licensee no longer possesses the teletherapy unit.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4520 SPOT CHECK RECORDS; REMOTE AFTERLOADER UNITS.

A. A licensee must retain a record of each spot check for remote afterloader units required under part 4731.4473 for three years. The record must include, as applicable:

(1) the date of the spot check;

(2) the unit manufacturer's name;

(3) the model number and serial number for the remote afterloader unit;

(4) the model number, serial number, and identity of the source;

(5) an assessment of timer accuracy;

(6) notations indicating the operability of each entrance door electrical interlock, radiation monitor, source exposure indicator light, viewing and intercom system, and clock and decayed source activity in the unit's computer;

(7) the name of the individual who performed the periodic spot check; and

(8) the signature of the authorized medical physicist who reviewed the record of the spot check.

B. A licensee must retain a copy of the procedures required under part 4731.4473, subpart 2, until the licensee no longer possesses the remote afterloader unit.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4521 SPOT CHECK RECORDS; GAMMA STEREOTACTIC RADIOSURGERY UNITS.

A. A licensee must retain a record of each spot check for gamma stereotactic radiosurgery units required under part 4731.4474 for three years. The record must include:

(1) the date of the spot check;

(2) the manufacturer's name, model number, and serial number for the gamma stereotactic radiosurgery unit;

(3) the model number, serial number, and identity of the instrument used to measure the output of the unit;

(4) an assessment of timer linearity and accuracy;

(5) the calculated on-off error;

(6) a determination of trunnion centricity;

(7) the difference between the anticipated output and the measured output;

(8) an assessment of source output against computer calculations;

(9) notations indicating the operability of radiation monitors, helmet microswitches, emergency timing circuits, emergency off buttons, electrical interlocks, source exposure indicator lights, viewing and intercom systems, timer termination, treatment table retraction mechanisms, and stereotactic frames and localizing devices (trunnions);

(10) the name of the individual who performed the periodic spot check; and

(11) the signature of the authorized medical physicist who reviewed the record of the spot check.

B. A licensee must retain a copy of the procedures required under part 4731.4474, subpart 2, until the licensee no longer possesses the gamma stereotactic radiosurgery unit.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.4522 OPERABILITY RECORDS; MOBILE REMOTE AFTERLOADER UNITS.

A licensee must retain a record of each check for mobile remote afterloader units required under part 4731.4475 for three years. The record must include:

A. the date of the check;

B. the manufacturer's name, model number, and serial number for the remote afterloader unit;

C. notations accounting for all sources before the licensee departs from a facility;

D. notations indicating the operability of each entrance door electrical interlock, radiation monitor, source exposure indicator light, viewing and intercom system, applicator, source transfer tube, and transfer tube applicator interface and the source positioning accuracy; and

E. the signature of the individual who performed the check.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4523 SURVEY RECORDS; THERAPEUTIC TREATMENT UNITS.

A licensee must maintain a record of radiation surveys of treatment units made according to part 4731.4476 for the duration of use of the unit. The record must include:

A. the date of the measurements;

B. the manufacturer's name, model number, and serial number for the treatment unit, source, and instrument used to measure radiation levels;

C. each dose rate measured around the source while the unit is in the off position and the average of all measurements; and

D. the signature of the individual who performed the test.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.4524 FULL-INSPECTION SERVICING RECORDS; TELETHERAPY AND GAMMA STEREOTACTIC RADIOSURGERY UNITS.

A licensee must maintain a record of the full-inspection servicing for teletherapy and gamma stereotactic radiosurgery units required under part 4731.4477 for the duration of use of the unit. The record must contain:

A. the inspector's radioactive material license number;

B. the date of inspection;

C. the manufacturer's name, model number, and serial number for both the treatment unit and source;

D. a list of components inspected and serviced and the type of service; and

E. the signature of the inspector.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4525 MEDICAL EVENT; REPORT AND NOTIFICATION.

Subpart 1. **Report required.** A licensee must report any event as a medical event, except for an event that results from patient intervention, in which:

A. the administration of radioactive material or radiation from radioactive material, except permanent implant brachytherapy, results in:

(1) a dose that differs from the prescribed dose or dose that would have resulted from the prescribed dose by more than five rems (0.05 Sv) effective dose equivalent, 50 rems (0.5 Sv) to an organ or tissue, or 50 rems (0.5 Sv) shallow dose equivalent to the skin and:

(a) the total dose delivered differs from the prescribed dose by 20 percent or more;

(b) the total dosage delivered differs from the prescribed dosage by 20 percent or more or falls outside the prescribed dosage range; or

(c) the fractionated dose delivered differs from the prescribed dose, for a single fraction, by 50 percent or more;

(2) a dose that exceeds five rems (0.05 Sv) effective dose equivalent, 50 rems (0.5 Sv) to an organ or tissue, or 50 rems (0.5 Sv) shallow dose equivalent to the skin from:

(a) an administration of a wrong radioactive drug containing radioactive material or the wrong radionuclide for a brachytherapy procedure;

(b) an administration of a radioactive drug containing radioactive material by the wrong route of administration;

(c) an administration of a dose or dosage to the wrong individual or human research subject;

(d) an administration of a dose or dosage delivered by the wrong mode of treatment; or

(e) a leaking sealed source; or

(3) a dose to the skin or an organ or tissue other than the treatment site that exceeds by:

(a) 50 rems (0.5 Sv) or more from the expected dose to that site from the procedure if the administration had been given in accordance with the written directive prepared or revised before administration; and

(b) 50 percent or more from the expected dose to that site from the procedure if the administration had been given in accordance with the written directive prepared or revised before administration.

B. for permanent implant brachytherapy, the administration of radioactive material or radiation from radioactive material excluding sources that were implanted in the correct site but migrated outside the treatment site that results in:

(1) the total source strength administered differing by 20 percent or more from the total source strength documented in the post-implantation portion of the written directive;

(2) the total source strength administered outside of the treatment site exceeding 20 percent of the total source strength documented in the post-implantation portion of the written directive; or

(3) an administration that includes any of the following:

(a) the wrong radionuclide;

(b) the wrong individual or human research subject;

(c) sealed source(s) implanted directly into a location discontiguous from the treatment site, as documented in the post-implantation portion of the written directive; or

(d) a leaking sealed source resulting in a dose that exceeds 50 rem (0.5 Sv) to an organ or tissue.

Subp. 2. **Events from patient intervention.** A licensee must report any event resulting from intervention of a patient or human research subject in which the administration of radioactive material or radiation from radioactive material results or will result in unintended permanent functional damage to an organ or a physiological system, as determined by a physician.

Subp. 3. **24-hour notification required.** A licensee must notify the commissioner within 24 hours after discovery of a medical event.

Subp. 4. **Written report.** A licensee must submit a written report to the commissioner within 15 days after discovery of a medical event. The report must not contain an individual's name or any other information that could lead to identification of an individual. The report must include:

A. the licensee's name;

B. the name of the prescribing physician;

C. a brief description of the event;

D. why the event occurred;

E. the effect, if any, on the individual who received the administration;

F. what actions, if any, have been taken or are planned to prevent recurrence; and

G. certification that the licensee notified the individual or the individual's responsible relative or guardian and, if not, why.

Subp. 5. **Notification of individual.**

A. A licensee must provide notification of a medical event to the referring physician and also notify the individual who is the subject of the medical event no later than 24 hours after its discovery, unless the referring physician personally informs the licensee either that the physician will inform the individual or that, based on medical judgment, telling the individual would be harmful.

B. A licensee is not required to notify the individual without first consulting the referring physician. If the referring physician or the affected individual cannot be reached within 24 hours, the licensee must notify the individual as soon as possible thereafter.

C. A licensee may not delay any appropriate medical care for the individual, including any necessary remedial care as a result of the medical event, because of any delay in notification.

D. To meet the notification requirements in this subpart, notification of the individual who is the subject of the medical event may be made instead to that individual's responsible relative or guardian.

E. If a verbal notification is made, the licensee must inform the individual, or appropriate responsible relative or guardian, that a written description of the event can be obtained from the licensee upon request. The licensee must provide a written description if requested.

Subp. 6. **Construction.** Aside from the notification requirement, nothing in this part affects any rights or duties of licensees and physicians in relation to each other, to individuals affected by a medical event, or to that individual's responsible relatives or guardians.

Subp. 7. **Individual identification.** A licensee must:

A. annotate a copy of the report provided to the commissioner with:

(1) the name of the individual who is the subject of the event; and

(2) the identification number or, if no other identification number is available, the Social Security number of the individual who is the subject of the event; and

B. provide a copy of the annotated report to the referring physician, if other than the licensee, no later than 15 days after the discovery of the medical event.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 36 SR 74; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.4526 DOSE TO AN EMBRYO/FETUS OR CHILD; REPORT AND NOTIFICATION.

Subpart 1. **Report required; embryo/fetus.** A licensee must report any dose to an embryo/fetus that is greater than five rems (50 mSv) dose equivalent that is a result of an administration of radioactive material or radiation from radioactive material to a pregnant woman unless the dose to the embryo/fetus was specifically approved, in advance, by the authorized user.

Subp. 2. **Report required; nursing child.** A licensee must report a dose to a nursing child that is a result of an administration of radioactive material to a breast-feeding woman that:

A. is greater than five rems (50 mSv) total effective dose equivalent; or

B. has resulted in unintended permanent functional damage to an organ or a physiological system of the child, as determined by a physician.

Subp. 3. **24-hour notification required.** A licensee must notify the commissioner within 24 hours after discovery of a dose to an embryo/fetus or nursing child that requires a report under subpart 1 or 2.

Subp. 4. **Written report.** A licensee must submit a written report to the commissioner within 15 days after discovery of a dose to an embryo/fetus or nursing child that requires a report under subpart 1 or 2. The report must not contain the individual's or child's name or any other information that could lead to identification of the individual or child. The report must include:

A. the licensee's name;

B. the name of the prescribing physician;

C. a brief description of the event;

D. why the event occurred;

E. the effect, if any, on the embryo/fetus or the nursing child;

F. what actions, if any, have been taken or are planned to prevent recurrence; and

G. certification that the licensee notified the pregnant woman or mother, or the mother's or child's responsible relative or guardian, and if not, why.

Subp. 5. **Notification of individual.**

A. A licensee must provide notification of an event requiring a report under subpart 1 or 2 to the referring physician and to the pregnant woman or mother, both hereafter referred to as the mother, no later than 24 hours after discovery of the event, unless the referring physician personally informs the licensee either that the physician will inform the mother or that, based on medical judgment, telling the mother would be harmful.

B. A licensee is not required to notify the mother without first consulting with the referring physician. If the referring physician or mother cannot be reached within 24 hours, the licensee must make the appropriate notifications as soon as possible thereafter.

C. A licensee may not delay any appropriate medical care for the embryo/fetus or for the nursing child, including any necessary remedial care as a result of the event, because of any delay in notification.

D. To meet the requirements of this subpart, notification may be made to the mother's or child's responsible relative or guardian instead of the mother.

E. If a verbal notification is made, the licensee must inform the mother, or the mother's or child's responsible relative or guardian, that a written description of the event can be obtained from the licensee upon request. The licensee must provide a written description if requested.

Subp. 6. **Individual identification.** A licensee must:

A. annotate a copy of the report provided to the commissioner with:

(1) the name of the pregnant individual or the nursing child who is the subject of the event; and

(2) the identification number or, if no other identification number is available, the Social Security number of the individual who is the subject of the event; and

B. provide a copy of the annotated report to the referring physician, if other than the licensee, no later than 15 days after the discovery of the event.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 36 SR 74; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.4527 REPORT OF LEAKING SOURCE.

A licensee must file a report within five days if a leak test required under part 4731.4424 reveals the presence of 0.005 microcurie (185 Bq) or more of removable contamination. The report must be filed with the commissioner. The written report must include:

A. the model number and serial number, if assigned, of the leaking source;

B. the identity of the radionuclide and its estimated activity;

C. the results of the test;

D. the date of the test; and

E. the action taken.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *November 28, 2012*

4731.4528 REPORT AND NOTIFICATION FOR AN ELUATE EXCEEDING PERMISSIBLE MOLYBDENUM-99, STRONTIUM-82, AND STRONTIUM-85 CONCENTRATIONS.

Subpart 1. **Telephone notification.** The licensee must notify, by telephone, the commissioner and the distributor of the generator, within seven days after discovery, that an eluate exceeded the permissible concentration listed in part 4731.4435, item A, at the time of generator elution. The telephone report to the commissioner must include the manufacturer, model number, and serial number (or lot number) of the generator; the results of the measurement; the date of the measurement; whether dosages were administered to patients or human research subjects, when the distributor was notified, and the action taken.

Subp. 2. **Written report.** The licensee must submit a written report to the commissioner within 30 days after discovery of an eluate exceeding the permissible concentration at the time of generator elution. The written report must include the action taken by the licensee; the patient dose assessment;

the methodology used to make this dose assessment if the eluate was administered to patients or human research subjects; the probable cause and an assessment of failure in the licensee's equipment, procedures, or training that contributed to the excessive readings if an error occurred in the licensee's breakthrough determination; and the information in the telephone report as required by subpart 1.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *46 SR 791*

Published Electronically: *May 26, 2022*

NUCLEAR MEDICINE TECHNOLOGY

4731.4600 DEFINITIONS.

Subpart 1. **Scope.** The following definitions apply to parts 4731.4605 to 4731.4620.

Subp. 2. **Accredited.** "Accredited" means an individual who has satisfactorily completed a nationally recognized examination in nuclear medicine and who maintains the registration or certification of the examining organization. Nationally recognized examinations are provided by the following organizations:

A. the American Registry of Radiologic Technologists (N) (ARRT);

B. the Nuclear Medicine Technology Certification Board (NMTCB); or

C. the American Society of Clinical Pathologists (NM) (ASCP).

Subp. 3. **Nuclear medicine technologist.** "Nuclear medicine technologist" means a person other than a licensed practitioner of the healing arts who administers radiopharmaceuticals and related drugs to human beings for diagnostic purposes, performs in vivo and in vitro detection and measurement of radioactivity, and administers radiopharmaceuticals to human beings for therapeutic purposes. A nuclear medicine technologist may perform such procedures only while under the general supervision of a licensed practitioner of the healing arts who is licensed to possess and use radioactive materials.

Subp. 4. **Direct supervision.** "Direct supervision" means an accredited nuclear medicine technologist or an authorized user currently listed on an agreement state or United States Nuclear Regulatory Commission radioactive materials license is physically present in the facility and available to respond.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *36 SR 74*

Published Electronically: *November 28, 2012*

4731.4605 MINIMUM STANDARDS FOR NUCLEAR MEDICINE TECHNOLOGISTS.

Subpart 1. **General requirements.** Except as specified in part 4731.4610, any individual working as a nuclear medicine technologist in Minnesota must meet the following minimum eligibility requirements:

A. graduation from high school or its equivalent;

B. attainment of 18 years of age; and

C. ability to adequately perform necessary duties without posing a hazard to the health or safety of patients, other employees, or members of the public.

Subp. 2. **Accreditation required.** Except as specified in part 4731.4610, any individual working as a nuclear medicine technologist in Minnesota on or after January 1, 2011, must be accredited.

Subp. 3. **Record retention.** The licensee must retain documentation of accreditation for five years and make it available for inspection upon request by the department.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *36 SR 74*
Published Electronically: *August 15, 2011*

4731.4610 EXCEPTIONS.

The individuals in items A to D are exempt from the examination requirement in part 4731.4600, subpart 2:

A. a licensed practitioner of the healing arts who is listed as an authorized user on an agreement state or United States Nuclear Regulatory Commission radioactive materials license;

B. individuals working as nuclear medicine technologists under the direct supervision of: (1) an individual who is accredited in nuclear medicine; or (2) a physician who appears as an authorized user on an agreement state or United States Nuclear Regulatory Commission radioactive materials license;

C. students enrolled in and participating in an accredited program for nuclear medicine technology or a school of medicine, osteopathic medicine, podiatry, or chiropractic who, as a part of the students' course of study, administers radioactive material during supervised clinical experience; or

D. an individual working as a nuclear medicine technologist before January 1, 2011, who is not accredited, provided the individual has completed the training in part 4731.4612.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *36 SR 74; L 2016 c 119 s 7*
Published Electronically: *September 13, 2016*

4731.4612 TRAINING FOR INDIVIDUALS FUNCTIONING AS A NUCLEAR MEDICINE TECHNOLOGIST BEFORE JANUARY 1, 2011, WHO ARE NOT ACCREDITED.

Subpart 1. **Training program.** Individuals working as a nuclear medicine technologist before January 1 , 2011, who are not accredited must complete a training program designed to demonstrate competency in the following areas:

A. patient and personnel protection including:

(1) biological effects of radiation;

(2) basic concepts of radiation protection; and

(3) Minnesota Department of Health rules for radiation exposure;

B. radiopharmaceutical characteristics including:

(1) half-life;

(2) method of localization; and

(3) biodistribution;

C. proper handling of radioactive materials including:

(1) inspection and survey of packages;

(2) storage of radioactive material;

(3) disposal of radioactive waste; and

(4) United States Department of Transportation training requirements for shippers;

D. factors affecting image quality including:

(1) equipment;

(2) patient and detector orientation;

(3) patient anatomical factors;

(4) anatomical landmarks;

(5) immobilization techniques; and

(6) radiopharmaceuticals;

E. facility monitoring including:

(1) survey equipment operation and uses; and

(2) radioactive spill responses; and

F. administration of radiopharmaceuticals during supervised clinical experience.

Subp. 2. **Clinical experience.** Clinical experience must be supervised by an individual who is accredited in nuclear medicine or by a physician who appears as an authorized user on an agreement state or United States Nuclear Regulatory Commission radioactive materials license.

Subp. 3. **Restrictions during training.** Individuals in a training program indicated in subpart 1 cannot work as a nuclear medicine technologist before obtaining documentation of competency as required in part 4731.4615 unless the individual works under the direct supervision of:

A. an individual who is accredited in nuclear medicine; or

B. a physician who appears as an authorized user on an agreement state or United States Nuclear Regulatory Commission radioactive materials license.

Subp. 4. **Continuing education.** Individuals working as nuclear medicine technologists before January 1, 2011, who are not accredited must:

A. obtain 24 hours of continuing education every 24 months;

B. have the continuing education training approved by any of the organizations listed in part 4731.4600, subpart 2; and

C. retain documentation of continuing education for five years and make it available for inspection upon request by the department.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *36 SR 74; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.4615 DOCUMENTATION OF COMPETENCY.

Subpart 1. **Nuclear medicine technologist; January 1, 2011.** An individual functioning as a nuclear medicine technologist prior to January 1, 2011, and who is not accredited must obtain documentation that the individual is competent to apply ionizing radiation to human beings.

Subp. 2. **Who can document competency.** The documentation of competency must be provided by a licensed practitioner of the healing arts under whose general supervision the individual is employed or has been employed.

Subp. 3. **Procedures and equipment.** The documentation of competency must specify the nature of procedures and the equipment the individual is competent to utilize and must be limited to work performed before January 1, 2011.

Subp. 4. **Record retention.** The documentation of competency must be retained by the individual for inspection upon request by the department.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *36 SR 74*
Published Electronically: *August 15, 2011*

4731.4620 REQUIREMENTS FOR OPERATORS OF FUSION IMAGING DEVICES.

Subpart 1. **Accreditation required.** When a unit is operated as a fusion imaging device or in a dual mode such as a SPECT/CT or PET/CT device, the operator must be accredited or must meet the requirements in chapter 4732.

Subp. 2. **Diagnostic CT imaging device.** When the unit is operated as a stand-alone diagnostic CT imaging device, the operator must meet the requirements in chapter 4732.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *36 SR 74*
Published Electronically: *August 15, 2011*

IRRADIATORS

4731.6000 PURPOSE AND SCOPE.

Subpart 1. **Applicability.** Parts 4731.6000 to 4731.6270 apply to the issuance of a license authorizing the use of and the radiation safety requirements for sealed sources containing radioactive materials used to irradiate objects or materials using gamma radiation in the following types of irradiators:

A. panoramic irradiators that have either dry or wet storage of the radioactive sealed sources;

B. underwater irradiators in which both the source and the product being irradiated are underwater; and

C. irradiators for which dose rates exceed five grays (500 rads) per hour at one meter from the radioactive sealed sources in air or in water, as applicable for the irradiator type.

Subp. 2. **Exemptions.** Parts 4731.6000 to 4731.6270 do not apply to:

A. self-contained dry-source-storage irradiators (those in which both the source and the area subject to irradiation are contained within a device and are not accessible by personnel);

B. medical radiology;

C. teletherapy;

D. radiography (the irradiation of materials for nondestructive testing purposes);

E. gauging; or

F. open-field (agricultural) irradiations.

Subp. 3. **Other law.** Parts 4731.6000 to 4731.6270 are in addition to other requirements of this chapter. Nothing in parts 4731.6000 to 4731.6270 relieves a licensee from complying with

other applicable federal, state, and local regulations governing the siting, zoning, land use, and building code requirements for industrial facilities.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6010 SPECIFIC LICENSE; APPLICATION.

A person must file an application for a specific license authorizing the use of sealed sources in an irradiator on the application for material license form prescribed by the commissioner. An application for a license, other than a license exempted from Code of Federal Regulations, title 10, part 170, must be accompanied by a fee according to Minnesota Statutes, section 144.1205. The application and one copy must be sent to the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6020 SPECIFIC LICENSE; APPROVAL.

The commissioner shall approve an application for a specific license for the use of licensed material in an irradiator if the applicant meets the general requirements under parts 4731.3070, subpart 1, items A to D, and 4731.3070, subpart 2, and if the application includes:

A. a description of the training provided to irradiator operators including:

(1) classroom training;

(2) on-the-job or simulator training;

(3) safety reviews;

(4) methods used by the applicant to test each operator's understanding of and ability to comply with this chapter, licensing requirements, and the irradiator operating and emergency procedures; and

(5) minimum training and experience of personnel who may provide training;

B. an outline of written operating and emergency procedures listed in part 4731.6170 that describes the radiation safety aspects of the procedures;

C. a description of the organizational structure for managing the irradiator, including:

(1) the radiation safety responsibilities and authorities of the radiation safety officer; and

(2) who, within the management structure, has the authority to stop unsafe operations and management personnel who have important radiation safety responsibilities or authorities;

D. a description of the training and experience required for the position of radiation safety officer;

E. a description of:

(1) access control systems required under part 4731.6060;

(2) radiation monitors required under part 4731.6090; and

(3) the method of detecting leaking sources required under part 4731.6200, including the sensitivity of the method;

F. a diagram of the facility that shows the locations of all required interlocks and radiation monitors;

G. if the applicant intends to perform leak testing of dry-source-storage sealed sources, a description of the applicant's established procedures for leak testing. The description must include the:

(1) instruments to be used;

(2) methods of performing the analysis; and

(3) pertinent experience of the individual who analyzes the samples;

H. if the applicant's personnel are to load or unload sources, a description of the qualifications and training of the personnel and the procedures to be used. If the applicant intends to contract for source loading and unloading at the applicant's facility, the loading or unloading must be done by an organization specifically authorized by the commissioner, the NRC, or an agreement state to load or unload irradiator sources; and

I. a description of the inspection and maintenance checks, including the frequency of the checks, required under part 4731.6210.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*

Published Electronically: *August 27, 2015*

4731.6030 START OF CONSTRUCTION.

An applicant may not begin construction of a new irradiator before submitting to the commissioner an application for a license for the irradiator and the fee required under Minnesota Statutes, section 144.1205. Activities undertaken before the issuance of a license are entirely at the risk of the applicant and have no bearing on the issuance of a license with respect to the requirements of this chapter. For purposes of this part, construction includes the construction of any portion of the permanent irradiator structure on the site, but does not include:

A. engineering and design work;

B. purchase of a site;

C. site surveys or soil testing;

D. site preparation, site excavation, or construction of warehouse or auxiliary structures; or

E. other preconstruction tasks.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6040 APPLICATIONS FOR EXEMPTIONS.

An application for a license or for amendment of a license authorizing use of a teletherapy-type unit for industrial irradiation of materials or objects may include proposed alternatives to the requirements under parts 4731.6000 to 4731.6270. The commissioner shall approve the proposed alternatives if the applicant provides adequate rationale for the proposed alternatives and demonstrates that the alternatives are likely to provide an adequate level of safety for workers and the public.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6050 PERFORMANCE CRITERIA; SEALED SOURCES.

Subpart 1. **Applicability.** Sealed sources installed after July 1, 1993, must meet the performance criteria of subparts 2 to 4.

Subp. 2. **General requirements.** Sealed sources must:

A. have a certificate of registration issued by the NRC under Code of Federal Regulations, title 10, section 32.210, or by an agreement state;

B. be doubly encapsulated; and

C. use radioactive material that is as nondispersible as practical and that is as insoluble as practical if the source is used in a wet-source-storage or wet-source-change irradiator.

Subp. 3. **Irradiator pools.** If sealed sources are to be used in irradiator pools, the sealed sources must be encapsulated in a material resistant to general corrosion and to localized corrosion, such as 316L stainless steel or other material with equivalent resistance.

Subp. 4. **Required leak testing.** In prototype testing of a sealed source, the sealed source must have been leak tested and found leak-free after each of the following tests:

A. temperature test. The test source must be held at -40 degrees Celsius for 20 minutes, 600 degrees Celsius for one hour, and then subjected to a thermal shock test with a temperature drop from 600 degrees Celsius to 20 degrees Celsius within 15 seconds;

B. pressure test. The test source must be twice subjected for at least five minutes to an external pressure (absolute) of 2,000,000 newtons per square meter;

C. impact test. A two-kilogram steel weight, 2.5 centimeters in diameter, must be dropped from a height of one meter onto the test source;

D. vibration test. The test source must be subjected three times for ten minutes each to vibrations sweeping from 25 hertz to 500 hertz with a peak amplitude of five times the acceleration of gravity. The test source must be vibrated for 30 minutes at each resonant frequency found;

E. puncture test. A 50-gram weight and pin, 0.3-centimeter pin diameter, must be dropped from a height of one meter onto the test source; and

F. bend test. If the length of the source is more than 15 times larger than the minimum cross-sectional dimension, the test source must be subjected to a force of 2,000 newtons at its center equidistant from two support cylinders, the distance between which is ten times the minimum cross-sectional dimension of the source.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6060 ACCESS CONTROL.

Subpart 1. **Panoramic irradiators.**

A. Each entrance to a radiation room at a panoramic irradiator must have a door or other physical barrier to prevent entry of personnel if the sources are not in the shielded position. Product conveyor systems may serve as barriers, as long as they reliably and consistently function as a barrier. It must not be possible to move the sources out of their shielded position if the door or barrier is open. Opening the door or barrier while the sources are exposed must cause the sources to return promptly to their shielded position. The personnel entrance door or barrier must have a lock that is operated by the same key used to move the sources. The doors and barriers must not prevent an individual in the radiation room from leaving.

B. Each entrance to a radiation room at a panoramic irradiator must have an independent backup access control to detect personnel entry while the sources are exposed. Detection of entry while the sources are exposed must cause the sources to return to their fully shielded position and must also activate a visible and audible alarm to make the individual entering the room aware of the hazard. The alarm must also alert at least one other individual who is on site of the entry. That individual must be trained on how to respond to the alarm and prepared to promptly render or summon assistance.

C. A radiation monitor must be provided to detect the presence of high radiation levels in the radiation room of a panoramic irradiator before personnel entry. The monitor must be integrated with personnel access door locks to prevent room access when radiation levels are high. Attempted personnel entry while the monitor measures high radiation levels must activate the alarm described

in item B. The monitor may be located in the entrance, normally referred to as the maze, but not in the direct radiation beam.

D. Before the sources move from their shielded position in a panoramic irradiator, the source control must automatically activate conspicuous visible and audible alarms to alert people in the radiation room that the sources will be moved from their shielded position. The alarms must give individuals enough time to leave the room before the sources leave the shielded position.

E. Each radiation room at a panoramic irradiator must have a clearly visible and readily accessible control that allows an individual in the room to make the sources return to their fully shielded position.

F. Each radiation room of a panoramic irradiator must contain a control that prevents the sources from moving from the shielded position unless the control has been activated and the door or barrier to the radiation room has been closed within a preset time after activation of the control.

G. Each entrance to the radiation room of a panoramic irradiator must be posted according to part 4731.2310. Radiation postings for panoramic irradiators must comply with part 4731.2310, except that signs may be removed, covered, or otherwise made inoperative when the sources are fully shielded.

H. After entering the panoramic irradiator, if the radiation room of a panoramic irradiator has roof plugs or other movable shielding, it must not be possible to operate the irradiator unless the shielding is in its proper location. This requirement may be met:

(1) by interlocks that prevent operation if shielding is not placed properly; or

(2) by an operating procedure requiring inspection of shielding before operating.

Subp. 2. **Underwater irradiators.**

A. Each entrance to the area within the personnel access barrier of an underwater irradiator must be posted according to part 4731.2310.

B. There must be a personnel access barrier around the pool, which must be locked to prevent access when the irradiator is not attended.

C. Only operators and facility management may have access to keys to the personnel access barrier.

D. There must be an intrusion alarm to detect unauthorized entry when the personnel access barrier is locked. Activation of the intrusion alarm must alert an individual, not necessarily on site, who is prepared to respond or summon assistance.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6070 SHIELDING.

Subpart 1. **Panoramic irradiators.** For panoramic irradiators, the radiation dose rate in areas that are normally occupied during operation may not exceed two millirems (0.02 mSv) per hour at any location 30 centimeters or more from the wall of the room when the sources are exposed. The dose rate must be averaged over an area not to exceed 100 square centimeters having no linear dimension greater than 20 centimeters. Areas where the radiation dose rate exceeds two millirems (0.02 mSv) per hour must be locked, roped off, or posted.

Subp. 2. **Dry-source-storage panoramic irradiators.** For dry-source-storage panoramic irradiators, the radiation dose rate at one meter from the shield when the source is shielded may not exceed two millirems (0.02 mSv) per hour and at five centimeters from the shield may not exceed 20 millirems (0.2 mSv) per hour.

Subp. 3. **Pool irradiators.** For pool irradiators, the radiation dose at 30 centimeters over the edge of the pool may not exceed two millirems (0.02 mSv) per hour when the sources are in the fully shielded position.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6080 FIRE PROTECTION.

For panoramic irradiators, the radiation room must have:

A. heat and smoke detectors, which must activate an audible alarm. The alarm must be capable of alerting a person who is prepared to summon assistance promptly;

B. a system whereby the sources automatically become fully shielded if a fire is detected; and

C. a fire extinguishing system capable of extinguishing a fire without the entry of personnel into the room. The system for the radiation room must have a shut-off valve to control flooding into unrestricted areas.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6090 RADIATION MONITORS.

Subpart 1. **Automatic product conveyor systems.**

A. Irradiators with automatic product conveyor systems must have a radiation monitor with an audible alarm located to detect loose radioactive sources that are carried toward the product exit. The alarms must comply with items B to D.

B. If the monitor detects a source, an alarm must sound and product conveyors must stop automatically.

C. The alarm must be capable of alerting an individual in the facility who is prepared to summon assistance.

D. Underwater irradiators in which the product moves within an enclosed stationary tube are exempt from the requirements of this subpart.

Subp. 2. **Underwater irradiators.**

A. Underwater irradiators that are not in a shielded radiation room must have a radiation monitor over the pool to detect abnormal radiation levels. The monitor must comply with items B to D.

B. The monitor must have an audible alarm and a visible indicator at entrances to the personnel access barrier around the pool.

C. The audible alarm may have a manual shut-off.

D. The alarm must be capable of alerting an individual who is prepared to respond promptly.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6100 CONTROL OF SOURCE MOVEMENT; PANORAMIC IRRADIATORS.

A. Items B to E apply to panoramic irradiators.

B. The mechanism that moves the sources must:

(1) require a key to activate. Only one key may be in use at any time and only operators or facility management may possess it. The key must be attached to a portable radiation survey meter by a chain or cable. The lock for source control must be designed so that the key may not be removed if the sources are in an unshielded position. The door to the radiation room must require the same key; and

(2) cause an audible signal to indicate that the sources are leaving the shielded position.

C. The console must have a source position indicator that indicates when the sources are in the fully shielded position, when they are in transit, and when the sources are exposed.

D. The control console must have a control that promptly returns the sources to the shielded position.

E. Each control must be clearly marked as to its function.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6110 IRRADIATOR POOLS.

Irradiator pools initially licensed after July 1, 1993, must:

A. have a watertight stainless steel liner or a liner metallurgically compatible with other components in the pool or be constructed so that there is a low probability of substantial leakage and have a surface designed to facilitate decontamination;

B. have a method to safely store sources during repairs of the pool;

C. have no outlets greater than 0.5 meter below the normal low water level that could allow water to drain out of the pool. Pipes that have intakes more than 0.5 meter below the normal low water level and that could act as siphons must have siphon breakers to prevent the siphoning of pool water;

D. be provided with a means to replenish water losses from the pool;

E. be provided with a water level indicator in a clearly visible location to indicate if the pool water level is below the normal low water level or above the normal high water level;

F. be equipped with a purification system designed to be capable of maintaining the water during normal operation at a conductivity of 20 microsiemens per centimeter or less and with a clarity so that the sources can be seen clearly;

G. be provided with a physical barrier, such as a railing or cover, around or over irradiator pools during normal operation to prevent personnel from accidentally falling into the pool. The barrier may be removed during maintenance, inspection, and service operations; and

H. not expose handling areas of tools or poles to radiation dose rates greater than two millirems (0.02 mSv) per hour.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6120 SOURCE RACK PROTECTION.

If the product to be irradiated moves on a product conveyor system, the source rack and the mechanism that moves the rack must be protected by a barrier or guides to prevent products and product carriers from hitting or touching the rack or mechanism.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6130 POWER FAILURES.

A. If electrical power at a panoramic irradiator is lost for longer than ten seconds, the sources must automatically return to the shielded position.

B. The lock on the door of the radiation room of a panoramic irradiator may not be deactivated by a power failure.

C. During a power failure, the area of any irradiator where sources are located may be entered only when using an operable and calibrated radiation survey meter.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6140 DESIGN REQUIREMENTS.

Subpart 1. **Applicability.** This part applies to irradiators whose construction began after July 1, 1993.

Subp. 2. **Panoramic irradiators.** For panoramic irradiators, a licensee must:

A. design shielding walls to meet generally accepted building code requirements for reinforced concrete and design the walls, wall penetrations, and entranceways to meet the radiation shielding requirements of part 4731.6070. If the irradiator will use more than 5,000,000 curies (2×10^{17} becquerels) of activity, the licensee must evaluate the effects of heating of the shielding walls by the irradiator sources;

B. design the foundation, with consideration given to soil characteristics, to ensure it is adequate to support the weight of the facility shield walls;

C. verify from the design and logic diagram that the access control system will meet the requirements of part 4731.6060;

D. verify that the number, location, and spacing of the smoke and heat detectors are appropriate to detect fires and that the detectors are protected from mechanical and radiation damage;

E. verify that the design of the fire extinguishing system provides the necessary discharge patterns, densities, and flow characteristics for complete coverage of the radiation room and that the system is protected from mechanical and radiation damage;

F. verify that the source rack will automatically return to the fully shielded position if off-site power is lost for more than ten seconds;

G. if the irradiator is to be built in seismic areas, design the reinforced concrete radiation shields to retain their integrity in the event of an earthquake by designing to the seismic requirements of an appropriate source, including:

(1) "Building Code Requirements for Reinforced Concrete (ACI318-89)," American Concrete Institute, chapter 21 (1989). The chapter is incorporated by reference, is not subject to frequent change, and is available from the Minitex interlibrary loan system; or

(2) local building codes;

H. verify that electrical wiring and electrical equipment in the radiation room are selected to minimize failures due to prolonged exposure to radiation;

I. determine that source rack drops due to loss of power will not damage the source rack and that source rack drops due to failure of cables (or alternate means of support) will not cause loss of integrity of sealed sources; and

J. review the design of the mechanism that moves the sources to ensure that the likelihood of a stuck source is low and that, if the rack sticks, a means exists to free it with minimal risk to personnel.

Subp. 3. **Pool and underwater irradiators.** For pool and underwater irradiators, a licensee must:

A. design the pool to ensure that:

(1) it is leak resistant;

(2) it is strong enough to bear the weight of the pool water and shipping casks;

(3) a dropped cask would not fall on sealed sources;

(4) all outlets or pipes meet the requirements under part 4731.6110, item C; and

(5) metal components are metallurgically compatible with other components in the pool;

B. verify that the design of the water purification system is adequate to meet the requirements of part 4731.6110, item F. The system must be designed so that water leaking from the system does not drain to unrestricted areas without being monitored;

C. when using radiation monitoring systems to detect contamination under part 4731.6200, subpart 2, verify that the design of radiation monitoring systems to detect pool contamination includes sensitive detectors located close to where contamination is likely to concentrate; and

D. verify that there are no crevices on the source or between the source and source holder that would promote corrosion on a critical area of the source.

Subp. 4. **All irradiators.** For all irradiators, a licensee must:

A. evaluate the location and sensitivity of the monitor to detect sources carried by the product conveyor system as required under part 4731.6090, subpart 1; and

B. verify that the product conveyor is designed to stop before a source on the product conveyor would cause a radiation overexposure to any person.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6150 CONSTRUCTION MONITORING AND ACCEPTANCE TESTING.

Subpart 1. **Applicability.** This part applies to irradiators whose construction began after July 1, 1993. The requirements of this part must be met prior to loading sources.

Subp. 2. **Panoramic irradiators.** For panoramic irradiators, a licensee must:

A. monitor the construction of the shielding to verify that its construction meets design specifications and generally accepted building code requirements for reinforced concrete;

B. monitor the construction of the foundations to verify that their construction meets design specifications;

C. test the movement of the source racks for proper operation prior to source loading. Testing must include source rack lowering due to simulated loss of power;

D. test the completed access control system to ensure that it functions as designed and that all alarms, controls, and interlocks work properly;

E. test the ability of the heat and smoke detectors to detect a fire, to activate alarms, and to cause the source rack to automatically become fully shielded;

F. test the operability of the fire extinguishing system;

G. demonstrate that the source racks can be returned to their fully shielded positions without off-site power;

H. if a computer system is used to control the access control system, verify that the access control system will operate properly if off-site power is lost and verify that the computer has security features that prevent an irradiator operator from commanding the computer to override the access control system when it is required to be operable; and

I. verify that the electrical wiring and electrical equipment that were installed meet the design specifications.

Subp. 3. **Pool and underwater irradiators.** For pool and underwater irradiators, a licensee must verify:

A. that the pool meets design specifications and must test the integrity of the pool;

B. that outlets and pipes meet the requirements under part 4731.6110, item C;

C. that the water purification system, the conductivity meter, and the water level indicators operate properly;

D. for pool irradiators, the proper operation of the radiation monitors and the related alarm if used to comply with part 4731.6190, subpart 2; and

E. for underwater irradiators, the proper operation of the over-the-pool monitor, alarms, and interlocks required under part 4731.6090, subpart 2.

Subp. 4. **All irradiators.** For all irradiators, a licensee must verify the proper operation of the monitor to detect sources carried on the product conveyor system and the related alarms and interlocks required under part 4731.6090, subpart 1.

Subp. 5. **Irradiators with product conveyor systems.** For all irradiators with product conveyor systems, a licensee must observe and test the operation of the conveyor system to ensure that the requirements under part 4731.6120 are met for protection of the source rack and the mechanism that moves the rack. Testing must include tests of any limit switches and interlocks used to protect the source rack and mechanism that moves the rack from moving product carriers.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6160 TRAINING.

Subpart 1. **Required instruction.** Before an individual is permitted to operate an irradiator without a supervisor present, the individual must be instructed in:

A. the fundamentals of radiation protection applied to irradiators, including:

(1) the differences between external radiation and radioactive contamination;

(2) units of radiation dose;

(3) dose limits under this chapter;

(4) why large radiation doses must be avoided;

(5) how shielding and access controls prevent large doses;

(6) how an irradiator is designed to prevent contamination;

(7) the proper use of survey meters and personnel dosimeters;

(8) other radiation safety features of an irradiator; and

(9) the basic function of the irradiator;

B. the requirements of parts 4731.1000 to 4731.1090 and 4731.6000 to 4731.6270 that are relevant to the irradiator;

C. the operation of the irradiator;

D. those operating and emergency procedures under part 4731.6170 that the individual is responsible for performing; and

E. case histories of accidents or problems involving irradiators.

Subp. 2. **Required qualifications.** Before an individual is permitted to operate an irradiator without a supervisor present, the individual must:

A. pass a written test on the instruction received consisting primarily of questions based on the licensee's operating and emergency procedures that the individual is responsible for performing and other operations necessary to safely operate the irradiator without supervision;

B. have received on-the-job training or simulator training in the use of the irradiator as described in the license application; and

C. demonstrate the ability to perform those portions of the operating and emergency procedures that the individual is to perform.

Subp. 3. **Safety reviews.** A licensee must conduct safety reviews for irradiator operators at least annually. The licensee must give each operator a brief written test on the information. Each safety review must include, to the extent appropriate:

A. changes in operating and emergency procedures since the last review, if any;

B. changes in rules and license conditions since the last review, if any;

C. reports on recent accidents, mistakes, or problems that have occurred at irradiators, if any;

D. relevant results of inspections of operator safety performance;

E. relevant results of the facility's inspection and maintenance checks; and

F. a drill to practice an emergency or abnormal event procedure.

Subp. 4. **Safety performance.** A licensee must evaluate the safety performance of each irradiator operator at least annually to ensure that rules, license conditions, and operating and emergency procedures are followed. The licensee must discuss the results of the evaluation with the operator and must instruct the operator on how to correct any mistakes or deficiencies observed.

Subp. 5. **Individuals with access.** Individuals who will be permitted unescorted access to the radiation room of an irradiator or the area around the pool of an underwater irradiator, but who have not received the training required for operators or radiation safety officers, must be instructed and tested in any precautions they should take to avoid radiation exposure, any procedures or parts of procedures under part 4731.6170 that they are expected to perform or comply with, and their proper response to alarms required under parts 4731.6000 to 4731.6270. Tests may be oral.

Subp. 6. **Response training.** Individuals who must be prepared to respond to alarms required under parts 4731.6060, subparts 1, item B, and 2, item D; 4731.6080; 4731.6090; and 4731.6200,

subpart 2, must be trained and tested on how to respond. Each individual must be retested at least once a year. Tests may be oral.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6170 OPERATING AND EMERGENCY PROCEDURES.

Subpart 1. **Operating procedures.** A licensee must have and follow written operating procedures for:

A. operation of the irradiator, including entering and leaving the radiation room;

B. use of personnel dosimeters;

C. surveying the shielding of panoramic irradiators;

D. monitoring pool water for contamination while the water is in the pool and before release of pool water to unrestricted areas;

E. leak testing of sources;

F. inspection and maintenance checks required under part 4731.6210;

G. loading, unloading, and repositioning sources, if the operations will be performed by the licensee; and

H. inspection of movable shielding required under part 4731.6060, subpart 1, item H, if applicable.

Subp. 2. **Emergency procedures.** A licensee must have and follow emergency or abnormal event procedures, appropriate for the irradiator type, for:

A. sources stuck in the unshielded position;

B. personnel overexposures;

C. a radiation alarm from the product exit portal monitor or pool monitor;

D. detection of leaking sources, pool contamination, or an alarm caused by contamination of pool water;

E. a low or high water level indicator, an abnormal water loss, or leakage from the source storage pool;

F. a prolonged loss of electrical power;

G. a fire alarm or explosion in the radiation room;

H. an alarm indicating unauthorized entry into the radiation room, area around the pool, or another alarmed area;

I. natural phenomena, including an earthquake, a tornado, flooding, or other phenomena as appropriate for the geographical location of the facility; and

J. the jamming of automatic conveyor systems.

Subp. 3. **Revision of procedures.** A licensee may revise operating and emergency procedures without commissioner approval only if:

A. the revisions do not reduce the safety of the facility;

B. the revisions are consistent with the outline or summary of procedures submitted with the license application;

C. the revisions have been reviewed and approved by the radiation safety officer; and

D. the users or operators have been instructed and tested on the revised procedures before the procedures are put into use.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6180 PERSONNEL MONITORING.

Subpart 1. **Irradiator operators.** Irradiator operators must wear a personnel dosimeter while operating a panoramic irradiator or while in the area around the pool of an underwater irradiator. The personnel dosimeter must be capable of detecting high energy photons in the normal and accident dose ranges. Each personnel dosimeter must be assigned to and worn by only one individual. Film badges must be replaced at least monthly and other personnel dosimeters that require replacement must be replaced at least quarterly. All personnel dosimeters must be evaluated at least quarterly or promptly after replacement, whichever is more frequent.

Subp. 2. **Other personnel.** Other individuals who enter the radiation room of a panoramic irradiator must wear a dosimeter, which may be a pocket dosimeter. For groups of visitors, only two people who enter the radiation room are required to wear dosimeters. If pocket dosimeters are used to meet the requirements of this subpart, a check of their response to radiation must be done at least annually. Acceptable dosimeters must read within plus or minus 30 percent of the true radiation dose.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.6190 RADIATION SURVEYS.

Subpart 1. **Panoramic irradiators.** For panoramic irradiators, the following radiation surveys must be conducted:

A. before the facility starts to operate, in the area outside the shielding of the radiation room, with the sources in the exposed position;

B. at intervals not to exceed three years, by the shielding of the irradiator;

C. before resuming operation after addition of new sources; and

D. after any modification to the radiation room shielding or structure that might increase dose rates.

Subp. 2. **Pool irradiators.** For pool irradiators, the following radiation surveys must be conducted:

A. before the facility starts to operate, in the area above the pool, after the sources are loaded;

B. at intervals not to exceed three years, by the shielding of the irradiator;

C. before resuming operation after addition of new sources;

D. after any modification to the radiation room shielding or structure that might increase dose rates; and

E. before release to unrestricted areas, water from the irradiator pool, other potentially contaminated liquids, and sediments from pool vacuuming must be monitored for radioactive contamination. Radioactive concentrations must not exceed those specified in part 4731.2750, subpart 7, Table 2 or 3.

Subp. 3. **All irradiators.**

A. For all irradiators, radiation surveys must:

(1) be modified to comply with part 4731.6070, if the radiation levels specified under part 4731.6070 are exceeded; and

(2) be conducted with portable radiation survey meters that are calibrated at least annually to an accuracy of plus or minus 20 percent for the gamma energy of the sources in use. The calibration must be done at two points on each scale or, for digital instruments, at one point per decade over the range that will be used. Portable radiation survey meters must be of a type that does not saturate and read zero at high radiation dose rates.

B. Before releasing resins for unrestricted use, the resins must be monitored before release in an area with a background level less than 0.05 millirem (0.5 μSv) per hour. The resins may be released only if the survey does not detect radiation levels above background radiation levels. The survey meter used must be capable of detecting radiation levels of 0.05 millirem (0.5 μSv) per hour.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6200 DETECTION OF LEAKING SOURCES.

Subpart 1. **Dry-source-storage sealed sources.** Each dry-source-storage sealed source must be tested for leakage at intervals not to exceed six months using a leak test kit or method approved by the commissioner, the NRC, or an agreement state. In the absence of a certificate from a transferor that a test has been made within the six months before the transfer, the sealed source may not be used until tested. The test must be capable of detecting the presence of 0.005 microcurie (200 becquerels) of radioactive material and must be performed by a person approved by the commissioner, the NRC, or an agreement state to perform the test.

Subp. 2. **Pool irradiators.**

A. This subpart applies to pool irradiators.

B. Sources may not be put into the pool unless the licensee tests the sources for leaks or has a certificate from a transferor that a leak test has been done within six months before the transfer.

C. Water from the pool must be checked for contamination each day the irradiator operates. The check may be done by using:

(1) a radiation monitor on a pool water circulating system; or

(2) analysis of a sample of pool water.

D. If a check for contamination under item C is done by analysis of a sample of pool water, the results of the analysis must be available within 24 hours.

E. If a licensee uses a radiation monitor on a pool water circulating system under item C, the detection of above normal radiation levels must activate an alarm. The alarm set-point must be set as low as practical, but high enough to avoid false alarms. The licensee may reset the alarm set-point to a higher level if necessary to operate the pool water purification system to clean up contamination in the pool if specifically provided for in written emergency procedures.

Subp. 3. **All irradiators.**

A. If a leaking source is detected:

(1) the licensee must arrange to remove the leaking source from service and have it decontaminated, repaired, or disposed of by a licensee of the commissioner, the NRC, or an agreement state that is authorized to perform these functions;

(2) the licensee must promptly check the licensee's personnel, equipment, facilities, and irradiated product for radioactive contamination;

(3) no product may be shipped until the product has been checked and found free of contamination. If a product has been shipped that may have been inadvertently contaminated, the licensee must arrange to locate and survey the product for contamination;

(4) if any personnel are found to be contaminated, decontamination must be performed promptly;

(5) if contaminated equipment, facilities, or products are found, the licensee must arrange to have the equipment, facilities, or products decontaminated or disposed of by a licensee of the commissioner, the NRC, or an agreement state that is authorized to perform these functions; and

(6) if a pool is contaminated, the licensee must arrange to clean the pool until the contamination levels do not exceed the appropriate concentration under part 4731.2750, subpart 7, Table 2, column 2.

B. Records must be maintained according to part 4731.3110.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6210 INSPECTION AND MAINTENANCE.

Subpart 1. **Required checks.** A licensee must perform inspection and maintenance checks that include, as a minimum, each of the following at the frequency specified in the license or license application:

A. operability of each aspect of the access control system required under part 4731.6060;

B. functioning of the source position indicator required under part 4731.6100, item C;

C. operability of the radiation monitor for radioactive contamination in pool water required under part 4731.6200, subpart 2, using a radiation check source, if applicable;

D. operability of the over-the-pool radiation monitor at underwater irradiators as required under part 4731.6090, subpart 2;

E. operability of the product exit monitor required under part 4731.6090, subpart 1;

F. operability of the emergency source return control required under part 4731.6100, item D;

G. leak-tightness of systems through which pool water circulates, by visual inspection;

H. operability of the heat and smoke detectors and extinguisher system required under part 4731.6080, but without turning extinguishers on;

I. operability of the means of pool water replenishment required under part 4731.6110, item D;

J. operability of the indicators of high and low pool water levels required under part 4731.6110, item E;

K. operability of the intrusion alarm required under part 4731.6060, subpart 2, if applicable;

L. functioning and wear of the system, mechanisms, and cables used to raise and lower sources;

M. condition of the barrier to prevent products from hitting the sources or source mechanism as required under part 4731.6120;

N. amount of water added to the pool to determine if the pool is leaking;

O. electrical wiring on required safety systems for radiation damage; and

P. pool water conductivity measurements and analysis as required under part 4731.6220, item B.

Subp. 2. **Repair.** Malfunctions and defects found during inspection and maintenance checks must be repaired without undue delay.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6220 POOL WATER PURITY.

A. A pool water purification system must be run sufficiently to maintain the conductivity of the pool water below 20 microsiemens per centimeter under normal circumstances. If pool water conductivity rises above 20 microsiemens per centimeter, a licensee must take prompt actions to lower the pool water conductivity and take corrective actions to prevent future recurrences.

B. A licensee must measure the pool water conductivity frequently enough, but no less than weekly, to ensure that the conductivity remains below 20 microsiemens per centimeter. Conductivity meters must be calibrated at least annually.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6230 ATTENDANCE DURING OPERATION.

A. An irradiator operator and at least one other individual who is trained in how to respond and prepared to promptly render or summon assistance if the access control alarm sounds must be present on site:

(1) whenever the irradiator is operated using an automatic product conveyor system; and

(2) whenever the product is moved into or out of the radiation room when the irradiator is operated in a batch mode.

B. At a panoramic irradiator at which static irradiations, when there is no movement of the product, occur, a person who has received the training on how to respond under part 4731.6160, subpart 6, must be on site.

C. At an underwater irradiator, an irradiator operator must be present at the facility whenever the product is moved into or out of the pool. Individuals who move the product into or out of the pool of an underwater irradiator need not be qualified as irradiator operators, but must have received the training under part 4731.6160, subparts 5 and 6. Static irradiations may be performed at an underwater irradiator without a person present at the facility.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6240 ENTERING AND LEAVING THE RADIATION ROOM.

Subpart 1. **Entry.** Upon first entering the radiation room of a panoramic irradiator after an irradiation, the irradiator operator must use a survey meter to determine that the source has returned to its fully shielded position. The operator must check the functioning of the survey meter with a radiation check source before entry.

Subp. 2. **Exit.** Before exiting from and locking the door to the radiation room of a panoramic irradiator prior to a planned irradiation, the irradiator operator must:

A. visually inspect the entire radiation room to verify that no one else is in it; and

B. activate a control in the radiation room that permits the sources to be moved from the shielded position only if the door to the radiation room is locked within a preset time after setting the control.

Subp. 3. **Entry during power failure.** During a power failure, the area around the pool of an underwater irradiator may not be entered without using an operable and calibrated radiation survey meter, unless the over-the-pool monitor required under part 4731.6090, subpart 2, is operating with backup power.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6250 IRRADIATION OF EXPLOSIVE OR FLAMMABLE MATERIALS.

A. Irradiation of explosive material is prohibited unless a licensee has received prior written authorization from the commissioner. Authorization shall not be granted unless the licensee can demonstrate that detonation of the explosive would not rupture the sealed sources, injure personnel, damage safety systems, or cause radiation overexposures of personnel.

B. Irradiation of more than small quantities of flammable material, with a flash point below 140 degrees Fahrenheit, is prohibited in panoramic irradiators unless a licensee has received prior written authorization from the commissioner. Authorization shall not be granted unless the licensee can demonstrate that a fire in the radiation room could be controlled without damage to sealed sources or safety systems and without radiation overexposures of personnel.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.6260 RECORDS AND RETENTION PERIODS.

A licensee must maintain the following records at the irradiator for the periods specified:

A. a copy of the license, license conditions, documents incorporated into a license by reference, and amendments thereto, until superseded by new documents or until the commissioner terminates the license for documents not superseded;

B. records of each individual's training, tests, and safety reviews provided to comply with part 4731.6160, subparts 1, 2, 3, 5, and 6, for three years after the individual terminates work;

C. records of the annual evaluations of the safety performance of irradiator operators required under part 4731.6160, subpart 4, for three years after the evaluation;

D. a copy of the current operating and emergency procedures required under part 4731.6170, until superseded or the commissioner terminates the license;

E. records of the radiation safety officer's review and approval of changes in procedures as required under part 4731.6170, subpart 3, item C, for three years from the date of the change;

F. evaluations of personnel dosimeters required under part 4731.6180, until the commissioner terminates the license;

G. records of radiation surveys required under part 4731.6190, for three years from the date of the survey;

H. records of radiation survey meter calibrations required under part 4731.6190 and pool water conductivity meter calibrations required under part 4731.6220, item B, for three years from the date of calibration;

I. records of the results of leak tests required under part 4731.6200, subpart 1, and the results of contamination checks required under part 4731.6200, subpart 2, for three years from the date of each test;

J. records of inspection and maintenance checks required under part 4731.6210, for three years;

K. records of major malfunctions, significant defects, operating difficulties or irregularities, and major operating problems that involve required radiation safety equipment, for three years after repairs are completed;

L. records of the receipt, transfer, and disposal of all licensed sealed sources as required under parts 4731.3105 and 4731.3115;

M. records on the design checks required under part 4731.6140 and the construction control checks as required under part 4731.6150, until the license is terminated. The records must be signed and dated. The title or qualification of the person signing must be included; and

N. records relating to decommissioning of the irradiator as required under part 4731.3080, subpart 7.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.6270 REPORTS.

Subpart 1. **Required reports.** If not reported under other parts of this chapter, a licensee must report the following events:

A. source stuck in an unshielded position;

B. any fire or explosion in a radiation room;

C. damage to the source racks;

D. failure of the cable or drive mechanism used to move the source racks;

E. inoperability of the access control system;

F. detection of radiation source by the product exit monitor;

G. detection of radioactive contamination attributable to licensed radioactive material;

H. structural damage to the pool liner or walls;

I. abnormal water loss or leakage from the source storage pool; and

J. pool water conductivity exceeding 100 microsiemens per centimeter.

Subp. 2. **Content.** A report under subpart 1 must include a telephone report within 24 hours according to part 4731.3110, subpart 3, item A, and a written report within 30 days according to part 4731.3110, subpart 3, item B.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

WELL LOGGING

4731.7000 LICENSES AND RADIATION SAFETY REQUIREMENTS FOR WELL LOGGING.

Subpart 1. **Applicability.** Parts 4731.7000 to 4731.7280 provide for the issuance of a license authorizing the use of licensed materials including sealed sources, radioactive tracers, radioactive markers, and uranium sinker bars in well logging in a single well and prescribe radiation safety requirements for persons using licensed materials in these operations. Parts 4731.7000 to 4731.7280 are in addition to, and not in substitution for, other requirements of this chapter.

Subp. 2. **Exemptions.** Parts 4731.7000 to 4731.7280 do not apply to the issuance of a license authorizing the use of licensed material in tracer studies involving multiple wells, such as field flooding studies, or to the use of sealed sources auxiliary to well logging but not lowered into wells.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7010 APPLICATION.

A person must file an application for a specific license authorizing the use of licensed material in well logging on an application for material license form prescribed by the commissioner. An application for a license, other than a license exempted from Code of Federal Regulations, title 10, part 170, must be accompanied by the fee prescribed in Minnesota Statutes, section 144.1205. The application must be sent to the Radioactive Materials Unit, Minnesota Department of Health, St. Paul, Minnesota.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7020 SPECIFIC LICENSE; WELL LOGGING.

The commissioner shall approve an application for a specific license for the use of licensed material in well logging if the applicant:

A. satisfies the general licensing requirements under parts 4731.0575 for special nuclear material, 4731.0765 for source material, and 4731.3070 for radioactive material, as appropriate, and any special requirements under parts 4731.7000 to 4731.7280;

B. develops a program for training logging supervisors and logging assistants and submits to the commissioner a description of the program that specifies:

(1) initial training;

(2) on-the-job training;

(3) annual safety reviews provided by the licensee;

(4) the means of demonstrating the logging supervisor's knowledge of, understanding of, and ability to comply with this chapter, licensing requirements, and the applicant's written operating and emergency procedures; and

(5) the means of demonstrating the logging assistant's knowledge of, understanding of, and ability to comply with the applicant's written operating and emergency procedures;

C. creates and submits written operating and emergency procedures according to part 4731.7210 or an outline summary of the procedures that includes the important radiation safety aspects of the procedures;

D. establishes and submits a description of the applicant's program for annual inspections of the job performance of each logging supervisor to ensure that this chapter, license requirements, and the applicant's written operating and emergency procedures are followed. Inspection records must be retained for three years after each annual internal inspection;

E. submits a description of the applicant's overall organizational structure as it applies to the radiation safety responsibilities in well logging, including specified delegations of authority and responsibility;

F. identifies the manufacturers and the model numbers of the leak test kits to be used if the applicant wants to perform leak testing of sealed sources; and

G. establishes and submits a description of procedures to be followed if the applicant wants to analyze its own wipe samples. The description must include:

(1) the instruments to be used;

(2) the methods of performing the analysis; and

(3) the pertinent experience of the person who will analyze the wipe samples.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *29 SR 755; 40 SR 145*
Published Electronically: *August 27, 2015*

4731.7030 AGREEMENT WITH WELL OWNER OR OPERATOR.

Subpart 1. **Agreement required.**

A. A licensee may perform well logging with a sealed source only after the licensee has a written agreement with the employing well owner or operator. The written agreement must be kept for three years after completion of the well logging operation. The agreement must include the terms in items B to F and identify who will perform the requirements in items B to F.

B. If a sealed source becomes lodged in the well, a reasonable effort must be made to recover it.

C. A person may not attempt to recover a sealed source in a manner that, in the licensee's opinion, could result in its rupture.

D. The radiation monitoring required under part 4731.7240 must be performed.

E. If the environment, any equipment, or personnel are contaminated with licensed material, they must be decontaminated before release from the site or release for unrestricted use.

F. If the sealed source is classified as irretrievable after reasonable efforts at recovery have been expended, the following requirements must be implemented within 30 days:

(1) each irretrievable well logging source must be immobilized and sealed in place with a cement plug;

(2) a means to prevent inadvertent intrusion on the source must be set at some point in the well, unless the source is not accessible to any subsequent drilling operations; and

(3) a permanent identification plaque, constructed of a long-lasting material, such as stainless steel, brass, bronze, or Monel, must be mounted at the surface of the well, unless mounting the plaque is not practical. The size of the plaque must be at least seven inches (17 cm) square and one-eighth inch (3 mm) thick. The plaque must contain:

(a) the word "CAUTION";

(b) the radiation symbol, except the color requirement under part 4731.2300 need not be met;

(c) the date the source was abandoned;

(d) the name of the well owner or well operator, as appropriate;

(e) the well name and well identification number or other designation;

(f) identification of the sealed source by radionuclide and quantity;

(g) the depth of the source and depth to the top of the plug; and

(h) an appropriate warning, such as, "DO NOT REENTER THIS WELL."

Subp. 2. **Variance.** A licensee may apply, under part 4731.0200, for commissioner approval, on a case-by-case basis, of proposed procedures to abandon an irretrievable well logging source in a manner not otherwise authorized in subpart 1, item F.

Subp. 3. **Exemption.** The written agreement between the licensee and the well owner or operator is not required if the licensee and the well owner or operator are part of the same corporate structure or otherwise similarly affiliated, but the licensee must still comply with subpart 1, items B to F.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7040 REQUEST FOR WRITTEN STATEMENTS.

A license is issued with the condition that the licensee shall, at any time before expiration of the license, upon the commissioner's request, submit written statements, signed under oath or affirmation, to enable the commissioner to determine whether the license should be modified, suspended, or revoked.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7050 LABELS, SECURITY, AND TRANSPORTATION PRECAUTIONS.

Subpart 1. **Labeling.**

A. A licensee may not use a source, source holder, or logging tool that contains licensed material unless the smallest component that is transported as a separate piece of equipment with the licensed material inside bears a durable, legible, and clearly visible marking or label. The marking or label must contain:

(1) the radiation symbol, except the color requirement under part 4731.2300 need not be met; and

(2) the words "DANGER (or CAUTION), RADIOACTIVE MATERIAL."

B. A licensee may not use a container to store licensed material unless the container has securely attached to it a durable, legible, and clearly visible label. The label must contain:

(1) the radiation symbol specified under part 4731.2300; and

(2) the words "CAUTION (or DANGER), RADIOACTIVE MATERIAL. NOTIFY CIVIL AUTHORITIES (or name of company)."

C. A licensee may not transport licensed material unless the material is packaged, labeled, marked, and accompanied with appropriate shipping papers according to parts 4731.0400 to 4731.0424.

Subp. 2. **Storage and transportation.**

A. A licensee must store each source containing licensed material in a storage container or transportation package that is locked and physically secured to prevent tampering or removal of licensed material from storage by unauthorized personnel.

B. A licensee must store licensed material in a manner that minimizes danger from explosion or fire.

C. A licensee must lock and physically secure the transport package containing licensed material in the transporting vehicle to prevent:

(1) accidental loss;

(2) tampering; or

(3) unauthorized removal of the licensed material from the vehicle.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 32 SR 831; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.7060 RADIATION DETECTION INSTRUMENTS.

Subpart 1. **Required survey instruments.** A licensee must keep a calibrated and operable radiation survey instrument capable of detecting beta and gamma radiation at each field station and temporary job site to make the radiation surveys required under parts 4731.2000 to 4731.2950 and 4731.7000 to 4731.7280. The radiation survey instrument must be capable of measuring 0.1 millirem (0.001 mSv) per hour through at least 50 millirems (0.5 mSv) per hour.

Subp. 2. **Availability.** A licensee must have available additional calibrated and operable radiation detection instruments sensitive enough to detect the low radiation and contamination levels that could be encountered if a sealed source ruptured. A licensee may own the instruments or may have a procedure to obtain them quickly from a second party.

Subp. 3. **Required calibrations.** A licensee must have each radiation survey instrument required under subpart 1 calibrated:

A. at intervals not to exceed six months and after instrument servicing;

B. for linear scale instruments, at two points located approximately one-third and two-thirds of full-scale on each scale; for logarithmic scale instruments, at midrange of each decade and at two points of at least one decade; and for digital instruments, at appropriate points; and

C. so that an accuracy within plus or minus 20 percent of the calibration standard can be demonstrated on each scale.

Subp. 4. **Record retention.** A licensee must retain calibration records for three years after the date of calibration for inspection by the commissioner.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7070 LEAK TESTING; SEALED SOURCES.

Subpart 1. **Testing and record keeping requirements.** A licensee that uses a sealed source must have the source periodically tested for leakage. The licensee must keep a record of leak test results in units of microcuries and retain the record for inspection by the commissioner for three years after the leak test is performed.

Subp. 2. **Method of testing.** The wipe of a sealed source must be performed using a leak test kit or method approved by the commissioner, the NRC, or an agreement state. The wipe sample must be taken from the nearest accessible point to the sealed source where contamination might accumulate. The wipe sample must be analyzed for radioactive contamination. The analysis must be capable of detecting the presence of 0.005 microcuries (185 Bq) of radioactive material on the test sample and must be performed by a person approved by the commissioner, the NRC, or an agreement state to perform the analysis.

Subp. 3. **Test frequency.**

A. Each sealed source, except an energy compensation source (ECS), must be tested 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 before the transfer, the sealed source may not be used until tested.

B. Each ECS that is not exempt from testing under subpart 5 must be tested at intervals not to exceed three years. In the absence of a certificate from a transferor that a test has been made within the three years before the transfer, the ECS may not be used until tested.

Subp. 4. **Removal of leaking source from service.**

A. If the test conducted under subparts 1 and 2 reveals the presence of 0.005 microcuries (185 Bq) or more of removable radioactive material, the licensee must remove the sealed source from service immediately and have it decontaminated, repaired, or disposed of by a person licensed by the commissioner, the NRC, or an agreement state to perform these functions. The licensee must check the equipment associated with the leaking source for radioactive contamination and, if contaminated, have it decontaminated or disposed of by a person licensed by the commissioner, the NRC, or an agreement state to perform these functions.

B. The licensee must submit a report to the commissioner within five days of receiving the test results. The report must:

(1) describe the equipment involved in the leak;

(2) include the test results;

(3) describe any contamination that resulted from the leaking source; and

(4) describe the corrective actions taken up to the time the report is made.

Subp. 5. **Exemptions.** The following sealed sources are exempt from the periodic leak test requirements under this part:

A. hydrogen-3 (tritium) sources;

B. sources containing licensed material with a half-life of 30 days or less;

C. sealed sources containing licensed material in gaseous form;

D. sources of beta- or gamma-emitting radioactive material with an activity of 100 microcuries (3.7 MBq) or less; and

E. sources of alpha- or neutron-emitting radioactive material with an activity of ten microcuries (0.37 MBq) or less.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7080 PHYSICAL INVENTORY.

A. A licensee must conduct a semiannual physical inventory to account for all licensed material received and possessed under the license. The licensee must retain records of the inventory for three years from the date of the inventory for inspection by the commissioner. The inventory must include:

(1) the quantity and kind of licensed material;

(2) the location of the licensed material;

(3) the date of the inventory; and

(4) the name of the individual conducting the inventory.

B. The physical inventory records may be combined with leak test records.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7090 RECORDS OF MATERIAL USE.

Subpart 1. **Use records.** A licensee must maintain records for each use of licensed material showing:

A. the make, model number, and a serial number or a description of each sealed source used;

B. in the case of unsealed licensed material used for subsurface tracer studies, the radionuclide and quantity of activity used in a particular well and the disposition of any unused tracer materials;

C. the identity of the logging supervisor who is responsible for the licensed material and the identity of logging assistants present; and

D. the location and date of use of the licensed material.

Subp. 2. **Record retention.** A licensee must make the records required under subpart 1 available for inspection by the commissioner. A licensee must retain the records for three years from the date of the recorded event.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
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4731.7100 DESIGN AND PERFORMANCE CRITERIA FOR SOURCES.

Subpart 1. **General requirements.** A licensee may only use sealed sources in well logging applications that:

A. are doubly encapsulated;

B. contain licensed material whose chemical and physical forms are as insoluble and nondispersible as practical; and

C. meet the requirements of subparts 2 to 4, as applicable.

Subp. 2. **Pre-1989 sources.** For a sealed source manufactured on or before July 14, 1989, a licensee may use the sealed source for use in well logging applications if it meets the requirements of USASI N5.10-1968, "Classification of Sealed Radioactive Sources," American Institute of Chemical Engineers, or the requirements in subpart 3 or 4. The standard is incorporated by reference, is not subject to frequent change, and is available through the Minitex interlibrary loan system.

Subp. 3. **Post-1989 sources; ANSI standard.** For a sealed source manufactured after July 14, 1989, a licensee may use the sealed source for use in well logging applications if it meets the oil-well logging requirements of "Sealed Radioactive Sources-Classification" ANSI/HPS N43.6-1997, American National Standards Institute (1997). The standard is incorporated by reference, is not subject to frequent change, and is available through the Minitex interlibrary loan system.

Subp. 4. **Post-1989 sources; prototype testing.** For a sealed source manufactured after July 14, 1989, a licensee may use the sealed source for use in well logging applications if the sealed source's prototype has been tested and found to maintain its integrity after each of the following tests:

A. temperature test. The test source must be held at -40 degrees Celsius for 20 minutes, 600 degrees Celsius for one hour, and then be subject to a thermal shock test with a temperature drop from 600 degrees Celsius to 20 degrees Celsius within 15 seconds;

B. impact test. A five kilogram steel hammer, 2.5 centimeters in diameter, must be dropped from a height of one meter onto the test source;

C. vibration test. The test source must be subjected to a vibration from 25 hertz to 500 hertz at an amplitude of five times the acceleration of gravity for 30 minutes;

D. puncture test. A one gram hammer and pin, 0.3 centimeters pin diameter, must be dropped from a height of one meter onto the test source; and

E. pressure test. The test source must be subjected to an external pressure of 24,600 pounds per square inch absolute (1.695×10^7 pascals).

Subp. 5. **Exemptions.**

A. Subparts 1 to 4 do not apply to sealed sources that contain licensed material in gaseous form.

B. Subparts 1 to 4 do not apply to energy compensation sources. An energy compensation source must be registered with the NRC under Code of Federal Regulations, title 10, section 32.210, or with an agreement state.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7110 INSPECTION AND MAINTENANCE; OPENING SOURCE OR SOURCE HOLDER.

Subpart 1. **Checks before use.**

A. Before each use, a licensee must visually check source holders, logging tools, and source handling tools for defects to ensure that the equipment is in good working condition and that required labeling is present.

B. If defects are found, the equipment must be removed from service until repaired and a record must be made listing:

(1) the date of the check;

(2) the name of the inspector;

(3) the equipment involved and what defects were found; and

(4) what repairs were made.

C. Records made under item B must be retained for three years after the defect is found.

Subp. 2. **Semiannual inspections.**

A. A licensee must have a program to ensure that required labeling is legible and that no physical damage is visible. This must be done by semiannual visual inspections and routine maintenance of:

(1) source holders;

(2) logging tools;

(3) injection tools;

(4) source handling tools;

(5) storage containers;

(6) transport containers; and

(7) uranium sinker bars.

B. If defects are found, the equipment must be removed from service until repaired, and a record must be made and retained for three years after the defect is found, listing:

(1) the date of the inspection;

(2) the equipment involved;

(3) inspection and maintenance operations performed;

(4) any defects found; and

(5) any actions taken to correct the defects.

Subp. 3. **Written procedure for removal.** Removal of a sealed source from a source holder or logging tool and maintenance on sealed sources or holders in which sealed sources are contained may not be performed by the licensee unless a written procedure developed under part 4731.7210 has been approved by the commissioner under part 4731.7020, item C, or by the NRC or an agreement state.

Subp. 4. **Stuck source requirements.** If a sealed source is stuck in the source holder, the licensee may not perform any operation, such as drilling, cutting, or chiseling, on the source holder unless the licensee is specifically approved by the commissioner, the NRC, or an agreement state to perform the operation.

Subp. 5. **Opening; repair; modification.** The opening, repair, or modification of any sealed source must be performed by persons specifically approved to do so by the commissioner, the NRC, or an agreement state.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7120 SUBSURFACE TRACER STUDIES.

A. A licensee must require all personnel handling radioactive tracer material to use protective gloves and, if required by the license, other protective clothing and equipment. The licensee must take precautions to avoid ingestion or inhalation of radioactive tracer material and to avoid contamination of field stations and temporary job sites.

B. A licensee may not knowingly inject licensed material into freshwater aquifers unless a variance to chapter 4725 or 4727 has been specifically authorized by the commissioner to do so.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7130 RADIOACTIVE MARKERS.

A licensee may use radioactive markers in wells only if the individual markers contain quantities of licensed material not exceeding the quantities specified under part 4731.3145. The use of markers is subject only to the requirements of part 4731.7080.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7140 URANIUM SINKER BARS.

A licensee may use a uranium sinker bar in well logging applications only if it is legibly impressed with the words "CAUTION: RADIOACTIVE-DEPLETED URANIUM. NOTIFY CIVIL AUTHORITIES (or company name) IF FOUND."

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7150 USE WITHOUT A SURFACE CASING.

A licensee may use a sealed source in a well without a surface casing for protecting freshwater aquifers only if the licensee follows a procedure for reducing the probability of the source becoming lodged in the well. The procedure must be approved by the commissioner according to part 4731.7020, item C, or by the NRC or an agreement state.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7160 ENERGY COMPENSATION SOURCE.

A. A licensee may use an energy compensation source (ECS) that is contained within a logging tool or other tool components only if the ECS contains quantities of licensed material not exceeding 100 microcuries (3.7 MBq).

B. For well logging applications with a surface casing for protecting freshwater aquifers, use of the ECS is subject only to parts 4731.7070 to 4731.7090.

C. For well logging applications without a surface casing for protecting freshwater aquifers, use of the ECS is subject only to parts 4731.7030, 4731.7070 to 4731.7090, 4731.7150, and 4731.7280.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7170 TRITIUM NEUTRON GENERATOR TARGET SOURCE.

A. Use of a tritium neutron generator target source, containing quantities not exceeding 30 curies (1,110 MBq) and in a well with a surface casing to protect freshwater aquifers, is subject to parts 4731.7000 to 4731.7270, except parts 4731.7030 and 4731.7100.

B. Use of a tritium neutron generator target source, containing quantities exceeding 30 curies (1,110 MBq) or in a well without a surface casing to protect freshwater aquifers, is subject to parts 4731.7000 to 4731.7280, except part 4731.7100.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7200 TRAINING.

Subpart 1. **Logging supervisor.** A licensee must not permit an individual to act as a logging supervisor until the individual:

A. completes training in the subjects under subpart 5;

B. receives copies of and instruction in:

(1) the applicable provisions of parts 4731.1000 to 4731.2950 and 4731.7000 to 4731.7280;

(2) the license under which the logging supervisor will perform well logging; and

(3) the licensee's operating and emergency procedures required under part 4731.7210;

C. completes on-the-job training and demonstrates competence in the use of licensed materials, remote handling tools, and radiation survey instruments by a field evaluation; and

D. demonstrates understanding of the materials under items A and B by successfully completing a written test.

Subp. 2. **Logging assistant.** A licensee must not permit an individual to act as a logging assistant until the individual:

A. receives instruction in applicable provisions of parts 4731.1000 to 4731.2950;

B. receives copies of and instruction in the licensee's operating and emergency procedures required under part 4731.7210;

C. demonstrates understanding of the materials under items A and B by successfully completing a written or oral test; and

D. receives instruction in the use of licensed materials, remote handling tools, and radiation survey instruments, as appropriate for the logging assistant's intended job responsibilities.

Subp. 3. **Safety reviews.** A licensee must provide safety reviews for logging supervisors and logging assistants at least once during each calendar year.

Subp. 4. **Records.** A licensee must maintain a record on each logging supervisor's and logging assistant's training and annual safety review. The training records must include copies of written tests and dates of oral tests given after July 14, 1987. The training records must be retained for three years following the termination of employment. Records of annual safety reviews must list the topics discussed and must be retained for three years.

Subp. 5. **Training subjects.** A licensee must include the following subjects in the training required under subpart 1, item A:

A. fundamentals of radiation safety, including:

(1) characteristics of radiation;

(2) units of radiation dose and quantity of radioactivity;

(3) hazards of exposure to radiation;

(4) levels of radiation from licensed material;

(5) methods of controlling radiation dose, including time, distance, and shielding; and

(6) radiation safety practices, including prevention of contamination, and methods of decontamination;

B. radiation detection instruments, including:

(1) use, operation, calibration, and limitations of radiation survey instruments;

(2) survey techniques; and

(3) use of personnel monitoring equipment;

C. equipment to be used, including:

(1) operation of equipment, including source handling equipment and remote handling tools;

(2) storage, control, and disposal of licensed material; and

(3) maintenance of equipment;

D. the requirements of pertinent state rules; and

E. case histories of accidents in well logging.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7210 OPERATING AND EMERGENCY PROCEDURES.

Subpart 1. **Requirement.** A licensee must develop and follow written operating and emergency procedures.

Subp. 2. **Operating and emergency procedures.** A licensee's written operating and emergency procedures must address:

A. the handling and use of licensed materials, including the use of sealed sources in wells without surface casing for protecting freshwater aquifers, if appropriate;

B. the use of remote handling tools for handling sealed sources and radioactive tracer material, except low-activity calibration sources;

C. methods and occasions for conducting radiation surveys, including surveys for detecting contamination, as required under part 4731.7230, subpart 2, items B to D;

D. minimizing personnel exposure, including exposures from inhalation and ingestion of licensed tracer materials;

E. methods and occasions for locking and securing stored licensed materials;

F. personnel monitoring and the use of personnel monitoring equipment;

G. transportation of licensed materials to field stations or temporary job sites, packaging of licensed materials for transport in vehicles, placarding of vehicles when needed, and physically securing licensed materials in transport vehicles during transportation to prevent accidental loss, tampering, or unauthorized removal;

H. picking up, receiving, and opening packages containing licensed materials, according to part 4731.2350;

I. for the use of tracers, decontamination of the environment, equipment, and personnel;

J. maintenance of records generated by logging personnel at temporary job sites;

K. inspection and maintenance of sealed sources, source holders, logging tools, injection tools, source handling tools, storage containers, transport containers, and uranium sinker bars as required under part 4731.7110;

L. identifying and reporting to the commissioner and the NRC regarding defects and noncompliance, as required under Code of Federal Regulations, title 10, part 21;

M. notifying proper persons, including the licensee's radiation safety officer and the commissioner, in the event of an accident or incident or abandonment of a source;

N. actions to be taken if a sealed source is lodged or damaged in a well; and

O. actions to be taken if a sealed source is ruptured, including:

(1) prevention of the spread of contamination;

(2) minimization of inhalation and ingestion of licensed materials; and

(3) obtaining and using suitable radiation survey instruments as required under part 4731.7060, subpart 2.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7220 PERSONNEL MONITORING.

A. A licensee may not permit an individual to act as a logging supervisor or logging assistant unless the individual wears a personnel dosimeter at all times during the handling of licensed radioactive materials. Each personnel dosimeter must be assigned to and worn by only one individual. Film badges must be replaced at least monthly and other personnel dosimeters that require replacement must be replaced at least quarterly. All personnel dosimeters must be evaluated at least quarterly or promptly after replacement, whichever is more frequent.

B. A licensee must provide bioassay services to individuals using licensed materials in subsurface tracer studies if required by the license.

C. A licensee must retain records of personnel dosimeters required under item A and bioassay results for inspection until the commissioner authorizes disposition of the records.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 46 SR 791*
Published Electronically: *May 26, 2022*

4731.7230 RADIATION SURVEYS.

Subpart 1. **Requirement.** A licensee must make radiation surveys, including but not limited to the surveys required under subpart 2, of each area where licensed materials are used and stored.

Subp. 2. **Safety surveys.**

A. Before transporting licensed materials, a licensee must make a radiation survey of the position occupied by each individual in the vehicle and of the exterior of each vehicle used to transport the licensed materials.

B. If the sealed source assembly is removed from the logging tool before departure from the temporary job site, a licensee must confirm that the logging tool is free of contamination by energizing the logging tool detector or by using a survey meter.

C. If a licensee has reason to believe that, as a result of any operation involving a sealed source, the encapsulation of the sealed source could be damaged by the operation, the licensee must conduct a radiation survey, including a contamination survey, during and after the operation.

D. A licensee must make a radiation survey at the temporary job site before and after each subsurface tracer study to confirm the absence of contamination.

Subp. 3. **Records.**

A. The results of surveys required under this part must be recorded and must include:

(1) the date of the survey;

(2) the name of the individual making the survey;

(3) the identification of the survey instrument used; and

(4) the location of the survey.

B. A licensee must retain records of surveys for inspection by the commissioner for three years after they are made.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7240 RADIOACTIVE CONTAMINATION CONTROL.

A. If a licensee detects evidence that a sealed source has ruptured or licensed materials have caused contamination, the licensee must immediately initiate the emergency procedures required under part 4731.7210.

B. If contamination results from the use of licensed material in well logging, the licensee must decontaminate all work areas, equipment, and unrestricted areas.

C. During efforts to recover a sealed source lodged in a well, a licensee must continuously monitor, with an appropriate radiation detection instrument or a logging tool with a radiation detector, the circulating fluids from the well, if any, to check for contamination resulting from damage to the sealed source.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7250 SECURITY.

A. A logging supervisor must be physically present at a temporary job site whenever licensed materials are being handled or are not stored and locked in a vehicle or storage place. The logging supervisor may leave the job site to obtain assistance if a source becomes lodged in a well.

B. During well logging, except when radiation sources are below ground or in shipping or storage containers, the logging supervisor or other individual designated by the logging supervisor

must maintain direct surveillance of the operation to prevent unauthorized entry into a restricted area.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7260 DOCUMENTS AND RECORDS; FIELD STATIONS.

A licensee must maintain the following documents and records at a field station:

A. a copy of parts 4731.1000 to 4731.2950 and 4731.7000 to 4731.7280;

B. the license authorizing the use of licensed material;

C. the operating and emergency procedures required under part 4731.7210;

D. the record of radiation survey instrument calibrations required under part 4731.7060;

E. the record of leak test results required under part 4731.7070;

F. physical inventory records required under part 4731.7080;

G. utilization records required under part 4731.7090;

H. records of inspection and maintenance required under part 4731.7110;

I. training records required under part 4731.7200, subpart 4; and

J. survey records required under part 4731.7230.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*
Published Electronically: *March 12, 2009*

4731.7270 DOCUMENTS AND RECORDS; TEMPORARY JOB SITES.

A licensee conducting operations at a temporary job site must maintain the following documents and records at the temporary job site until the well logging operation is completed:

A. the operating and emergency procedures required under part 4731.7210;

B. evidence of the latest calibration of the radiation survey instruments in use at the site as required under part 4731.7060;

C. the latest survey records required under part 4731.7230, subpart 2, items A, B, and D;

D. the shipping papers for the transportation of radioactive materials required under part 4731.0402; and

E. when operating under reciprocity according to part 4731.0355, a copy of the NRC or agreement state license authorizing the use of licensed materials.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755*

Published Electronically: *March 12, 2009*

4731.7280 NOTIFICATION OF INCIDENTS AND LOST SOURCES; ABANDONMENT PROCEDURES.

Subpart 1. **Notification; ruptured source.** A licensee must immediately notify the commissioner by telephone according to part 4731.0200, subpart 5, and subsequently, within 30 days, by confirmatory letter if the licensee knows or has reason to believe that a sealed source has been ruptured. The letter must:

A. designate the well or other location;

B. describe the magnitude and extent of the escape of licensed materials;

C. assess the consequences of the rupture; and

D. explain efforts planned or being taken to mitigate these consequences.

Subp. 2. **Notification; other incidents.** A licensee must notify the commissioner of the theft or loss of radioactive materials, radiation overexposures, excessive levels and concentrations of radiation, and certain other accidents as required under parts 4731.2600 to 4731.2620 and 4731.3110.

Subp. 3. **Abandonment and sealing procedures.** If a sealed source becomes lodged in a well, and when it becomes apparent that efforts to recover the sealed source will not be successful, the licensee must:

A. notify the commissioner by telephone according to part 4731.0200, subpart 5, of the circumstances that resulted in the inability to retrieve the source;

B. obtain commissioner approval to implement abandonment procedures;

C. obtain a variance from the sealing requirements of chapter 4725 or 4727 and comply with the conditions of the variance;

D. if applicable, inform the commissioner that the licensee implemented abandonment before receiving commissioner approval because the licensee believed there was an immediate threat to public health and safety;

E. advise the well owner or operator, as appropriate, of the abandonment procedures under part 4731.7030, subpart 1 or 2; and

F. ensure that abandonment procedures are implemented within 30 days after the sealed source has been classified as irretrievable or request of the commissioner an extension of time if unable to complete the abandonment procedures.

Subp. 4. **Report of irretrievable source.** A licensee must, within 30 days after a sealed source has been classified as irretrievable, make a report in writing to the commissioner. The licensee must send a copy of the report to each appropriate state or federal agency that issued permits or otherwise approved of the drilling operation. The report must contain:

A. the date of occurrence;

B. a description of the irretrievable well logging source involved, including the radionuclide and its quantity, chemical, and physical form;

C. surface location and identification of the well;

D. results of efforts to immobilize and seal the source in place;

E. a brief description of the attempted recovery effort;

F. depth of the source;

G. depth of the top of the cement plug;

H. depth of the well;

I. the immediate threat to public health and safety justification for implementing abandonment if prior commissioner and variance approval was not obtained according to subpart 3, item D;

J. any other information, such as a warning statement, contained on the permanent identification plaque; and

K. the identity of state and federal agencies receiving a copy of this report.

Statutory Authority: *MS s 144.1202; 144.1203*

History: *29 SR 755; 44 SR 239*

Published Electronically: *September 13, 2019*

PHYSICAL PROTECTION OF CATEGORY 1 AND CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL

4731.8000 PHYSICAL PROTECTION OF CATEGORY 1 OR CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL.

A. Parts 4731.8010 to 4731.8090 apply to any person who, under the regulations in this chapter, possesses or uses at any site, an aggregated category 1 or category 2 quantity of radioactive material.

B. Parts 4731.8100 to 4731.8125 apply to any person who, under the regulations of this chapter:

(1) transports or delivers to a carrier for transport in a single shipment, a category 1 or category 2 quantity of radioactive material; or

(2) imports or exports a category 1 or category 2 quantity of radioactive material; the provisions only apply to the domestic portion of the transport.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8005 EXEMPTION FOR WASTE.

A licensee that possesses radioactive waste that contains category 1 or category 2 quantities of radioactive material is exempt from the requirements of parts 4731.8010 to 4731.8125. Except that any radioactive waste that contains discrete sources, ion-exchange resins, or activated material that weighs less than 2,000 kg (4.409 lbs) is not exempt from the requirements of this part. The licensee must implement the following requirements to secure the radioactive waste:

A. use continuous physical barriers that allow access to the radioactive waste only through established access control points;

B. use a locked door or gate with monitored alarm at the access control point;

C. assess and respond to each actual or attempted unauthorized access to determine whether an actual or attempted theft, sabotage, or diversion occurred; and

D. immediately notify the local law enforcement agency (LLEA) and request an armed response from the LLEA upon determination that there was an actual or attempted theft, sabotage, or diversion of the radioactive waste that contains category 1 or category 2 quantities of radioactive material.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8010 PERSONNEL ACCESS AUTHORIZATION REQUIREMENTS FOR CATEGORY 1 OR CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL.

Subpart 1. **General.**

A. Each licensee that possesses an aggregated quantity of radioactive material at or above the category 2 threshold must establish, implement, and maintain its access authorization program in accordance with the requirements of parts 4731.8010 to 4731.8040.

B. An applicant for a new license and each licensee that is newly subject to the requirements of parts 4731.8010 to 4731.8040 upon application for modification of its license must implement the requirements of parts 4731.8010 to 4731.8040, as appropriate, before taking possession of an aggregated category 1 or category 2 quantity of radioactive material.

C. Any licensee that has not previously implemented the Security Orders or been subject to the provisions of parts 4731.8010 to 4731.8040 must implement the provisions of parts 4731.8010 to 4731.8040 before aggregating radioactive material to a quantity that equals or exceeds the category 2 threshold.

Subp. 2. **General performance objective.** The licensee's access authorization program must ensure that the individuals specified in subpart 3, item A, are trustworthy and reliable.

Subp. 3. **Applicability.**

A. Licensees must subject the following individuals to an access authorization program:

(1) any individual whose assigned duties require unescorted access to category 1 or category 2 quantities of radioactive material or to any device that contains the radioactive material; and

(2) reviewing officials.

B. Licensees need not subject the categories of individuals listed in part 4731.8030, subpart 1, items A to M, to the investigation elements of the access authorization program.

C. Licensees must approve for unescorted access to category 1 or category 2 quantities of radioactive material only those individuals with job duties that require unescorted access to category 1 or category 2 quantities of radioactive material.

D. Licensees may include individuals needing access to safeguards information-modified handling under Code of Federal Regulations, title 10, part 73, in the access authorization program under parts 4731.8010 to 4731.8040.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8015 ACCESS AUTHORIZATION PROGRAM REQUIREMENTS.

Subpart 1. **Granting unescorted access authorization.**

A. Licensees must implement the requirements of parts 4731.8010 to 4731.8040 for granting initial or reinstated unescorted access authorization.

B. Individuals who have been determined to be trustworthy and reliable must also complete the security training required by part 4731.8055, subpart 3, before being allowed unescorted access to category 1 or category 2 quantities of radioactive material.

Subp. 2. **Reviewing officials.**

A. Reviewing officials are the only individuals authorized to make trustworthiness and reliability determinations that allow individuals to have unescorted access to category 1 or category 2 quantities of radioactive materials possessed by the licensee.

B. Each licensee must name one or more individuals to be reviewing officials. After completing the background investigation on the reviewing official, the licensee must provide, under oath or affirmation, a certification that the reviewing official is deemed trustworthy and reliable by the licensee. The licensee must provide oath or affirmation certifications to the Radioactive Materials Unit, Minnesota Department of Health, 625 Robert Street N, P.O. Box 64975, St. Paul, MN 55164-0975. The fingerprints of the named reviewing official must be taken by a law enforcement agency, federal or state agency that provides fingerprinting services to the public, or commercial fingerprinting services authorized by a state to take fingerprints. The licensee must recertify that the reviewing official is deemed trustworthy and reliable every ten years in accordance with part 4731.8020, subpart 3.

C. Reviewing officials must be permitted to have unescorted access to category 1 or category 2 quantities of radioactive materials or access to safeguards information or safeguards information-modified handling, if the licensee possesses safeguards information or safeguards information-modified handling.

D. Reviewing officials cannot approve other individuals to act as reviewing officials.

E. A reviewing official does not need to undergo a new background investigation before being named by the licensee as the reviewing official if:

(1) the individual has undergone a background investigation that included fingerprinting and an FBI criminal history records check and has been determined to be trustworthy and reliable by the licensee; or

(2) the individual is subject to a category listed in part 4731.8030, subpart 1.

Subp. 3. **Informed consent.**

A. Licensees must not initiate a background investigation without the informed and signed consent of the subject individual. This consent must include authorization to share personal information with other individuals or organizations as necessary to complete the background investigation. Before a final adverse determination, the licensee must provide the individual with an opportunity to correct any inaccurate or incomplete information that is developed during the background investigation. Licensees do not need to obtain signed consent from those individuals that meet the requirements of part 4731.8020, subpart 2. A signed consent must be obtained prior to any reinvestigation.

B. The subject individual may withdraw consent at any time. Licensees must inform the individual that:

(1) if an individual withdraws consent, the licensee may not initiate any elements of the background investigation that were not in progress at the time the individual withdrew consent; and

(2) the withdrawal of consent for the background investigation is sufficient cause for denial or termination of unescorted access authorization.

Subp. 4. **Personal history disclosure.** Any individual who is applying for unescorted access authorization must disclose the personal history information that is required by the licensee's access authorization program for the reviewing official to make a determination of the individual's trustworthiness and reliability. Refusal to provide, or the falsification of, any personal history information required by parts 4731.8010 to 4731.8040 is sufficient cause for denial or termination of unescorted access.

Subp. 5. **Determination basis.**

A. The reviewing official must determine whether to permit, deny, unfavorably terminate, maintain, or administratively withdraw an individual's unescorted access authorization based on an evaluation of all information collected to meet the requirements of parts 4731.8010 to 4731.8040.

B. The reviewing official must not permit any individual to have unescorted access until the reviewing official has evaluated all of the information collected to meet the requirements of parts 4731.8010 to 4731.8040 and determined that the individual is trustworthy and reliable. The reviewing official has authority to deny unescorted access to any individual based on information obtained at any time during the background investigation.

C. The licensee must document the basis for concluding whether or not there is reasonable assurance that an individual is trustworthy and reliable.

D. The reviewing official has authority to terminate or administratively withdraw an individual's unescorted access authorization based on information obtained after the background investigation has been completed and the individual granted unescorted access authorization.

E. Licensees must maintain a list of persons currently approved for unescorted access authorization. When a licensee determines that a person no longer requires unescorted access or meets the access authorization requirement, the licensee must remove the person from the approved list as soon as possible, but no later than seven working days, and take prompt measures to ensure that the individual is unable to have unescorted access to the material.

Subp. 6. **Procedures.** Licensees must develop, implement, and maintain written procedures for implementing the access authorization program. The procedures must include provisions for the notification of individuals who are denied unescorted access. The procedures must include provisions for the review, at the request of the affected individual, of a denial or termination of unescorted access authorization. The procedures must contain a provision to ensure that the individual is informed of the grounds for the denial or termination of unescorted access authorization and allow the individual an opportunity to provide additional relevant information.

Subp. 7. **Right to correct and complete information.**

A. Prior to any final adverse determination, licensees must provide each individual subject to parts 4731.8010 to 4731.8040 with the right to complete, correct, and explain information obtained as a result of the licensee's background investigation. Confirmation of receipt by the individual of this notification must be maintained by the licensee for a period of one year from the date of the notification.

B. If, after reviewing a criminal history record, an individual believes that it is incorrect or incomplete in any respect and wishes to change, correct, update, or explain anything in the record, the individual may initiate challenge procedures. These procedures include direct application by the individual challenging the record to the law enforcement agency that contributed the questioned information or a direct challenge as to the accuracy or completeness of any entry on the criminal history record and must be sent to the Federal Bureau of Investigation, Criminal Justice Information Services (CJIS) Division, ATTN: SCU, Mod. D-2, 1000 Custer Hollow Road, Clarksburg, WV 26306, as specified in Code of Federal Regulations, title 28, sections 16.30 to 16.34. In the latter case, the Federal Bureau of Investigation (FBI) will forward the challenge to the agency that submitted the data, and will request that the agency verify or correct the challenged entry. Upon receipt of an official communication directly from the agency that contributed the original information, the FBI Identification Division makes any changes necessary according to the information supplied by that agency. Licensees must provide at least ten days for an individual to initiate action to challenge the results of an FBI criminal history records check after the individual has reviewed the criminal history record. The licensee shall make a final adverse determination based upon the criminal history records only after receipt of the FBI's confirmation or correction of the record.

Subp. 8. **Records.**

A. The licensee must retain documentation regarding the trustworthiness and reliability of individual employees for three years from the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material.

B. The licensee must retain a copy of the current access authorization program procedures as a record for three years after the procedure is no longer needed. If any portion of the procedure is superseded, the licensee must retain the superseded material for three years after the record is superseded.

C. The licensee must retain the list of persons approved for unescorted access authorization for three years after the list is superseded or replaced.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 46 SR 791*

Published Electronically: *May 26, 2022*

4731.8020 BACKGROUND INVESTIGATIONS.

Subpart 1. **Initial investigation.**

A. Before allowing an individual unescorted access to category 1 or category 2 quantities of radioactive material or to the devices that contain the material, licensees must complete a background investigation of the individual seeking unescorted access authorization. The scope of the investigation must encompass at least the seven years preceding the date of the background investigation or since the individual's 18th birthday, whichever is shorter. The background investigation must include, at a minimum:

(1) fingerprinting and an FBI identification and criminal history records check under part 4731.8025;

(2) verification of true identity. Licensees must verify the true identity of the individual who is applying for unescorted access authorization to ensure that the applicant is who he or she claims to be. A licensee must review official identification documents such as driver's license, passport, government identification, and certificate of birth issued by the state, province, or country of birth and compare the documents to personal information data provided by the individual to identify any discrepancy in the information. Licensees must document the type, expiration, and identification number of the identification document, or maintain a photocopy of identifying documents on file in accordance with part 4731.8035. Licensees must certify in writing that the identification was properly reviewed and must maintain the certification and all related documents for review upon inspection;

(3) employment history verification. Licensees must complete an employment history verification, including military history. Licensees must verify the individual's employment with each previous employer for the most recent seven years before the date of application;

(4) verification of education. Licensees must verify that the individual participated in the education process during the claimed period;

(5) character and reputation determination. Licensees must complete reference checks to determine the character and reputation of the individual who has applied for unescorted access authorization. Unless other references are not available, reference checks may not be conducted with any person who is known to be a close member of the individual's family including, but not limited to, the individual's spouse, parents, siblings, or children, or any individual who resides in the individual's permanent household. Reference checks under parts 4731.8010 to 4731.8040 must be limited to whether the individual has been and continues to be trustworthy and reliable;

(6) the licensee must also, to the extent possible, obtain independent information to corroborate that provided by the individual, such as seeking references not supplied by the individual; and

B. If a previous employer, educational institution, or any other entity with which the individual claims to have been engaged fails to provide information or indicates an inability or unwillingness to provide information within a time frame deemed appropriate by the licensee, but at least after ten business days of the request, or if the licensee is unable to reach the entity, the licensee must document the refusal, unwillingness, or inability in the record of investigation; and attempt to obtain the information from an alternate source.

Subp. 2. **Grandfathering.**

A. Individuals who have been determined to be trustworthy and reliable for unescorted access to category 1 or category 2 quantities of radioactive material under a Fingerprint Order may continue to have unescorted access to category 1 and category 2 quantities of radioactive material without further investigation. These individuals must be subject to the reinvestigation requirement under subpart 3.

B. Individuals who have been determined to be trustworthy and reliable under the provisions of Code of Federal Regulations, title 10, part 73, or the security orders for access to safeguards information, safeguards information-modified handling, or risk-significant material may have unescorted access to category 1 and category 2 quantities of radioactive material without further investigation. The licensee must document that the individual was determined to be trustworthy and reliable under the provisions of Code of Federal Regulations, title 10, part 73, or a security order. Security order, in this context, refers to any order that was issued by the NRC that required fingerprints and an FBI criminal history records check for access to safeguards information, safeguards information-modified handling, or risk-significant material such as special nuclear material or large quantities of uranium hexafluoride. These individuals must be subject to the reinvestigation requirement under subpart 3.

Subp. 3. **Reinvestigations.** Licensees must conduct a reinvestigation every ten years for any individual with unescorted access to category 1 or category 2 quantities of radioactive material. The reinvestigation must consist of fingerprinting and an FBI identification and criminal history records check in accordance with part 4731.8025. The reinvestigations must be completed within ten years of the date on which these elements were last completed.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8025 REQUIREMENTS FOR CRIMINAL HISTORY RECORDS CHECKS OF INDIVIDUALS GRANTED UNESCORTED ACCESS TO CATEGORY 1 OR CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL.

Subpart 1. **General performance objective and requirements.**

A. Except for those individuals listed in part 4731.8030 and those individuals grandfathered under part 4731.8020, subpart 2, each licensee subject to the provisions of parts 4731.8010 to 4731.8040 must fingerprint each individual who is to be permitted unescorted access to category 1 or category 2 quantities of radioactive material. Licensees must transmit all collected fingerprints to the NRC for transmission to the FBI. The licensee must use the information received from the FBI as part of the required background investigation to determine whether to grant or deny further unescorted access to category 1 or category 2 quantities of radioactive materials for that individual.

B. The licensee must notify each affected individual that fingerprints are used to secure a review of the individual's criminal history record, and must inform the individual of the procedures for revising the record or adding explanations to the record.

C. Fingerprinting is not required if a licensee is reinstating an individual's unescorted access authorization to category 1 or category 2 quantities of radioactive materials if:

(1) the individual returns to the same facility that granted unescorted access authorization within 365 days of the termination of the individual's unescorted access authorization; and

(2) the previous access was terminated under favorable conditions.

D. Fingerprints do not need to be taken if an individual who is an employee of a licensee, contractor, manufacturer, or supplier has been granted unescorted access to category 1 or category 2 quantities of radioactive material, access to safeguards information, or safeguards information-modified handling by another licensee, based upon a background investigation conducted under parts 4731.8010 to 4731.8040, the Fingerprint Orders, or Code of Federal Regulations, title 10, part 73. An existing criminal history records check file may be transferred to the licensee asked to grant unescorted access in accordance with the provisions of part 4731.8035, item C.

E. Licensees must use the information obtained as part of a criminal history records check solely for the purpose of determining an individual's suitability for unescorted access authorization to category 1 or category 2 quantities of radioactive materials, access to safeguards information, or safeguards information-modified handling.

Subp. 2. **Prohibitions.**

A. Licensees shall not base a final determination to deny an individual unescorted access authorization to category 1 or category 2 quantities of radioactive material solely on the basis of information received from the FBI involving:

(1) an arrest more than one year old for which there is no information of the disposition of the case; or

(2) an arrest that resulted in dismissal of the charge or an acquittal.

B. Licensees shall not use information received from a criminal history records check obtained under parts 4731.8010 to 4731.8040 in a manner that would infringe upon the rights of any individual under the First Amendment to the Constitution of the United States, nor shall licensees use the information in any way that would discriminate among individuals on the basis of race, religion, national origin, gender, or age.

Subp. 3. **Procedures for processing of fingerprint checks.**

A. For the purpose of complying with parts 4731.8010 to 4731.8040, licensees must submit to the U.S. Nuclear Regulatory Commission, Director, Division of Physical and Cyber Security Policy, 11545 Rockville Pike, ATTN: Criminal History Program/Mail Stop T-07D04M, Rockville, MD 20852, one completed, legible standard fingerprint card (Form FD-258, ORIMDNRCOOOZ), electronic fingerprint scan or, where practicable, other fingerprint record for each individual requiring unescorted access to category 1 or category 2 quantities of radioactive material. Copies of these forms may be obtained by emailing MAILSVS.Resource@nrc.gov. Guidance on submitting electronic fingerprints can be found at https://www.nrc.gov/security/chp.html.

B. Fees for the processing of fingerprint checks are due upon application. Licensees must submit payment with the application for the processing of fingerprints through corporate check, certified check, cashier's check, money order, or electronic payment, made payable to "U.S. NRC." For guidance on making electronic payments, contact the, Division of Physical and Cyber Security Policy by emailing crimhist.resource@nrc.gov. Combined payment for multiple applications is acceptable. The NRC publishes the amount of the fingerprint check application fee on the NRC public website. To find the current fee amount, go to the Licensee Criminal History Records Checks

& Firearms Background Check information page at https://www.nrc.gov/security/chp.html and see the link for "How do I determine how much to pay for the request?".

C. The commission must forward to the submitting licensee all data received from the FBI as a result of the licensee's applications for criminal history records checks.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 44 SR 239; 46 SR 791; 49 SR 1193*
Published Electronically: *May 28, 2025*

4731.8030 RELIEF FROM FINGERPRINTING, IDENTIFICATION, AND CRIMINAL HISTORY RECORDS CHECKS AND OTHER ELEMENTS OF BACKGROUND INVESTIGATIONS.

Subpart 1. **Exemption to certain security checks.** Fingerprinting, and the identification and criminal history records checks required by section 149 of the Atomic Energy Act of 1954, as amended, and other elements of the background investigation are not required for the following individuals prior to granting unescorted access to category 1 or category 2 quantities of radioactive materials:

A. an employee of the commission or of the Executive Branch of the U.S. government who has undergone fingerprinting for a prior U.S. government criminal history records check;

B. a member of Congress;

C. an employee of a member of Congress or a congressional committee who has undergone fingerprinting for a prior U.S. government criminal history records check;

D. the governor of a state or the governor's designated state employee representative;

E. federal, state, or local law enforcement personnel;

F. state radiation control program directors and state homeland security advisors or their designated state employee representatives;

G. agreement state employees conducting security inspections on behalf of the NRC under an agreement executed under section 274.i. of the Atomic Energy Act;

H. representatives of the International Atomic Energy Agency (IAEA) engaged in activities associated with the U.S./IAEA Safeguards Agreement who have been certified by the NRC;

I. emergency response personnel who are responding to an emergency;

J. commercial vehicle drivers for road shipments of category 1 and category 2 quantities of radioactive material;

K. package handlers at transportation facilities such as freight terminals and railroad yards;

L. any individual who has an active federal security clearance, provided that the individual makes available the appropriate documentation. Written confirmation from the agency/employer

that granted the federal security clearance or reviewed the criminal history records check must be provided to the licensee. The licensee must retain this documentation for a period of three years from the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material; and

M. any individual employed by a service provider licensee for which the service provider licensee has conducted the background investigation for the individual and approved the individual for unescorted access to category 1 or category 2 quantities of radioactive material. Written verification from the service provider must be provided to the licensee. The licensee must retain the documentation for a period of three years from the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material.

Subp. 2. **Additional exemption.** Fingerprinting, and the identification and criminal history records checks required by section 149 of the Atomic Energy Act of 1954, as amended, are not required for an individual who has had a favorably adjudicated U.S. government criminal history records check within the last five years, under a comparable U.S. government program involving fingerprinting and an FBI identification and criminal history records check provided that the individual makes available the appropriate documentation. Written confirmation from the agency/employer that reviewed the criminal history records check must be provided to the licensee. The licensee must retain this documentation for a period of three years from the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material. These programs include, but are not limited to:

A. national agency check;

B. Transportation Worker Identification Credentials (TWIC) under Code of Federal Regulations, title 49, part 1572;

C. Bureau of Alcohol, Tobacco, Firearms, and Explosives background check and clearances under Code of Federal Regulations, title 27, part 555;

D. Health and Human Services security risk assessments for possession and use of select agents and toxins under Code of Federal Regulations, title 42, part 73;

E. hazardous material security threat assessment for hazardous material endorsement to commercial driver's license under Code of Federal Regulations, title 49, part 1572; and

F. Customs and Border Protection's Free and Secure Trade (FAST) Program.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 44 SR 239*

Published Electronically: *September 13, 2019*

4731.8035 PROTECTION OF INFORMATION.

A. Each licensee who obtains background information on an individual under parts 4731.8010 to 4731.8040 must establish and maintain a system of files and written procedures for protection of the record and the personal information from unauthorized disclosure.

B. The licensee shall not disclose the record or personal information collected and maintained to persons other than the subject individual, the individual's representative, or to those who have a need to have access to the information in performing assigned duties in the process of granting or denying unescorted access to category 1 or category 2 quantities of radioactive material, safeguards information, or safeguards information-modified handling. No individual authorized to have access to the information shall disseminate the information to any other individual who does not have a need to know.

C. The personal information obtained on an individual from a background investigation may be provided to another licensee:

(1) upon the individual's written request to the licensee holding the data to disseminate the information contained in the individual's file; and

(2) when the recipient licensee verifies information such as name, date of birth, Social Security number, gender, and other applicable physical characteristics.

D. The licensee must make background investigation records obtained under parts 4731.8010 to 4731.8040 available for examination by an authorized representative of the commissioner to determine compliance with the regulations and laws.

E. The licensee must retain all fingerprint and criminal history records received from the FBI, including data indicating no record, or a copy of these records if the individual's file has been transferred, on an individual for three years from the date the individual no longer requires unescorted access to category 1 or category 2 quantities of radioactive material.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8040 ACCESS AUTHORIZATION PROGRAM REVIEW.

A. Each licensee must be responsible for the continuing effectiveness of the access authorization program. Each licensee must ensure that access authorization programs are reviewed to confirm compliance with the requirements of parts 4731.8010 to 4731.8040 and that comprehensive actions are taken to correct any noncompliance that is identified. The review program must evaluate all program performance objectives and requirements. Each licensee must at least annually review the access program content and implementation.

B. The results of the reviews, along with any recommendations, must be documented. Each review report must identify conditions that are adverse to the proper performance of the access authorization program, the cause of the conditions, and, when appropriate, recommend corrective actions, and corrective actions taken. The licensee must review the findings and take any additional corrective actions necessary to preclude repetition of the condition, including reassessment of the deficient areas where indicated.

C. Review records must be maintained for three years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8050 SECURITY PROGRAM.

Subpart 1. **Applicability.**

A. Each licensee that possesses an aggregated category 1 or category 2 quantity of radioactive material must establish, implement, and maintain a security program in accordance with the requirements of parts 4731.8050 to 4731.8090.

B. An applicant for a new license and each licensee that would become newly subject to the requirements of parts 4731.8050 to 4731.8090 upon application for modification of its license must implement the requirements of parts 4731.8050 to 4731.8090, as appropriate, before taking possession of an aggregated category 1 or category 2 quantity of radioactive material.

C. Any licensee that has not previously implemented the security orders or been subject to the provisions of parts 4731.8050 to 4731.8090 must provide written notification to the commissioner at least 90 days before aggregating radioactive material to a quantity that equals or exceeds the category 2 threshold.

Subp. 2. **General performance objective.** Each licensee must establish, implement, and maintain a security program that is designed to monitor and, without delay, detect, assess, and respond to an actual or attempted unauthorized access to category 1 or category 2 quantities of radioactive material.

Subp. 3. **Program features.** Each licensee's security program must include the program features, as appropriate, described in parts 4731.8055 to 4731.8085.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8055 GENERAL SECURITY PROGRAM REQUIREMENTS.

Subpart 1. **Security plan.**

A. Each licensee identified in part 4731.8050 must develop a written security plan specific to its facilities and operations. The purpose of the security plan is to establish the licensee's overall security strategy to ensure the integrated and effective functioning of the security program required by parts 4731.8050 to 4731.8090. The security plan must, at a minimum:

(1) describe the measures and strategies used to implement the requirements of parts 4731.8050 to 4731.8090; and

(2) identify the security resources, equipment, and technology used to satisfy the requirements of parts 4731.8050 to 4731.8090.

B. The security plan must be reviewed and approved by the individual with overall responsibility for the security program.

C. A licensee must revise its security plan as necessary to ensure the effective implementation of commissioner requirements. The licensee must ensure that:

(1) the revision has been reviewed and approved by the individual with overall responsibility for the security program; and

(2) the affected individuals are instructed on the revised plan before the changes are implemented.

D. The licensee must retain a copy of the current security plan as a record for three years after the security plan is no longer required. If any portion of the plan is superseded, the licensee must retain the superseded material for three years after the record is superseded.

Subp. 2. **Implementing procedures.**

A. The licensee must develop and maintain written procedures that document how the requirements of parts 4731.8050 to 4731.8090 and the security plan will be met.

B. The implementing procedures and revisions to these procedures must be approved in writing by the individual with overall responsibility for the security program.

C. The licensee must retain a copy of the current procedure as a record for three years after the procedure is no longer needed. Superseded portions of the procedure must be retained for three years after the record is superseded.

Subp. 3. **Training.**

A. Each licensee must conduct training to ensure that those individuals implementing the security program possess and maintain the knowledge, skills, and abilities to carry out their assigned duties and responsibilities effectively. The training must include instruction in:

(1) the licensee's security program and procedures to secure category 1 or category 2 quantities of radioactive material, and in the purposes and functions of the security measures employed;

(2) the responsibility to report promptly to the licensee any condition that causes or may cause a violation of commissioner requirements;

(3) the responsibility of the licensee to report promptly to the local law enforcement agency and licensee any actual or attempted theft, sabotage, or diversion of category 1 or category 2 quantities of radioactive material; and

(4) the appropriate response to security alarms.

B. In determining those individuals who must be trained on the security program, the licensee must consider each individual's assigned activities during authorized use and response to potential situations involving actual or attempted theft, diversion, or sabotage of category 1 or

category 2 quantities of radioactive material. The extent of the training must be commensurate with the individual's potential involvement in the security of category 1 or category 2 quantities of radioactive material.

C. Refresher training must be provided at a frequency not to exceed 12 months and when significant changes have been made to the security program. This training must include:

(1) review of the training requirements of this subpart and any changes made to the security program since the last training;

(2) reports on any relevant security issues, problems, and lessons learned;

(3) relevant results of commissioner inspections; and

(4) relevant results of the licensee's program review and testing and maintenance.

D. The licensee must maintain records of the initial and refresher training for three years from the date of the training. The training records must include dates of the training, topics covered, a list of licensee personnel in attendance, and related information.

Subp. 4. **Protection of information.**

A. Licensees authorized to possess category 1 or category 2 quantities of radioactive material must limit access to and unauthorized disclosure of their security plan, implementing procedures, and the list of individuals that have been approved for unescorted access.

B. Efforts to limit access must include the development, implementation, and maintenance of written policies and procedures for controlling access to, and for proper handling and protection against unauthorized disclosure of, the security plan, implementing procedures, and the list of individuals that have been approved for unescorted access.

C. Before granting an individual access to the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access, licensees must:

(1) evaluate an individual's need to know the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access; and

(2) if the individual has not been authorized for unescorted access to category 1 or category 2 quantities of radioactive material, safeguards information, or safeguards information-modified handling, the licensee must complete a background investigation to determine the individual's trustworthiness and reliability. A trustworthiness and reliability determination must be conducted by the reviewing official and must include the background investigation elements contained in part 4731.8020, subpart 1, item A, subitems (2) to (6), and item B.

D. Licensees need not subject the following individuals to the background investigation elements for protection of information:

(1) the categories of individuals listed in part 4731.8030, subpart 1, items A to M; or

(2) security service provider employees, provided written verification that the employee has been determined to be trustworthy and reliable, by the required background investigation in part 4731.8020, subpart 1, item A, subitems (2) to (6), and item B, has been provided by the security service provider.

E. The licensee must document the basis for concluding that an individual is trustworthy and reliable in order to be granted access to the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access.

F. Licensees must maintain a list of persons currently approved for access to the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access. When a licensee determines that a person no longer needs access to the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access, or no longer meets the access authorization requirements for access to the information, the licensee must remove the person from the approved list as soon as possible, but no later than seven working days, and take prompt measures to ensure that the individual is unable to obtain the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access.

G. When not in use, the licensee must store its security plan, implementing procedures, and the list of individuals that have been approved for unescorted access in a manner to prevent unauthorized access. Information stored in nonremovable electronic form must be password protected.

H. The licensee must retain as a record for three years after the document is no longer needed:

(1) a copy of the information protection procedures; and

(2) the list of individuals approved for access to the security plan, implementing procedures, or the list of individuals that have been approved for unescorted access.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 46 SR 791*

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4731.8060 LOCAL LAW ENFORCEMENT AGENCY (LLEA) COORDINATION.

A. A licensee subject to parts 4731.8050 to 4731.8090 must coordinate, to the extent practicable, with an LLEA for responding to threats to the licensee's facility, including any necessary armed response. The information provided to the LLEA must include:

(1) a description of the facilities and the category 1 and category 2 quantities of radioactive materials along with a description of the licensee's security measures that have been implemented to comply with parts 4731.8050 to 4731.8090; and

(2) a notification that the licensee shall request a timely armed response by the LLEA to any actual or attempted theft, sabotage, or diversion of category 1 or category 2 quantities of material.

B. The licensee must notify the commissioner within three business days if:

(1) the LLEA has not responded to the request for coordination within 60 days of the coordination request; or

(2) the LLEA notifies the licensee that the LLEA does not plan to participate in coordination activities.

C. The licensee must document its efforts to coordinate with the LLEA. The documentation must be kept for three years.

D. The licensee must coordinate with the LLEA at least every 12 months, or when changes to the facility design or operation adversely affect the potential vulnerability of the licensee's material to theft, sabotage, or diversion.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8065 SECURITY ZONES.

A. Licensees must ensure that all aggregated category 1 and category 2 quantities of radioactive material are used or stored within licensee-established security zones. Security zones may be permanent or temporary.

B. Temporary security zones must be established as necessary to meet the licensee's transitory or intermittent business activities, such as periods of maintenance, source delivery, and source replacement.

C. Security zones must, at a minimum, allow unescorted access only to approved individuals through:

(1) isolation of category 1 and category 2 quantities of radioactive materials by the use of continuous physical barriers that allow access to the security zone only through established access control points. A physical barrier is a natural or man-made structure or formation sufficient for the isolation of the category 1 or category 2 quantities of radioactive material within a security zone; or

(2) direct control of the security zone by approved individuals at all times; or

(3) a combination of continuous physical barriers and direct control.

D. For category 1 quantities of radioactive material during periods of maintenance, source receipt, preparation for shipment, installation, or source removal or exchange, the licensee must, at a minimum, provide sufficient individuals approved for unescorted access to maintain continuous surveillance of sources in temporary security zones and in any security zone in which physical barriers or intrusion detection systems have been disabled to allow such activities.

E. Individuals not approved for unescorted access to category 1 or category 2 quantities of radioactive material must be escorted by an approved individual when in a security zone.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

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4731.8070 MONITORING, DETECTION, AND ASSESSMENT.

Subpart 1. **Monitoring and detection.**

A. Licensees must establish and maintain the capability to continuously monitor and detect without delay all unauthorized entries into its security zones. Licensees must provide the means to maintain continuous monitoring and detection capability in the event of a loss of the primary power source, or provide for an alarm and response in the event of a loss of this capability to continuously monitor and detect unauthorized entries.

B. Monitoring and detection must be performed by:

(1) a monitored intrusion detection system that is linked to an on-site or off-site central monitoring facility;

(2) electronic devices for intrusion detection alarms that will alert nearby facility personnel;

(3) a monitored video surveillance system;

(4) direct visual surveillance by approved individuals located within the security zone; or

(5) direct visual surveillance by a licensee designated individual located outside the security zone.

C. A licensee subject to parts 4731.8050 to 4731.8090 must also have a means to detect unauthorized removal of the radioactive material from the security zone. This detection capability must provide:

(1) for category 1 quantities of radioactive material, immediate detection of any attempted unauthorized removal of the radioactive material from the security zone. Such immediate detection capability must be provided by:

(a) electronic sensors linked to an alarm;

(b) continuous monitored video surveillance; or

(c) direct visual surveillance; or

(2) for category 2 quantities of radioactive material, weekly verification through physical checks, tamper-indicating devices, use, or other means to ensure that the radioactive material is present.

Subp. 2. **Assessment.** Licensees must immediately assess each actual or attempted unauthorized entry into the security zone to determine whether the unauthorized access was an actual or attempted theft, sabotage, or diversion.

Subp. 3. **Personnel communications and data transmission.** For personnel and automated or electronic systems supporting the licensee's monitoring, detection, and assessment systems, licensees must:

A. maintain continuous capability for personnel communication and electronic data transmission and processing among site security systems; and

B. provide an alternative communication capability for personnel, and an alternative data transmission and processing capability, in the event of a loss of the primary means of communication or data transmission and processing. Alternative communications and data transmission systems may not be subject to the same failure modes as the primary systems.

Subp. 4. **Response.** Licensees must immediately respond to any actual or attempted unauthorized access to the security zones, or actual or attempted theft, sabotage, or diversion of category 1 or category 2 quantities of radioactive material at licensee facilities or temporary job sites. For any unauthorized access involving an actual or attempted theft, sabotage, or diversion of category 1 or category 2 quantities of radioactive material, the licensee's response must include requesting, without delay, an armed response from the LLEA.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8075 MAINTENANCE AND TESTING.

A. Each licensee subject to parts 4731.8050 to 4731.8090 must implement a maintenance and testing program to ensure that intrusion alarms, associated communication systems, and other physical components of the systems used to secure or detect unauthorized access to radioactive material are maintained in operable condition and are capable of performing their intended function when needed. The equipment relied on to meet the security requirements of this part must be inspected and tested for operability and performance at the manufacturer's suggested frequency. If there is no suggested manufacturer's suggested frequency, the testing must be performed at least annually, not to exceed 12 months.

B. The licensee must maintain records on the maintenance and testing activities for three years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8080 REQUIREMENTS FOR MOBILE DEVICES.

Each licensee that possesses mobile devices containing category 1 or category 2 quantities of radioactive material must:

A. have two independent physical controls that form tangible barriers to secure the material from unauthorized removal when the device is not under direct control and constant surveillance by the licensee; and

B. for devices in or on a vehicle or trailer, unless the health and safety requirements for a site prohibit the disabling of the vehicle, the licensee must utilize a method to disable the vehicle or trailer when not under direct control and constant surveillance by the licensee. Licensees must not rely on the removal of an ignition key to meet this requirement.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*
Published Electronically: *August 27, 2015*

4731.8085 SECURITY PROGRAM REVIEW.

A. Each licensee must be responsible for the continuing effectiveness of the security program. Each licensee must ensure that the security program is reviewed to confirm compliance with the requirements of parts 4731.8050 to 4731.8090 and that comprehensive actions are taken to correct any noncompliance that is identified. The review must include the radioactive material security program content and implementation. Each licensee must, at least annually, review the security program content and implementation.

B. The results of the review, along with any recommendations, must be documented. Each review report must identify conditions that are adverse to the proper performance of the security program, the cause of the conditions, and, when appropriate, recommend corrective actions, and any corrective actions taken. The licensee must review the findings and take any additional corrective actions necessary to preclude repetition of the condition, including reassessment of the deficient areas where indicated.

C. The licensee must maintain the review documentation for three years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*
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4731.8090 REPORTING OF EVENTS.

A. The licensee must immediately notify the local law enforcement agency (LLEA) after determining that an unauthorized entry resulted in an actual or attempted theft, sabotage, or diversion of a category 1 or category 2 quantity of radioactive material. As soon as possible after initiating a response, but not at the expense of causing delay or interfering with the LLEA response to the

event, the licensee must notify the commissioner. In no case shall the notification to the commissioner be later than four hours after the discovery of any attempted or actual theft, sabotage, or diversion.

B. The licensee must assess any suspicious activity related to possible theft, sabotage, or diversion of category 1 or category 2 quantities of radioactive material and notify the LLEA as appropriate. As soon as possible, but not later than four hours after notifying the LLEA, the licensee must notify the commissioner.

C. The initial telephone notification required by item A must be followed within 30 days by a written report submitted to the commissioner. The report must include sufficient information for the commissioner's analysis and evaluation, including identification of any necessary corrective actions to prevent future instances.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

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4731.8100 ADDITIONAL REQUIREMENTS FOR TRANSFER OF CATEGORY 1 AND CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL.

A licensee transferring a category 1 or category 2 quantity of radioactive material to a licensee of the commissioner, the NRC, or an agreement state must meet the license verification provisions of this part instead of those listed in part 4731.3105, subpart 3.

A. Any licensee transferring category 1 quantities of radioactive material to a licensee of the commissioner, the NRC, or an agreement state, prior to conducting the transfer, must verify with the NRC's license verification system or the license-issuing authority that the transferee's license authorizes the receipt of the type, form, and quantity of radioactive material to be transferred and that the licensee is authorized to receive radioactive material at the location requested for delivery. If the verification is conducted by contacting the license-issuing authority, the transferor must document the verification. For transfers within the same organization, the licensee does not need to verify the transfer.

B. Any licensee transferring category 2 quantities of radioactive material to a licensee of the commissioner, the NRC, or an agreement state, prior to conducting the transfer, must verify with the NRC's license verification system or the license-issuing authority that the transferee's license authorizes the receipt of the type, form, and quantity of radioactive material to be transferred. If the verification is conducted by contacting the license-issuing authority, the transferor must document the verification. For transfers within the same organization, the licensee does not need to verify the transfer.

C. In an emergency where the licensee cannot reach the license-issuing authority and the license verification system is nonfunctional, the licensee may accept a written certification by the transferee that it is authorized by license to receive the type, form, and quantity of radioactive material to be transferred. The certification must include the license number, current revision number, issuing agency, expiration date, and, for a category 1 shipment, the authorized address.

The licensee must keep a copy of the certification. The certification must be confirmed by use of the NRC's license verification system or by contacting the license-issuing authority by the end of the next business day.

D. The transferor must keep a copy of the verification documentation as a record for three years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 44 SR 239*

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4731.8105 APPLICABILITY OF PHYSICAL PROTECTION OF CATEGORY 1 AND CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL DURING TRANSIT.

The shipping licensee must meet the requirements of parts 4731.8100 to 4731.8125 unless the receiving licensee has agreed in writing to arrange for the in-transit physical protection required under parts 4731.8100 to 4731.8125.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8110 PREPLANNING AND COORDINATION OF SHIPMENT OF CATEGORY 1 OR CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL.

A. Each licensee that plans to transport, or deliver to a carrier for transport, licensed material that is a category 1 quantity of radioactive material outside the confines of the licensee's facility or other place of use or storage must:

(1) preplan and coordinate shipment arrival and departure times with the receiving licensee;

(2) preplan and coordinate shipment information with the governor or the governor's designee of any state through which the shipment will pass to:

(a) discuss the state's intention to provide law enforcement escorts; and

(b) identify safe havens; and

(3) document the preplanning and coordination activities.

B. Each licensee that plans to transport, or deliver to a carrier for transport, licensed material that is a category 2 quantity of radioactive material outside the confines of the licensee's facility or other place of use or storage must coordinate the shipment no-later-than arrival time and the expected shipment arrival with the receiving licensee. The licensee must document the coordination activities.

C. Each licensee who receives a shipment of a category 2 quantity of radioactive material must confirm receipt of the shipment with the originator. If the shipment has not arrived by the no-later-than arrival time, the receiving licensee must notify the originator.

D. Each licensee who transports or plans to transport a shipment of a category 2 quantity of radioactive material, and determines that the shipment will arrive after the no-later-than arrival time provided in item B must promptly notify the receiving licensee of the new no-later-than arrival time.

E. The licensee must retain a copy of the documentation for preplanning and coordination, and any revision thereof, as a record for three years.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8115 ADVANCE NOTIFICATION OF SHIPMENT OF CATEGORY 1 QUANTITIES OF RADIOACTIVE MATERIAL.

Subpart 1. **Advanced notification required.** As specified in subparts 2 and 3, each licensee must provide advance notification to the commissioner and the governor of a state, or the governor's designee, of the shipment of licensed material in a category 1 quantity, through or across the boundary of the state, before the transport or delivery to a carrier for transport of the licensed material outside the confines of the licensee's facility or other place of use or storage.

Subp. 2. **Procedures for submitting advance notification.**

A. The notification must be made to the commissioner and to the office of each appropriate governor or governor's designee. The contact information, including telephone numbers and mailing addresses, of governors and governors' designees, is available on the NRC website at https://scp.nrc.gov/special/designee.pdf. A list of the contact information is also available upon request from the Director, Division of Materials Safety, Security, State, and Tribal Programs, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Notifications to the commissioner must be to the Radioactive Materials Unit, Minnesota Department of Health, 625 Robert Street N, P.O. Box 64975, St. Paul, MN 55164-0975, or email at health.ram@state.mn.us.

B. A notification delivered by mail must be postmarked at least seven days before transport of the shipment commences at the shipping facility.

C. A notification delivered by any means other than mail must reach the commissioner at least four days before the transport of the shipment commences and must reach the office of the governor or the governor's designee at least four days before transport of a shipment within or through the state.

Subp. 3. **Information to be furnished in advance notification of shipment.** Each advance notification of shipment of category 1 quantities of radioactive material must contain the following information, if available at the time of notification:

A. the name, address, and telephone number of the shipper, carrier, and receiver of the category 1 radioactive material;

B. the license numbers of the shipper and receiver;

C. a description of the radioactive material contained in the shipment, including the radionuclides and quantity;

D. the point of origin of the shipment and the estimated time and date that shipment will commence;

E. the estimated time and date that the shipment is expected to enter each state along the route;

F. the estimated time and date of arrival of the shipment at the destination; and

G. a point of contact, with a telephone number, for current shipment information.

Subp. 4. **Revision notice.**

A. The licensee must provide any information not previously available at the time of the initial notification, as soon as the information becomes available but not later than commencement of the shipment, to the governor of the state or the governor's designee and to the commissioner.

B. A licensee must promptly notify the governor of the state or the governor's designee of any changes to the information provided under item A and subpart 3. The licensee must also immediately notify the commissioner of any such changes.

Subp. 5. **Cancellation notice.** Each licensee who cancels a shipment for which advance notification has been sent must send a cancellation notice to the commissioner and to the governor of each state or to the governor's designee previously notified. The licensee must send the cancellation notice before the shipment would have commenced or as soon thereafter as possible. The licensee must state in the notice that it is a cancellation and identify the advance notification that is being canceled.

Subp. 6. **Records.** The licensee must retain a copy of the advance notification and any revision and cancellation notices as a record for three years.

Subp. 7. **Protection of information.** State officials, state employees, and other individuals, whether or not licensees of the commissioner, the NRC, or an agreement state, who receive schedule information of the kind specified in subpart 3 must protect that information against unauthorized disclosure as specified in part 4731.8055, subpart 4.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 44 SR 239; 46 SR 791*
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4731.8120 PHYSICAL PROTECTION OF CATEGORY 1 AND CATEGORY 2 QUANTITIES OF RADIOACTIVE MATERIAL DURING SHIPMENT.

Subpart 1. **Shipments by road.**

A. Each licensee who transports, or delivers to a carrier for transport, in a single shipment, a category 1 quantity of radioactive material, must:

(1) ensure that movement control centers are established that maintain position information from a remote location. These control centers must monitor shipments 24 hours a day, seven days a week, and have the ability to communicate immediately, in an emergency, with the appropriate law enforcement agencies;

(2) ensure that redundant communications are established that allow the transport to contact the escort vehicle when used and movement control center at all times. Redundant communications may not be subject to the same interference factors as the primary communication;

(3) ensure that shipments are continuously and actively monitored by a telemetric position monitoring system or an alternative tracking system reporting to a movement control center. A movement control center must provide positive confirmation of the location, status, and control over the shipment. The movement control center must be prepared to promptly implement preplanned procedures in response to deviations from the authorized route or a notification of actual, attempted, or suspicious activities related to the theft, loss, or diversion of a shipment. These procedures shall include, but not be limited to, the identification of and contact information for the appropriate LLEA along the shipment route;

(4) provide an individual to accompany the driver for those highway shipments with a driving time period greater than the maximum number of allowable hours of service in a 24-hour duty day as established by the Department of Transportation Federal Motor Carrier Safety Administration. The accompanying individual may be another driver;

(5) develop written normal and contingency procedures to address:

(a) notifications to the communication center and law enforcement agencies;

(b) communication protocols that must include a strategy for the use of authentication codes and duress codes and provisions for refueling or other stops, detours, and locations where communication is expected to be temporarily lost;

(c) loss of communications; and

(d) responses to an actual or attempted theft or diversion of a shipment; and

(6) each licensee who makes arrangements for the shipment of category 1 quantities of radioactive material must ensure that drivers, accompanying personnel, and movement control center personnel have access to the normal and contingency procedures.

B. Each licensee who transports category 2 quantities of radioactive material must maintain constant control and/or surveillance during transit and have the capability for immediate communication to summon appropriate response or assistance.

C. Each licensee who delivers to a carrier for transport, in a single shipment, a category 2 quantity of radioactive material must:

(1) use carriers who have established package tracking systems. An established package tracking system is a documented, proven, and reliable system routinely used to transport objects of value. In order for a package tracking system to maintain constant control and/or surveillance, the package tracking system must allow the shipper or transporter to identify when and where the package was last and when it should arrive at the next point of control;

(2) use carriers who maintain constant control and/or surveillance during transit and have the capability for immediate communication to summon appropriate response or assistance; and

(3) use carriers who have established tracking systems that require an authorized signature prior to releasing the package for delivery or return.

Subp. 2. **Shipments by rail.**

A. Each licensee who transports, or delivers to a carrier for transport, in a single shipment a category 1 quantity of radioactive material must:

(1) ensure that rail shipments are monitored by a telemetric position monitoring system or an alternative tracking system reporting to the licensee, third-party, or railroad communications center. The communications center must provide positive confirmation of the location of the shipment and its status. The communications center must implement preplanned procedures in response to deviations from the authorized route or to a notification of actual, attempted, or suspicious activities related to the theft or diversion of a shipment. These procedures shall include, but not be limited to, the identification of and contact information for the appropriate LLEA along the shipment route; and

(2) ensure that periodic reports to the communications center are made at preset intervals.

B. Each licensee who transports, or delivers to a carrier for transport, in a single shipment a category 2 quantity of radioactive material must:

(1) use carriers who have established package tracking systems. An established package tracking system is a documented, proven, and reliable system routinely used to transport objects of value. In order for a package tracking system to maintain constant control and/or surveillance, the package tracking system must allow the shipper or transporter to identify when and where the package was last and when it should arrive at the next point of control;

(2) use carriers who maintain constant control and/or surveillance during transit and have the capability for immediate communication to summon appropriate response or assistance; and

(3) use carriers who have established tracking systems that require an authorized signature prior to releasing the package for delivery or return.

Subp. 3. **Investigations.** Each licensee who makes arrangements for the shipment of category 1 quantities of radioactive material must immediately conduct an investigation upon the discovery that a category 1 shipment is lost or missing. Each licensee who makes arrangements for the shipment of category 2 quantities of radioactive material must immediately conduct an investigation, in coordination with the receiving licensee, of any shipment that has not arrived by the designated no-later-than arrival time.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8125 REPORTING OF EVENTS.

A. The shipping licensee must notify the appropriate local law enforcement agency (LLEA) and the commissioner within one hour of its determination that a shipment of category 1 quantities of radioactive material is lost or missing. The appropriate LLEA is the law enforcement agency in the area of the shipment's last confirmed location. During the investigation required by part 4731.8120, subpart 3, the shipping licensee must provide agreed upon updates to the commissioner on the status of the investigation.

B. The shipping licensee must notify the commissioner within four hours of its determination that a shipment of category 2 quantities of radioactive material is lost or missing. If, after 24 hours of its determination that the shipment is lost or missing, the radioactive material has not been located and secured, the licensee must immediately notify the commissioner.

C. The shipping licensee must notify the designated LLEA along the shipment route as soon as possible upon discovery of any actual or attempted theft or diversion of a shipment or suspicious activities related to the theft or diversion of a shipment of a category 1 quantity of radioactive material. As soon as possible after notifying the LLEA, the licensee must notify the commissioner upon discovery of any actual or attempted theft or diversion of a shipment, or any suspicious activity related to the shipment of category 1 radioactive material.

D. The shipping licensee must notify the commissioner as soon as possible upon discovery of any actual or attempted theft or diversion of a shipment, or any suspicious activity related to the shipment, of a category 2 quantity of radioactive material.

E. The shipping licensee must notify the commissioner and the LLEA as soon as possible upon recovery of any lost or missing category 1 quantities of radioactive material.

F. The shipping licensee must notify the commissioner as soon as possible upon recovery of any lost or missing category 2 quantities of radioactive material.

G. The initial telephone notification required by items A to D must be followed within a period of 30 days by a written report submitted to the commissioner. The report must include:

(1) a description of the licensed material involved, including kind, quantity, and chemical and physical form;

(2) a description of the circumstances under which the loss or theft occurred;

(3) a statement of disposition, or probable disposition, of the licensed material involved;

(4) actions that have been taken, or will be taken, to recover the material; and

(5) procedures or measures that have been, or will be, adopted to ensure against a recurrence of the loss or theft of licensed material.

H. Subsequent to filing the written report, the licensee must also report any additional substantive information on the loss or theft within 30 days after the licensee learns of such information.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8130 FORM OF RECORDS.

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

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

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4731.8135 RECORD RETENTION.

Licensees must maintain the records that are required by parts 4731.8000 to 4731.8140 for the period specified by the applicable rule. If a retention period is not otherwise specified, these records must be retained until the commissioner terminates the facility's license. All records related to parts 4731.8000 to 4731.8140 may be destroyed upon termination of the license.

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145*

Published Electronically: *August 27, 2015*

4731.8140 CATEGORY 1 AND CATEGORY 2 RADIOACTIVE MATERIALS.

Subpart 1. **Table 1 - category 1 and category 2 threshold.** The Terabecquerel (TBq) values are the regulatory standard. The curie (Ci) values specified are obtained by converting from the TBq value. The Ci values are provided for practical usefulness only.

Radioactive material	Category 1 (TBq)	Category 1 (Ci)	Category 2 (TBq)	Category 2 (Ci)
Americium-241	60	1,620	0.6	16.2
Americium-241/Be	60	1,620	0.6	16.2
Californium-252	20	540	0.2	5.40
Cobalt-60	30	810	0.3	8.10
Curium-244	50	1,350	0.5	13.5
Cesium-137	100	2,700	1	27.0
Gadolinium-153	1,000	27,000	10	270
Iridium-192	80	2,160	0.8	21.6
Plutonium-238	60	1,620	0.6	16.2
Plutonium-239/Be	60	1,620	0.6	16.2
Promethium-147	40,000	1,080,000	400	10,800
Radium-226	40	1,080	0.4	10.8
Selenium-75	200	5,400	2	54.0
Strontium-90	1,000	27,000	10	270
Thulium-170	20,000	540,000	200	5,400
Ytterbium-169	300	8,100	3	81.0

Subp. 2. **Calculations concerning multiple sources or multiple radionuclides.** The "sum of fractions" methodology for evaluating combinations of multiple sources or multiple radionuclides, described in items A and B, is to be used in determining whether a location meets or exceeds the threshold and is thus subject to the requirements of parts 4731.8000 to 4731.8140.

A. If multiple sources of the same radionuclide and/or multiple radionuclides are aggregated at a location, the sum of the ratios of the total activity of each of the radionuclides must be determined to verify whether the activity at the location is less than the category 1 or category 2 thresholds of Table 1, as appropriate. If the calculated sum of the ratios, using the equation below, is greater than or equal to 1.0, then the applicable requirements of parts 4731.8000 to 4731.8140 apply.

B. First determine the total activity for each radionuclide from Table 1. This is done by adding the activity of each individual source, material in any device, and any loose or bulk material that contains the radionuclide. Then use the equation in this item to calculate the sum of the ratios by inserting the total activity of the applicable radionuclides from Table 1 in the numerator of the equation and the corresponding threshold activity from Table 1 in the denominator of the equation. Calculations must be performed in metric values (i.e., TBq) and the numerator and denominator values must be in the same units.

$$\frac{R1}{AR1} + \frac{R2}{AR2} + \cdots + \frac{Rn}{ARn} \geq 1.0$$

Where,

R1 = total activity for radionuclide 1

R2 = total activity for radionuclide 2

Rn = total activity for radionuclide n

AR1 = activity threshold for radionuclide 1

AR2 = activity threshold for radionuclide 2

ARn = activity threshold for radionuclide n

Statutory Authority: *MS s 144.1201; 144.1202; 144.1203; 144.1204; 144.1205*

History: *40 SR 145; 49 SR 1193*

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